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Research Application Summary

Adoption of cowpea bruchid control technologies in eastern Uganda

Nampala, P.[1] , Kongai, H.[2] , Kityo, R.[2,3], Bashaasha, B.[2], Oruka, B.[2], Mugisha, J.[2] & Adipala, E.[1]

[1]Regional Universities Forum for Capacity Building in Agriculture, P. O. Box 16811, Wandegeya, Kampala, Uganda
[2]College of Agriculture and Environmental Sciences, Makerere University, P. O. Box 7062, Kampala, Uganda
[3]Department of Agricultural Sciences, School of Natural Sciences, Bugema University, P. O. Box 6529, Kampala, Uganda
Corresponding author: p.nampala@ruforum.org

Abstract

Infestation and damage of stored cowpea (*Vigna unguiculata*) grain by bruchids (*Callosobruchus maculatus*) is a challenge to majority of farmers in drier parts of Uganda where the crop serves as a major source of vegetables especially during the dry season. Although several measures are being used to avert the problem, it remains apparent despite proven control strategies that have been disseminated. This study was undertaken to identify factors hindering adoption of cowpea bruchid control technologies; and was conducted in 2013 using a survey questionnaire in eastern Uganda with 160 farmers. Results revealed that key variables including lack of inputs, labour limitation, lack of capital, lack of market, high input costs, transport limitation and lack of information on recommended bruchid control technologies significantly constrained the adoption of cowpea bruchid control technologies. Lack of inputs had the highest (80%), while transport limitation was the least considered (6.3%). Thus, non-adoption and/ or partial adoption could be attributed to several factors which demonstrate that it takes more than effective technologies in postharvest handling to secure adoption. Uptake pathways should take these factors into consideration.

Key words: Adoption, *Callosobruchus maculatus, Vigna unguiculata*

Résumé

L'infestation et les dommages du grain de niébé (*Vigna unguiculata*) stocké par les bruches (*Callosobruchus maculatus*) sont un défi pour la majorité des agriculteurs dans les régions les plus sèches de l'Ouganda où la culture est une source majeure de légumes, en particulier pendant la saison sèche. Bien que plusieurs mesures soient utilisées pour éviter le problème, il reste apparent malgré les stratégies de contrôle éprouvées qui ont été diffusées. Cette étude a été entreprise pour identifier les facteurs entravant l'adoption des technologies de lutte contre le bruchidés du niébé ; et a été menée en 2013 à l'aide d'un questionnaire d'enquête dans l'est de l'Ouganda auprès de 160 agriculteurs. Les résultats ont révélé que des variables clés telles que le manque d'intrants, la limitation de la main-d'œuvre, le manque de capital, le manque de marché, les coûts élevés des intrants, la limitation du transport et le manque d'informations sur les technologies de lutte contre les bruches recommandées ont considérablement limité l'adoption des technologies de lutte contre les bruches du niébé. Le manque d'intrants était le plus élevé (80%), tandis que la limitation du transport était la moins prise en compte (6,3%). Ainsi, la non-adoption et / ou l'adoption partielle pourraient être attribuées à plusieurs facteurs qui démontrent qu'il faut plus que des technologies efficaces dans la gestion post-récolte pour garantir l'adoption. Les voies d'adoption doivent prendre ces facteurs en considération.

Mots clés : Adoption, *Callosobruchus maculatus, Vigna unguiculata*

Introduction

Cowpea (*Vigna unguiculata*) is mainly grown in the drier parts of Uganda, especially in the eastern and northern regions of the country for both its leaves and grain that are used as food (Adipala *et al*., 1997). The young leaves, immature pods and peas of fresh cowpea are used as vegetables while the grain is used for preparing several snacks and main meal dishes (Jackai and Adalla, 1997). The primary constraint to production of cowpea is pest infestation both in the field and during storage. Available literature indicates several studies and control practices at field infestation level with great success leading to increased grain yield. This success however is not sustained at grain storage stage (Karungi *et al*., 2000a,b).

Bruchid beetles cause dry weight losses of 10-40% in dry beans in less than six months of storage, and rendering potentially up to 70% unfit for human consumption (Jones *et al*., 2011). Thus, effective control options against field pest infestations should be complemented with appropriate control strategies against storage pests to preserve the harvest. Apparently, several appropriate control strategies against storage pests in grain legumes including use of oils and botanicals, sealed containers, triple plastic bagging, co-storage with ash and other abiotic materials have been recommended (Kasenge *et al*., 1999). Unfortunately, in many farming communities, there is very limited or no adoption at all. In some cases, partial adoption is evident and this escalates the problem (Pattanayak *et al*., 2002; Mavunganidze *et al*., 2013). Existing literature on technology adoption is skewed to aspects of what determines decision to adopt or reject an innovation. To this end, there is a post of empirical studies that address the connections related to farmers' decisions to adopt recommended innovations and their decisions to obtain information not only on new technologies available but also on practices that are recommended by research. The purpose of this study reported in this paper was to examine factors that affect adoption of recommended cowpea bruchid control technologies.

Methodology

A household survey involving 160 farmers was carried out with a purpose of establishing cowpea storage management practices and to identify factors hindering adoption of recommended bruchid control technologies. The survey was conducted during the two growing seasons of 2013 and the same farmers identified served as the sample for both seasons, thus the sample size for the study was 160 households. Purposive sampling was done in order to identify farmers who produce and store as opposed to subsistence farmers who do not store grain for the individual farmers mainly because the interest was to identify famers who produced and stored as opposed to opposed to the subsistence who lived from hand to mouth. Also, it was presumed that these farmers had knowledge in the recommended cowpea storage management technologies. The survey identified the commonly used control strategies using a study tool that contained several elements including; data on cowpea production and marketing, varieties grown, quantity of output, storage facilities used and their values, bruchid control technologies used by farmers and factors hindering adoption of recommended bruchid control technologies were collected using a pretested structured questionnaire and recorded. Data were coded, summarized and descriptive statistics (means, frequencies, standard deviations and percentages) were generated. A statistical computer package; Statistical Package for Social Scientists (SPSS) was used to summarize the data. Also, exploratory data analysis (EDA) was carried out to check for symmetry, skewness and data distribution.

Results and discussion

Cowpea production and marketing and its influence on bruchid control. From the study, results showed that four different cowpea varieties namely ebelat, icirikukwai, Kenya (black) and MU93 are predominantly grown. However, ebelat was the most widely grown as indicated by 74% of the farmers followed by icirikukwai (34%), MU93 (37%) and Kenya (13%). This is probably because ebelat was found to be more marketable and icirikukwai was used mainly for subsistence because it was considered tastier than the other varieties. According to the farmers interviewed, varieties are selected based on various attributes (Table 1). The majority (31.3%) of the farmers grew Ebelat because it was found to be marketable compared to the rest of the varieties. Other important attributes associated with this variety include high yielding, attractive colour, and excellent taste.

Table 1. Proportion of farmers cultivating different cowpea varieties and reasons for growing them in the area of study

Attribute	Ebelat		Icirikukwai		MU 93		Kenya (black)	
	F	%	F	%	F	%	F	%
Marketable	50	31.3	10	6.3	11	6.9	19	11.9
High yielding	30	18.8	18	11.3	18	11.3	5	3.1
Large size	21	13.1	0	0	3	1.9	2	1.3
Common	22	13.8	15	9.4	3	1.9	0	0
Tasty	35	21.9	15	9.4	9	5.6	0	0
Early maturing	2	1.3	3	1.9	3	1.9	2	1.3
Resistant to field pests	11	6.9	9	5.6	11	6.9	1	0.6
Attractive colour	14	8.8	2	1.3	1	0.6	1	0.6
Traditional variety	6	3.8	4	2.5	0	0	0	0

F= frequency, n=160

Icirikukwai on the other hand was grown mainly because it was also high yielding and tasty. The main attributes considered by the farmers growing Kenya (black) variety were its high yield and marketability as revealed by 11.3% and 11.9% of the farmers, respectively. MU93 was mainly grown because it was a high yielding variety.

Cowpea is produced for both consumption and as a source of income as indicated by 84% of the farmers. Although the crop served as a source of income in the study area, there were variations among districts with respect to the number of farmers selling cowpea grain. In Kumi district, 76% of the farmers sold their grain compared to 63.3% and 56% in Pallisa and Soroti districts, respectively.

Most of the cowpea grain was sold locally. This was mainly because farmers found it costly and difficult to transport to distant places where they could possibly get higher profit. The other reason could be lack of marketing information about the crop.

Although farmers sold the cowpea grain within their respective districts, purchases were not restricted to specific locations. The aggregation of the purchase will most likely influence infestation of bruchids.

The majority of the farmers (61.5%) sold cowpea grain to wholesalers while 58.7%, 17.3% and 5.8% sold their grain to retailers, fellow farmers and exporters, respectively (Fig. 1). Although final consumers are expected to constitute the highest percentage of the farmers' customers because the crop serves as a major source of vegetables, they only constituted 44.2%.

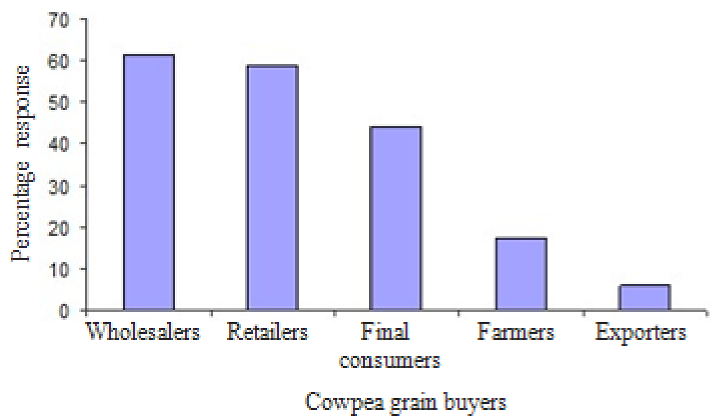

Figure 1. Farmers' cowpea grain buyers during the year 2013.

The probable reason for the wholesaler being the most important cowpea customer is the convenience of obtaining grain in bulk from one point, thus minimizing transport costs. This process is further enhanced by the fact that wholesalers identify local traders in the area who buy and gather the produce on their behalf.

During sale of the cowpea grain, it was found that buyers considered quality as the price determinant. The specific aspects of quality considered were bruchid infestation and damage, size, colour, varietal mixtures and general cleanliness (Fig. 2). Fifty seven percent of the respondents cited bruchid infestation and damage as aspect of quality considered while 15%, 12%, 9% and 7% of the respondents reported grain size, colour, variety mix and general cleanliness, respectively, as aspects of quality considered during purchase.

Generally, most of the cowpea grains were found to have at least some bruchid emergence holes. Quality was judged by the extent of damage as indicated by the number of bruchid emergence holes and presence of bruchids themselves on the grain. Murdock *et al*. (1997) also observed that cowpea on sale in markets in sub-Saharan Africa often has bruchid emergence holes.

Results of the present study indicated that local traders preferred white coloured (ebelat, MU93 and icirikukwai) cowpea while traders from the Uganda – Kenya border (around Malaba and Busia) plus those exporting it to Kenya preferred Kenya (black) variety. The white large sized varieties (ebelat and MU93) were preferred by local traders while the white small sized (icirikukwai) was preferred by final consumers. Although bruchid damage is one of the most important quality attributes in determining the price of cowpea, colour as a quality attribute is subjective since it depends on the buyer.

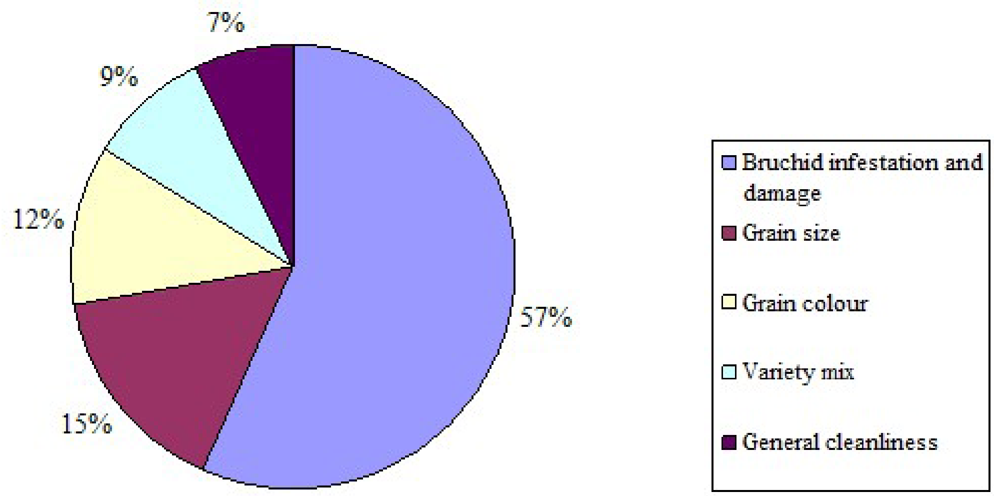

Figure 2. A aspects of cowpea grain quality considered during purchase in the year 2013.

Cowpea storage methods and bruchid control technologies

Cowpea storage methods. Two storage methods were encountered. These included polythene bags and granaries. In the former method, cowpea grains are packed in polythene bags or "sacks" after shelling and kept in residential houses on cemented or earth floors while in the latter, the pods are stores ubshelled. The pods are either poured directly on the floor of the granary or on top of millet stored within the granary. The relative use of these methods within the study districts is given in Figure 3.

Generally, a majority (70%) of the farmers stored cowpea grain in polythene bags, which were kept in residential houses. Farmers preferred this particular method in order to protect the grain from thieves who in many cases have vandalized granaries. Close monitoring of the cowpea grain and maintaining its quality are other reasons explaining why a majority of the farmers preferred this method. Studies conducted elsewhere (Ranalli *et al*., 2003) revealed that storage conditions have a significant impact on the quality of the seed and thus seeds should be stored under proper conditions to prevent its deterioration.

Cowpea bruchid control technologies. Results of the present study revealed that farmers used various control technologies ranging from use of locally available materials such as wood ash to chemicals. In general, nine different technologies were encountered as being used by farmers to control bruchids on cowpea during storage. The control technologies were wood ash, actellic dust, malathion dust, neem tree leaves, *Lantana camara,* sun- drying, millet husks, hot pepper and unthreshing. Some of these bruchid control technologies have been tested and proved effective against bruchids while the efficacy of other technologies have not been tested and documented though used by farmers to control bruchids during storage. Therefore, for purposes of this study the control technologies were grouped into two categories namely recommended bruchid control technologies (RBCT) and untested traditional bruchid control technologies (UTBCT). Thus, wood ash, actellic dust, malathion dust, neem and lantana camara were grouped into RBCT category while sun drying, use of millet husks, hot pepper and unthreshing were grouped into the UTBCT category. To show the comparative use of RBCT and UTBCT, the relative use of the various technologies within the study areas is summarized in Table 2.

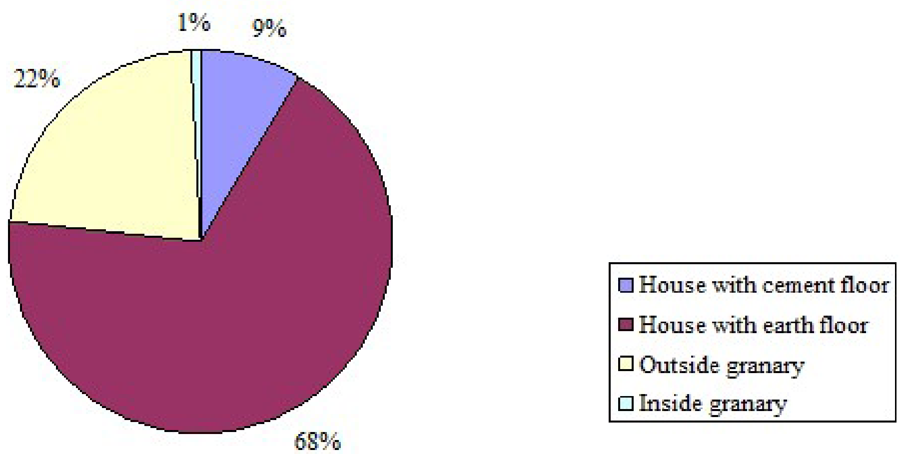

Figure 3. Proportion of responses on facilities used for cowpea storage in the area of study, during 2013.

Table 2. Recommended and traditional bruchid control technologies used by farmers during the year 2013 in eastern Uganda

	Kumi	Pallisa	Soroti	Overall
Recommended	78.0	14.3	10.0	33.3
Wood ash	8.0	1.7	4.0	5.3
Actellic dust	42.0	5.0	2.0	17.9
Malathion dust	28.0	5.0	0.0	12.1
Neem	4.0	1.7	4.0	3.6
Lantana	0.0	0.0	4.0	1.4
Traditional	22.0	85.7	90.0	66.7
Sun drying	66.0	68.3	30.0	44.4
Millet husks	4.0	0.0	0.0	1.4
Hot pepper	2.0	0.0	10.0	4.8
Unthreshing	4.0	0.0	8.0	4.8

Across all the 3 districts, UTBCT were predominantly used mainly because some farmers used both UTBCT and RBCT. Generally, however, the majority (78%) of farmers interviewed in Kumi district used the RBCT while in Pallisa and Soroti districts, most farmers used UTBCT (Table 2). Among the UTBCT, sundrying was the most widely used while millet husks was least used. This is probably due to the fact that sundrying as a bruchid control technology is readily available and more reliable than other control strategies.

The limited use of the RBCT was attributed to lack of information on the efficacy of these technologies while the variations in relative use of these control technologies within the study districts is associated with the research activities and scale of cowpea production among the districts.Findings of the study revealed that actellic dust and malathion dusts were the most used RBCT. Wood ash on the other hand was used by 8.0%, 1.7% and 4.0% of the farmers in Kumi, Pallisa and Soroti districts, respectively. One of the reasons for the unpopular use of wood ash for bruchid control among farmers was that it is associated with ill fate in addition to the doubts about its efficacy. Nevertheless, Murdock *et al*. (1997) reported that wood ash is effective in bruchid control during storage though its efficacy is dependent on the mechanical filling of the spaces between the grains.

Due to the fact that traders are part of the stakeholders in ensuring quality cowpea production with respect to storage, the study sought to establish the different technologies they used to control bruchid infestation and damage. Results indicate that, among the RBCT used by traders are actellic dust, malathion dust and fumigants and the UTBCT include sundrying, use of hot pepper, use of salted and sealed bags.

Factors hindering adoption of cowpea bruchid control technologies. The factors pointed as hindrances to adoption of cowpea bruchid control technologies include high input costs, lack of information on bruchid control technologies, capital, labour, transport and market (Table 3). Eighty percent of the respondents indicated that they were not able to take up RBCT because the required inputs were not available. Katinila *et al*. (1998) in a study conducted in southern Tanzania also reported that most farmers found unavailability of inputs as a great constraint to adoption of improved maize technologies. Where inputs are unavailable, farmers cannot purchase them. Similarly, Reardon *et al*. (1997) observed that where improved inputs were not used, it was either because farmers lacked access to them or because their use was not justified in terms of profitability and risk under current agronomic and economic conditions. Unavailability of inputs in some of the sub-counties was attributed to the low effective demand due to poverty of farmers and location in less accessible areas. Speirs and Olson (1992) observed that private input merchants find little commercial incentives to distribute inputs in less-accessible areas and outside cash-crop zones. Also, some of the local materials which were presumed to be common were found to be rare in some places. For example, the neem tree was reported to be scarce in some sub-counties.

Table 3. Factors hindering adoption of cowpea bruchid control technolgies

Factor	Percentage of farmers
Lack of inputs	80
Lack of information on recommended bruchid control technologies	55
Labour limitation	47
Lack of capital	14
Lack of market for the output	16
High input costs	13
Transport limitation	6.3

Respondents were asked whether they had received information about RBCT and from what sources. Fifty five percent of the respondents indicated that they were not aware of RBCT. Extension service provision is the main channel of delivering information about new or improved technologies to farmers through interaction and consequently extension workers encourage farmers to use proven technologies. Extension officers during extension visits and attendance at on-farm demonstrations provide technical advice on the use of different inputs thus encouraging the farmers to take up improved technologies (Ogwal, 2003). Many studies have been conducted to evaluate the effectiveness and efficiency of bruchid control technologies but this information reaches a limited number of end users mainly because the end users have a low rate of contact with extension service providers. For example, Kasenge *et al*., (2002) in an on farm study carried out in Kumi and Iganga districts found that the best treatments that reduced bruchid damage levels included mixing cowpea with tephrosia and solarisation which registered 2.8% and 8.8% bruchid injury levels, respectively. Findings of this study, however, indicate that none of the respondents used these technologies and this could be because it has not reached a good number of end users. Katinila *et al*. (1998) also reported that extension service and agricultural research organisations had low rates of contact with farmers hence constraining adoption of improved maize technologies in Southern Tanzania. Ineffectiveness of bruchid control technologies information delivery, therefore, was found to be a constraint to adoption of RBCT in eastern Uganda.

Labour limitation was another factor reported by 47% of the farmers as constraining adoption of RBCT. According to the farmers interviewed, cowpea grain is harvested, dried and prepared for storage during peak labour requirement periods, that is to say, all other crops would also be competing for the same labour, and as such little time and labour would be spared for purposes of addressing the bruchid problem which would have not began then. Therefore, the treatment of the cowpea grain for storage purposes would be deferred till the labour demands are less. Fourteen percent of the farmers reported that shortage of funds (capital) constrained them from using RBCT. Farmers find it easy to adopt technologies that require little cash outlay relative to their income level. This, therefore, explains why majority of farmers used UTBCT.

Lack of market for the output (cowpea grain) was yet another constraint identified as hindering adoption of RBCT as shown by 16% of the farmers. Other studies conducted in Africa also showed that market oriented production created incentives for farmers to use inputs (Strasberg *et al*., 1999). The farmers' decision as to which crop to use improved technologies is often determined by the marketing prospects of the crop, that is, the ability to generate adequate cash to reimburse investment in the improved technology.

In addition, 13% of the farmers reported, high input costs as a constraint to adoption of RBCT. Similar findings were reported by Katinila *et al*. (1998) in a study carried out in Southern Tanzania where more costly technologies like fertilizer, herbicide and disease control measures were adopted by only a few farmers. They found that only 20% of the respondents had adopted improved storage technologies.

Transport was found to be a hindrance by 6.3% of the farmers. Findings revealed that the main means of transport in the rural areas where the study was conducted was bicycles and yet not all farmers could afford bicycles. This was mainly because of poor infrastructure. For example, in Kameke sub-county, the respondents could only be accessed by bicycle or motor cycle. In an earlier study, it was observed that an extensive road network in the rural areas could help reduce transport costs hence input costs and also help in providing inputs in a timely fashion. Similarly a study in Burkina Faso revealed that investment in road infrastructure had the potential to reduce farm gate fertilizer costs by approximately the same amount as the fertilizer subsidy that was in effect at the time (Reardon, 1998).

Summary and conclusions

The study identified the major constraints hindering adoption of RBCT as lack of inputs, labour and information. To address these, an integrated approach involving partnership with extension service providing institutions such as government, NGOs and CBOs should be sought. Use of approaches such as the farmer field schools to enhance uptake of appropriate cowpea post-harvest handling and recommended storage management practices should be encouraged. This would enhance farmers participation in technology improvement and dissemination. Farmers should be educated on customer needs assessments. This would enable them to realise the need to produce the right variety in terms of colour and size of cowpea for a target market so that they avoid producing given varieties just because they are common. The farmers should also be helped to change the attitude that consuming or selling cowpea with bruchid emergence holes is okay. Farmers through training should be made to realise that whereas cowpea with bruchid emergence holes can be tolerated in the local markets, it cannot be tolerated in the international market. If farmers are to benefit from international trade, they have to provide grain without bruchid emergence holes.

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