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Adoption of on-farm hermetic storage for cowpea in West and Central Africa in 2012

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ABSTRACT

This study is based on interviews with 3456 randomly selected cowpea farmers in 322 villages in ten countries in West and Central Africa in 2010 and 2012. It uses descriptive statistics to track the trends in adoption of cowpea storage technology compared to previous studies and Firth logistic regression to identify important factors in adoption. The interviews indicate that regionally about 46% of respondents use some type of hermetic storage for their cowpeas and about 44% of the quantity of cowpea stored on farms is in hermetic containers. Both the percentage of respondents and the percentage of stored quantity fall slightly short of the 50% benchmark hypothesized. The 2010–2012 estimates compare to about 30% of cowpea quantity stored in hermetic containers in 2003–2004. Regionally, the most commonly used hermetic storage container is the triple layer Purdue Improved Cowpea Storage (PICS) bag. In PICS villages, local unavailability is the most common reason for not using the bags. The logit analysis shows that living in a village with PICS activities is the single most important factor explaining adoption of the technology. In six of the nine regressions participation in the demonstrations was also positive and a statistically significant determinant of adoption. For someone living in a PICS village and participating in the activities the combined effect is highly influential. In Niger such an individual would be 27% more likely than a non-participant from a non-PICS village to use PICS bags. In Senegal he or she would be 55% more likely. Some form of exposure to PICS activities or village technicians is key in adoption of the PICS technologies, though it may not be direct contact with a PICS technician. On average additional cash flow due to storage of cowpea in PICS bags is estimated at $26.58/100 kg bag more than sale at harvest.

1. Introduction

On-farm hermetic storage has the potential to dramatically change cowpea production in West and Central Africa. It offers farmers a safe, cost effective storage technology that is almost perfectly scalable. Hermetic storage is effective on a few kilograms of grain and is equally practical for many tons. Farmers no longer need to sell cowpea at harvest because of the lack of affordable storage. They can now participate in the gains from storage that have long been the domain of urban traders. Anecdotal information indicates that inventory storage programs are now starting to provide loans based on cowpea in storage, because lenders have confidence that their collateral will be safe. Hermetic storage also may be extended to cereals, oilseeds, other grain legumes and other dried food products. Research is now in progress on use of hermetic storage for those other crops (https://ag.purdue.edu/ipia/pics/Pages/picsworkshop2012.aspx).

However, adoption of improved post-harvest technology in Africa has in general been very slow. The 2011 World Bank "Missing Food" study found that overall grain storage losses are still 13.5% of production and that aside from hermetic storage for cowpea there are very few examples of any substantial adoption of improved grain storage technology in Africa. The question remains if farmers

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will make non-chemical hermetic storage for cowpea standard practice. The 2003–2004 data collected by Moussa et al. (2011) indicates that about 30% of cowpea stored on-farm was in potentially hermetic containers, but much of that also was treated with insecticide because farmers did not trust the efficacy of hermetic storage alone. Data collected in 2010 in Niger and Burkina Faso indicated that over 70% of farm-stored cowpea was in hermetic containers and from 7% to 38% of farm-stored cowpea was in Purdue Improved Cowpea Storage (PICS) bags (Moussa et al., 2010). The goal of this study is to estimate the region wide adoption of hermetic storage for cowpea by farmers in West and Central Africa and to identify constraints to its use. The study is based on a survey of 3456 farmers in ten countries. Because PICS bags are often the most cost-effective hermetic option in Africa, statistical analysis focuses on logit regression to estimate how independent factors affect PICS bag adoption. This study is of interest to storage scientists, food security experts, development workers and donors.

Hermetic storage is an ancient technique that can use any sealed airtight container. For grain storage in West and Central Africa recycled metal drums, plastic jugs and plastic bags have been used on a limited scale. In West and Central Africa drums are in high demand for transport and storage of water, and often are too expensive for cowpea storage. Plastic jugs are good for storing small amounts, but are cumbersome as the quantities increase beyond 100 kg. Rigid sided containers must be fully filled to function well for hermetic storage; consequently they are not as scale flexible as bags. Recycled plastic bags are often vented (i.e. Portland cement and sugar bags) or they are not robust enough to hold grain.

The key innovation introduced by Larry Murdock and colleagues was in the form of the triple layer PICS bags. They are a cost effective, scale neutral technology for cowpea storage. PICS bags are composed of an outer layer of ordinary woven polypropylene and two inner liners of high density polyethylene (HDPE), 80 microns thick (Baributsa et al., 2010). Cowpeas coming from the field usually have a low level of insect infestation. When the grain is sealed in an air tight container, the insects quickly consume the oxygen and the insects die or go into dormancy. PICS bags were originally developed in the late 1980s with funding from the U.S. Agency for International Development (USAID) funded Bean/Cowpea Collaborative Research Support Program (CRSP). For the next 20 years the bags were promoted by NGOs and extension organizations on a small scale basis, but there was no reliable source of the heavy duty plastic liners. From 2007 to 2010, the PICS project with support from the Bill and Melinda Gates Foundation implemented cowpea hermetic storage demonstrations in almost 31,000 villages in West and Central Africa, and worked with African manufacturers to produce and market bags appropriate for this use. PICS started with pilot activities in 2007 in 100 villages each in Niger and Burkina Faso, and 100 villages in Nigeria in 2008. By the end of the 2011/2012 storage season, PICS had conducted demonstrations in almost 31,000 villages in Benin, Burkina Faso, Cameroon, Ghana, Mali, Niger, Nigeria, Senegal, Tchad and Togo. During this period six plastic manufacturers in five West African countries produced and sold over 1.8 million PICS bags. Most of these bags have a capacity of 100 kg. Initially the project helped distributors finance PICS bag orders, but by 2010 the distribution system was entirely in the hands of African entrepreneurs.

Moussa et al. (2011) review the adoption literature for grain storage technology in Africa. Because storage has been a key problem identified by West and Central African farmers, there have been several studies of cowpea storage adoption, but few for other commodities. Schwartz et al. (1993) included cowpea metal drum storage in their impact assessment of Operation Cowpea in Senegal 1984–1986. Boys et al. (2007) showed that cowpea storage research was a good investment for the US Agency for International Development (USAID) in Senegal even though survey data suggested that metal drum use had peaked for cowpea storage. The Boys et al. (2007) survey indicated that as of 2004 about 60% of cowpea stored on Senegalese farms was in metal drums, down from over 85% a decade earlier, because as old metal drums rusted and ceased to be airtight Senegalese farmers were not replacing them with newer drums due to cost.

In 2003–2004, Moussa et al. (2011) surveyed a random sample of 795 farmers in the main cowpea growing areas of Benin, Burkina Faso, Cameroon, Mali, Niger, Nigeria and Senegal. Overall, they estimated that approximately 30% of grain in the region was hermetically stored using the CRSP-developed triple bags, double bags or closed top metal drum storage techniques. The double bag is a local adaptation of the triple bag technique adapting liners originally manufactured for other purposes. The typical double bag uses a woven sack with one liner of low density polyethylene. In most cases the double bag liner is much thinner than that of the PICS bag, only 40 or 50 microns. In the 2003–2004 surveys Nigeria showed the highest percentage of farmers using double bags (29%) followed by Burkina Faso with 27% (Moussa, 2006). Cameroon, Mali, Niger and Senegal have respectively the rate of use of 24, 22, 11% and 7%. The proportion of stored cowpea in double bags in 2003–2004 was: Benin, zero; Burkina Faso, 13%; Cameroon, 9%; Mali, 0.1%; Niger, 3%; Nigeria, 23% and Senegal, 16%. Research indicates that the double bags are quite effective if insects are killed prior to storage by use of the CRSP solar heater or by insecticide. In that case the liner only has to protect against re-infestation from outside. When used without insecticide, solar heater treatment or other insect killing strategy, the double bags are often pierced by insects inside the bags and consequently they are no longer air tight.

Only a few farmers reported using triple bags in 2003–2004, 7% in Nigeria and 1% in Cameroon (Moussa, 2006). Because PICS triple bags were not commercially available until 2007, the source of these triple bags is not clear. Comments by some respondents indicate that many of these farmers used two of the low density polyethylene liners of the same type used in the double bags.

Storage insecticides are commonly used for cowpea throughout West and Central Africa. Moussa (2006) indicated that the percentage of farmers using insecticide in woven bags to store their cowpea varied from 38% in Nigeria to 16% in Burkina Faso. In both Niger and Cameroon 22% of farmers stored cowpea in woven bags with insecticide. Though storage insecticides are not needed with hermetic storage, many farmers reported using insecticides as additional 'insurance' against infestation. This was particularly true when farmers were using the double bags. Moussa (2006) reported that regionally about 75% farmers who stored in double bags used insecticide. By country the following percentages of farmers reported using insecticide in double bags: Burkina Faso, 56%; Cameroon, 79%; Niger, 73%; Nigeria, 76%; and Mali, 96%. Outside of Nigeria, Moussa (2006) found that insecticide was rarely put in metal drums; in Nigeria 22% of farmers used insecticide in their metal storage drums.

For crops other than cowpea, adoption by smallholder African farmers of improved storage technologies has been modest. For example, Tefera et al. (2011) reviewed the use of metal silos for grain storage in Africa. They document an FAO program that distributed 1723 metal silos in Burkina Faso, Tchad, Guinea, Madagascar, Malawi, Mozambique, Namibia and Senegal. Those silos had a cumulative capacity of 1648 MT. While the silos are technically effective and long lasting, the initial up front cost often discourages African farmers. For example in 2008–2009, a 90 kg silo in Kenya cost about US$40. For comparison, during that same period a 100 kg PICS bag retailed for $2–$3. The US based company GrainPro produces hermetic grain storage products that are marketed in 32 African countries. GrainPro large scale storage cocoons with a capacity of multiple tons are widely used by government food security agencies and humanitarian groups. The use of