ELSEVIER
www.elsevier.com/locate/worlddev

World Development Vol. 77, pp. 115–128, 2016
0305-750X/

http://dx.doi.org/10.1016/j.worlddev.2015.08.004

Estimating Price Discounts for Low-Quality Maize in sub-Saharan Africa: Evidence from Benin

DIDIER KADJO, JACOB RICKER-GILBERT and CORINNE ALEXANDER*
Purdue University, USA

Summary. — This article uses household data from Benin to estimate the extent that markets in sub-Saharan Africa discount damaged maize. Stated preference methods indicate that a 10% increase in insect damage results in a 9% maize price discount. However, revealed preference methods indicate that this discount is only 3%. Discounts are larger immediately after harvest than they are in the lean period when maize is scarce. Our results help explain why many smallholder farmers sell maize at harvest rather than making the effort to preserve grain of good quality for later in the season when it may fetch a higher price.

Key words — maize quality, price discounts, post-harvest, market participation, sub-Saharan Africa

1. INTRODUCTION

Smallholder farmers in sub-Saharan Africa (SSA) face many obstacles that make it difficult for them to increase their income and improve their food security. One major problem is that many smallholder farmers sell their maize immediately after harvest, rather than making the effort to preserve grain of good quality for later in the season when it may fetch a higher price. One reason why this occurs is because many smallholders must deal with a binding liquidity constraint at harvest to pay for immediate needs like school fees that makes the need for cash at harvest imperative (Renkow, 1990; Saha & Stroud, 1994; Stephens & Barrett, 2011). The second reason for early sale is that without access to effective and affordable storage technology, grain placed in storage may experience substantial damage from post-harvest pests, such as insects, rodents, and mold.

Pests are major impediments to grain storage and household food security that create two problems. First, pest damage reduces the quantity available for households to sell and consume later in the year. Second, farmers potentially receive a price discount for lower quality damaged grain that is marketed. Markets in developed countries have explicit standards for maize quality and discount schedules that give price penalties to visibly damaged maize. However, formal quality standards do not exist in most rural maize markets in SSA, which is where most of the maize transactions in the region take place.

Despite its importance, the issue of possible quality premiums or damage discounts for maize in informal rural markets has received limited attention in the literature. In a recent meta-analysis of post-harvest loss in SSA, Affognon, Mutungi, Sanginga, and Borgemeister (2015) cite quality loss in the post-harvest as one of the major problems that has yet to be fully understood or quantified. This is an important issue because as noted in Hodges, Buzby, and Bennett (2011, p. 43), "successful markets depend on a consistent supply of better-quality produce." Furthermore, Jones, Alexander, and Lowenberg-Deboer (2014) develop a financial model for measuring profitability of storage that includes quality loss. They conclude that when quality losses are considered in an economic analysis of the returns to storing maize, the "total value loss" can far exceed traditional estimates that only consider quantity of maize lost in storage.

With these considerations in mind, the objective of this article is to estimate the extent to which insect damage affects the price that smallholder farm households in SSA receive and pay for maize in rural markets. We test two main hypotheses that to our knowledge remain largely unanswered to date. The first (null) hypothesis is: *there is no statistically significant price discount for maize that has been damaged by insects*. If markets in SSA do not place a premium on high quality maize (discount damaged maize), this can help explain why poor quality maize exists, which has negative implications for household food security and health.

The second (null) hypothesis is: *the average price discount is the same in the early post-harvest period and lean period for maize with the same level of damage*. Markets may value quality and thus discount damaged maize in the period immediately following harvest, when quantity is plentiful and is generally of high quality. However, in the lean period maize becomes scarce and quality may become less important as people must eat what is available regardless of insect damage.

This article uses data from a random sample of 360 smallholder maize farmers conducted across Benin after the 2011–12 harvest. We conduct a straightforward experiment showing farmers maize with different levels of insect damage to test the two hypotheses presented above. We first ask farmers the price per kilogram and level of insect damage for the maize that constituted their largest maize sale and purchase in the past post-harvest season. Second, we ask farmers to value maize at each damage level for purchase and sale. Our estimates include a parsimonious specification that includes only the level of insect damage as a control, and a full specification that incorporates other household-level, and market-level factors, along with information about transaction partners as control variables. Since some farmers do not sell (buy) maize because they price they receive (pay) is below (above) their reservation value, we have a number of missing values for maize price in our experiment. We deal with this potential selection bias issue caused by farmers not buying

* This work was funded by the Bill and Melinda Gates Foundation under the Purdue Improved Crop Storage (PICS) project. Final revision accepted: August 18, 2015.

or selling maize using the Heckman sample selection correction method, following Heckman (1979).

To our knowledge this article is the first study to empirically quantify price discounts for damaged maize using revealed preference data from smallholder farmers in SSA. In doing so, it makes three contributions to the literature. First, we obtain quantitative estimates of maize damage discounts for a representative sample of smallholder maize farmers regardless of how long they store their maize. Many of these farmers are both producers and consumers of maize so we ask them how they value damaged maize when they operate on each side of the market. Second, we compare the results from past-transactions (revealed preference) with those from farmers' perceptions (stated preference) about the effects of insect damage on maize prices. We use these two methods to compare the accuracy of each estimation approach. Third, for sale and purchase transactions, we test whether the price discounts for damaged maize are significantly different between the time period immediately after harvest and the lean season.

Previous literature suggests that there may be unofficial price discounts for insect damage in West African cowpea markets (Langyintuo, Ntoukam, Murdock, Lowenberg-DeBoer, & Miller, 2004). However, there is limited information on possible insect damage discounts for maize, and virtually no information at the farmer-level. To our knowledge the only published study in Africa by Compton *et al.* (1998) uses trader focus groups in Ghana to construct a maize discount schedule based on stated preferences. Hoffmann and Gatobu (2014) survey a population of Kenyan farmers who store maize for longer than six months. The authors use an experimental auction and conclude that asymmetric information about unobservable maize attributes such as the existence of aflatoxins may also contribute to the prevalence of smallholder autarky in staple grains.

Our study complements and extends the work by Hoffman and Gatobu, as we believe maize prices should reflect observable quality during market transactions. We focus on potential discounts for maize with different levels of insect damage and how those discounts may be different between the early post-harvest period and the lean period.

The rest of this article is organized as follows. The next section describes how data collection and the experiment were conducted in the selected areas. Subsequent sections present the empirical estimation, results, and conclusions.

2. MAIZE MARKETING IN BENIN

Private sector trading among farmers and traders dominates the maize marketing system in Benin. However, the government still intervenes in cereal markets. The national office for food security called "Office National d'Appui a la Securite Alimentaire (ONASA)" buys and stores maize and other cereals to resell between harvests to smooth out market supplies and limit price surges.

Smallholder farmers buy and sell maize in local rural markets, and occasionally in larger district markets. There is no formal quality control mechanism in these markets, so market participants implement their own practices to verify maize quality. Most traders prefer to purchase maize during the harvest season and the early post-harvest period, when prices are lowest and good quality grain is abundant. They build up their stocks to take advantage of spatial and temporal price arbitrage that occurs later in the season. Wholesale traders assemble maize from different rural and district markets to resell it in regional or urban markets.

During harvest and early post-harvest period, maize is fresh and of good quality so the risk of damaged grain being concealed in bags is low. Indeed, many wholesale traders often only sample a certain portion of the maize they purchase to check for quality. They may also hire middlemen in rural areas to collect and ensure that good quality maize is being purchased.

Wholesale traders buy maize during the lean period only when there is acute demand in the consumer markets. However, retail traders represent more constant market partners for farmers, since they operate in local and district markets throughout the seasons. Women are the main retail maize traders across rural markets in Benin, just as in other West African countries. Retail traders buy different amounts of maize from farmers and resell it out of their small shops or kiosks to other rural dwellers and farm households who run out of their own produced maize stocks.

Quality control is less of a challenge for market participants when small quantities of maize are traded, as is often the case when smallholders buy and sell maize in the lean period. When the traded quantity is small, it is relatively easy for farmers and traders to determine observable maize characteristics through visual controls and touching maize contained in bags and baskets. It is important to note that market participants can only judge maize quality based on its observable characteristics and do not have the means to test for unobservable characteristics that could be harmful to them, such as the maize being contaminated with aflatoxin.

3. DATA

Data used in this study come from a random survey conducted from July to August 2012 in Benin. We selected six departments out of 12 in Benin using multiple criteria of agricultural productivity, food security, and geographical repartition. Two counties called "Sous-Prefecture" were then randomly chosen in each department, followed by the random selection of one district in each identified county. The villages for farmer interviews were also randomly chosen in each district. In a final step we randomly selected 30 farmers from a census of maize farmers from each village. In total 360 farmers were interviewed, but we retain 357 observations because two farmers did not store maize and one farmer was an outlier with a quantity produced far above (51 times) the average production of other farmers, and thus cannot be considered a smallholder.

The number of respondents differs depending on the evaluation method that is used. Only farmers who were involved in market transactions during the past post-harvest season were interviewed for the revealed preference (RP) evaluation. There were 246 farmers who sold maize (69% of the sample) and 134 (37% of the sample) who purchased maize. All 357 farmers were asked to elicit their preferences for a range of maize qualities for the stated preference (SP) evaluation.

In each sampled village the survey started with a focus group discussion. These focus groups were composed of 10–15 male and female maize farmers from the selected villages. The enumerators explained the purpose of the study to participants, and participants helped to evaluate how realistic the damage levels that we presented were for marketed maize in the village. In addition, the focus group participants were asked to differentiate the major periods in the season when price and quality vary, to capture local market conditions. In summary, shortly after the harvest, maize prices are relatively low and the quality and quantity are generally high.