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An experimental approach to estimating the value of grain moisture information to farmers in Bangladesh

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ABSTRACT

In the developing world grain storage losses are high and in humid areas inadequate grain drying is often a source of storage problems. Farmers and traders depend on traditional grain moisture estimation methods which are subject to a wide error margin. Grain storage decisions could be improved if farmers and traders had a low cost grain moisture meter that fit their needs. The goal of this study was to determine the desired grain moisture meter functionality and to estimate the value of grain moisture measurement for small holder farmers and for small-scale grain traders, using Bangladesh as a case study. This study was based on interviews with 140 randomly selected Bangladeshi rice farmers in 2016 and 2017, discussions with millers at 30 rice mills and a voucher based moisture meter sales program. It shows that except for rice kept for seed and home consumption, most Bangladeshi farmers sell their rice shortly after harvest to satisfy cash needs and to eliminate storage risks. They say that they would store more rice on-farm if they had better storage methods including cost-effective grain moisture testing. Survey results show that the average farm storage loss was 52 kg or 563 Taka (US$6.78) annually. Using experimental economics methods, farmers were given the opportunity to purchase a probe type grain moisture meter through vouchers with a range of prices. Twenty three of the 140 of the participants (i.e. 16%) purchased at an average of price of 374 Taka (i.e. US$4.67). No farmer purchased a voucher price over 800 Taka (US$10.00). Those who purchased moisture meters had larger farms and produced more rice than those who did not exercise the voucher. They were also younger on average, have more education and more off farm income than non-purchasers.

1. Introduction

Estimates indicate that 20%–30% of grain in developing countries is lost before it reaches consumers. In humid areas, one of the key problems is inadequate drying before storage and one of the constraints to proper drying is measuring grain moisture content. Grain drying is a costly process. It takes time, energy and money. While traditional solar drying uses free energy, it requires substantial labor. The traditional grain moisture measurement methods used by farmers and small scale traders in the developing world have a wide margin of error. Grain moisture is often misjudged and consequently grain is stored at higher than optimal moisture leading to mold and other damage. There are several grain moisture meters commercially available, but the price of this equipment is not within the purchasing power of developing country farmers and traders. Several research teams around the world are developing low cost moisture testing technology, but they lack information on the functionality that farmers need and the value of such technology for farmers and traders. Consequently, those researchers lack key design criteria needed to create technology that meets the needs of their stakeholders. The problem is that farmers, researchers and extension personnel in developing countries lack the economic information needed to develop low cost moisture meters and use them in grain marketing and storage decision making.

The focus of this study is on design criteria because appropriate design criteria are essential to engineering solutions to solve international development problems (ASME, 2009). Business,

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engineering and development experience indicates that in most cases developing country problems cannot be solved by cheaper versions of "First World" solutions (Prahalad, 2005; Polak and Warwick, 2013). In most cases it is essential to understand the needs of the developing country stakeholders and their priorities, and redesign the solutions for them.

Grain drying has long been a key concern for grain storage in the tropics, especially the humid tropics. For example, Hall (1970) focuses on grain drying as a key component of good grain management in the tropics. The recent World Bank (2011) report entitled "Missing Food: The Case of Post-Harvest Grain Losses in Sub-Saharan Africa" emphasized the need for improved grain drying to enhance food security. The World Food Program action research trials in Burkina Faso and Uganda (Costa, 2014) identified good grain drying as key to reducing fungal problems.

The lack of a cost effective means for smallholder farmers to identify when grain is dry enough to store is frequently cited as a key constraint (Robbins et al., 2004). Commercially available grain moisture measurement includes counter top models used by many American farmers which are often priced at US$300 to US$400 and the handheld Chinese made probe or cup devices which are priced at under US$100. Several research teams are focusing on lower cost grain moisture measurement (e.g. Rai et al., 2005; Ileleji et al., 2012; Tubb et al., 2017).

The rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. Rice is grown on about 10.5 million hectares which has remained almost stable over the past three decades. About 75% of the total cropped area and about 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh. The population of Bangladesh is still growing by about two million every year and may increase by another 30 million over the next 20 years. Reducing post harvest losses is a key method to maintain food security in the face of rising population and shrinking crop land area.

Bangladesh produces three rice crops per year in the Aus, Aman and Boro seasons. Aman is generally cultivated in December to January whereas Boro is in March to May and that of Aus from July to August. In recent years, generally in most regions of Bangladesh, the rice farmers mainly produce Boro and Aman. With multiple harvests annually, the rice supply and consequently the price in Bangladesh is not strongly seasonal (Figs. 1 and 2).

After harvest, rice is typically sun dried before storage or marketing. A moisture level of 12%–13% is recommended for safe storage in the temperature range of 20–40 °C, but farmers have many traditional ways of determining grain moisture (Ileleji et al., 2012). Some bite on the kernels and claim to know when the grain can be safely stored. Others shake a handful of grain and say that a rattling sound indicates that it is dry enough to store. Yet others will thrust their hand into a sack of grain and say that if the hand goes in easily, the grain is dry enough. Comparisons between farmer methods and measured grain moisture in Africa indicate that there is a 4%–5% of error around the farmer moisture assessment (Robbins et al., 2004). A farmer might think that grain is ready to store, but in reality it is 18% moisture and will deteriorate rapidly.

The so called "Salt Jar Method" is quite accurate, but may not help farmers when removing the last few percentage points of moisture. The salt jar method involves shaking grain in a jar with non-idodized salt. If the salt sticks to the side of the jar, the grain is above 15% moisture (Robbins et al., 2004). The salt jar does not help the farmer determine if grain has reached the 12% moisture often recommended for storage in the tropics.

In Bangladesh grain is retained on-farm for consumption either in the form of parboiled rice or raw paddy. The commonly used storage structures are made of bamboo, earthenware and jute. Other small storage containers are earthen pitchers, drums, tins and wooden chests. The size of these storage structures varies considerably from house to house depending on the economic condition of the family, amount of rice produced and stored.

The need for farm level grain moisture measurements also depends on the structure and technology used for commercial rice milling. In the past, paddy rice was parboiled and dried on farm or by small scale traders. This rice was processed into finished rice by entrepreneurs with husking machines located in the village bazaar or mobile units that would come to the farmyard or trader's shop. More recently, semi-automatic mills were established to buy paddy rice from farmers or small scale traders, parboil, dry and husk that rice at the same location. The semi-automatic mills typically use open sun drying after parboiling. However, the rice milling sector in Bangladesh is undergoing another change (Ali, 2011). New automatic rice mills are being set up at a growing rate (Table 1). Automatic rice mills use a continuous flow process. Paddy rice goes in and finished rice ready for consumer markets comes out. With on-

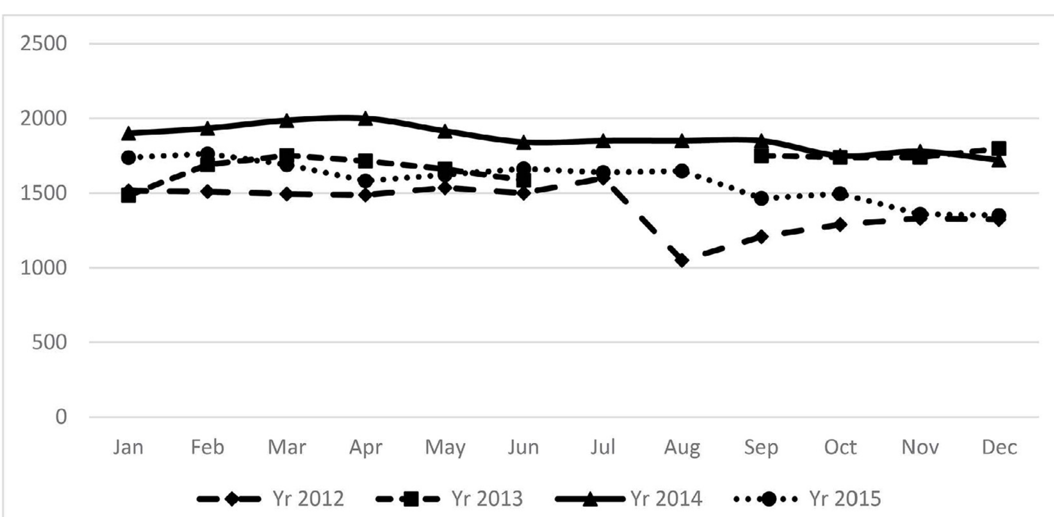

Fig. 1. Bangladesh average wholesale price of Aman season paddy during 2012-2015. Aman season rice is usually harvested in December and January.
Source: BBS (2014-2016)