Potential of Mechanical Grain Dryers in Addressing Exposure of Rice Farmers to Weather Risks

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Weather risks brought by prolonged rainfall and cloudy days hamper grain drying operations in the Philippines as majority still employ the sun drying method, which limits the opportunity of rice farmers to earn a higher income. While mechanical dryers are considered an important adaptation mechanism to address weather risks, more research needs to be done on their benefits and their disadvantages. This study adapted the Inter-governmental Panel on Climate Change (IPCC) concept which equates hazard, exposure, and vulnerability to quantify risk. Hazard was assessed in terms of the probability of four straight rainy- or cloudy-day occurrences based on a 30-year daily rainfall and cloudiness data. Exposure of farmers and traders to this event was described in terms of a cropping calendar followed by the farmers, while vulnerability was quantified in terms of the effects of exposure to continuous rains, particularly as price discounts for quality-degraded grains. About 74\% of the total rice harvest in Isabela, Philippines is being dried using the sun drying method. Based on the probability of exposure to extended rainy/cloudy days and the qualitative losses as indicated by price penalty for quality-degraded grains, total qualitative losses amounting to 117 metric tons valued at PhP \textsterling 407.17 million (USD \textsterling 8.14 million) is incurred in the province every year. With artificial or mechanical grain dryers, exposure of rice farmers to prolonged rainfall or cloudy days that constrain sun drying operations can be minimized or eliminated.

Keywords: mechanical grain dryer, weather risks, four-straight rainy/cloudy days, paddy

INTRODUCTION

High postharvest losses and lack of postharvest facilities are among the critical constraints hampering the Philippine rice value chain and limiting the competitiveness of the rice industry. The aggregate rice postproduction losses from harvesting to storage stand at 14.4\% (Salvador et al. 2012), 30\% of which is due to drying loss. Aside from such quantitative losses, grain qualitative losses are also incurred because of improper drying and delays in postproduction activities. Delays in postharvest activities are caused by a lack of drying facilities as well as labor and/or inclement weather that constrain drying operations. To help address these concerns regarding the limitations of the traditional sun drying method, mechanical grain dryers were developed and provided to farmers through various farming organizations. With mechanical dryers, losses like spillage and over-drying are kept at minimum levels. Moreover, because mechanical dryers can be used anytime, drying can be completed in a short span of time, thereby arresting grain quality deterioration. PhilMech studies show that mechanically-dried grains have higher milling recovery and lower percentage of broken grains.

Despite the benefits of using mechanical grain dryers, the reported successful adoption in other Asian countries, and the aggressive effort of the government in promoting the technology, programs on the provision of drying facilities show limited success. The dismal record of mechanical dryer adoption is mainly attributed to the high operating costs that continuously rise with the soaring prices of fossil-based energy. Other contributory factors include the use of systems and technologies that are not suitable to existing climatic conditions, prevailing marketing systems, and economic conditions. Most rice farmers still sell their produce immediately after harvesting and threshing without drying. The burden of drying is transferred to rice traders and millers, which often results in depressed prices of paddy received by farmers. Moreover, a large number of farmers still prefer...
sun drying as it is a cheaper option. They can also choose to sell their grains in wet or fresh form should the sun drying operations encounter any problems. These can be done during the dry season but could be difficult to achieve during the rainy season as well as in areas with no dry season or with evenly distributed rainfall throughout the year. On the other hand, most traders opt to buy wet or fresh paddies so that they could do the drying themselves, thus gaining more control over the grain quality. In addition, the large majority of rice farmers do not even practice mechanical drying even though this results in better rice quality, as they see little to no benefit to this process (Gragasin et al. 2004; Salvador et al. 2004; Chupungco et al. 2008; Dela Cruz et al. 2009; Malanon et al. 2011).

With the emerging challenges brought about by the Rice Tariffication Law, such as the need to improve rice competitiveness, the falling farm gate prices of paddies as an effect of the new rice trade liberalization regime, the widespread adoption of combine harvesters which has since constrained grain drying operations, the increasing climatic variability, and the enforcement of the law against highway drying, value-adding activities such as drying before marketing are again being recognized as a means to expand the earning potential of rice farmers. There is a pressing need to promote mechanical grain dryers by focusing on the other benefits accrued to the technology on how adopting these machines reduces the exposure of farmers or traders to weather risks brought by prolonged rainy days or cloudy days, when sun drying is not possible. While mechanical grain dryers may have the potential to reduce the vulnerability of farmers to weather risks, the benefits derived from this intervention need to be verified as there are limited studies undertaken to assess the effectiveness of mechanical grain dryer usage as a technological strategy in addressing weather risks.

This study quantify the weather-related risk confronting rice farmers and traders in drying grains by using traditional sun drying method. It also demonstrate the potential of mechanical dryer in reducing the exposure of rice stakeholders to weather risks.

MATERIALS AND METHODS

Locale of the Study

The study was conducted in Isabela, the second largest producer of rice in the Philippines (PSA 2018). In addition, adoption rates for mechanization technologies that includes mechanical grain dryers are found to be among the highest nationwide (PHiLMech).

Data Collection

Agro-climatic data on rainfall and cloudy days from the years 1987–2017 were gathered from the PAGASA Provincial Agro-Met Station. A face-to-face interviews with 230 rice farmers, including those who have used mechanical grain dryers, were also conducted. To supplement the gathered information, key informant interviews in 24 rice-producing areas, actual field observations, and secondary data collection were done.

Analytical Procedure

To assess the weather risks that affect rice farmers during drying, the formula of risk as defined by IPCC was used:

\[ \text{Risk} = \text{Hazard} \times \text{Exposure} \times \text{Vulnerability} \]

where, (1) hazard was assessed in terms of the probability of occurrence of four-straight rainy/cloudy days. The study used 30-year-old historical data covering 1987–2017 taken from PAGASA-Isabela State University (ISU) AgroMet Station. The probability of four straight rainy days was computed as the total number of four-straight rainy or cloudy days in a month over the total number of possible four straight rainy days on the same month. The probability of occurrence of hazard for 2050 was projected based on the available information from PAGASA. The relationship of the amount of rainfall and the probability of four-straight rainy and cloudy days was established using OLS regression. This was done to determine if the amount of rainfall could be used as a predictor of the occurrence of the hazard; (2) Exposure was based on the cropping calendar followed by rice farmers; (3) Vulnerability or consequence of prolonged rainfall hazards based on the actual experiences of rice farmers was defined in terms of the volume of qualitative losses and price penalty/discount due to grain quality degradation as a result of heavy downpour and/or delayed drying due to prolonged rainfall and cloudy days.

RESULTS AND DISCUSSION

Postharvest Handling of Rice Produce

Rice farmers in Isabela predominantly practice selling their produce in fresh or wet paddy form after harvesting and threshing (Table 1). This is due to the favorable prices of wet paddy and reduced costs of hauling, as traders typically pick up the produce from the farm. Other respondents stated that they are able to immediately sell their grains because of commitments with private traders who provide capital and other input requirements during the crop production period. The urgent need for cash, lack of drying facilities, scarce labor during peak harvest
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periods, and other postharvest operations were also identified as factors that greatly affect postharvest handling.

The high percentage of farmers selling fresh paddy entail the dominance of traders who procure wet paddy, as these traders own or have access to large-scale and state-of-the-art postharvest facilities which give them the capability to handle wet grains. In addition, the presence of ambulant traders from other provinces such as Nueva Ecija and Bulacan causes price distortions as the local traders were forced to jack up their prices in order to compete with the roving buyers. Moreover, some large trader-millers with no credit-market tie-up arrangement with farmers generally offer higher prices to satisfy their volume requirement.

Selling fresh paddy was more pronounced during the wet season when drying is more problematic and costlier, suggesting that grain drying in the province is no longer a major on-farm activity as drying is mostly performed by traders/millers or grain processors. Farmers perceived that the additional gain from doing the value-adding activity is not enough to compensate the risks associated with drying.

Grain Drying

Based on the farm survey, 31% of the farmers dry their grains before marketing while 90% dry a small portion of harvest to be retained for home consumption. Nearly all respondents (98%) used the sun drying method before storing or milling their grains. While there were mechanical dryers provided by the government to farm cooperatives and irrigators’ associations, these facilities were mostly used by seed producers and some traders.

In terms of the distribution of rice produce, 63% of the total production was sold or marketed, 17% was retained for home consumption, 12% was for landlord or tenant share, and 8% was for the combine harvester share (RCH) (Fig. 5). In terms of the total volume dried, 74% of the total production was dried using the sun drying method and 26% was dried using mechanical dryers (Fig. 1).

Four-Straight Rainy/Cloudy Day Hazard and Exposure of Rice Farmers

After harvesting and threshing, the farm produce needs to be dried before milling or storage. Sun drying remains the primary method used by farmers and traders, but it has its limitations especially in areas where rainfall is unpredictable or widely distributed throughout the year. Studies showed that failure to dry grains within four days results in significant quality degradation with a corresponding reduction in the value of produce (Dela Cruz and Adamos 2009). The occurrence of four-straight rainy or cloudy days during the time of harvest indicates the period when drying losses, particularly qualitative losses, are huge; hence, coping mechanisms like the use of artificial or mechanical dryers are critically needed.

The result on the likelihood of four-straight rainy/cloudy days during the dry season for the period 1987–2017 is plotted in Figure 2. The chance of experiencing continuous rain ranged from 0 – 0.38. While the probability was relatively low, this suggests that there were still chances of failure to dry even during the dry season. During the wet season, the probability ranged from 0 – 0.58 (Fig. 3). The increased likelihood of four-straight rainy days demonstrated that sun drying is more problematic during the wet season.

The average probability of four-straight rainy days during the dry season did not exhibit large variations during the periods 1987–2000 and 2001–2010. However, the projections for 2050 indicate a dramatic decline in the probability of continuous rainy days (Table 2). This is in contrast to the wet season in which the probability of four-straight rainy days is expected to increase by 22% by 2050 (Table 3).

Table 1. Percentage of farmers selling fresh paddy immediately after harvest, Isabela, 2018.

<table>
<thead>
<tr>
<th>Season</th>
<th>Number Reporting</th>
<th>Percent Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry season</td>
<td>156</td>
<td>68</td>
</tr>
<tr>
<td>Wet season</td>
<td>166</td>
<td>72</td>
</tr>
<tr>
<td>Both seasons</td>
<td>159</td>
<td>69</td>
</tr>
</tbody>
</table>

Table 2. Probability of four-straight rainy/cloudy day occurrence, dry season, Isabela.

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>MONTH</th>
<th>Mean</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987–2000</td>
<td>February</td>
<td>0.0837</td>
<td>0.0207</td>
</tr>
<tr>
<td></td>
<td>March</td>
<td>0.0759</td>
<td>0.0129</td>
</tr>
<tr>
<td>2001–2010</td>
<td>April</td>
<td>0.0837</td>
<td>0.0507</td>
</tr>
<tr>
<td>2011–2017</td>
<td></td>
<td>0.0999</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

*Calculated based on the projections of PAGASA
Exposure of Rice Farmers to Four-Straight Rainy/Cloudy Day Hazard

During the dry season, 5% of the respondents harvest/dry their produce during the month of February, 85% in March, and 10% in April, during the dry season. For the wet season, 7% harvest their crop in August, 26% in September, 64% in October, and 3% in November. Factoring in the cropping calendar followed by rice farmers, the probability and exposure to prolonged rainy days are detailed in Table 4. The average probability and exposure to four straight rainy/cloudy days for the period 2011–2017 was 0.0482 during the dry season and surged to 0.1498 during the wet season (Fig. 4).

Table 3. Probability of four-straight rainy/cloudy day occurrence, wet season, Isabela.

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>MONTH</th>
<th>Mean</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987–2000</td>
<td>August 0.0852, September 0.1465, October 0.2558, November 0.2262</td>
<td>0.1769</td>
<td>0.4045</td>
</tr>
<tr>
<td>2001–2010</td>
<td>August 0.1226, September 0.13, October 0.1871, November 0.3133</td>
<td>0.1882</td>
<td>0.4345</td>
</tr>
<tr>
<td>2011–2017</td>
<td>August 0.0873, September 0.1762, October 0.1475, November 0.1381</td>
<td>0.1373</td>
<td>0.5977</td>
</tr>
<tr>
<td>2050*</td>
<td>August 0.1004, September 0.2503, October 0.2444, November 0.2434</td>
<td>0.2096</td>
<td>-</td>
</tr>
</tbody>
</table>

*Calculated based on the projections of PAGASA

Vulnerability of Rice Farmers to Four-Straight Rainy/Cloudy Days during Drying Period and Benefits with the use of Mechanical Grain Dryers

Based on the farmer survey and key informant interviews, quality-degraded grains due to delayed drying result in a 19% reduction in price. On average, rice farmers in the province incurred PhP 108.73 million and PhP 298.44 million during the dry and wet seasons, respectively, with a total of PhP 407.17 million per year (Table 5). With the estimated volume of harvest dried using mechanical grain dryers, benefits in terms of prevented qualitative losses amounted to 30,420.6 metric tons valued at PhP 105.86 million per year (Table 6).
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Table 5. Rice qualitative losses during drying operation due to four-straight rainy/cloudy days, Isabela, 2018 (no mechanical grain dryers).

<table>
<thead>
<tr>
<th>PARTICULAR</th>
<th>DRY SEASON</th>
<th>WET SEASON</th>
<th>BOTH SEASONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of 4-rainy day occurrence x exposure</td>
<td>0.0482</td>
<td>0.1498</td>
<td></td>
</tr>
<tr>
<td>Volume of losses (^1), kg</td>
<td>31,244,638</td>
<td>85,757,953</td>
<td>117,002,504</td>
</tr>
<tr>
<td>Price discount (^2), Php/kg</td>
<td>3.48</td>
<td>3.48</td>
<td></td>
</tr>
<tr>
<td>Value of qualitative losses, Php</td>
<td>108,731,298.00</td>
<td>298,437,678.00</td>
<td>407,168,715.00</td>
</tr>
</tbody>
</table>

\(^1\)Production (Dry season: 703,800mt; Wet season: 484,784 mt) x probability of 4-rainy/cloudy day occurrence x exposure.

\(^2\)At Php18.30/kg, average price dry paddy x 19% penalty for grains with degraded quality.

Table 6. Prevented rice qualitative losses during drying with the use of mechanical grain dryers, Isabela, 2018.

<table>
<thead>
<tr>
<th>PARTICULAR</th>
<th>DRY SEASON</th>
<th>WET SEASON</th>
<th>BOTH SEASONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of 4-rainy day occurrence x exposure</td>
<td>0.0482</td>
<td>0.1498</td>
<td></td>
</tr>
<tr>
<td>Volume of losses (^1), kg</td>
<td>8,123,603</td>
<td>22,297,048</td>
<td>30,420,651</td>
</tr>
<tr>
<td>Price discount (^2), Php/kg</td>
<td>3.48</td>
<td>3.48</td>
<td></td>
</tr>
<tr>
<td>Value of qualitative losses, Php</td>
<td>28,270,137.00</td>
<td>77,593,728.00</td>
<td>105,863,866.00</td>
</tr>
</tbody>
</table>

\(^1\)Production (Dry season: 703,800mt; Wet season: 484,784 mt) x 26% dried using MGDs x probability of 4-rainy/cloudy day occurrence x exposure.

\(^2\)At Php18.30/kg, average price dry paddy x 19% penalty for grains with degraded quality.

CONCLUSION AND RECOMMENDATION

Weather risks brought by prolonged rainy and cloudy days are among the sources of production risks in rice farming. With extended rainy days projected to intensify, become more frequent or more unpredictable, adaptation mechanisms are needed to safeguard the produce and income of farmers. While mechanization technologies were primarily intended to improve productivity, other benefits in terms of reducing the exposure and vulnerability of rice farmers to climate hazards are not well-documented. This study attempted to fill this gap by evaluating the potential of mechanical grain dryer as an adaptation mechanism to address climate-related risks. While only 2% of rice farmers in Isabela used mechanical grain dryers, rice traders and millers employ mechanical dryers. Although this technology is not popularly adopted by farmers in the area as most of them practice selling wet paddy, the use of mechanical dryers by millers/traders enable them to procure wet grains from the farmers. The average probability and exposure to four-straight rainy/cloudy days for the period 2011–2010 was 0.0482 during the dry season and increased to 0.1498 during the wet season. Rice farmers and traders/millers in the province incur an average of PhP 407.17 million (USD 8.14 million) value of qualitative losses per year due to prolonged drying time which affect the quality and price of paddy. The use of mechanical dryers eliminates the risks associated with sun drying, particularly during four-straight rainy/cloudy days that constrains drying operation.

Results of this study could be replicated in major rice production areas of the country, especially in regions that are categorized as highly at risk to projected rainfall change. These areas include Cagayan, Bicol Region, Cordillera Administrative Region, Central Luzon, Southern Tagalog, and Eastern Visayas. The quantities of grain qualitative losses are likely to be higher in these areas; hence, potential benefits from introducing adaptation measures are expected to be enormous.

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