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Farmers' Willingness to Pay for Rice Post-Harvest Handling Technology in Ethiopia: Review Study

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Abstract

The agricultural sector is the most important sector in the Ethiopian economy. Rice belongs to the family "Gramineae" and the genus "*Oryza*". Rice (*Oryza sativa* L.) is one of the main staple foods for 70% of the population of the world. Africa produces an average of 14.6 million tons of rough rice in the years 1989 to 1996 on 7.3 million hectare of land equivalent to 2.6% and 4.6% of the world total production and rice area respectively. Rice is a recently introduced crop that contributes to food security and farm income in Ethiopia. Despite the contribution, there is considerable loss in rice production at the farm level due to improper post-harvest handling. Therefore, reducing rice loss at the farm level are important storage technology and policy objectives to optimally design interventions targeted at reducing losses. The objective of this review is farmers' Willingness to Pay (WTP) for rice post-harvest handling technology in Ethiopia. Specifically, review factors affecting storage materials of rice and determinants of household WTP. Among the different literatures the result from Tobit model revealed that post-harvest loss was significantly influenced by variables such as family labour, education level, land allocated for rice, access to milling machine, frequency of extension contact, storage facility, and volume of rice production. In addition to this by reviewing different literatures income of the household, education level of the respondent, media exposure, respondent perception about quality of seed, household family size, farm size, livestock holding and age of the respondent are significant variables that explain WTP of rice.

Keywords: Rice post-harvest technology; Rice post-harvest loss; WTP; Production

Introduction

Background of the study

The agricultural sector is the most important sector in the Ethiopian economy that features strongly in the overarching economic policy of the country Agricultural Development Led Industrialization (ADLI). It serves as source of income and employment for the majority of the country's population. Currently, agriculture is contributes over 35.8% to the national GDP, almost 90% of export and 72.7% of employment [1].

Despite having all this importance, agriculture continues to face a number of problems and challenges. The major ones are adverse climatic conditions, lack of appropriate land use system resulting in soil and other natural resources degradation, limited use of improved agricultural technologies, the predominance of subsistence agriculture and lack of and/or absence of business oriented agricultural production system, limited or no access to market facilities resulting in low participation of the smallholder farmers in value chain or value addition of their produces [2].

Rice belongs to the family "Gramineae" and the genus "*Oryza*". There are about 25 species of *Oryza* of these only two species were cultivate, namely *Oryza sativa* Linus and *Oryza glaberrima* Stead. The former is originated from north-eastern India to southern China but has spread to all parts of the world. The latter is still confined to its original home land, West Africa. Rice (*Oryza sativa* L.) is one of the main staple foods for 70% of the population of the world. Africa produces an average of 14.6 million tons of rough rice in the years 1989-1996 on 7.3 million hectares of land equivalent to 2.6% and 4.6% of the world total production and rice area respectively [3].

According to Flowers [4], it is the most important food crop for almost half of the world's population by over half the world population. The total world production of un-milled rice (paddy) is around 592 Million tons (Mt) (based on the average production for 2000 and 2001). Ninety percentage of this total is grown in developing countries, mostly in Asia, while Latin America and Africa produce 3.8% and 2.8%, respectively [5].

It estimated that by 2025, 10 billion people were depending on rice as a main food and demand reach about 880 Mt. Many Asian countries and international institutions agree to the strengthening of national programmes for policy and financial support to research, seed production and extension of hybrid rice [6]. In fact, there has been an expansion of area under High-Yielding Varieties (HYV), and in 1998 more than 90% of irrigated areas in Asia were under HYVs [7].

In SSA, agricultural development is important for poverty reduction and food security. Along with the major cereals grown in the region, the importance of rice is now increasing rapidly [8]. Rice has become a highly strategic and priority commodity for food security in Africa consumption is growing faster than that of any other major staple on the continent because of high population growth, rapid urbanization and changes in eating habits [9].

According to Lawrence [10] improvement in rice productivity potential would therefore play a critical role in feeding the sub-saharan Africa population that were expect to double during the next two decades. Therefore, there is a need to support farmers to increase rice productivity rather than acreage cultivated. Among the challenges that national policies should address is access to and use of improve technologies. If the negative productivity effects are to be reversed, new and existing technologies must be quickly up scaled and out scaled. This cannot be achieved unless the relevant information is provided to farmers in a timely manner.

Rice in Ethiopia has big potential to contribute to food security and even to generate foreign currency from its export [11]. It has been formally promoted through introduction of different improved varieties since 2002 by the Ministry of Agriculture (MoA), the Ethiopian Institute of Agricultural Research (EIAR) and the Japan International Cooperation Agency (JICA).

Among the target commodities that have received due emphasis in promotion of agricultural production, rice is one which is considered as the "Millennium crop" expected to contribute in ensuring food security in the Ethiopia. Research and development activities so far undertaken on rice in the country, have shown good productivity level, has also shown the existence of considerably vast suitable ecologies for production along with the possibility of growing, where other food crops do not do well, and compatible with various traditional food recipes like bread, soup, "injera", and local beverages (like "tella" and "areki") and the country has also a comparative advantage of producing rice due to the availability of huge and cheap rural labour as the crop is labour intensive [12].

Since 2015/16 to 2016/17, Ethiopian rice production trends show decrease in both production and productivity [13]. The introduction and expansion of rice production in suitable agro-ecologies and proper storage technology could be an option to achieve food security and self-sufficiency, because rice is not a traditional staple food in Ethiopia, it is considered a high potential emergency and food security crop.

Besides the efforts have been made to generate and promote rice technology in potential areas well, rice post-harvest technologies haven't been introduced and therefore farm household's food demand was not met as expected [14]. The traditional methods of post-harvest handing cause high losses, poor product quality and substantial reduce of income; this is associated with the serious unavailability and lack of access to appropriate tools [15]. Overall, following Aryal et al. [16], farmers' WTP for a given agricultural technologies and post-harvest handling mechanization is a function of knowledge, attitude, and intention even demographic, socio-economic and institutional characteristics such as age, sex, income and accessibility and prices affect purchase behaviour also shape a consumer's WTP because those characteristics affect attitudes toward agricultural technologies. Hence, Farmer level quantitative losses are not adequately documented on rice (Table 1).

Crop type	Area in hectare			Production in quintal			Yield (quintal /hectare)		
	2014/15	2015/16	2016/17	2014/15	2015/16	2016/17	2014/15	2015/16	2016/17
Rice	46,823.22	45,454.18	48,418.09	13,18,218.53	12,68,064.47	13,60,007.26	28.15	27.9	28.09

Table 1: Trends on rice production and productivity in Ethiopia from 2014-17.

Objectives of the study

The general objective of this study was to review farmers' WTP for rice post-harvest handling technology in Ethiopia.

The specific objectives are:

- To review factors affecting the post-harvest and storage materials of rice.
- To review determinants of household WTP.

Methodology

This article is based on intensive literature review of published and unpublished materials like books, articles and other scholarly materials.

Literature Review

Basic concept of rice post-harvest handling

Post-harvest: The period after separation from the site of immediate growth or production. It begins at cutting and ends when the food enters the mouth. For most post-harvest loss studies, the end point is reached when the grain or grain product is finally prepared for future consumption [17].

According to FAO [18], the term 'post-harvest losses' refers to the decrease in edible food yield in quality and quantity throughout the part of the supply that specifically leads to edible food for human consumption. On the other hand, food losses occurring at the end of the food chain (retail and final consumption) are referred to as 'food waste', which relates to retailer and consumer behaviour.

According to Ila'ava [19], post-harvest technology is a series of processes as a part of rice cultivation cycle (Figure 1) and any handling techniques or treatments applied to the economic part of a crop just harvested from the field for the purposes of transforming it into a form, condition, or composition that adds value, makes it storable or prolongs its shelf-life, and makes it usable or edible. Rice is a grain crop and is not immediately available for cooking at the harvest time. Belonging to the grass family, it needs to be field-dried after been separated from its straw and panicles, cleaned of its chaff and any foreign matter in it, and further dried to the required moisture content before it can processed for it to be edible or dried to be stored away for future processing. Several stages of post-harvest handling of rice grains includes field-drying, threshing, shed-drying, cleaning, grading, storing, weighing, and milling before making it fit for human consumption. It is important to observe carefully all the stages of post-harvest handling as each stage will affect the other to determine the quality of grain, mill recovery rate and the minimizes losses that can be controlled.

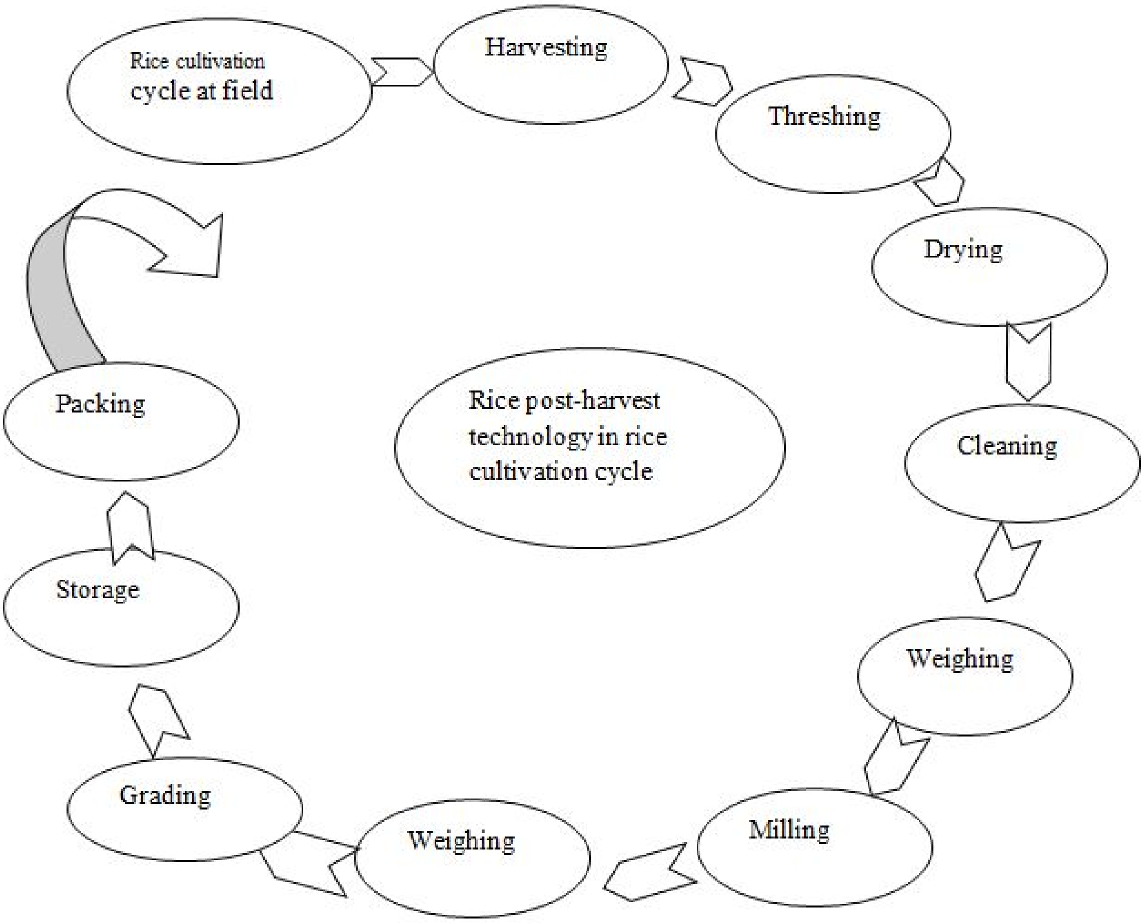

Figure 1: Illustration of different stages of rice post-harvest handling techniques.

WTP: It refers to measures the amount of money the individual is willing to pay for an increase in the quantity or quality of the environmental good. It is the amount that leaves the household indifferent between the expected marginal utility under the old set of technologies and the discounted expected marginal utility of the change in future incomes as a result of the new set of agricultural technologies [20].

Economic valuation of natural resources

According to Bateman et al. [21], "*economic valuation refers to the assignment of money values to non-marketed assets, goods and services, where the money values have a particular and precise meaning*" and refers not only to what people actually pay (direct contribution to the economy), but also includes what people are willing to pay (or give up). Non-marketed goods and services refer to those, which may not be directly bought and sold in the market place.

The Total Economic Value (TEV) that people attach to an environmental good is the summation of use value and non-use value. Use value refers to the benefit people get by making actual use of the good now or in the future. Use value is derived from the actual use of the environment while non-use values are non-instrumental values which are in the real nature of the thing but unassociated with actual use, or the option to use the thing [22]. Similarly, Robinson [23] explained that the TEV of an environmental resource includes use benefits as well as non-use benefits. Use benefits include both direct and indirect uses. Direct use values accrue from the physical use of the good, such as fishing in a river, visiting a national park or production of forestry products. Indirect use values include the service provided by an environmental resource such as water purification, reduced soil degradation, and reduced flood damage. Non-use benefits may be obtained from environmental resources without actually using them. These include existence value, option value, bequest value and vicarious value.

Why economic valuation?

People also value goods and services that cannot be produced without exploiting or damaging natural resources (most market goods). Unlike market goods, the value of environmental goods goes largely unmeasured because markets do not provide these goods. The same source also explained that markets fail to capture the value of environmental and natural resources due to two common market failures:

- The perceived need to take account of environmental damage in measuring economic performance.

- Economists' valuations of environmental damage are now admissible evidence in fixing the compensation to be paid by those the courts hold responsible for the damage.

Factors affecting post-harvest losses and storage materials of rice

Storage plays a vital role in the food supply chain and several studies reported that maximum losses happen during this operation [24,25]. The common storage facilities used by Ethiopian farmers are Gota, Gotera and Sacks. Gota is the best one in terms of maintaining the moisture content, protecting from fire hazards, theft and also to protect from pests but sack is the easiest to easily move from one place to another especially if the grain stays till the flooding time. The indigenous storage structures are made of locally available materials (grass, wood, mud etc.) without any scientific design, and cannot guarantee to protect crops against pests for a long time and them leading to 20%-30% grain losses, particularly due to post-harvest insect pests and grain pathogens [26]. As a result, smallholder farmers end up selling their grain soon after harvest, only to buy it back at an expensive price just a few months after harvest, falling in a poverty trap therefore using metal silo and pics bang an effective grain storage technology for reducing post-harvest insect and pathogen losses in rice while improving smallholder farmers' food security in developing countries (Figure 2).

Figure 2: Improved pics bag and metal silos used for grain storage.

Kaminski and Christiaensen [27] also pointed out the importance of education in reducing PHL. They argue that education combined with economic incentives such as easier access to markets *via* better infrastructure can significantly reduce losses. In addition, Parfitt et al. [28] pointed to the growing need of improving infrastructure, particularly in rural areas, as a key instrument to reduce post-harvest losses. Furthermore, Tefera et al. [29] particularly points out to the specific case of the adoption of metal silos for storing grains in Kenya, whose benefits could be greatly increased if better rural infrastructure was provided. Thus the findings listed above suggest that infrastructure and modern storage materials are an important determinant of the levels of PHL and the potential for reducing PHL.

According to Hagos and Zemedu [30], by using probit model in the case of Fogera District of Ethiopia, households labour availability, education level of the household head, land holding, distance to the nearest village market, proximity to the main market, distance to access agricultural extension, access to the source of rice seeds, access to new cultivars of rice and off-farm income affect the factors that determine the adoption of rice improved varieties.

Study conducted by Mukesh [31] on post-harvest losses of paddy (rice) and maize by using, multiple linear regressions out of ten variables production and education were significant and positive relationship. In addition, other variables such as storage facilities, weather conditions and timely labour availability were found to be negatively significant on paddy post-harvest losses whereas education of the respondent, area under irrigation, timely labour availability, storage and transportation shows negatively significant and all the other variables were found non-significant in the case of maize. According to his finding improvement in storage facilities and timely availability of labour may be minimize losses to a great extent in the case of paddy and for the case of maize the researcher suggested that storage facilities, threshers, transportation and labour should be availability on the required time, then post-harvest losses might reduce from its level.

The post-harvest loss is much more costly than pre-harvest loss both in terms of money and labour requirement. Besides, farmers are forced to sell their produce at throw away prices due to absence of proper storage and marketing facilities and other factors. Accordingly, the magnitude of the post-harvest loss depends, on nature of the commodity, the condition of the produce at the time of harvest, distance travelled and nature of the road network and its quality [32]. Moreover, Grethe et al. [33] noted that socio-economic factors and agricultural technology were the main causes of rice harvest losses in developing countries. They argued that spillage, inefficient retrieval, inefficient processing of rice as well as inadequate machinery, poor operator skills, biological deterioration and infestation by storage pest, poor transport conditions or defective packaging of grain can lead to quantitative packaging of grain leading to quantitative losses of product.

Majumder et al. [25] in their study showed that rice harvest losses directly related to field management as well as the meticulousness of farmers' harvesting operations. A late harvest, for example, can bring about losses from attacks by birds and other pests. Insufficient drying of grain can cause losses from the development of moulds and insects. They also reported that threshing cause losses from broken grains and encourage the development of insects. In addition poor storage conditions can bring about losses caused by the combined action of moulds, insects, rodents and other pests and poor transport conditions or defective packaging of grain can also lead to quantitative losses of product.

The research conducted by Mohammed [34] using multiple linear regression revealed that storage facility; weather condition and labour availability shows significant negative association with post-harvest loses in sample farms. Whereas thresher and transportation factor shows significant positive association with post-harvest loses. Coefficient of storage facility shows there is great scope of improvising storage structure in study area. Labour availability and weather condition was main conditions in reduces post-harvest loses. Moreover, Priefer et al. [35] suggested that rice harvest losses were increased by farmers' poor harvesting operation skills, insufficient government management, and a lack of relevant policies. Liu [36] argued found that inadequate infrastructure, poor awareness of grain saving and loss reduction, lag in harvesting operation technology, and small-scale scattered production were common factors affecting post-harvest rice losses in China and other developing countries.

According to Amentae et al. [37] wheat post-harvest loss in the case of Arsi Zone of Oromia region. By using Tobit model revealed that volume of production and distance to the nearest market place affects post-harvest loss positively on contrary storage facility on filed and at home, and weather conditions, sex of household head, active-age household family size, livestock holding, and, conditions during threshing process and transportations conditions were significance and negatively affect post-harvest losses of wheat. In addition, a descriptive type of research by Tadele [26] investigated the magnitude of post-harvest losses in maize in Africa and its relative effects on food security and ecosystem health and recommended strategies for its mitigation. The researcher found that there were considerable post-harvest losses in both quality and quantity of maize grains. The reasons for these losses were unfavourable weather conditions, outdated harvesting practices, inadequate transportation facilities, and inappropriate storage facilities, limited access to marketing information, temperature and humidity.

Determinants of household willingness to pay

Goktolga and Esengun [38], conducted research on factors affecting the consumers' WTP higher prices for genetically unmodified products: tomato case study in Turkey. By using ordered logit model from gender, age, level of education, household size, monthly household income, status of the mother, monthly food expenditure and concern (level of consumer concern) variable the result indicates that household size and monthly household income had negative effects on the WTP extra, while monthly food expenditure and concern had positive effects.

According to Muhammad et al. [39], on the work of factors affecting consumers' WTP for certified organic food products, by using Ordinary Least Squares (OLS) model from and considering the dependent variable is consumer's expenditure on organic food as a percentage of total food expenditure. The independent variables include awareness, age, gender, nationality, education, monthly income, employment status, and household size. Variables like age, nationality, education, monthly income and household size affect significantly consumers' WTP for organic food. Age has a positive and significant influence on consumers' WTP for organic food, i.e. the result implies that WTP for organic food increases with the age. This finding is slightly different from the findings of other researchers who claim that WTP for organic food is the highest at the middle age (25-40) but our finding has more than one logical reason in its support. First, education and income usually increases with age which also has a positive and significant impact on consumers' WTP for organic food. Second, young people's health consciousness is a rare phenomenon but as the people gets older and the diseases of aging caught up their minds, they become more and more health conscious. Thus as their age increases, more threat is posed by various diseases and hence their WTP for healthier food also increases. The other reason could be a large young expat population working in the low paid jobs and older population represents different ethnic population (local origin) with high income, education and more resources.

Nationality, education and monthly income are the other important factors that influence consumer's WTP for organic food positively and significantly. Education and monthly income has often been sighted as the important factors to influence WTP but nationality, in our findings, is a new variable that turn out to influence consumers' WTP for organic food. As mentioned earlier, this implies that people from emirates origin are more willing to pay for organic food than non-emirates and the reasons are clear; the immigrants are usually low paid workers and lack the necessary knowledge and resources to consume organic food. Household size is usually reported as having negative influence on consumers' WTP for organic food, as feeding more people out of limited resources becomes increasingly difficult. But our findings reveals the polar opposite case, i.e. larger is the household size-the more is their WTP for organic food. The obvious reason for such finding is that majority of emirates population have traditionally a large household size and more resources compared to others.

According to Tolera et al. [40], on the study factors affecting farmers' WTP for extension services in Haramaya district, Ethiopia by selecting 134 households randomly and interviewed using interview schedules prepared for the purpose. The data were analyzed by using both descriptive and econometric model (Logit model). The results of the study from the analysis of determinants of the WTP from logit model showed a significant positive relationship between WTP and household income, and farm size. Other household characteristics such as household age, media exposure, and family size were found negatively and significantly related with WTP. Finally, this study recommended that by targeting farmers, with high level of income, large farm sizes, and household with small family size, the commercialization of extension services would take the advantages of these features and hence their greater abilities to pay for extension services.

Gonfa [41] identifies factor which affect farmers' WTP for improved forage seed in LIVES districts of West Shewa Zone, Ethiopia with the objective of identifying determinants of farmers' WTP for improved forage seed and to assess the seed system in LIVES districts of West Shewa Zone, Ethiopia. The study includes both primary and secondary data. A multi-stage stratified sampling technique was used to collect data from 181 farmers. The data were analyzed using descriptive statistics and econometric model. Contingent valuation method of double bounded elicitation format of contingent valuation method was employed to estimate the parameters in the bivariate probit model. From the result of the study: lack of proper linkage between different actors involved in seed systems; inadequate supply of good quality seed at affordable prices; low level of private sector involvement in the formal system were typical challenges in the seed system of the study area. The response of households' for scenario indicated that the mean WTP for alfalfa, elephant grass, oats and vetch was found to be ETB 173.82, 0.54 per cutting, 39.13 per kg and 28.51 per kg, respectively.

The model results revealed that variables such as family size, farm size, livestock holding, on-farm cash income, initial bids, distance to all weather roads and to input supplying institutions, sex, age and access to credit services were highly significant in influencing the probability of WTP for improved forage seed varieties. Farm size was correlated positively and significantly with the willingness of respondents to pay for alfalfa seed at 5% significance level. The marginal effect of this variable shows that a unit increase in farm size increases the probability of being willing to pay for alfalfa seed by 0.16 keeping other factors constant. Contact with extension agents had significant and positive effect on WTP for alfalfa seed and significant at 1% significance level. The marginal effect value shows that the probability of being willing to pay for alfalfa seed for farmers who have contact with extension agents increases by 0.21, *Ceteris paribus*. Sex of the household head was found to be significantly and positively related to WTP for alfalfa at 5% significance level. The marginal effect value shows that the probability of being willing to pay for alfalfa seed for farmers who were male headed increases by a factor of 0.19, *Ceteris paribus*. Livestock ownership in TLU was found to positively affect the willingness of the respondent to pay at 1% significance level in both equations. The marginal effect of this variable indicates that for each additional increment of TLU, the probability of being willing to pay both for the first and second bid prices for the vetch seed will increase by about 0.03, keeping other variables constant at their means.

Wendimu and Bekele [42] conducted research on determinants of households' WTP for quality water supply, using the Contingent Valuation Method (CVM). The study was conducted with randomly selected households in the factory villages of Wonji Shoa Sugar Estate, Ethiopia. The value elicitation method used is a close ended format questionnaire with additional close ended format, and open ended follow up questions which is closer to the market scenario respondents are familiar with. The empirical model used in this study is the Tobit model. The result of the study revealed that income of the household, education level of the respondent, reliability on existing water supply, respondent perception about quality of the existing water supply, household family size and age of the respondent are significant variables that explain WTP. But from the above variable age, sex and household size negatively affect WTP. The mean WTP for quality water supply is found to be $0.025 per 20 L which is well above the current tariff rate of the Oromiya regional government in Ethiopia.

The study conducted by Kong [43] on the determinants of farmers' WTP and their payment levels for ecological compensation of the Poyang Lake Wetland in China. The CVM and Heckman's two-step model were employed for the empirical study. Results show that 46.58% of farmers are willing to pay ecological compensation, with an average price of $64.39/household per year. The influencing factors that significantly influence farmers' WTP include household income, residential location, emphasis on improvement of wetland resources, arable land area, and contracted water area. In addition, household income, residential location, arable land area, and contracted water area are significantly related to their payment levels.

Biadgilign et al. [44] identify determinants of WTP for the retreatment of insecticide treated mosquito nets in rural area of eastern Ethiopia. By using the Tobit model the result indicates that About 159 (76.4%) of them have received a treated insecticide when they obtained. One hundred twenty five (60.4%) know that the net should be retreated. Around 110 (50.7%), 80 (36.9%) and 27 (12.4%) of the participants feel that the current price of ITNs as negotiable/not as such expensive, expensive and cheap respectively. About 306 (96.5%) of them reported that they support that ITNs be given freely and 257 (82.9%) were mentioned that the retreatment service should be provided without charge. The WTP amounts ranged from 0 USD to 10.4 USD. The mean with SD of the respondents from open ended elicitation method for WTP was 1 USD and 1.53 USD. The reduced Tobit regression models showed that from age, marital status, occupation, family size know the benefit of a mosquito net, family member travel anywhere in the last one month, and malaria can lead to death of children, average income more than 10.4 USD per month and those household who live within a distance in 30 minute to the health facility were the determinant for WTP, therefore producers will pay those improved post-harvest handing technology based on their cost benefit analysis for better reduction of post-harvest loss rice grain.

Conclusion and Recommendations

Conclusion

This reviewed studies conducted on rice in Ethiopia. The issue of post-harvest loss is critical for increasing population and high food demand countries particularly developing countries like Ethiopia. The process of the post-harvest stage starts from harvesting and ends when agricultural commodities marketed at the farm level and there are considerable losses in crop output at all these stages. The main objective of this review was to review farmers' WTP for rice post-harvest handling technology in Ethiopia. The review specifically has focused on factors affecting the storage materials of rice and determinants of household WTP.

However, Ethiopian rice post-harvest loss are generally increased, our qualitative survey and a review of relevant literature show that relatively larger farmers and large-scale producers in the country but loss are higher. Communication media such as television, workshops and demonstration of the metal silos and pics bag in different rural villages among strategies being used by Ethiopian Institute of Agricultural Research (EIAR), Japan International Cooperation Agency (JICA) and The Effective Grain Storage for Sustainable Livelihoods of African Farmers Project (EGSP) project partners to promote such technology for better reduction post-harvest loss of rice grain.

Different authors' studies factors affecting the storage materials and post-harvest loss were analyzed by using econometric model. In most studies out of different variables included family labour, education level, land allocated for rice, access to milling machine, frequency of extension contact, storage facility, and volume of rice production significantly affected. In addition to this determinant of household WTP was affect by income of the household, education level of the respondent, media exposure, and respondent perception about quality of seed, household family size, farm size, livestock holding and age of the respondent and they maximum WTP to improved technology measured by producers cost benefit analysis.

Recommendation

Keeping the finding of the reviewed in the conclusions above into consideration the following recommendations can be suggested those who concerned both governmental and nongovernmental.

- Giving awareness and education both governmental and non-governmental stakeholders should strengthen through establishing Farmers Training Centres (FTCs) ,especially on aspects of rice post-harvest handling practices to bring change in the extent of farmer level post-harvest loss.
- The storage structures should be maintained and select based on alternative and cost-effective and they should be improved pics bag and metal silo considering suitability to local conditions.
- Installation and introducing technology rice production area should greatly help to reduce losses and concerned bodies create an impressive knowledge merit and demerit of the technology.
- There should be sufficient infrastructure and market accesses to deliver their product and the improved technology.
- The media should deliver and announce farmers oriented programs based on production and improved technology.

References

1. CIA (2018) The work of a nation, Ethiopian economy profile 2018. Central Intelligence Agency. The World Fact Book.
2. Bezabih E (2010) Market Assessment and value chain analysis in Beneshangual Gumuze: Ethiopia. SID-Consult-Support Integrated Development.
3. Cock JH (1985) Cassava: new potential for a neglected crop. Westview Press, Boulder, CO, USA, pp: 191.
4. Flowers TJ (2004) Improving crop salt tolerance. J Exp Bot 55: 307-319.
5. FAOSTAT (2001) FAO Statistical Databases.
6. FAO (2001) Workshop on policy support for rapid adoption of hybrid rice on large-scale production in Asia, Hanoi, Vietnam.
7. Evenson RE (2000) Crop genetic improvement and agricultural development. Consultative Group on International Agricultural Research – CGIAR.
8. Balasubramanian V, Sie M, Hijmans RJ, Otsuka K (2007) Increasing rice production in sub-Saharan Africa: challenges and opportunities. Advances in Agronomy 94: 55-133.
9. Diagne A, Alia DY, Wopereis MCS, Saito K, Nakelse T, et al. (2013) Impact of rice research on income, poverty and food security in Africa: an ex-ante analysis. In: Wopereis MCS, Johnson DE, Ahmadi N, Tollens E, Jalloh A (eds), Realizing Africa's rice promise. CABI, Cotonou, Benin, pp: 390-423.
10. Lawrence DS (1992) Marketing and Agribusiness Development Paper No. 1. Department of political Economy. University of Glasgow.
11. Halos-Kim, Leonides (2015) Value-addition, agro-enterprises, partnerships & market access. African Journal of Food, Agriculture, Nutrition and Development 15.
12. Bloom DE, Sachs JD, Collier P, Udry C (1998) Geography, Demography, and Economic Growth in Africa. Brookings Papers on Economic Activity 1998: 207-295.
13. CSA (2016) Estimate of Area, Production and Yield of Crops for Meher Season in Ethiopia.
14. Assefa K, Alemu D, Shiratori K, Kirub A (2011) Challenges and opportunities of rice in Ethiopian agricultural development. Ethiopian Institute of Agricultural Research.
15. Takele A (2010) Analysis of rice profitability and marketing chain: The case of Fogera Woreda, South Gondar Zone, Amhara national regional state, Ethiopia. Haramaya University.
16. Aryal KP, Chaudhary P, Pandit S, Sharma G (2009) Consumers' Willingness to Pay for Organic Products: A Case From Kathmandu Valley. J Agric Environ 10: 15-26.
17. Makki F (2014) Development by dispossession: Terra Nullius and the socialecology of new enclosures in Ethiopia. Rural Sociol 79: 79-103.
18. FAO (2011) The state of food and agriculture: Women in agriculture-Closing the gender gap for development: FAO Rome, Italy.
19. Ila'ava VP (2015) Handbook on Rice Post-Harvest Techniques. Department of Agriculture & Livestock (NDAL) and Japan International Cooperation Agency (JICA), Konedobu, Papua New Guinea.
20. Horna DJ, Oppen MV (2007) Farmer willingness to pay for seed-related information: rice varieties in Nigeria and Benin. Environment and Development Economics, 12: 799-825.
21. Bateman I, Carson RT, Day B, Hanemann M, Hanley N, et al. (2002) Economic valuation with stated preference techniques: summary guide: Department for Transport, Local Government and the Regions, London.
22. Tarfasa S (2007) Household's willingness to pay for solid waste management options: the case of Yekka sub city, Addis Ababa, Ethiopia. School of graduate studies of Addis Ababa University, Ethiopia.
23. Robinson J (2001) A review of techniques to value environmental resources in coastal zones. CRC for Coastal Zone Estuary and Watetway Management, University of Queensland, Australia.
24. Aulakh J, Regmi A (2013) Post-harvest Food Losses Estimation: Development of Consistent Methodology. Agricultural and Applied Economics Association 2013, AAEA & CAES Joint Annual Meeting, Washington DC.
25. Majumder S, Bala B, Arshad F, Haque M, Hossain M (2016) Food security through increasing technical efficiency and reducing postharvest losses of rice production system in Bangladesh. Food Secur 8: 361-374.
26. Tefera T (2012) Post-harvest losses in African maize in the face of increasing food shortage. Food Secur 4: 267-277.
27. Kaminski J, Christiaensen L (2014) Post-harvest losses in sub-Saharan Africa what do farmers say? Global Food Security 3:149-158.
28. Parfitt J, Barthel M, Macnaughton S (2010) Food waste within food supply chains: quantification and potential for change to 2050. Philos Trans R Soc Lond B Biol Sci 365:3065-3081.
29. Tefera T, Kanampiu F, De-Groote H, Hellin J, Mugo S, et al. (2011) The Metal Silo: An Effective Grain Storage Technology for Reducing Post-Harvest Insect and Pathogen Losses in Maize while Improving Smallholder Farmers' Food Security in Developing Countries. Crop Prot 30: 240-245.
30. Hagos A, Zemedu L (2015) Determinants of Improved Rice Varieties Adoption in Fogera District of Ethiopia. Sci Technol Arts Res 4: 221.
31. Mukesh K (2015) An economic analysis and postharvest losses of major cereals in Bastar Plateau of Chhattisgarh. Indira Gandhi Krishi Vishwavidyalaya, Raipur.
32. Pregojin F, Allatn H, Izzat M, Ajalin I, Masri ALM, et al. (2004) Postharvest losses of tomatoes and table grapes: Acta Horticultural Proceedings of the 5th International Postharvest Symposium, Verona, Italy.
33. Grethe H, Dembele A, Duman N (2011) How to Feed the World's Growing Billions: Understanding FAO World Food Projections and Their Implications (Study for WWF Deutschland and the Heinrich-Böll-Stiftung, Berlin).
34. Mohammed A (2015) An economic analysis and postharvest losses of major cereals in northern hills of Chhattisgarh state. Indira Gandhi Krishi Vishwavidyalaya, Raipur.
35. Priefer C, Jörissen J, Bräutigam KR (2013) Technology Options for Feeding 10 Billion People: Options for Cutting Food Waste. Institute for Technology Assessment and Systems Analysis.
36. Liu G (2014) 'Food Losses and Food Waste in China: A First Estimate'. OECD Food, Agriculture and Fisheries Papers 66: 3-29.
37. Amentae TK, Hamo TK, Gebresenbet G, Ljungberg D (2017) Exploring Wheat Value Chain Focusing on Market Performance, Post-Harvest loss,

and Supply Chain Management in Ethiopia: The Case of Arsi to Finfinnee Market Chain. Journal of Agricultural Science 9: 22.

38. Goktolga G, Esengun K (2009) Determining the factors affecting the consumers' willingness to pay higher prices for genetically unmodified products: Tomato case study in Turkey. Br Food J 111: 1188-1199.

39. Muhammad S, Fathelrahman E, Ullah R, Ullah T (2015) Factors Affecting Consumers' Willingness to Pay for Certified Organic Food Products in United Arab Emirates. Journal of Food Distribution Research. Food Distribution Research Society. 46: 1-9

40. Tolera T, Temesgen D, Rajan DS (2014) Factors affecting farmers' willingness to pay for agricultural extension services: The case of Haramaya District, Ethiopia. Int J Agric Sci Res 3: 268-277.

41. Gonfa L (2015) Farmers' willingness to pay for improved forage seed in LIVES Districts of West Shewa Zone, Ethiopia.

42. Wendimu S, Bekele W (2011) Determinants of individual willingness to pay for quality water supply: the case of Wonji Shoa Sugar Estate, Ethiopia. WIT Transactions on Ecology and The Environment, WIT Press.

43. Kong F, Xiong K, Zhang N (2014) Determinants of Farmers' Willingness to Pay and Its Level for Ecological Compensation of Poyang Lake Wetland, China:A Household-Level Survey. Sustainability 6: 6714-6728.

44. Biadgilign S, Reda AA, Kedir H (2015). Determinants of willingness to pay for the retreatment of insecticide treated mosquito nets in rural area of eastern Ethiopia. Int J Equity Health 14: 99.