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FACTORS RESPONSIBLE FOR POST-HARVEST LOSSES AND THEIR EFFECTS ON RICE PRODUCING FARMERS: A CASE STUDY OF AFIFE AND AVEYIME RICE PROJECTSIN THE VOLTA REGION OF GHANA

A. Taiwo[1], A. Bart-Plange[2]

[1]*Associate Professor, Department of Agricultural Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria*

[2]*Professor, Department of Agricultural Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana*

ABSTRACT- ***Agriculture plays a key role in the overall economic performance of Ghana in terms of its contribution to GDP. The sector also plays a very significant role in the food security enhancement, poverty alleviation and employment generation efforts of the Nation. However, in more recent years, there has been a remarkable decrease in the contribution of agriculture to the gross domestic products (GDP). One of the most prominent crops that contribute greatly to the country's GDP is rice. This paper discusses the factors responsible for post-harvest losses in rice production in Ghana using the Afife Irrigation Project located in Ketu-North and Avevime Rice Project located in North Tongu Districts of the Volta Region of Ghana as case studies. First, the socio-demographic characteristics of the farmers and the adopted rice post-harvest technology were examined.The causes of post-harvestlosses in the rice value chain and their effects on the farmers' income as well as possible solutions for ameliorating the losses are then explained. It is finally argued that only an integrated approach to rice production and rural development vis-à-vis a holistic community-based agricultural mechanization can create the path to a balanced economic development in Ghana through rice sufficiency.***

In conclusion, the study revealed that although most of the farmers have some level of education, they still experienced highly unacceptable high level of post-harvest losses of rice during harvesting, threshing, and winnowing. This is because of inefficient use of machinery when available due to poor training of stake holders in operation , repairs and maintenance.. The result of this is incalculable damage done to the crops in the field during bird attack as a result of the ensuing delay in not only harvesting but handling, transportation to processing centres and subsequently all the unit operations that constitute processing.

If the Nation is to achieve an accelerated economic growth, a national agricultural mechanization strategy which holistically integrates agricultural development and rural development with a carefully designed community-based agricultural mechanization and extension must be put in place and implemented. The underlying principles and concept of such a strategy must incorporate all levels of available mechanization from hand tool-based to modern high level technology. This will enable the stake holders in all the socio-economic strata to be carried along without leaving anyone behind. The Nation's agricultural engineers must accept the challenge to design and develop indigenous machines, structures and systems suitable for crop production, harvesting, processing and storage for each of the socio-economic stratum.

Keywords:*Post-harvest losses, Rice value chain, Agricultural mechanization, Food security, Post-harvest technology.*

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1. INTRODUCTION

Agriculture plays a key role in the overall economic performance of Ghana in terms of its contribution to GDP. The sector also plays a very significant role in the food security enhancement, poverty alleviation and employment generation efforts of the Nation. However, in more recent years, there has been a remarkable decrease in the contribution of agriculture to the gross domestic products (GDP). One of the most prominent crops that contribute greatly to the country's GDP is rice. Rice (*Orizaspp*) belongs to the family Gramineae, a cereal grains believed to be next to wheat as, the most widely cultivated crop in the world as well as being the most important food crop among almost half of the world's population [13]. In Ghana, for example, rice production rose from 235,950 metric tons in 2003 to 246,716 metric tons in 2006 representing 4.6% risein domestic production [8]. Despite the rise in domestic production, the consumption of rice far exceeded local production, within the same interval of time, precipitating an increase in the rice imports bill to bridge the supply-demand gap [8]. Production of rice in Ghana is mainly in the hands of small-scale farmers who are still using traditional or unimproved technologies thus creating a wide gap between the actual yield and potential field production which has resulted in low resource productivity [16]. Although considerable priority has been accorded to the production sector in the country, relatively little priority has been given to required post-production activities leading to unprecedented high food losses. Post-harvest management in Ghana, like in most developing countries of the region, is grossly unsatisfactory. Losses incurred as a result of inadequate product handling, lack of access to post-harvest machineries and methods, poor storage and improper distributions methods result in diminished returns to producers.

According to [5], post-harvest losses comprise all changes in the palatability, wholesomeness or quality of food that prevents it from being consumed by people. It may also denote the disappearance of food and should be directly measurable in economic, quantitative, qualitative or nutritional terms. Post-harvest losses can occur during any of the stages in the post-harvest operations (harvesting, threshing, drying, winnowing, storing, milling and transportation).

Post-harvest losses may be either quantitative or qualitative or even both. Quantitative losses lead to a reduction in weight or volume of the final usable product from the potential yield or harvestable paddy while qualitative losses leads to a reduction in value of the usable product due to physical and chemical changes in the rice which diminish the grain size, cause poor appearance, bad taste and foul aroma. Quantitative post-harvest losses of rice in Sub-Saharan Africa are estimated to be between 10 to 22% while qualitative losses could be as high as 50%.

It is imperative to note however, where and why the losses occur in the production chain of Ghana so that measures could be taken that will reduce them to thebarest minimum so that adequate food security could be ensured with consequent minimal rice importation.

There was a lot of effort put into attempt made to increase rice yield by both the local farmers and the government of the Republic of Ghana but to no avail perhaps due to certain production factors not yet understood which may include post-harvest losses as well as untimely and possibly inappropriate cultural practices carried-out by farmers in conjunction with inconsistent government agricultural policies to made specifically improve rice quality, farmers lives and ensuring food security all year round.

1.1 Rice Production in Ghana

Presently, rice is grown and harvested on every continent of the planet earth except the Antarctica, where conditions make its growth impossible. The majority of all rice produced comes from India, China, Japan, Indonesia, Thailand, Burma, Bangladesh and some West African countries. More than 550 million tons of rice is produced annually around the globe with Asian farmers accounting for 92% of the world's total rice production[18]. Globally,it competes with other cereal grains such as wheat oats and barley in terms of cultivation and consumption.

Many African countriesincluding Ghana are making steady progress in rice production; it is currently one of the most dominant cereals cultivated in the country. Rice production in Ghana has been in place since the 17th Century when it was then one of the leading commercial crops. In the Eastern Region, precisely in the Manya Krobo District, cultivation of rice on a large scale started about forty-five (45) years ago after the establishment of rice milling centers by the University of Ghana Research station and some other Non-GovernmentalOrganizations. Volta Region has alsobeen noted for rice production on a large scale particularly inthe Afife Irrigation Project in the Ketu-North District since 1962 and the Aveyime Irrigation Project in North Tongu. The upland fields are used for rain fed rice cultivation while cultivation under the irrigation schemes is in the lowland fields. The commonest varieties of rice grown are TogoMarshall and Jasmine 85 as well as other improved early maturing varieties.

1.2 Major Causes of Post-harvest Losses in Rice Production

The causes of post-harvest losses, which some estimates suggest could range from 15 to as high as 50 percent of what is produced. Post-harvest losses can occur during any of the various stages of post-production system.

The main causes of rice losses in post-harvest operations include: delayed harvesting and threshing, heavy dependence on traditional threshing practices, heavy rainfall during harvesting and drying seasons, lack of mechanical drying facilities, over-boiling or under-boiling instead of steaming the paddy in parboiling, high broken percentage in hulling and polishing, lack of proper technical knowledge [2]. Post-harvest losses result from 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 [8].

In addition, other causes of post-harvest losses are birds attack, poor marketing system, government policies, bumper harvest and poor post-harvest management system. However, some of these factors can be controlled by the producer and the government whilst others are beyond their control.

1.3 Effect of Post-harvest Losses on Rice Production

Goletti and Wolff[10], stated that when post-harvest losses occurred there are effect on: 1) food security, 2) poverty and 3) sustainable use of resources. The study also indicated that poor management practices when adopted by large farm sizes tend to have higher effect on rice loss than when adopted by small farm sizes. However, both quantitative and qualitative losses of rice could have negative impact on the producer since there is serious socio-economic reduction in the output.

On the other hand, the losses incurred by the producer could result in gain for the livelihood of the labourers engaged in manual grain picking when they go back to the field to glean.

1.4 Measures for Reducing Post-harvest Losses

A systematic analysis of production and handling system of all commodities including rice is the first logical step in identifying an appropriate strategy for reducing post-harvest losses. It is important to select the technologies that are appropriate for the size of each post-harvest enterprise [14];[15]. Marketing companies and cooperatives are essential for handling produce and reducing post-harvest losses by providing facilities for accumulating, preparing and transporting produce to markets; by coordinating marketing activities; and by distributing profits equitably to members.

Goletti, [9] listed the most relevant issues for developing countries as: the need for a regulatory framework that promotes growth while safe-guarding welfare; adequate market information to be given to all participants involved; investment in post-harvest research and participation in international agreements that promote trade and food safety.

In addition, a cost-benefit analysis to determine the return on investment in the recommended post-harvest technologies is essential. However, the major constraints continue to be high post-harvest losses, poor marketing systems, weak research and development capacity, and inadequacies in policies, infrastructure, and information exchange [12]. However, rice losses could be minimized by observing the following improved methods and practices: harvest the paddy at proper time (80% of the grains ripening), milling rice with the use of modern milling machines, threshing with mechanical threshers and using current post-harvest technologies to process rice.

Rice experts believe farmers could cut losses by altering production methods, such as moving from hand reaping to mechanical harvesting. As with all agricultural decisions, however, the cost of an improvement is a deciding factor in its adoption. IRRI estimates the cost of its rat-catching systemwhich lasts just for a few seasons as US$400 per hectare. This can be equal to one third or more of the value of a rice crop, and mayeven be too much for a farmer to pay. Government policies are important for minimizing losses, especially where commodity crops like rice and corn are concerned. According to agronomists, policies that promote a stable, sufficient supply of these crops in an open, competitive marketplace stimulate food producers to be more efficient and quality conscious [3].

The former West Africa Rice Development Association (WARDA) now known as the Africa Rice Center (ARC) has recommended that priority should be given to training programs for production and agriculture extension workers to prevent quality deterioration at the farm level and to gradually introduce quality standards both for paddy and milled rice [1].

This main objective of this paper is to show that the factors responsible for high post-harvest losses among rice producing farmers in Ghana can be alleviated by an appropriate mechanization of the rice value chain .The problems of high post-harvest losses cannot, of course be completely solved by agricultural mechanization alone but a dynamic expansion of the agricultural extension to include engineering extension is also essential in order to provide holistic approach to proffering solution to the

problem of post-harvest losses and effects on rice-producing farmers.

Rice grain is lost at every step from harvesting operations to consumption. Post-harvest or post-production losses of rice occur both on farm and off farm levels. The term post-harvest losses in rice production means any reduction in the amount of edible rice grain due to reduction of availability, edibility, wholesomeness or quality that prevents the rice grains from being consumed by people[11] . The reduction in the moisture content of rice grain and the removal of inedible portions such as husk and bran in the process of milling are not considered as post- harvest losses.

Estimates of the post-harvest losses of food grains in the developing world from mishandling, spoilage and pest infestation are put at 25%; this means that one-quarter of what is produced never reaches the consumer for whom it was grown, and the effort and money required to produce it are lost-forever. Estimates of production losses in developing countries are hard to judge [7] . Both quantitative and qualitative losses occur in crops between harvest and consumption. Qualitative losses, such as loss in edibility, nutritional quality, caloric value, and consumer acceptability of the products, are much more difficult to assess than quantitative losses.

A study by the International Rice Research Institute IRRI, in the Philippines has estimated that between 5 to 16 percent of rice is lost in the harvest process, which includes harvesting, handling, threshing, and cleaning [13]. During the post-harvest period, another 5 to 21 percent disappears in drying, storage, milling, and processing. Total estimated losses, not counting later losses by retailers and consumers, run from 10 to 37 percent of all rice grown. FAO reported similar estimates of rice loss in Southeast Asia [4].

Other recent scientific surveys place rice losses in China at 5 to 23 percent (not counting processing), and in Vietnam at 10 to 25 percent under typical conditions and 40 to 80 percent under more extreme conditions [20]; [17] .

A survey that was carried out in 13 member countries of the Africa Rice Center indicated that some major problems common to many countries are inappropriate harvesting and field handling methods which causes serious post-harvest losses and the milling of low quality rice. Harvest and post-harvest losses account for 15 to 50% of the market value of the initial production which equates to a value of $30 to $75 per ton. In 2004, post-harvest losses were estimated to be about 38,000 tons of milled rice equivalent, a value of $20 million per annum. This is not a profitable or sustainable way to farm. In developing countries, post-harvest losses destroy about 15 to 16 percent of the rice crop [6].

Between 10-40% of the food that is grown never reaches the market or a consumer's plate because of insects, birds and rodents that get into storage containers, losses during harvesting and processing, market demand for "perfect" unblemished produce, and other factors[19] ; [4].

To effectively minimize these losses, the following must be done:

There is the need to understand the biological and environmental factors involved in post-harvest deterioration and use the appropriate post-harvest technology procedures that will slow down deterioration and maintain quality and safety of the commodities.

2. RESULTS AND DISCUSSION

2.1 Sex Distribution

Out of the 50 rice farmers interviewed, 41 respondents, representing 82% were males whilst the remaining percentages were females. The result of this study therefore indicated that more males engaged in rice production (industrial crops) than females.

Table 1- Sex Distribution of the Respondents

Sex	Frequency	Percentage
Male	41	82
Female	9	18
Total	50	100

In addition, the study also supports or consistent with the established fact in literature that more females engage in subsistence cropping (produce 70% of subsistence food crops) while most males are into cash crops production in Ghana[19] . Also this percentage of female in rice production could be as a result of the tremendous amount of drudgery involved in rice cultivation.

2.2 Age Distribution

The results in Table 2 indicate that 46% of farmers interviewed fell into the age bracket between 20-39years. Out of these, 42% were between 30-39 years while only 4% were in the 20-29 years age bracket. This suggests that majority of the rice farmers were youths.In addition, 36% of the farmers fell into the middle age bracket between 40-49 years. This indicates that majority of the farmers were

energetic and have the potentiality of growing into a robust rice industry if they are adequately supported. The study also revealed that 12% of the clienteles aged between 50-59years and 6% aged 60years and above. Also more youth in rice production is in the right direction since youth are more receptive to trying new ideas, agricultural technologies and practices which adults can learn from them to increase yield.

Table 2-Age Distribution of Farmers

Age	Frequency	Percentage
20-29	2	4
30-39	21	42
40-49	18	36
50-59	6	12
60+	3	6
Total	50	100

2.3 Level of Education

Farmers' level of education is one of the vital components of increasing productivity in agriculture since productivity intertwines with the use of technology. This means that farmers need to know if not anything at all can read and understand so as to follow the changing trend in technology.

Table 3 -Level of Education of Farmers

Age	Frequency	Percentage
Primary	26	52
Secondary	15	30
Tertiary	5	10
No formal education	4	8
Total	50	100

However, the findings of this study revealed that majority of rice farmers interviewed, had some level of education. Therefore any attempts made to introduce new technology may not be too difficult to accept. In addition, their level of education enabled them to assess or measure their outputs without any delay. Instructions of the used of machines and other inputs with accuracy would not be a problem. However, due to their average level of education, they were able to determine the occurrence of rice losses in the value chain of production.

2.4 Farming Experience

Majority of the farmers (34%) indicated that they have been in the production of rice for 6-10 years followed by the next 30% which had farming experience of 1-5 years.

Table 4- Farming Experience

Farming experience (yrs)	Frequency	Percentage
1-5	15	30
6-10	17	34
11-15	8	16
16-20	5	10
20+	5	10
Total	50	100

Farmers who have experience between 11-15 years constituted 16% of the respondents. The farmers who had cultivated rice for between 16-20 years and 20years above also constituted 10%. This result showed that the farmers were highly experienced in rice cultivation implying that they could be relied upon for sustainable rice production with minimal post-harvest losses if and when provided with the required inputs(Table 4).

2.5 Average Farm Size

Half (50 %) of the farmers studied put 2-3 ha of land under rice cultivation while 40 % cultivated only 1 ha. Only 8 % of them cultivated 4 ha or more.

Table 5- Average Farm Size of the Respondents

Farm size (ha)	Frequency	Percentage (%)
1	20	40
2	18	36
3	8	16
4+	4	8
Total	50	100

These results, therefore, suggest that majority of the rice farmers are small scale rice growers and that they could easily have increased rice yield if appropriate measures are put in place to reduce post-harvest losses. This assertion is backed up by the axiom that says that "production by the masses tends to be more efficient than mass production" (Table 5).

2.6 Adopted Post-Harvest Technologies

The post-harvest technologies that are currently used by the farmers include: harvesting- crop cutting(harvesting) with the use of hand–sickle,combine harvester; crop drying-sun drying on bare concrete floor, tarpaulin; winnowing - use of locally manufactured motorized winnower, traditional manual winnower; milling- the use of CPL150, SB30 and SB10 milling machines.
Increase in rice production has to do with the use of standard technological knowledge base and intensive management practices (Table 6; Table 7).

Table 6- Adopted Harvesting and ThreshingTechnology

Method of harvesting and threshing	Frequency	Percentage (%)
Sickle	33	66
Combine harvester	17	34
Total	50	100

These results revealed that majority of farmers (66%) currently use hand sickle for rice crop cutting (or harvesting) whilst the remaining 34% made use of combine harvester. Similarly 66% of farmers thresh their cut rice with the use of manual method (use of locally made wooden flail on wooden box called atito or "bambam").
Unfortunately more rice was reported lost with the use of combine harvester than with use of the manual devices because the fields were not properly prepared for the use of combine harvesters (combine harvesters cannot work efficiently on fields with excessive surface undulations). The implication of this is that the requisite engineering extension services were either inadequate or not available.

2.7 Effects of Post-Harvest Losses of Rice on Farmers

The impacts of Post- harvest losses (effects of losses) from harvesting (crop cutting), threshing, drying, and milling resulted in low output.

Table 7- AdoptedDrying Technology

Drying facilities	Frequency	Percentage (%)
Tarpaulin	11	22
Bare concrete floor	37	74
Mechanical dryers	2	4
Total	50	100

In addition, loss of rice could result in high importation of rice (high import bill), food insecurity, shortage of food and hunger, high rate of poverty among farmers, poor healthcare, poor education and living standard among the farming population and inability and non-willingness when able to continue production in the next growing season.

Table 8- Effects of Post-Harvest Losses of Rice onFarmers

Effects of losses	Response	Frequency	Percentage (%)
Food insecurity	agree	50	100
Poverty	agree	50	100
Poor healthcare	agree	50	100
Food Shortage and hunger	agree	41	82
	disagree	9	18
Loss of trust and hatred	agree	45	90
	disagree	5	10
inability to continue production	agree	40	80
	disagree	10	20

2.8 Causes of Postharvest Losses

Table 9 shows that delay in harvesting and incomplete threshing, low efficiency in the use of machinery even when provided, irregular rainfall pattern, inadequate

labour and lack of fund and appropriate machinery are the major factors fingered out as the major factors responsible for postharvest losses in rice production in the study area. This position was taken by all the participants interviewed in the study area. The implication of this is that it is not just sufficient to supply appropriate machinery in order to solve the problem of high post-harvest losses. It should also be backed up with well-organized and coordinated training programmes at both the farmers' level and the level of the frontline extension staff of the Ministry of Food and Agriculture (MoFA).

Apart from the afore-listed causes based on the response of all the respondents, other causes of postharvest losses in rice production are improper material handling and drying operations as well as birds attack.

Table 9- Causes of Post-Harvest Losses

Causes	Response	Frequency	Percentage (%)
Delay in harvesting and incomplete threshing	agree	50	100
Improper handling operations	agree	49	98
	disagree	1	2
Improper drying	agree	47	94
	disagree	3	6
Birds attack	agree	48	96
	disagree	2	4
Low efficiency in the use of machinery	agree	50	100
Others (Rainfall, lack of fund, labour, machinery etc.)	agree	50	100

3. CONCLUSIONS

In conclusion, the study revealed that although most of the farmers have some level of education, they still experienced highly unacceptable high level of post-harvest losses of rice during harvesting, threshing, and winnowing. This is because of inefficient use of machinery when available due to poor training of stake holders in operation , repairs and maintenance.. The result of this is incalculable damage done to the crops in the field during bird attack as a result of the ensuing delay in not only harvesting but handling, transportation to processing centres and subsequently all the unit operations that constitute processing.

If Ghana is to achieve anaccelerated economic growth, a national agricultural mechanization strategy which holistically integrates agricultural development and rural development with a carefully designed community-based agricultural mechanization and extension must be put in place and implemented. The underlying principles and concept of such a strategy must incorporate all levels of available mechanization from hand tool-based to modern high level technology. This will enable the stake holders in all the socio-economic strata to be carried along without leaving anyone behind.The Nation's agricultural engineers must accept the challenge to design and develop indigenous machines, structures and systems suitable for crop production, harvesting, processing and storage for each of the socio-economic stratum.

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AUTHORS' BIBLIOGRAPHY

Adewunmi Taiwo
Dr. A. Taiwo is currently an Associate Professor in the Department of Agricultural Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, NIGERIA. He was in the University of Cape Coast, Ghana for about two years as a visiting scholar . It was while here that he worked with some of his colleagues, including Prof. A. Bart-Plange to carry out some research activities which produced this work.
Email: padetaiwo@yahoo.com

Ato Bart-Plange
Prof. A. Bart-Plange is a Professor in the Department of Agricultural Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, GHANA. He was on a two year sabbatical appointment in the Department of Agricultural Engineering, University of Cape Coast, GHANA at the time Dr. Taiwo was there.
Email: abartp@yahoo.com