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Pre-harvest and post-harvest practices along the plantain (*Musa* spp. AAB) fruit value chain in Ghana that predispose them to ripening

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ABSTRACT

The present research sought to find out the practices of farmers and aggregators (wholesalers and retailers) in Ghana that might reduce the shelf-life of plantains (*Musa spp*. AAB). Primary data was obtained from a survey conducted on hundred (100) plantain farms and responses from 754 plantain aggregators from 95 major markets in communities spread across Ghana. There were variations in the planting style of farmers encountered in the study. Practices such as the haphazard planting (not planting in rows) by the farmers in the present study encouraged the growth of weeds, resulting in little aeration around the plants. Most of the farmers (65 to 80%) had good knowledge of plantains diseases. The bulk of the farmers interviewed used visual observation to assess the maturity of the plantain fruits and harvesting was mainly based on market demand. The Ashanti Region served as the main hub for the trading of plantains in Ghana with plantains from this region found in seven (7) out of the ten (10) regions surveyed. Traders preferred not to buy produce from far regions for sale in their region because of increased cost of transportation and hastened ripening of the plantain fruits prior to sale. All (100%) the plantain traders transported the plantains in vehicles meant for cargo or general goods, thus not providing the right conditions for transport of the plantain fruits. It is apparent from this present study that the practices of the various actors along the plantain value chain (farmers and traders) accelerate the ripening and subsequent softening of plantain fruits.

Keywords: Plantains; Ghana; ripening; harvesting; transportation

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Introduction

Plantain (*Musa* spp. AAB), a predominantly tropical crop, is an important staple and source of rural income for inhabitant farmers and aggregators alike of the tropics (Ortiz & Vuylsteke, 1996). Dzomeku *et al.* (2011) stated that plantain cultivation tends to contribute more income to female farmers than to male farmers. Ayanwale *et al*. (2016) reported that there has been little or no change in the cultural practices of the plantain farmers. Though increased research and extension activities have introduced improved production technologies to farmers contributing to the enhanced

livelihood, plantain farmers are still faced with post-harvest losses. As a climacteric fruit, plantains continue metabolic reactions when harvested just like when on the plant (Ayanwale *et al*., 2016; Sugri *et al*., 2010; Shaun & Ferris, 1998). The most important metabolic processes before and after the harvest of plantains have been reported to be transpiration and respiration (Ayanwale *et al*., 2016). These metabolic processes result in the harvested unripe mature plantain ripening within two to seven days after harvest (Robinson, 1996).

Several researchers have conducted studies aimed at extending the shelf-life, at the same time controlling the post-harvest quality of plantains, using storage conditions and treatments like botanical extracts (Kumah *et al.*, 2013), short-term anaerobic conditions (Wendakoon *et al*., 2006), cold shock treatment (Zhang *et al*., 2010), cold storage (Lichtemberg *et al*., 2001) and irradiation (Ofosu *et al*., 2020; Zaman *et al*., 2007). However, these studies may not yield much if the main actors of the plantain value chain made up of the input suppliers, farmers, aggregators (wholesalers and retailers), processors and consumers (Adeoye *et al*., 2013) identified by Dzomeku *et al*. (2011) as important components in the plantain production chain are unaware of their practices that might reduce the shelf-life of plantain fruits. This present study therefore sought to find out the practices of plantain farmers and marketers that might pre-dispose plantain fruits to develop shorter shelf-life.

Materials and Methods

Primary data was collected with structured questionnaires with open and close-ended questions. The survey was conducted on a total of one hundred (100) plantain farms, twenty (20) farms each in the Ashanti, Bono, Central, Eastern and Western Regions, and ninety-five (95) major markets in Ghana. Random sampling was used to select twenty (20) farmers in each study region. A total of seven hundred and fifty-four (754) plantain aggregators and traders from the ninety-five (95) major markets participated in the study.

The questionnaire administered on the farms focused on cultural practices on the farms visited, farmers' knowledge of plantain diseases and post-harvest practices of plantain farmers. The questionnaire administered to the plantain aggregators and traders sought to find out the mode of transport for the produce, type of packaging for transport and whether the plantains were transported as bunches or a mixture of bunches and fingers. Lastly, the questionnaire assessed the storage problems of plantains encountered by the aggregators and traders. The data collected were subjected to analysis of variance using Statistix 10 statistical software. Significant means were separated using Tukey's HSD with 5% level of significance. Graphs were plotted using Microsoft Excel Spreadsheet.

Results and Discussion

General demography of farmers and farms

Majority (95%) of the farmers involved in the farm survey were men. This observation was in contrast to the assertion by Dzomeku *et al*. (2011) that more females than males were involved in the cultivation of plantains. All the farmers had extensive experience in cultivating plantain because the mean number of years of plantain cultivation was 10.7 years. The mean size of the plantain fields was 3.3 acres. These observations were similar to the findings of Dzomeku *et al*. (2011) that plantain farmers usually have over a decade of plantain farming experience and these are usually by small-scale producers (FAO, 2015). The demography of the farmers in the present study gives an indication that these small-scale farmers, predominantly

men, should be able to effectively carry out the necessary cultural practices on their farms and not rely on hired labour (Tarjem & Tufan, 2023; Meinzen-Dick *et al*., 2012).

Planting style, field sanitation, and weed control

There were wide variations in the planting method of the farmers (Fig. 1). A greater number of farmers in the Eastern (80%) and Ashanti Regions (75%) planted in rows; whereas in the Western (70%), Central (60%) and Bono (50%) Regions, a similar greater number of farmers did not adopt any proper planting pattern (Fig. 1). These notwithstanding, in the Western Region, 30% of the farmers adopted row planting while 25% of the farmers also adopted row planting in the Central and Bono Regions. The bulk of the farms were weedy at the time of visit (Table 1). However, few farmers were in the process of clearing the weed on their farms. Only nine (9) farms were entirely free of weeds. This was indicative of bad farm hygiene practice by the farmers in this study.

The practices such as the haphazard planting (not planting in rows) by the farmers in the present study encouraged the growth of weeds (Abouziena & Haggag, 2016), and provided little aeration around the plants (Azme *et al*., 2016). Weeds are considered to be the second most important constraint to plantain production (Banful *et al*., 2008). An unkempt farm can serve as the perfect habitat for the spread of diseases (Banful *et al*., 2008). The improper positioning of plantain plants in the present study might lead to overcrowding, providing very little room for aeration (Azme *et al*., 2016), and causing the trapping of humid air and ethylene produced from ripening fruits (Mamnoie & Dolatkhahi, 2013). This quickly spread to neighbouring plants and hasten ripening, consequently reducing storage life. The practice of pruning the dead plantain leaves by the farmers in this present study should be encouraged. The presence of such leaves drooping over fruits may hasten ripening of the fruits by trapping pockets of humid air and creating a favourable environment for fungal diseases. Pruning of *Musa* leaves has been reported not to affect the green life (Robinson & Anderson, 1990).

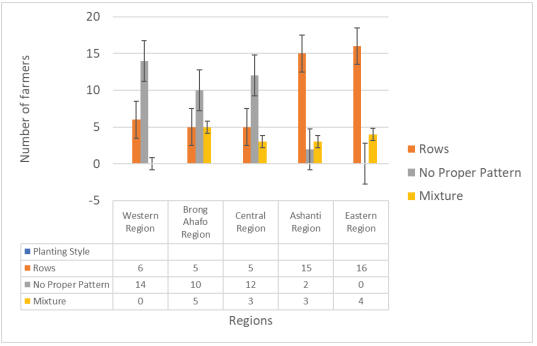

Fig.1: The planting method of plantain farmers in five regions of Ghana

TABLE 1
Weed clearing practice of farmers

	Western Region	Bono Region	Central Region	Ashanti Region	Eastern Region
Yes	1	1	1	4	2
No	11	15	14	11	10
Half cleared	8	4	5	5	8

Knowledge and source of knowledge of plantain diseases among farmers

Except for Bono Region, most of the farmers (65% to 80%) in the other regions had good knowledge of plantains diseases (Fig. 2). In all the regions, except Central Region, the farmers had their knowledge of plantain diseases from Agricultural Extension Agents (Fig. 3). Only a few farmers in the Brong Ahafo Region indicated that they had gotten their knowledge of plantain diseases through literature search. Other farmers also relied on information from

colleague farmers (Fig. 3). Knowledge of plantain diseases would ensure that the farmers kept their farms in a state that would not encourage the proliferation of these diseases (Kiros-Meles & Abang, 2008).

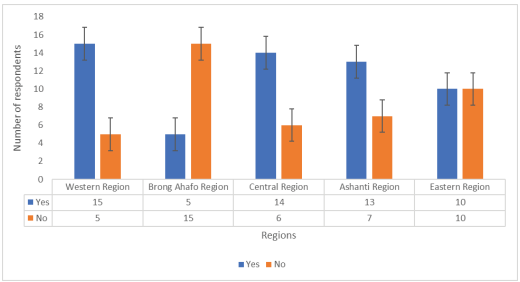

Fig. 2: Farmers' knowledge of plantain diseases

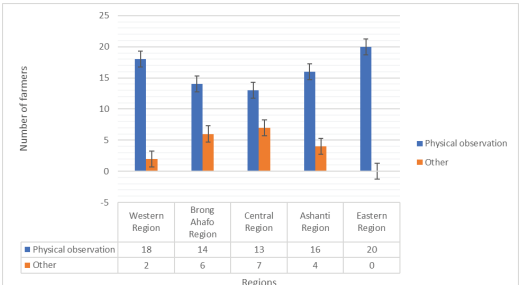

Fig. 3: Farmers' sources of knowledge of plantain diseases

Assessment of maturity and time for harvesting of plantain fruits

Majority (81%) of the farmers interviewed used visual observation to assess the maturity of the plantain fruits (Fig. 4). The others (19%) used the time from planting as the main method of assessing maturity. Harvesting was done mainly based on market demand once the maturity period had been reached. Generally, however, farmers left the fruits on the plant prior to sale instead of harvesting and storing them.

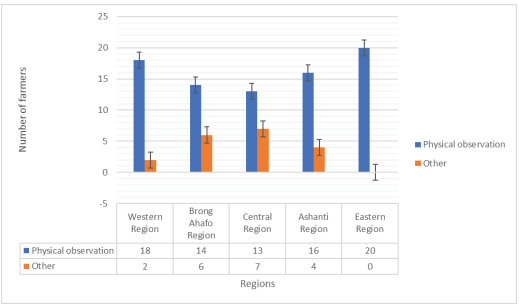

Fig. 4: Methods of assessment of plantain fruits maturity by farmers

Maturity at harvest is the most important factor that determines postharvest-life and final quality such as appearance, texture, flavor, and nutritive value of fruits (El-Ramady *et al*., 2015). Plantain fruits harvested too early (before 12 weeks) may lack flavor and may not ripen properly, while produce harvested too late may be fibrous or have very limited market life (Mejía-Gutiérrez *et al*., 2012). The use of the visual method by farmers in the present study in assessing maturity can lead to the fruits being harvested when they are past physiological maturity. This is also evidenced by the short time between the harvesting and the start of ripening as reported by most of the farmers.

Mejía-Gutiérrez *et al*. (2012) suggested that the best harvesting age for plantain is 16 weeks after flowering because the fruits will have an acceptable appearance thus making it suitable for national and international markets. Some plantain farmers depend on the fruits having a marketable life and target market for which fruit is intended before harvesting their fruits (Robinson, 1996; Thompson & Burden, 1995). Klee (1993) indicated that leaving the fruits on the plant beyond physiological maturity would result in the fruits having significantly more internal ethylene than the

detached fruits. Consequently, the practice found in the present study where farmers tend to leave their fruits on the plant, hoping to slow down its ripening is not recommended since it rather hastens the ripening process (Koratkar, 2017).

Storage of plantain fruits, problems encountered and proffered solution

Most (60%) of the farmers "stored" the harvested plantain fruit in the open prior to sale (Table 2). None of the respondents stored their plantain prior to sale in polyethylene bags. Most of the respondents in the Ashanti Region preferred to leave the plantain fruits on the plants than harvest and store prior to sale. These fruits would ripen quicker (Klee, 1993), rather than remain green for longer as anticipated by the farmers. Some farmers stored their fruits under trees and covered them with plantain leaves for a day or two days. At the markets, some stored in stalls.

The two most important problems aggregators/traders encountered were rodents and insect damage and ripening. To overcome some of these challenges, aggregators/traders who had problems with fruits ripening sold off the ripened fruits at a lower price to food processors who used them for "kaaklo", "kelewele" and for frying for sale with cowpeas. The rodent-damaged and insect-damaged fruits were sold to livestock farmers for the feeding of pigs and other livestock.

TABLE 2
Storage of plantain fruits after harvest

Storage Material	Number of respondents					Mean
	Western Region	Brong Ahafo Region	Central Region	Ashanti Region	Eastern Region	
Open	12	14	16	2	16	12.0
Poly bags	0	0	0	0	0	0.0
Jute	0	3	1	0	0	0.8
Basket	0	2	0	1	2	1.0
Other	8	1	3	16	2	6.0

Tukey HSD (0.05): Storage material = 8.399

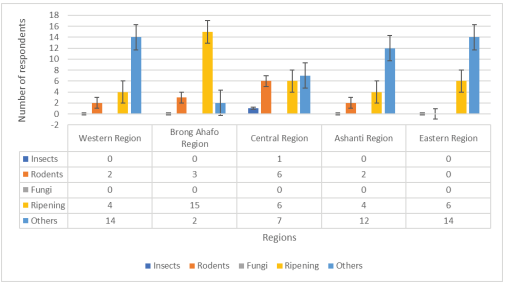

Fig 5: Problems encountered by traders during storage of plantains

Source plantains for purchase

Most (53%) of the aggregators interviewed obtained their fruits from either the Ashanti Region or the Bono Region (Fig. 6). The Ashanti Region served as the main hub for the trading of plantains in Ghana (Fig. 6). Produce from this region was found in most of the other regions of Ghana. The Bono, Eastern and Central Regions also served as the source of the plantain fruits for at least five (5) of

the regions of Ghana. There was the trend of traders not buying produce from far regions for sale in their region. The aggregators asserted that buying from far places increased the cost of transportation and also hastened the rate of ripening of the fruits before they became ready for sale.

These fruits were mainly transported in open trucks (52.31%) that are not made to purposely transport plantains. The environmental conditions during storage and transit of climacteric fruits determine the rate at which the fruits eventually submit to senescence (Leleń & Wasiak, 2018). The temperature of the transported goods must be maintained at an optimal level to extend the shelf life (Leleń & Wasiak, 2018; Van Zeebroeck *et al*., 2007). In the present study, majority of the plantain traders transported the plantains in general purpose vehicles. This implies that the right temperature for the transport of the fruits would not be provided.

TABLE 3
Type of transport of plantain fruits by aggregators

Type of transport	Vans	Open trucks	Tricycles	Others
Number of aggregators	210	443	143	51
Percentage	24.79	52.31	16.88	6.02

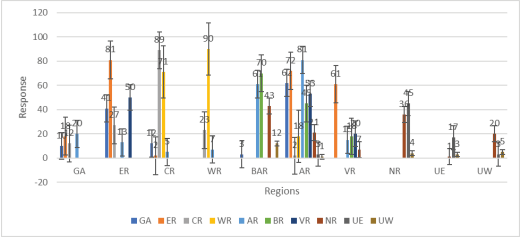

Fig 6: Sources of plantain fruits for purchase by traders (GA = Greater Accra Region; ER = Eastern Region; CR = Central Region; WR = Western Region; BAR = Brong Ahafo Region; AR = Ashanti Region; VR = Volta Region; NR = Northern Region; UE = Upper East Region; UW = Upper West Region)

As a climacteric fruit, plantain tends to undergo many physiological changes during storage and transportation (Sharma & Singh, 2000). However, all small scale plantain farmers do not even practice the basic postharvest methods such as cooling, sorting, and grading (Nartey, 2011). As a consequence of this, the fruits are lumped together, resulting in ripening fruits getting mixed with unripe green mature fruits (Asante-Kyei *et al*., 2019). Such an observation was also made in the present study. Furthermore, fruits harvesting was mostly done in the afternoon when the internal temperature of the fruits would have increased, and hence served as a catalyst in the ripening process.

Conclusion and Recommendation

Farmers generally had good knowledge of plantain cultivation practices. However, most of the farmers relied on market availability to harvest their produce, which could be after the plantain fruits have reached physiological maturity. Plantains harvested by the farmers in the present study were not stored in any proper way prior to sale to aggregators/traders. It was discovered that certain practices of plantain traders, for example, transporting in vehicles that are not particularly suited to transport plantains tend to accelerate fruit ripening and subsequent softening of fruits.

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