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CASE STUDY

Yieldwise model adoption on post-harvest loss reduction and livelihood of smallholder maize farmers in the Wa Municipality of Ghana

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Abstract

This study sought to assess the impact of adoption of the YieldWise model on postharvest loss reduction and livelihood of smallholder maize farmers in the Wa Municipality using an established crop aggregation center, Antika for a case study. The study employed random and purposive sampling techniques to sample 140 smallholder maize farmers and 10 Antika crop aggregation center managers in the Wa Municipality. A well-structured questionnaire was used to obtain data from the selected sample population. The findings revealed that the timelines of input supply, ready market, access to extension service, availability of recommended inputs, and training on post-harvest loss reduction are factors influencing the adoption of the YieldWise model by smallholder farmers in the Wa Municipality. The availability of recommended inputs was the main influencing factor, followed by access to extension service, while ready market was the least. The introduction of the YieldWise model had an impact on the harvesting and postharvest loss reduction among smallholder maize farmers in the selected study area. The adoption of the model contributed to a reduction in harvesting losses by an average of 46.24 kg/ha (25.66 %), reduction in shelling and threshing losses by 28.11 kg/ha (19.74 %), reduction in storage losses 12.85 kg/ha (54.99 %), whereas transportation losses remained almost same, thus, 0.62 kg/ha and 0.68 kg/ha for Antika and non-Antika farmers respectively. The study revealed that, the adoption of the YieldWise model by Antika for it business operation has contributed to the improvement of the livelihood of smallholder maize farmers in the Wa Municipality. Many farmers (30.4 %) could secure food for their families throughout the year, 26.5 % could pay for their children's school fees, 17.1 % of the farmers have been able to purchase a motorcycle or tricycle, 11.1 % of the farmers have been able to expand their main occupation, 10.6% have built new houses, and 4.3 % have been able to marry. The study recommends that a ready market is incorporated into the YieldWise model to help farmers market their produce promptly. The model should also consider transportation assistance to smallholder farmers to reduce transportation losses.

Keywords: YieldWise Model, Smallholder Maize Farmers, Postharvest Loss, Wa Municipality

Introduction

Maize thrives in almost every region of Ghana. Maize is the most important cereal grain produced in Ghana, accounting for 74 % of total cereal production (MoFA, 2011). In 2019, Ghana recorded a record output of 3.06 million tonnes (MoFA, 2020). It can be grown in the country's northern savannah, transitional, forest, and coastal savannah zones. Maize production season is June-October in the Northern region; however, maize is left in the field to dry until late November/December exposing the maize to many postharvest loss factors (Opit *et al*., 2014). The maize market in Ghana is dominated by small-scale traders, most of whom are women. The farmer/seller, the local assembler, the commission agent, the long-distance wholesaler, and the market-based wholesaler/market-based retailer are the five primary participants in the maize trade (Obeng *et al*., 1990).

Post-harvest operations such as drying and storage are among the essential areas along the maize value chain for small-holder farmers and traders. In Ghana, on-farm drying and storage are predominant postharvest practices used by small-scale traders. However, smallholder farmers and traders frequently experience grain losses owing to insect infestation, mould growth and discoloration as a result of improper postharvest handling procedures (Akowuah *et al*., 2015). Post-harvest loss of maize is a threat to food security and also causes financial loss to farmers and the nation as a whole.

Reducing postharvest cereal losses along the supply and value chain could be one efficient strategy to assist boost food security, combat hunger on a long-term basis, reduce the amount of agricultural land required for production, promote rural development, and improve farmers' livelihoods. Many institutions and organizations have taken measures to minimize postharvest loss of food, and notable among them is The Rockefeller Foundation. The Rockefeller Foundation has in the recent past introduced an initiative to connect various actors along the maize supply and value chain to reduce postharvest losses and increase farmers' income. The YieldWise initiative of the Rockefeller Foundation aims to minimise post-harvest loss by at least 50 % across various agricultural value chains in Africa while also increasing small-holder farmers' earnings by 15 % (Rockefeller Foundation, 2015). The YieldWise model aims to reduce postharvest loss by providing processors with a constant and predictable market, as well as training, input, and funding, and ultimately turning food that would have been lost into money for farmers. Furthermore, by connecting smallholder farmers and processors, the supply chain would be more stable due to continuous and available sufficient quantities of high-quality raw materials.

To date, many innovations and initiatives developed to address the many causes of food loss in Africa have either failed to reach the intended targets or have failed to provide the anticipated results. This largely has been due to the lack of awareness about the interventions or their high cost making it difficult for farmers to purchase or pay for their use. The YieldWise model is an excellent management tool that help operators of grain handling facilities that deal with farmers to provide all the needed resources that help to address their challenges after harvesting to marketing of their grains.

Since the introduction of the YieldWise model, no study has been done in Ghana to assess its impact on postharvest loss reduction and the livelihood of small-holder grain farmers. This study, therefore, is a case study of the adoption of the YieldWise by a Crop Aggregation Center, Antika Company Limited

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and its impact on the postharvest management of grains and the livelihood of small-holder farmers operating as out-growers for Antika in Wa Municipality of the Upper West region of Ghana.

Materials and Methods

Location of study area

The Wa Municipality is one of the nine districts/municipal assemblies in the Upper West Region of Ghana. The Upper West Region is in Ghana's north-western corner, bordering Ivory Coast to the west, Burkina Faso to the north, the Upper East Region to the east, and the Northern Region to the south. Wa is located between the latitudes of 1° 40' N and 2° 45' N, and the longitudes of 9° 32' W and 10° 20'W. It covers around 234.74 square kilometres, or about 6.4 per cent of the region's surface mass (Yahaya, 2012). The geographical setting of the study area is shown in Figure 1.

Antika crop aggregation centres at Wa Municipal

Antika Company Limited was founded and incorporated in Ghana in 2004 under the laws of the 1962 Ghana Private Company Act (179) which has now been replaced with the company Act, 2019 (Act 992). The company is based in Wa, the regional capital of Ghana's Upper West region. Antika Company Limited's core mandate is the production of high-quality seeds, as well as the distribution and sale of agro-inputs such as fertilizer, agro-chemicals, seeds, and simple farm tools to small-scale farmers at affordable prices. Another goal of Antika Company Limited is to increase farm productivity and income among small-scale farmers in the Upper West region and Ghana as a whole (Kanyiri, 2019).

Experimental design

This study was conducted in two phases. The first phase consisted of a field survey of sampled maize farmers in Wa Municipal and the managers of the Antika Crop Aggregation Centre. The second phase of the research comprised a field experiment on the postharvest loss of maize in selected farmer fields as well as the analysis into the livelihood of farmers who work as out-growers for Antika Company Limited.

Population

Wa Municipality was selected for the study since it was envisioned that a higher percentage of maize farmers who are beneficiaries of the YieldWsie model are from the Municipality. The Municipality also has many maize farmers and crop aggregation centre managers who are considered key to achieving the study's objectives.

Sampling techniques

Simple random sampling was used to select respondents using the lottery method since the list of all beneficiaries was available. Beneficiaries who were selected but could not participate were replaced through the same process. The use of stratified and simple random sampling ensured randomness, fair distribution, reliability and representativeness of the sample.

The purposive sampling technique is employed when the respondent is selected on grounds that the respondent suits the purpose of the study (Durrheim and Painter, 2006). Purposive sampling was employed in selecting the managers of the Crop Aggregation Centres who oversee the implementation of the YieldWise model at Antika Company Limited in the Wa Municipality and other stakeholders. They were selected based on their direct involvement in the implementation of the YieldWise model and knowledge about the nature of its operation. Table 1 highlights the estimated study population and sample size used for the study.

Table 1 Estimated population and sample size of respondents

Sample Frame	Population Size	Sample Size
Farmers	550	140
CAC Managers	20	10
Total	570	150

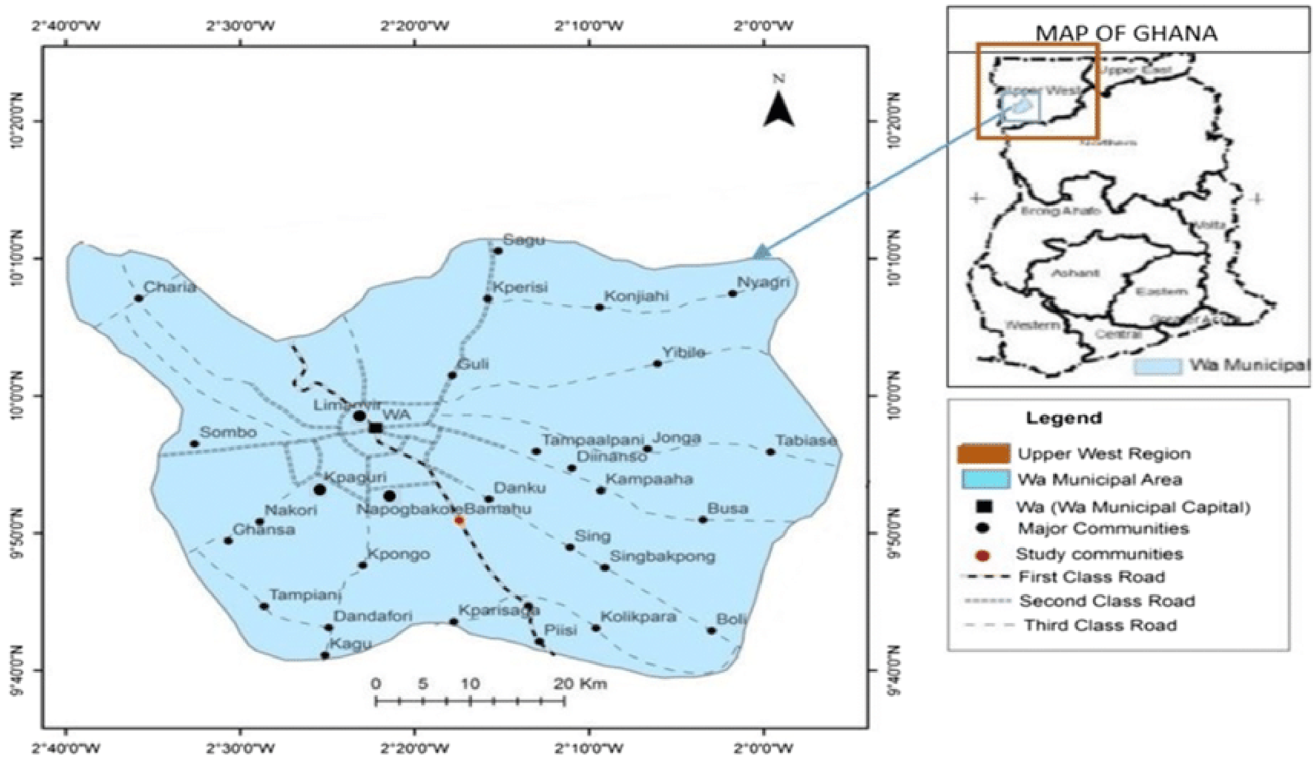

Figure 1 Map of Wa Municipality (Source: Yahaya, 2012)

Data collection

A survey involving the use of structured questionnaires was used for this study. The questionnaire was created based on existing literature on the YieldWise model. The questionnaire was the primary source of data collection. Among the key issues raised in the questionnaire include the views of maize farmers and managers of Antika Crop Aggregation Centre on the factors influencing the adoption of the YieldWise model by small-holder maize farmers in Wa, the influence of the model on postharvest reduction, and the impact on the livelihood of the farmers. A pilot survey was conducted in a Wa suburb to identify any loopholes in the questionnaire, which were then corrected to guarantee the validity and reliability of the research instrument, that is, the questionnaires were appropriate and relevant. Farmers were communicated to in English, *Waali* and *Dagaare*.

Field analysis

A total of ten (10) farmers were selected from 10 farmer base organizations (FBOs) since each FBO had a total of fifteen (15) farmers and another group of 10 farmers were also selected from nearby communities whose FBOs are not benefiting from the YieldWise model.

Determination of harvesting losses

The farmers under the farmers base organisation have farm sizes not less than 5 acres of maize farms. Therefore Five (5) acres from each of the selected farmers' fields were marked out and harvested as practised by the farmer during harvesting. This was used to estimate the quantity of maize lost during harvesting. According to MOFA (2012), an average of fifteen (15) maxi bags (100 kg/bag) of maize grains is often obtained from one acre of maize field. Therefore, the calculation of the total loss of maize from the farmers' field according to this research was computed by subtracting first harvest from the total harvest (ie, 1st harvest + gleaned quantity). Where gleaned quantities are maize grains recovered from the demarcated area after harvesting has been completed.

Determination of shelling/ threshing losses

Two different types of shelling/ threshing methods are practised by the farmers in the study area, these are the use of shelling/ threshing machine and or beating maize cops stack in bags. In both methods, losses were determined by collecting the cobs and chaff after the first threshing/shelling and carefully hand threshed/shelled by picking the grains and also carefully winnowing the chaff.

The total maize grains recovered after (both the first and second) threshing/shelling represented the estimated quantity of grains obtained during the entire threshing/shelling process. Losses during threshing/shelling was determined after subtracting first round shelling from entire produce after shelling where the number of grains received during second threshing/shelling was subtracted from the entire maize grains recovered after the threshing/shelling of the maize grains.

Determination of losses during transportation

The farmer's way of conveying produce from the field to the house for storage was considered. This was done in various ways and included the use of head pans, donkey/bullock carts, bicycles, motorbikes, tractors and trucks. The assessment was done by first weighing the maize on the farm to know the quantity to be transported. The transported produce was reweighed at home to know the quantity lost through transportation. The quantity lost was determined by deducting reweighed quantity from the total quantity that was weighed earlier.

Determination of losses during storage

Each of the farmers was made to store four (4) bags (100 kg) of maize using the farmers' routine approach of storage for a period of four months, from 30th November 2020 to 30th March 2021. At the end of each month, a sample of fifty (50) grams of grains were collected from each of the bags from the top, middle and bottom portions to determine the following:

- Number of grains made up of 50 g.
- Number of grains with holes in 50 g.
- Number of weevils present in 50 g of grains.

Mouldiness was determined using the colour appearance technique, where yellowish, grey and greenish grains were collected and separated. At the end of the four months (120 days) the pre-weighed bags of grains were reweighed. Storage losses were calculated by subtracting the final weight from the initial weight.

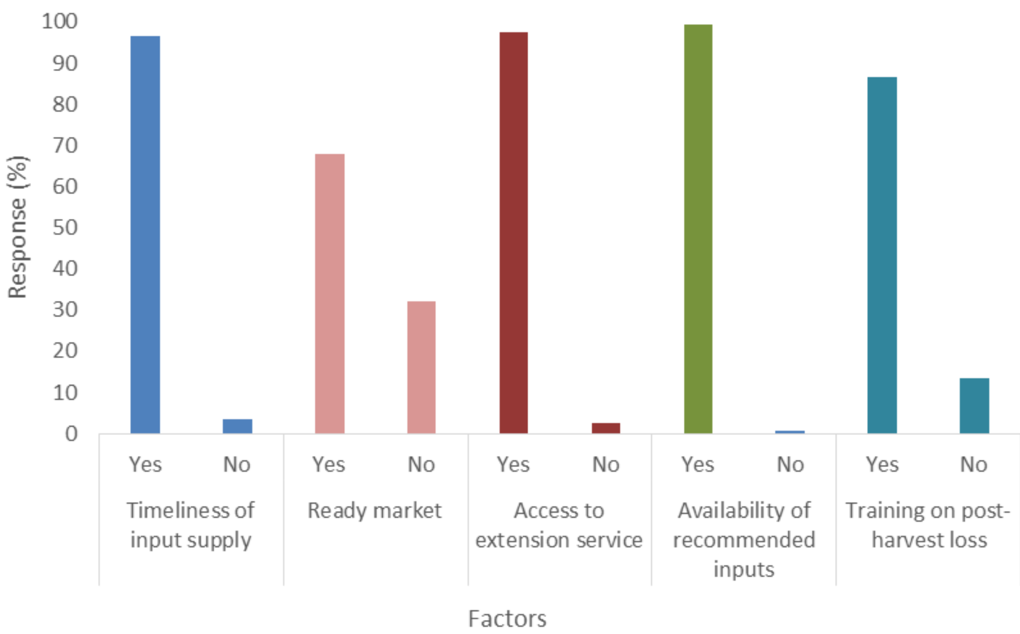

Figure 2 Factors influencing the adoption of the YieldWise model by smallholder farmers in Wa Municipal

Method of data analysis

Statistical software, R-studio and Microsoft Excel were used to analyse the data collected from the field experiment. Descriptive and inferential statistics were used to arrive at conclusions. Frequency distribution tables and charts were used to establish relationships between data variables.

Results and Discussion

Factors influencing the adoption of the YieldWise model

From the analysis of survey data, it was noted that the factors identified to be influencing the adoption of the YieldWise model include timeliness of input supply, ready market, access to extension service, availability of recommended inputs, and training on post-harvest loss management. The statistical presentation of the identified factors is presented in Figure 2.

Analysis of responses from farmers showed that factors such as timeliness of input supply, ready market, access to extension service, availability of recommended inputs, and training on post-harvest loss management are factors which influenced their decision to participate in the Antika scheme which is operated on the YieldWise model.

In Figure 2, 99.3 % of farmers who were involved in the survey attested to the fact that the availability of recommended inputs was the main factor for the adoption of the YieldWise model, whereas only 0.3 % did not consider availability of recommended inputs as an influencing factor for adopting the YieldWise model. It can be deduced from the results that under the YieldWise model the inputs provided to farmers meet the needs of the farmers. The availability of recommended inputs was the highest recorded influencing factor for the farmers operating under the YieldWise model, followed by "access to extension service". Analysis of the results revealed that 97.3 % considered access to extension service as an influencing factor. The results imply that knowledge of agricultural practices through farmer education has an influence on farming activities of farmers in the Wa Municipality. The timeliness of input supply was the third highest factor farmers considered as important in relation to the YieldWise model.

Also, the survey results revealed that 96.7 % of farmers considered timeliness of input supply was as a key factor that influenced their adoption of the model, whiles 3.3 % did not consider the timeliness of input supply. Thus, inputs are supplied to majority of farmers at the appropriate time when it is needed. The next influencing factor is the training on post-harvest loss management. According to the results, 86.7 % farmers revealed that the regular training the received on post-harvest loss management was an important factor they considered in adopting the YieldWise model.

The ready market was the least among the factors influencing the adoption of the YieldWise model by the farmers. The results showed that less than three quarters (68.0 %) of farmers considered the ready market as a factor for adopting the YieldWise model. It can be inferred from the results that the ready market provided to farmers under the model is not adequate or some farmers already have a ready market for their produce.

Impact of YieldWise model on post-harvest loss reduction

Maize losses are identified to occur at different postharvest stages during shelling, winnowing, bagging, storage and transportation. The statistical presentation of the losses recorded at the various stages in comparison between farmers operating as out-growers for Antika and farmers who were operating on their own is presented in Figure 3.

Figure 3 highlights the average losses of maize that occurred at different stages for farmers under the YieldWise model compared to farmers who are not under the YieldWise model. The results revealed that the highest average loss of maize occur during harvesting by non-Antika farmers, 188.01 Kg/ha, as Antika farmers recorded a 139.77 Kg/ha average loss of maize during harvesting. Thus, the postharvest training farmers received under operation of the YieldWise model by Antika Company Limited contributed to the savings of 46.24 Kg/ha (25.66 %) of maize losses during harvesting.

Non-Antika farmers recorded the highest average shelling and threshing losses, thus 142.40 Kg/ha whiles Antika farmers recorded 114.29 Kg/ha average shelling and threshing losses. It can be inferred from the results that the training and services provided farmers by Antika under the YieldWise model made

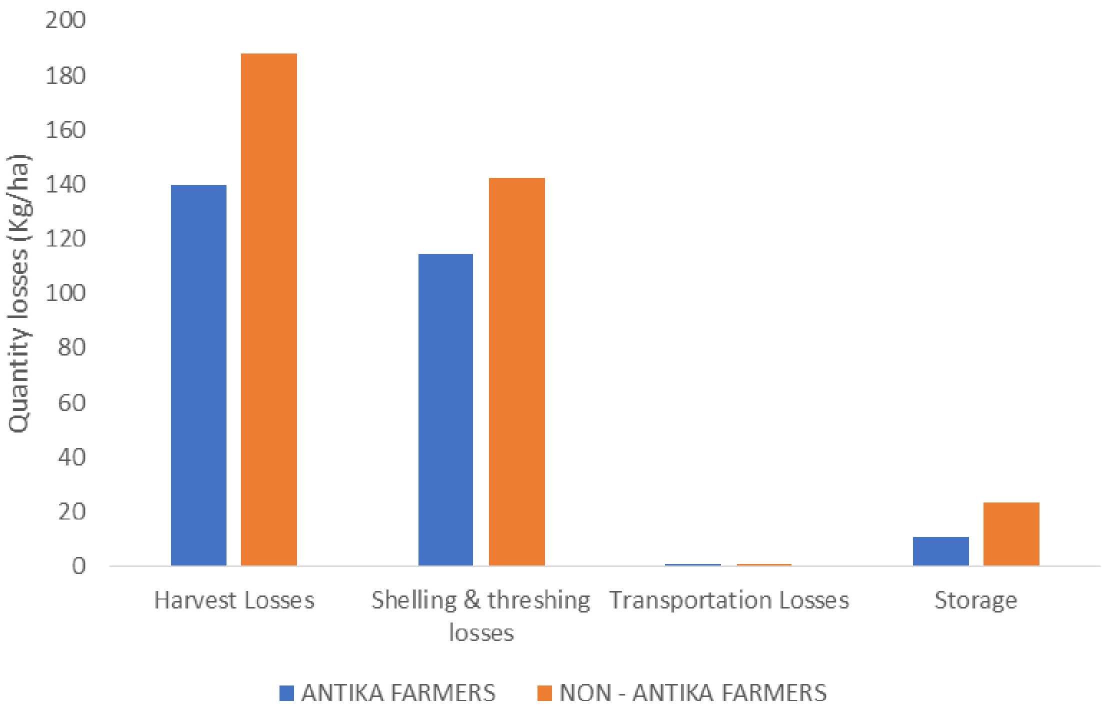

Figure 3 Average losses of maize between Antika framers and non-Antika farmers in Wa Municipal

savings of about 28.11 Kg/ha (19.74 %) on average on losses during shelling and threshing. Sugr *et al*. (2021) reported that postharvest losses in maize decreased from 36.7 % to 3.1 by disseminating appropriate technologies and training to farmers in the Upper West Region of Ghana. However, the average transportation loss of maize recorded by farmers under the Antika scheme and non-Antrika farmers was almost the same at recorded average transportation losses of 0.62 Kg/ha and 0.68 kg/ha respectively.

Analysis of the storage losses shows that the highest average storage loss of maize (23.37 Kg/ha) occurred among the non-Antika farmers, whereas Antika farmers recorded 10.52 Kg/ha. The results indicate that the initiative under the YieldWise model caused an average of 12.85 Kg/ha (54.99 %) reduction in storage losses. From the results, the relatively low quantity of harvesting losses, shelling and threshing losses, transportation losses, and storage losses of maize among Antika farmers as compared to non- Antika farmers could be attributed to the inputs supplied to farmers and the training on postharvest loss reduction provide under the model as showed in Figure 3.

Impact of YieldWise model on the livelihood of smallholder maize farmers

Maize farmers under the YieldWise model use their income in diverse ways to improve their standard of living. Figure 4 is the statistical presentation of how smallholder maize farmers in Wa have been able to improve on their livelihood under the YieldWise model.

According to the findings, some farmers have been able to; secure household food, sponsor child education, purchase motorcycle/tricycle, expand occupation, built houses for themselves, and been able to marry from the income of their farm produce. Analysis of the results showed that majority of the farmers (30.4 %) can secure food for their families all year round. This implies that after joining the Antika scheme operating with the YieldWise model, at least farmers are always able to provide for the primary needs of the family. It was also revealed that after the adoption of the YieldWise model, 26.5 % of farmers can sponsor the education of their children, while 17.1 % have been able to purchase motorcycle/tricycles from their farm income.

Again, analysis of the results revealed that 11.1 % of the smallholder maize farmers have been able to expand their occupation after the adoption of the YieldWise model, and 10.6 % attested that they have been able to build a new house for themselves. Few farmers (4.3 %) attested that they have been able to marry from the generated income from farming. All farmers attested to have improved on their livelihood after adoption of the YieldWise model. The findings were in line with The Rockefeller Foundation (2015), which stated that actions designed to reduce post-harvest losses have a direct impact on food security and the livelihoods of smallholder farmers in Sub-Saharan Africa. It can be deduced from the findings that the introduction of the YieldWise model have had a positive impact on the livelihood of smallholder maize farmers in Wa Municipal.

Conclusion

Factors such as timeliness of input supply, ready market, access to extension service, availability of recommended inputs, and training on post-harvest loss were identified to influence the adoption of the YieldWise model by smallholder maize farmers. The availability of recommended inputs was the main influencing factor. The provision of inputs, services and training programmes as stipulated under the YieldWise model had an impact on the harvesting and postharvest loss reduction of the farmers grains. The study showed that the adoption of the YieldWise model resulted in an average reduction in harvest losses of 46.24 kg/ha (25.66 %), reduction in shelling and threshing losses 28.11 kg/ha (19.74 %), a reduction in storage losses of 12.85 kg/ha (54.99 %), however, transportation losses remained virtually same for Antika and non-Antika farmers with a recorded average transportation loss of 0.62 kg/ha and 0.68 kg/ha, respectively.

The YieldWise model is reported to have improved the livelihood of smallholder maize farmers under the Antika Crop Aggregation Centre in Wa Municipality as many farmers are

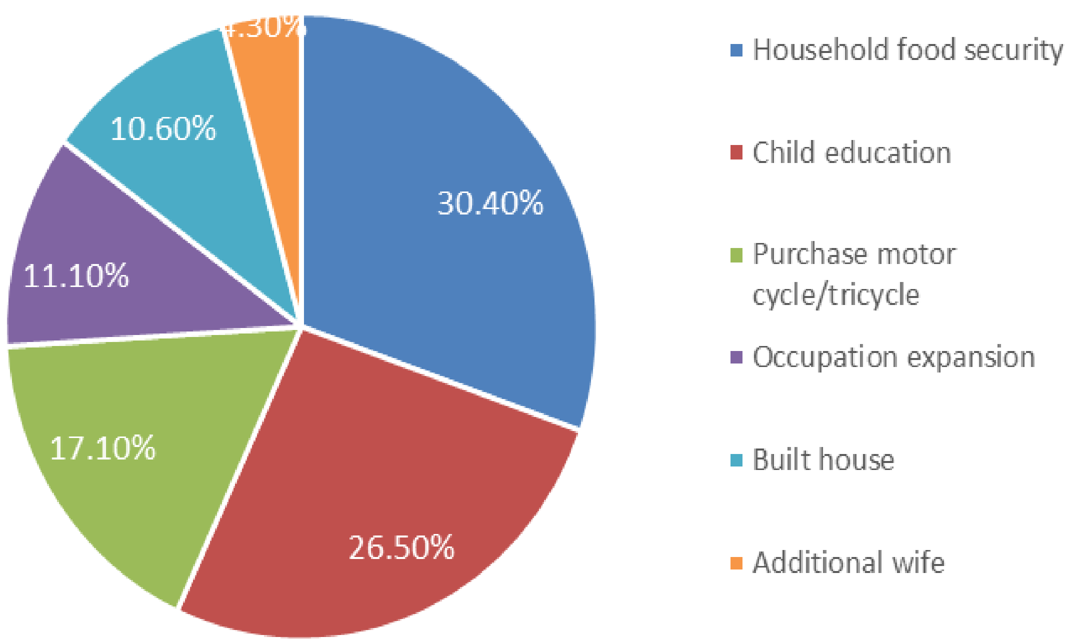

Figure 4 Improved livelihood of smallholder maize farmers under the YieldWise model in Wa Municipal

able to secure food for their family throughout the year, pay for their children's school fees, purchase a motorcycle/tricycle, expand their main occupation, and few built a new house for themselves.

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Conflicts of Interest Declaration

The authors declare no conflict of interest.

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