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# Factors affecting the implementation of Good Agricultural Practices (GAP) on cassava production in Grand Cape Mount County, Liberia

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**Abstract** The surveys conducted in Grand Cape Mount County, Liberia to study the factors affecting the implementation of Good Agricultural Practices (GAP) on cassava production using semi-structured questionnaires showed that each of the socio-economic characteristics of cassava farmer was significantly different among each GAP implementation. The age of the farmers was negatively influenced by the product storage and on-site transportation (-0.18, $P<0.05$). The land ownership positively influenced the level of compliance with disease and pest-free production (0.30, $P<0.01$). The income (-0.20, $P<0.05$) and GAP practicing period (-0.21, $P<0.05$) were negatively influenced by farmers getting variable seeds while the smallholder cassava farmer (0.26, $P<0.05$) was positively influenced by this factors. In addition, the farmer was positively influenced by the post-harvesting handling (0.28, $P<0.01$). The level of GAP compliance was at a moderate level in all items, while data recording was at a low level. Agricultural extensionists should emphasize elevating the level of GAP compliance among the farmers in Grand Cape Mount County, Liberia.

**Keywords:** Good Agricultural Practice, GAP, Cassava, Liberia

## Introduction

Rice and cassava are staple foods in Liberia but rice alone accounts for half of all calories consumed in the country. Yet, Liberia produces only 40% of its local rice needs, while importing 300,000 metric tons a year. As for cassava, it is the second-most consumed crop in Liberia with 60% of the farmers producing it, supplementing rice to ensure food security. However, food shortages in Liberia have been compounded by a series of crises, such as the

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impacts from long-term conflicts to outbreaks of Ebola, rice shortages and the COVID-19 pandemic – a long-term solution was needed (Global Agriculture and Food Security Program, 2021).

Cassava, however, is still produced using very low levels of inputs and is usually intercropped with rice, maize and peppers. Efforts to improve the productivity of cassava have been carried out by the Central Agricultural Research Institute (CARI) by developing cassava varieties that have high yields, disease resistance and root quality. CARICASS I, CARICASS II, and CARICASS III are examples of the improved varieties that have already been released for the cassava farmers.

Households of the cassava farmers are still faced with many problems associated with cassava production, processing and marketing. To address the constraints linked to cassava production, processing and marketing, several techniques have been proposed to solve these problems. These proposed techniques, however, are the practices that are associated with good agricultural practices (GAP). For example, the application of chemical agents to increase yields is one of the main issues in the farms as the farmers may or may not use these agents based on GAP.

GAP is a worldwide standard that has been adopted to produce quality crops and it addresses environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products" (FAO COAG 2003 GAP paper). GAP primarily involves the application of good management practices to maintain consumer confidence in food quality and food safety by taking into account the optimal use of inputs to ensure workers' health and minimize detrimental environmental impacts on farming operations.

The importance of cassava to Liberia, in conjunction with the need to comply with GAP, has driven the Ministry of Agriculture (MOA) to collaborate with other stakeholders to work on streamlining to supply the essential inputs to the cassava farmers. However, the poor infrastructure and the early-emerging agricultural outreach in Liberia have limited the activities of MOA and its stakeholders to promote agricultural technologies nationwide.

These hindrances may not deter the will of the government of Liberia to promote cassava production nationwide. The study by the National Cassava Sector Coordinating Committee Liberia (NCSCCL) showed the potential of cassava in providing food security as well as creating revenue from exporting value-added products of cassava. For example, basic processed products of cassava such as cassava bread, snacks and biscuits have potential for to export to Asia, the EU and the USA. European countries, such as Belgium, Germany, the Netherlands, Spain and Portugal, also demand cassava to use as feedstuffs

in the animal production industry. Such a prospect has driven the efforts of the local agricultural officers across Liberia to work on ensuring that cassava has been produced adhering to the standards that will ensure cassava and its products getting access to both local and international markets.

Grand Cape Mount, which is a County in the northwestern portion of Liberia with an area of about 5,162 square kilometres, has more than 4,000 cassava plantations. These plantations were reported to account for about 3.3 per cent of the total area of cassava planted in the country. The remote areas where cassava has been grown are thus very difficult to access, making it necessary for the local agricultural extensionists to provide GAP training for the cassava farmers within their own jurisdiction. Before such training can be commenced, surveys should be conducted to determine the factors which might affect the implementation of GAP on cassava production in the area of Grand Cape Mount County.

The project aims to study how GAP will be implemented and determine the factors that influence GAP implementation in producing cassava because different attributes can play a role to drive the GAP implementation by the growers in different parts of Liberia. The trained farmers will be encouraged by the officials of the Ministry of Agriculture and Department of Extension to assist other farmers to adopt GAP for cassava production there as well. This should contribute to the reduced usage of toxic agrochemicals because the growers are concerned about their health and the environment (Enold *et al.*, 2021).

The research aimed to investigate the factors affecting the implementation of GAP in cassava production in Grand Cape Mount County, Liberia and explore the underlying factors that affect GAP.

## Materials and methods

### *Description of the study area*

This study was carried out in Grand Cape Mount County, Liberia. Grand Cape Mount County is located in the northwestern portion of the West African nation of Liberia, bordering the Republic of Sierra Leone. It is one of 15 counties that constitute the first level of administrative division in the nation, and it has five districts. Robertsport serves as the capital with the area of the County measuring 5,162 square kilometres (1,993 sq. mi.). This County is located where the farmers depend on rainwater and other small creeks for production.

There are several agricultural projects such as the Rural Economic Transformation Project, and the Smallholder Agriculture Transformation and Agribusiness Revitalization Project that give technical support to farmers in this region. There are also extension officers that advise farmers on technical activities in their production and post-harvest losses**.**

***Population, sampling size and data collection***

One hundred fifty cassava farmers in Grand Cape Mount County (in Garwula and Tewor districts), Liberia (including GAP-trained farmers, smallholder farmers and large farmers) were interviewed using simple random sampling. The sampling size was calculated using the Taro Yamane formula (Yamane, 1973), with acceptable sampling error at 7% and data was collected from March to May 2022.

The interview was conducted using manual questionnaires with qualitative and quantitative questions, including open- and closed-ended questions on every farmer's farm in Grand Cape Mount County. The questionnaire was used to collect data on the levels of GAP compliance, such as source of water, cultivation site, getting of variable seeds, product storage and on-site transportation, disease and pest-free production, management of high-yield production, harvesting and post-harvesting handling, and data recording.

***Data analysis***

The collected data was used to identify those factors that influenced the implementation of GAP. It consisted of the characteristics of farmers including gender, age, education, number of family members, number of laborers, farming experience, membership of farm organizations, cultivated area size, land ownership, GAP training, financial support, income per year, GAP practicing periods, and owned farmland were analyzed using frequency and percentage.

The level of GAP implementation was then analyzed as arithmetic mean and standard deviation by dividing the interpretation intervals based on the principle of class interval. Each class interval is divided into equal points and the interpretation criteria of the scores are defined as follows:

Mean is in the range of < 0.49 = None of GAP implementation. Mean is in the range of 0.50-1.49 = Low level of GAP implementation. Mean is in the range of 1.50-2.49 = Moderate level of GAP implementation. Mean is in the range of > 2.50 = High level of GAP implementation. The relationship between demographic factors and GAP implementation items were analyzed using the chi-square test and the relationship level was measured using

Cramer's V correlation coefficient (if both variables were of nominal measure scale or if only one variable was of nominal measure scale). The other variable was analyzed using Spearman's rank-order correlation coefficient (if both variables were an ordinal measure scale).

## Results

### *Socio-economic characteristics of the respondents*

The socio-economic characteristics of the farmers are shown in Table 1. About half of the respondents were male (52.0%). Most of the farmers (61.4%) were of young age (≤ 40 years old). The majority of the farmers (88.6%) had an education level lower than a bachelor's degree. The families were characterized as medium-sized with 4-6 persons (41.3%) and the majority of the number of laborers was two persons (29.3%). The majority of the farmers (70.0%) had farming experience of more than 10 years. Half of the farmers were members of organizations. Most of the farmers (70.6%) cultivated area less than or equal to 10 hectares for farming. Farmers owned land (68.0%) more than those who rented (32.0%). Farmers farmed on the land belonging to the government (20%), the community (34.7%) and private (45.3%). Most of the farmers (76.6%) indicated that they had attended the GAP training organized by the Department of Agricultural Extension (DOAE) at least once a year. Most of farmers (71.3%) practiced GAP more than 2 years. The farmers received financial support from NGOs (36.0%), Banks (22%), government (14.7%) and their private fund (27.3%). About half of farmers were smallholder cassava farmers (53.3%), of which 69.4% had income less than 300 USD.

### *GAP information from farmers in the study area*

The majority of the farmers (71.3%) had improved their livelihoods and nutrition. Almost half of the farmers (46.0%) sold their produce for income, while the rest (54.0%) did not. Some of the farmers (37.3%) cultivated cassava for their household consumption. Most of the farmers (51.3%) grew other crops with cassava on the same plot of land.

Most of the growers producing a crop in Grand Cape Mount County obtained their knowledge about GAP from friends (16.7%), flyers (15.3%), newspaper (13.3%), radio (12.0%), TV (11.3%) and agricultural officer (9.3%). The farmers had several reasons to practice GAP. These reasons were the results of community agreement (25.3%), product price (22.7%), customer needs (19.3%), concern about health (16.7%) and environmental friendly (16.0%). Some of the farmers practiced GAP because the practice did not affect the environment (28.7%), no or less deleterious effect to consumer's

health (28%), good quality of product (18.0%), high price (16.0%) and high demand (9.3%).

**Table 1.** Socio-economic characteristics of farmers (n=150)

| Attributes | Characteristics | Frequency | Percentage |
|---|---|---|---|
| Farm location | Garwula | 82 | 54.7 |
| | Tewor | 68 | 45.3 |
| Gender | Male | 78 | 52.0 |
| | Female | 72 | 48.0 |
| Age of farmer | <20 years | 22 | 14.7 |
| | 20-30 years | 39 | 26.0 |
| | 31-40 years | 31 | 20.7 |
| | 41-50 years | 28 | 18.7 |
| | 51-60 years | 21 | 14.0 |
| | > 60 years | 9 | 6.0 |
| Education level | Lower than primary school | 29 | 19.3 |
| | Primary school | 46 | 30.7 |
| | Junior secondary school | 32 | 21.3 |
| | Senior secondary school | 26 | 17.3 |
| | Bachelor's degree | 15 | 10.0 |
| | Master's degree | 2 | 1.3 |
| | Doctoral degree | - | - |
| The number of family members | 1-3 persons | 48 | 32.0 |
| | 4-6 persons | 62 | 41.3 |
| | > 6 persons | 40 | 26.7 |
| The number of laborers | 1 person | 40 | 26.7 |
| | 2 persons | 44 | 29.3 |
| | 3 persons | 34 | 22.7 |
| | > 3 persons | 32 | 21.3 |
| Farming experience | < 10 years | 45 | 30.0 |
| | 10-20 years | 57 | 38.0 |
| | > 20 years | 48 | 32.0 |
| Membership of farming organization | Yes | 75 | 50.0 |
| | No | 75 | 50.0 |
| Cultivated area | < 5 hectares | 50 | 33.3 |
| | 5 – 10 hectares | 56 | 37.3 |
| | > 10 hectares | 44 | 29.3 |
| Land ownership | Owner | 102 | 68.0 |

| Attributes | Characteristics | Frequency | Percentage |
|---|---|---|---|
| | Rent | 48 | 32.0 |
| GAP training | Never | 35 | 23.3 |
| | Once (per year) | 68 | 45.3 |
| | >1 time (per year) | 47 | 31.3 |
| Financial support | Government project | 22 | 14.7 |
| | Bank | 33 | 22.0 |
| | NGO | 54 | 36.0 |
| | Private funds | 41 | 27.3 |
| Income per year | <100 USD | 31 | 20.7 |
| | 100 USD-200 USD | 31 | 20.7 |
| | 201 USD-300 USD | 42 | 28.0 |
| | 301 USD-400 USD | 22 | 14.7 |
| | 401 USD-500 USD | 13 | 8.7 |
| | >501 USD | 11 | 7.3 |
| GAP practicing period | >1 year | 43 | 28.7 |
| | 2-3 years | 57 | 38.0 |
| | >3 years | 50 | 33.3 |
| Own farmland | Government | 30 | 20.0 |
| | Community | 52 | 34.7 |
| | Private | 68 | 45.3 |
| Smallholder farmer | Yes | 80 | 53.3 |
| | No | 70 | 46.7 |

The farmers encountered several constraints in the GAP regulation. These limitations were farm location (20.7%), usage of agricultural chemicals (20.0%), production management before harvest (18.7%), source of water for agriculture (14.0%), harvest and post-harvest loss (10.7%), production storage and transportation (10.7%) and data recording (5.3%). Some of the farmers (30.0%) used irrigation water from wells for cassava cultivation while others (70.0%) irrigated cassava with rainwater (30.0%), waterways (24.7%), drilling (14.7%) and dam (0.7%).

### *GAP implementation level of the farmers*

Most of the farmers in the study area implemented GAP on their farms at a moderate level in all GAP items, except for data recording that was at the low level (Table 2). Some farmers found it very difficult to comply with GAP rules and standards, which contributed to the low proportion of the farmers practicing GAP. About one-fourth of the farmers (23.3%) did not participate in GAP training.

**Table 2.** The level of GAP compliance

| GAP items | Level | Frequency | % | Mean | Practical level |
|---|---|---|---|---|---|
| Source of water for agriculture | None | 29 | 19.33 | 1.55* | Moderate |
| | Low | 41 | 27.33 | | |
| | Moderate | 48 | 32.01 | | |
| | High | 32 | 21.33 | | |
| Cultivation site | None | 9 | 6.04 | 1.83 | Moderate |
| | Low | 48 | 32.21 | | |
| | Moderate | 52 | 34.90 | | |
| | High | 40 | 26.85 | | |
| Getting of variable seeds | None | 13 | 8.67 | 1.80 | Moderate |
| | Low | 46 | 30.67 | | |
| | Moderate | 49 | 32.67 | | |
| | High | 42 | 28.00 | | |
| Product storage and on-site transportation | None | 13 | 8.72 | 1.78 | Moderate |
| | Low | 46 | 30.87 | | |
| | Moderate | 51 | 34.23 | | |
| | High | 39 | 26.17 | | |
| Disease and pest-free production | None | 27 | 18.00 | 1.63 | Moderate |
| | Low | 38 | 25.33 | | |
| | Moderate | 48 | 32.00 | | |
| | High | 37 | 24.67 | | |
| Management of high-yield production | None | 3 | 2.00 | 1.91 | Moderate |
| | Low | 46 | 30.67 | | |
| | Moderate | 63 | 42.00 | | |
| | High | 38 | 25.33 | | |
| Harvesting and post-harvesting handling | None | 2 | 1.33 | 1.92 | Moderate |
| | Low | 49 | 32.67 | | |
| | Moderate | 58 | 38.67 | | |
| | High | 41 | 27.33 | | |
| Data recording | None | 49 | 32.67 | 0.95 | Low |
| | Low | 60 | 40.00 | | |
| | Moderate | 41 | 27.33 | | |
| | High | 0 | 0.00 | | |
| **Overall** | | | | **1.67** | **Moderate** |

* Level of GAP practical level is classifled as score, <0.49 = none, 0.50 – 1.49 = low, 1.50 - 2.49 = moderate, >2.50 = high

**Table 3.** Chi-square and correlation analysis among factors affecting practice of GAP

| Factor | GAP implementation items | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Source of water for agriculture** | **Cultivation site** | **Getting of variable seeds** | **Product storage and on-site transportation** | **Disease and pest-free production** | **Management of high-yield production** | **Harvesting and post-harvesting handling** | **Data recording** |
| **Farm location**[a] | 1.80 (0.11) | 0.15 (0.03) | 5.46 (0.19) | 3.34 (0.15) | 0.78 (0.07) | 2.69 (0.13) | 3.49 (0.15) | 1.75 (0.11) |
| **Gender**[a] | 4.69 (0.18) | 6.18 (0.20) | 0.84 (0.08) | 7.40 (0.22) | 2.45 (0.13) | 1.44 (0.10) | 3.47 (0.15) | 2.03 (0.12) |
| **Age**[b] | 12.05 (0.11) | 16.65 (-0.15) | 11.72 (0.12) | 29.47* (-0.18) | 10.91 (0.00) | 13.42 (-0.01) | 21.08 (-0.01) | 14.98 (0.15) |
| **Education**[b] | 15.22 (0.09) | 18.20 (-0.03) | 6.25 (0.04) | 21.18 (0.04) | 19.66 (0.02) | 17.24 (-0.07) | 5.10 (0.01) | 5.09 (0.09) |
| **The number of family members**[b] | 4.18 (-0.12) | 3.37 (0.02) | 6.05 (-0.08) | 7.79 (-0.02) | 1.77 (-0.04) | 3.71 (0.04) | 5.83 (-0.04) | 6.65 (-0.12) |
| **The number of laborers**[b] | 7.67 (-0.05) | 15.56 (0.07) | 14.43 (-0.09) | 1.16 (0.01) | 4.17 (-0.05) | 5.85 (-0.05) | 4.38 (0.06) | 2.38 (0.01) |
| **Farming experience**[b] | 3.07 (0.11) | 5.46 (-0.13) | 5.90 (-0.04) | 1.60 (0.10) | 3.49 (-0.06) | 8.72 (-0.08) | 4.65 (0.10) | 2.92 (-0.08) |
| **Belong to farmer organization membership status**[a] | 0.59 (0.06) | 1.65 (0.11) | 0.77 (0.07) | 1.10 (0.09) | 5.29 (0.19) | 0.67 (0.07) | 0.31 (0.05) | 0.28 (0.04) |
| **Cultivated area**[b] | 9.67 (-0.18) | 5.68 (-0.01) | 6.53 (-0.03) | 6.80 (0.05) | 6.78 (-0.07) | 6.71 (0.13) | 12.41 (-0.02) | 6.15 (-0.10) |
| **Land owner**[a] | 3.54 (0.15) | 1.59 (0.10) | 6.82 (0.21) | 1.44 (0.10) | 13.27** (0.30) | 0.78 (0.07) | 2.40 (0.13) | 1.01 (0.08) |
| **GAP training**[b] | 12.84* (-0.06) | 5.64 (0.15) | 9.50 (0.03) | 11.44 (0.19) | 4.15 (-0.01) | 8.55 (0.06) | 4.58 (0.01) | 4.13 (0.08) |
| **Financial support**[a] | 7.23 (0.13) | 8.52 (0.14) | 12.83 (0.17) | 4.51 (0.10) | 8.25 (0.14) | 5.13 (0.11) | 13.40 (0.17) | 5.87 (0.14) |
| **How much income have you got per year**[b] | 12.03 (0.10) | 16.26 (0.00) | 25.48* (-0.20) | 18.18 (-0.05) | 11.93 (0.06) | 14.03 (-0.02) | 18.58 (-0.11) | 7.77 (-0.04) |

**Table 3. (Con.)**

| Factor | GAP implementation items | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Source of water for agriculture | Cultivation site | Getting of variable seeds | Product storage and on-site transportation | Disease and pest-free production | Management of high-yield production | Harvesting and post-harvesting handling | Data recording |
| How long have you been practicing GAP[b] | 1.42 (0.05) | 8.02 (0.04) | 13.81* (-0.21) | 7.28 (-0.01) | 2.55 (0.01) | 3.19 (0.03) | 7.09 (0.00) | 2.18 (-0.01) |
| Are you a smallholder cassava farmer[a] | 2.81 (0.14) | 7.61 (0.23) | 10.44* (0.26) | 1.94 (0.11) | 0.78 (0.07) | 2.83 (0.14) | 12.10** (0.28) | 0.14 (0.03) |
| Who owns the land you farm on[a] | 4.52 (0.12) | 6.33 (0.15) | 6.44 (0.15) | 3.62 (0.11) | 11.90 (0.20) | 5.87 (0.14) | 4.61 (0.12) | 1.69 (0.08) |
| What is the main purpose for growing cassava in household | 6.91 (0.15) | 2.07(0.08) | 13.09*(0.21) | 2.82(0.10) | 5.48(0.14) | 4.36(0.12) | 3.84(0.11) | 11.46*(0.20) |
| Where do you get the information about the GAP method in cassava production | 19.24(0.21) | 28.80(0.25) | 37.54*(0.29) | 26.09(0.24) | 27.72(0.25) | 37.07*(0.29) | 19.62(0.21) | 22.10(0.27) |

[a] Cramer`s V coefficient, [b] Spearman`s Rank-Order coefficient, * significant at 0.05 level, ** significant at 0.01 level

The relationship between demographic factors and GAP implementation items are showed in Table 3. The correlation between age and product storage and on-site transportation showed a statistically-significant difference ($P<0.05$) with Chi-square value at 29.47 and correlation coefficient value of Spearman`s Rank Order at -0.18. The farmers with the age ≤ 30 years had a moderate level on the practice about product storage and on-site transportation. Those with the age above 30 years had a low level on this practice.

The correlation between land ownership and disease and pest-free production showed a statistically-significant difference ($P<0.05$) with Chi-square value at 13.27 and correlation coefficient value of Cramer`s V at 0.30. The farmers who had the right to own land had a moderate level on the practice about disease and pest-free production. Those without land ownership had a low level on this issue. The correlation between income and getting of variable seeds showed a statistically-significant difference ($P<0.05$) with Chi-square value at 25.48 and correlation coefficient value of Spearman`s Rank Order at -0.20. The farmers with the income ≤ 300 USD had a moderate level on the practice of getting of variable seeds. The farmers with the income above 300 USD had a low level on this point.The correlation between GAP practicing and getting of variable seeds showed a statistically-significant difference ($P<0.05$) with Chi-square value at 13.81 and correlation coefficient value of Spearman`s Rank Order at -0.21. The farmers practicing GAP ≤ 3 years had the moderate-high level on the practice of getting of variable seeds. The farmers with GAP practicing more than 3 years had the low level on this point.

The correlation between smallholder cassava farmers and getting of variable seeds showed a statistically-significant difference ($P<0.05$) with Chi-square value at 10.44 and correlation coefficient value of Cramer`s V at 0.26. The smallholder farmers had a moderate level on the practice about getting of variable seeds. Other groups of farmers had a low level on getting of variable seeds. The correlation between smallholder cassava farmers and harvesting and post-harvesting handling showed a statistically-significant difference ($P<0.01$) with Chi-square value at 12.10 and correlation coefficient value of Cramer`s V at 0.28. The smallholder farmers had a moderate level on the practice about harvesting and post-harvesting handling. Other groups of farmers had a high level on harvesting and post-harvesting handling.

The correlation between the main purpose for growing cassava in the household and getting of variable seeds showed a statistically-significant difference ($P<0.05$) with Chi-square value at 13.09 and correlation coefficient value of Cramer`s V at 0.21. The farmers who grew cassava for consumption had a moderate level on the practice about getting of variable seeds. The farmers who grew cassava for sale had a high level on the practice about getting

of variable seeds. Those who grew cassava for both consumption and sale had a moderate level on getting of variable seeds.

The correlation between the main purpose for growing cassava in the household and data recording showed a statistically-significant difference ($P<0.05$) with Chi-square value at 11.46 and correlation coefficient value of Cramer`s V at 0.20. The farmers who grew cassava for consumption had a moderate level on the practice about data recording. The farmers who grew cassava for sale had a high level on the practice about data recording. Those who grew cassava for both consumption and sale also had a high level on data recording. The correlation between getting the information about the GAP method and getting of variable seeds showed a statistically-significant difference ($P<0.05$) with Chi-square value at 37.54 and correlation coefficient value of Cramer`s V at 0.29. The farmers who obtained the information about GAP from friends and newspapers had a high level on the practice about getting of variable seeds. The farmers who obtained the information about GAP from radio, flyers, agricultural officers, family members and other means had a moderate level on the practice about getting of variable seeds. Those who obtained the information about GAP from television had a low level on getting of variable seeds.

The correlation between getting the information about the GAP method and management of high-yield production showed a statistically-significant difference ($P<0.05$) with Chi-square value at 37.07 and correlation coefficient value of Cramer`s V at 0.29. The farmers who obtained the information about GAP from friends and family members had a high level on the practice about management of high-yield production. The farmers who obtained the information about GAP from flyers, agricultural officers, teachers and other means had a moderate level on the practice about management of high-yield production. Those who obtained the information about GAP from television, radio and newspapers had a low level on management of high-yield production.

## Discussion

Most of the GAP implementation of the cassava farmers in Grand Cape Mount County, Liberia is at a moderate level, while data recording is the only GAP implementation that is at low level. The low level of GAP implementation on data recording may be because the respondents are illiterate. It was reported that in Liberia the male and female literacy rate is 62.7% and 34.09%, respectively. The average adult literacy rate is only 48.30% (Anonymous, 2022). Such a high illiteracy rate may contribute to the low GAP implementation on data recording and undermine the credibility of the collected

data on other aspects of GAP implementation. To address this problem, the government should improve the education system for the majority of the poorly educated population who are subsisting on cassava production (Coulibaly *et al*., 2014). This can be achieved by focusing on mobilizing the youth's potential, through enhanced knowledge, strengthened capacities and technical support (Food and Agriculture Organization of the United Nations, 2022).

The combination of age and enough farming experience may contribute to the moderate levels of other GAP implementations. These GAP implementations are based on practices and experience, and the levels of these GAP implementations should be elevated to a high level if the literacy rate increases. An agricultural officer may also be in a position to upgrade the level of GAP implementation among these farmers if the officerhas developed new extension services and techniques (Ganpat *et al*., 2014).

The age and product storage and on-site transportation ($P<0.05$) was significantly correlated. The farmers of age ≤30 years had a moderate level on the practice about product storage and on-site transportation. Those with the age above 30 years had a low level on this practice. As cassava is a field crop which requires labour to work in the field, the older farmers may not be as strong as the younger farmers and the latter thus are committed to carrying out product storage and on-site transportation more than the former. Putting physical conditions aside, attitude and mindset might also play a role in which age might influence certain practices.

Age is one of the six factors associated with a decreased likelihood that farmers adopted high level GAP, and a subsequent increased probability that farmers adopted low or moderate level GAP among vegetable farmers in the upper north of Thailand (Supapunt *et al*., 2021). Age was a negative determinant of adoption among chili farmers in the study in northeastern Thailand. The younger farmers tended to adopt more practices in the set of GAP. They opened their minds to innovation and tried to gather more information as well as improving their knowledge (Athipanyakul and Pak-uthai, 2012).

In Grand Cape Mount County, Liberia, most of the participants involved in GAP are the youth and these younger farmers are gradually accepting the ideas of GAP. Prior to the civil war, farmers had practiced traditional farming or shifting cultivation as their ways of farming. Older farmers, aged above 30 years, are not familiar with GAP which contributes to a low level on this practice, while the young farmers have a moderate level on GAP.

The income, GAP practicing period, type of farmer (smallholder or not smallholder farmer), main purpose for growing cassava and source of the information about the GAP method in cassava production showed significant

correlation with getting of variable seeds. The last factor highly influenced GAP implementation because farmers could share direct experience from friends and could get access to information from the newspapers. Planting cassava crops requires high investment and the crop can be harvested and sold within almost a one-year period. Using reliable, propagative materials for planting cassava, which they have learned from friends and newspapers, should ensure crop productivity and economic return.

The source of the information about the GAP method in cassava production showed a highly-significant correlation with management of high-yield production. Friends and family members are the ones that can share first-hand experiences to the cassava farmers regarding the management of high-yield cassava production. Living in the same neighborhood provides the opportunity for the farmers to make farm visits to the demonstration plots and learn the techniques used to obtain high yields. As the management of high-yield production is knowledge and experience intensive, these people are very important and can be an essential source of useful information about the GAP method in cassava production. It was reported that demonstration plots and any written materials, either as a comic, a flyer or an SMS are the preferred sources of information. With regard to the comic, farmers were of the opinion that pictures can be more helpful than text as illiteracy remains to be a problem (Mitschke, 2017).

Land ownership showed significant correlation with disease and pest-free production. Insect pests and diseases are the main constraints in causing yield loss in cassava production. Preventing pests from spreading into the pest-free land is a rational option to mitigate yield loss. The reduction of cassava yield can mean the reduction of profit or even the loss of an investment. Cassava farmers who own land will opt to use disease- and pest-free production in producing cassava because they have an incentive to capitalize land use for making a profit. Land ownership was found to be more likely to adopt practices that facilitate sustainable agricultural adoption rates (Adesida *et al.,* 2021). Thus, the farmer's right to own land is an essential precursor to facilitate the farmers' adoption of certain practices that will help them make a profit.

The purpose of the farmers for growing cassava in the household had a significant correlation with data recording. The farmers who grew cassava for sale had a high level on the practice about data recording. They have to follow GAP guidelines on this practice should they want to sell their cassava. The practice, as required by GAP, has many benefits. One is the economic benefit because the farmers will know the cost and the profit of cassava production. The other is the know-how benefit should the farmers utilize the data to improve productivity and increase profitability. Data recording can be

considered to be the backbone of successful, sustainable cassava production. However, most cocoa and coffee farmers in Northern Haiti did not record training, cleaning or harvesting activities, and water treatments (Navarro *et al.*, 2020). Although data recording and recordkeeping are the challenges for the smallholder farmers, such practice may be adopted if the added gain is big enough (Hansen and Trifković, 2014).

The smallholder cassava farmers had significantly correlated with the practice on harvesting and post-harvesting handling. The smallholder farmers had a moderate level on this practice. The smallholder farmers can be characterized as a family farmer who relies on relatives' labor to meet production needs and they typically retain a portion of their harvest for household consumption. These farmers thus are not obliged to perform the practice on harvesting and post-harvesting handling to the higher level. Since the smallholder farmers depend mainly on wages during the harvest season (Ehlert *et al.*, 2011), they do not have the incentive to perform a practice that does not have direct benefit to them.

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