# Tree Crop Information Needs and Use Among Farmers and Extension Agents in Ghana

Kingsley Ofosu-Ampong
Abdul-Latif Jizorkuwie
Paul Schmidt
Wuletawu Abera

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Disclaimer: The images in this report under the extension officer's profile or user personas are AI-generated.

# Background

Climate change presents a formidable challenge for Ghana, manifesting through extreme precipitation events, erratic rainfall patterns, prolonged droughts, and temperature fluctuations (FAO, 2020; Awuni et al., 2023). These climatic shifts are contributing to significant vegetation loss and declining agricultural yields—particularly within the rain-fed agriculture and agroforestry sectors. This vulnerability affects the livelihoods of approximately 70% of the population, who depend directly on these sectors for income and food security (Jansen, 2020). Furthermore, declining productivity may drive agricultural expansion, increasing pressure on natural resources, accelerating biodiversity loss, and potentially leading to land and water disputes that threaten environmental sustainability, social cohesion, and political stability.

As part of the Ghana Tree Crops Diversification Project, the Alliance Bioversity-CIAT aims to develop adaptation strategies for e-extension services for Ghana's tree crop sector. To this end, this report aims understanding the information use and needs of farmers and extension agents i.e. identifying key user groups within the value chains, assessing the types of information they need and currently receive, understanding how they utilize this information in their agricultural practices, and determining their preferred information systems and formats. These insights aim to inform strategies that enhance decision-making and improve the effectiveness of tree crop advisory services in Ghana.

This report presents a user information needs analysis from five key perspectives:

1. Demographic Analysis: An assessment of the demographics of farmers and extension agents involved in seven key tree crops in Ghana—cocoa, cashew, shea, coconut, oil palm, mango, and rubber. This section identifies both cross-cutting and crop-specific challenges faced by farmers.

2. Information Access and Gaps: An evidence-based analysis of the types of climate and agricultural information farmers require versus what they actually receive. This includes a review of access channels, frequency, quality, preferred formats, and delivery mechanisms for agro-climatic information.

3. Information Utilization and Farmer Typologies: Insights into how farmers apply information in their decision-making and agricultural practices. The analysis also categorizes farmers into two main information user groups within the agricultural value chain.

4. System Preferences and Digital Advisory Use: An exploration of farmers' preferred information systems, including use of digital advisory tools. The analysis highlights variations in information needs based on the source (e.g., extension services, digital platforms), service quality, frequency, and farmers' willingness to pay for tailored agro-climatic information.

5. Extension Officer Personas: Findings from interviews with extension agents were used to develop extension officer profiles or "user personas"—fictional yet evidence-based representations that capture key characteristics, behaviours, preferences, and information needs. These personas support the design of human-centered climate information services tailored to real-world extension contexts.

This report employs a combination of surveys and interviews to assess the information needs of farmers and extension officers. The report is structured to guide the reader through the analysis process, beginning with data collection and methodology, followed by the findings, the human-centered design approach, and conclusion. The methodological

### Project methodology

In selecting the regions and districts for data collection, this report focused on the dominance of specific crops based on data from the Ministry of Food and Agriculture (MoFA) regarding crop production across regions and districts. For example, in the Eastern Region, oil palm and mango were identified as the dominant crops, while in the Western Region, rubber and coconut were predominant (see Table A).

We anticipated collecting responses from 50 farmers per crop, along with interviews with five extension officers per crop in each region. Upon arrival in the field, the research team engaged with the District Directors of Agriculture, who provided initial briefings and assigned two extension agents per district to support data collection efforts.

The extension agents received training from the researchers assigned to each region. These researchers were also responsible for monitoring the data collection process to ensure data accuracy and proper interpretation of the survey as the extension agents conducted interviews with the farmers. Additionally, the researchers facilitated interview sessions with the extension officers.

Data were collected between 12 December 2024 and 16 December 2024 using the ODK (Open Data Kit) data collection tool. The survey instruments included both quantitative and qualitative questions aimed at assessing current information sources, adoption of climate-smart agricultural practices, and farmers' information needs and preferences.

By the end of the survey period, a total of 318 responses were received from farmers and 60 responses from extension officers. We used several R packages including MASS, ggplot2, and vcd for analysis and visualisation. Descriptive statistics, such as counts and percentages, were used to summarize categorical variables, including socio-demographic characteristics, access to agricultural information, as well as farmers' needs and preferences. Extension officers' profiles, or user personas, were developed based on interviews conducted with the participants to support a human-centred interactive system for the seven tree crops in Ghana (see Findings 5: Human-centered design approach for developing climate information service).

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Table A. Crops and focus regions

| Crop | Region | District (Town) |
|---|---|---|
| Oil palm | Eastern | Kade, Asuom |
| Mango | Eastern and Greater Accra | Somanya and Shai Osu Doku |
| Rubber | Western | Ahanta West |
| Cashew | Bono | Wenchi |
| Cocoa | Ashanti | Asante Akim South and Sekyere |
| Shea | Northern and Upper West | Savulugu and Sisalla East |
| Coconut | Western | Shama, Elembelle |

The research findings are organized into five key areas, each directly aligned with the project's mandate and objectives.

# User demographics

## - Farmers

The total respondents were 318, comprising 67.6% males and 32.39% females. The majority of the farmers were above 50 years (42.14%), those between the age group 41-50 years were 92 (28.93%), and those 31-40 years were 23.27%. Educational attainment among respondents is predominantly basic, with 48.74% having only primary education. A substantial (15.41%) have no formal education whatsoever, while 21.38% have reached secondary education and 14.47% have attained tertiary education. This educational profile has significant implications for agricultural extension services and technology adoption.

Most farmers have over 16 years' experience in farming, and farming was the main source of household income for 92% of the farmers. Regionally, the data was collected from Western region 95 (29.87%), Eastern region 74 (23.27%), Ashanti region 50 (15.72%), Bono region 50 (15.72%), Greater Accra 22 (6.92%), Upper West region 21 (6.60%).

Table 1 presents the distribution of gender, age groups, farming experience, and educational levels across farmers categorized by their main income crops. The representation of women in mango farming is notably low compared to other crops (Fig. 1). With the exception of shea, all income crops are predominantly cultivated by men. Shea, traditionally considered a women's crop, involves significant female participation in its care and processing, particularly in the northern region. This is reflected in the higher number of female respondents engaged in shea cultivation. Farmers aged 51 and above formed the majority of survey respondents, a trend that is also reflected across most crops—except shea, which had no respondents in this age category. With the exception of rubber and shea, most crops were primarily cultivated by farmers with over 15 years of farming experience. This limited educational background may hinder farmers' ability to access and effectively use agricultural technologies, posing a significant barrier to innovation and productivity.

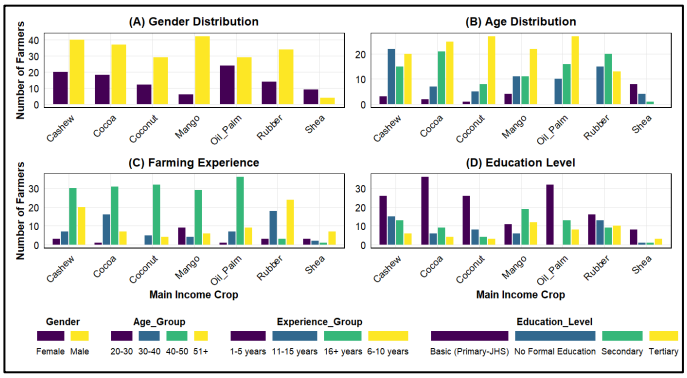


Fig 1. Socio-demographic profiles of farmers categorized by main income crops

The farmers surveyed demonstrate considerable agricultural experience, with most having over 16 years in farming (see Fig. 1). For 92% of respondents, farming constitutes the main source of household income, underlining the critical importance of agricultural productivity to rural livelihoods.

**Table 1: Demographic attributes of the respondents**

| Variable | Count | Percentage% |
|---|---|---|
| **Gender** | | |
| Male | 215 | 67.61 |
| Female | 103 | 32.39 |
| **Age Group** | | |
| 20-30 | 18 | 5.66 |
| 31-40 | 74 | 23.27 |
| 41-50 | 92 | 28.93 |
| 51 and above | 134 | 42.14 |
| **Educational Level** | | |
| No formal education | 49 | 15.41 |
| Basic (Primary-JHS) | 155 | 48.74 |
| Secondary | 68 | 21.38 |
| Tertiary | 46 | 14.47 |
| **Farming Years** | | |
| 1-5years | 20 | 6.29 |
| 6-10years | 77 | 24.21 |
| 11-15years | 59 | 18.55 |
| 16and above | 162 | 50.94 |
| **Main Household Income** | | |
| Farming | 295 | 92.77 |
| Formal Employment | 13 | 4.09 |
| Trading | 3 | 0.94 |
| Other | 7 | 2.20 |

The majority of questionnaire respondents were aged 51 and above, a trend reflected across most crops, with the exception of shea, which had no respondents in this age group. Except for rubber and shea, all crops were predominantly cultivated by farmers with over 15 years of experience.

Most crops are predominantly cultivated by men, with mango farming showing particularly low levels of female participation. An exception is shea, traditionally considered a "women's crop" in the northern region, where women play a central role in both its cultivation and processing.

### Challenges faced by farmers

Farmers mainly reported a lack of input and capital as their biggest challenges, followed by pests, diseases, and market access (Fig. 2). Less common issues include lack of information and land issues. Lack of capital is seen as a major challenge among all crops, but most especially for cashew, cocoa, mango and oil palm farmers. Coconut farmers expressed the highest concern for pests and diseases, which is understandable given the recent Cape Saint Paul Wilt Disease (CSPWD) outbreak that caused significant crop losses, devastating the livelihoods of many farmers. The coconut farmers also expressed lack of information as a major concern, probably reflecting their inability to control or mitigate the impact of the disease due to lack of knowledge. From the demographic insights, we recommend the following:

1. **Youth Engagement**: The aging farmer population signals an urgent need for policies that attract and retain youth in agriculture. Programs focusing on agricultural entrepreneurship, modernization, and value chain development could appeal to younger generations.
2. **Crop Diversification**: The different demographic patterns across crops suggest opportunities for promoting strategic crop diversification aligned with farmer profiles, helping to build resilience while leveraging existing knowledge.
3. **Knowledge Transfer**: Given the extensive experience of most farmers, mechanisms to facilitate knowledge transfer from older to

younger farmers could preserve valuable traditional practices while integrating modern approaches.

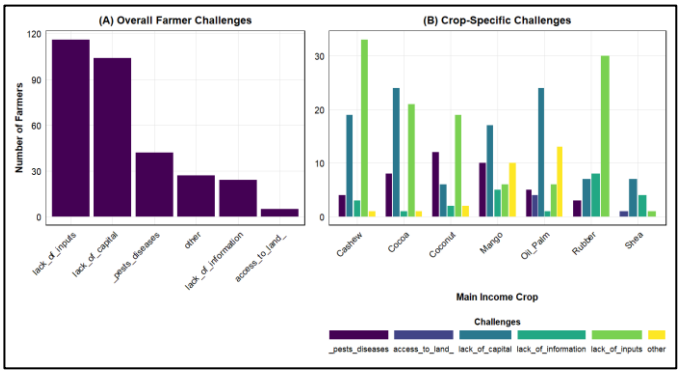


Fig 2. Challenges faced by farmers

## - Extension Agents

A total of 60 respondents participated in the survey, comprising 44 males and 16 females (Fig. 3B1) The age distribution revealed that 57% were between 31 and 40 years old, 13% were over 51, and 11% were between 41 and 50 (Fig 3B2). Notably, the Western region had the highest respondent count (16), attributed to the sampling of extension agents for both rubber and coconut crops, unlike other regions where only one crop was sampled (Fig. 3A). Government extension agents constituted 70% of the respondents, while private sector agents accounted for 30%. On average, female extension agents served 447 farmers, compared to 1,366 served by male agents (Fig. 3C1). The primary objective for most extension agents (75%) was improving farmer productivity, with others focusing on quality enhancement and promoting sustainable practices (Fig. 3C2). Many agents provided services for multiple tree crops, with cocoa receiving the most services (22), followed by rubber, mango, oil palm, coconut, cashew, and shea.

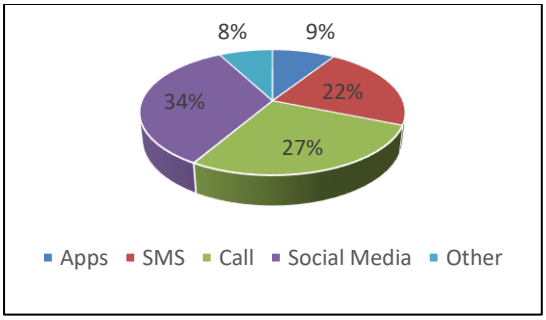


Figure 3A: Platform used by extension agents

A significant 74% of respondents identified resource limitations as a major impediment to their work (Fig. 3A1). These resource limitations included insufficient government funding, lack of transportation for reaching remote areas, lack of resources on specific tree crops, and shortages of essential supplies like seeds, fertilizers, and demonstration kits.

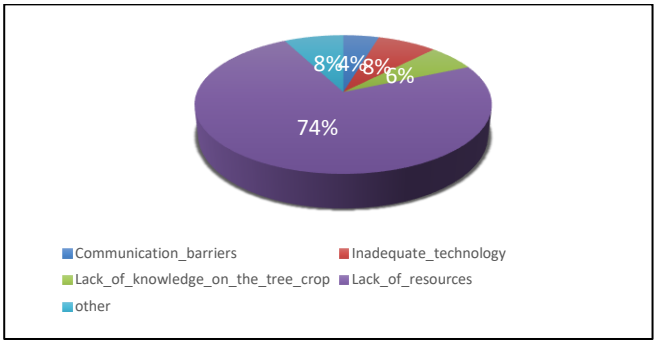


Figure 3A1. Challenges faced by extension agents

Additionally, a lack of specialized knowledge on tree crops was cited as a barrier, with many extensionists acknowledging the need for more time and research in this area. Inadequate technology, such as limited access to smartphones, tablets, or reliable internet for agricultural advisory apps, also posed significant challenges. Communication barriers affected 8% of respondents. Other cited obstacles included a lack of continuous professional development, low salaries and incentives, and limited access to research.

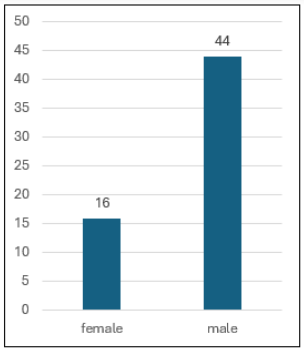


Figure 3B1: Gender distribution of respondents

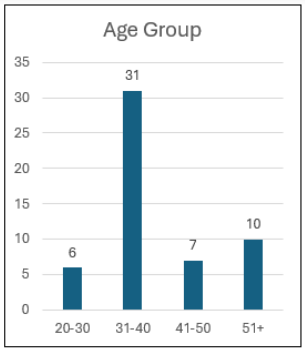


Figure 3b2: Age groups of respondents

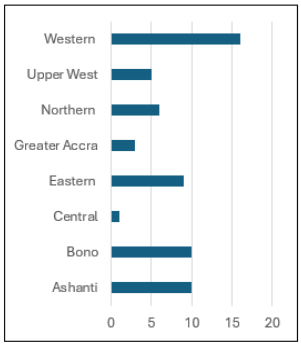


Figure 3B3: Regional distribution of respondents

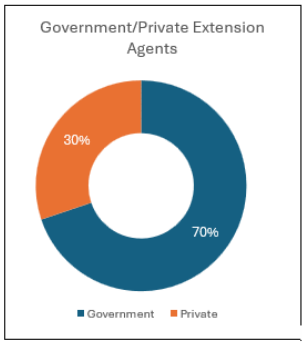


Figure 3B4: Government and Private sector extensionists

Fig 3B. Gender, age, regional, government/private distribution of sampled extension agents

Despite existing challenges, 58.3% of extension agents reported using digital tools (Fig. 3E). However, only 55% of them use these tools specifically for delivering crop-related services. Addressing the barriers to digital tool adoption—particularly within the tree crop sector—could help engage the remaining 30% of agents who currently do not use such tools (Fig. 3D). This would significantly enhance the reach and effectiveness of advisory services to farmers. Social media emerged as the most prevalent platform (34%), followed by calls, SMS, and dedicated apps (Fig. 3A).

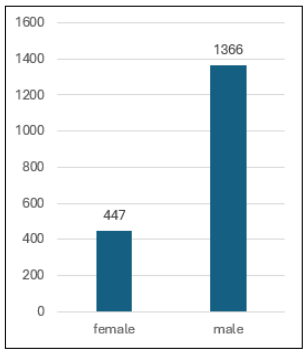


Figure 3C1: Average number of farmers served

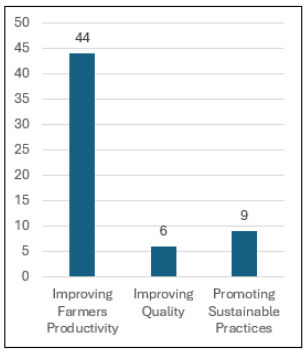


Figure 3C2: Primary goals for providing service

Figure 3C: farmers served and primary goal of extension agents

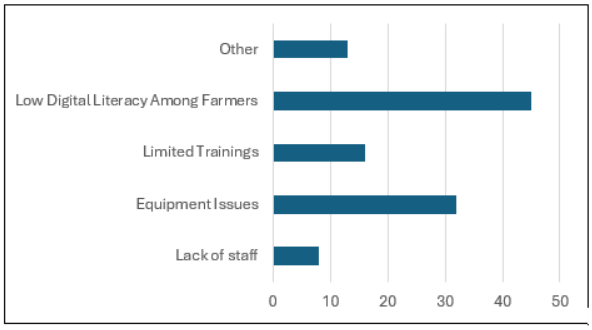


Figure 3D: Barriers to the usage of digital tools

However, 75% of respondents identified low literacy among farmers as a major barrier to digital tool adoption (Fig. 3D). Equipment issues and a lack of training were also significant concerns, affecting 53% and 27% of respondents, respectively.

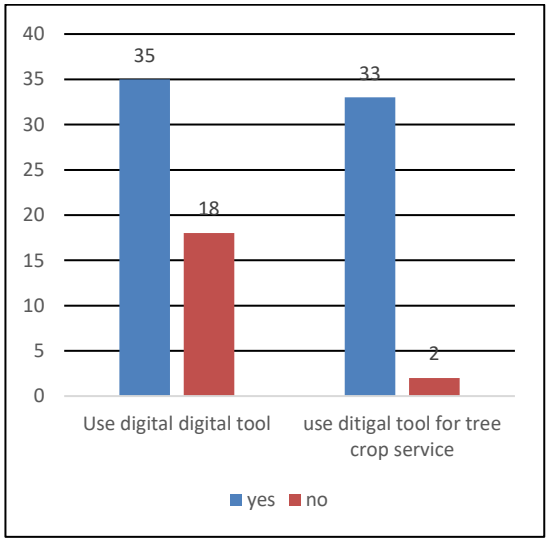


Figure 3E: Digital tool usage

# Information access and gaps

### Access to Information

The survey revealed that 66% of farmers reported receiving extension services and information, while 34% did not. Farmers cultivating cashew and cocoa had higher access than those cultivating other crops. About 58.4% of farmers receive extension services from government extension officers, followed by 33.1% from NGOs. The private sector dominates over the government sector in providing extension services for cocoa and shea, whereas the government sector is the primary provider for other crops.

### Frequency and Quality of Information

Most farmers receive advice seasonally (54%) or on demand (26%). Weekly (10%) and annual (8.1%) advice are less common (Fig. 4). Farmers who received extension relevance of the information the highest at 4.3/5, followed by quality (4.29/5), format (4.17/5), and accuracy (4.14/5). Timeliness received the lowest rating, 3.95/5, indicating room for improvement in providing information at the right time when the farmers need it. Farmers had the most trust for information or extension from government agriculture extensionists, mainly due to the good reputation of the Ministry of Food and Agriculture. Furthermore, the private sector is the second most trusted source of extension services; some private sectors have established a good reputation among some tree crop cultivation, which is why some farmers chose it as a trusted information source.

### What information is provide to farmers?

From the data analysis we found that farmers' information they currently receive can be grouped into three categories: crop management practices, agro-chemical use, and farm management and business skills. Information received under the

1. **crop management practices** include pruning (most frequently mention practice), weed control, fertilizer application, pest and disease management, planting techniques, harvesting and post-harvest practices, crop diversification and lining and pegging.
2. For **agro-chemical usage** includes safe handling and application, responsible chemical use and non-use of herbicides.
3. While **farm management and business skills** include record keeping, marketing, farm maintenance, sales techniques and farm division into plots.

There were also responses to specific crop techniques information farmers receive;

- Cocoa: fermentation, pollination and specific disease control
- Rubber: tapping skills, disease detection, and treatment
- Mango: use of approved chemicals, crate harvesting, and fruit drop management
- Cassava: planting spacing and harvesting methods

The information provided to farmers reveals a strong focus on pruning and the safe use of agro-chemicals, coupled with training in farm management and business skills, all contributing to a clear shift towards sustainable agriculture.

### What information does farmers need

For all crops, 80.50% of farmers wanted climate information or weather forecast; the group of farmers who showed the greatest need for this information were mango farmers (93.75%) (see Table 2), possibly due to mangoes higher sensitivity to weather fluctuations and shorter harvesting window - missing the optimal harvest window due to unexpected weather can lead to substantial losses. Pest and disease were the second most wanted information with 77.04% of all farmers needing information on pests and diseases, cocoa farmers, oil palm and coconut farmers were those who most wanted on pests and diseases. Thus, 98.18% of cocoa farmers wanted information on pests and diseases, followed by oil palm and coconut farmers (88.68% and 80.49% respectively). Other information needed by farmers were planting, pruning, seed and varieties, soil management, harvesting, marketing, post-harvest handling, access to inputs, and buyer information (Table 2).

Table 2: Information needs of farmers

| Information type | All Crops | Cocoa | Cashew | Mango | Rubber | Coconut | Oil Palm | Shea |
|---|---|---|---|---|---|---|---|---|
| Climate Information or Weather forecasts | 80.50 | 65.45 | 88.33 | **93.75** | 81.25 | 75.61 | 75.47 | 92.31 |
| Pest and disease control | 77.04 | **98.18** | 48.33 | 77.08 | 72.92 | 80.49 | 88.68 | 76.92 |
| Planting | 54.09 | **90.91** | 73.33 | 35.42 | 47.92 | 63.41 | 16.98 | 23.08 |
| Pruning | 53.77 | **94.55** | 80.00 | 31.25 | 18.75 | 46.34 | 52.83 | 0.00 |
| Seed and varieties | 51.26 | 89.09 | 45.00 | 25.00 | 45.83 | 53.66 | 35.85 | **92.31** |
| Soil management | 50.00 | **96.36** | 40.00 | 54.17 | 29.17 | 46.34 | 33.96 | 38.46 |
| Harvesting | 47.80 | **89.09** | 50.00 | 50.00 | 31.25 | 26.83 | 30.19 | 53.85 |
| Marketing | 43.08 | **7.27** | 66.67 | 72.92 | 50.00 | 29.27 | 20.75 | 84.62 |
| Post harvest handling | 40.25 | **78.18** | 35.00 | 43.75 | 2.08 | 17.07 | 54.72 | 46.15 |
| Access to farm inputs | 40.25 | 45.45 | 26.67 | **62.50** | 31.25 | 24.39 | 49.06 | 46.15 |
| Buyer information | 25.79 | 7.27 | 30.00 | **68.75** | 22.92 | 14.63 | 7.55 | 46.15 |

### Most preferred information needs of farmers

Furthermore, we were interested in knowing the **most** preferred information needs of the farmers. This time the analysis shows that pest and disease control is overwhelmingly the top priority for farmers (26.6%), followed by climate information/weather forecasts (19.2%), marketing information (15.4%), and access to farm inputs (14.1%) (see Fig. 4).

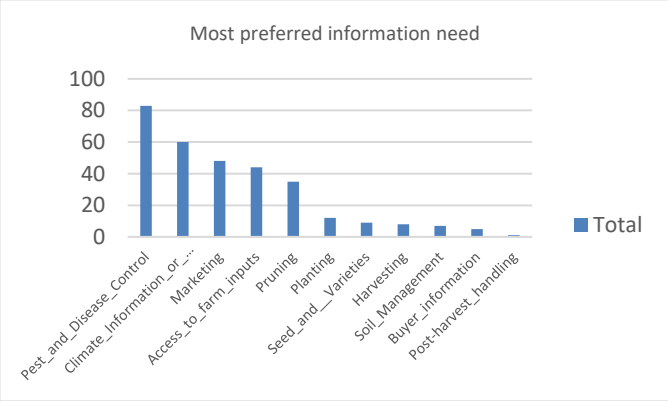


Fig 4. Most preferred information need of farmers

### Priority Information Needs

1. Pest and Disease Control (n=83, 26.6%): By far the most sought-after information, reflecting the significant impact of crop protection on farm productivity and income stability.
2. Climate Information/Weather Forecasts (n=60, 19.2%): The second highest priority, indicating farmers' growing awareness of climate variability and its effects on farming decisions.
3. Marketing (n=48, 15.4%): A substantial number of farmers prioritize market-related information, highlighting the importance of commercialization aspects.
4. Access to Farm Inputs (n=44, 14.1%): Information about sourcing and utilizing agricultural inputs represents a significant need.
5. Pruning (n=35, 11.2%): Technical information on crop management practices, particularly pruning, remains important.

### Preferred Method of Receiving Agro-climatic Information

Most farmers prefer to receive information through **Radio (63%), SMS (43.71%),** and the **news (36.48%).** Few Farmers prefer to receive information through smartphone applications (23.9%); among these, cashew and oil palm farmers are more likely to utilise smartphone applications for information (23.33% and 20.75%, respectively). Other farmers still prefer in-person delivery of information from extension officers and through group learning; this represents "Other' methods preferred (4.09%).

Table 3. Crops and farmer systems preference of receiving information

| Preferred Method | All crops | Cashew | Cocoa | Coconut | Mango | Oil Palm | Rubber | Shea |
|---|---|---|---|---|---|---|---|---|
| Radio | 63.84 | **95.00** | 92.73 | 68.29 | 60.42 | 81.13 | 70.83 | 61.54 |
| SMS | 43.71 | 33.33 | 52.73 | **65.85** | 52.08 | 49.06 | 52.08 | 53.85 |
| News | 36.48 | **60.00** | 40.00 | 41.46 | 33.33 | 35.85 | 43.75 | 30.77 |
| Public announcement systems | 30.82 | 33.33 | 27.27 | 26.83 | 16.67 | 35.85 | **43.75** | 30.77 |
| Interactive Voice Response | **23.90** | 0.00 | 7.27 | 9.76 | 16.67 | 22.64 | 20.83 | 23.08 |
| Smartphone apps | **23.90** | 23.33 | 5.45 | 9.76 | 10.42 | 20.75 | 0.00 | 0.00 |
| USSD | 7.23 | 0.00 | 3.64 | 7.32 | 10.42 | **16.98** | 0.00 | 0.00 |
| Other | 4.09 | 1.67 | 0.00 | 0.00 | 8.33 | 0.00 | 0.00 | 0.00 |

### How farmers receive the information (approach)

Based on the provided information, farmers of the seven tree crops in Ghana receive agro-advisory information from extension agents through three dominant approaches, which can be broadly categorized as:

- **In-Person Interactions:** This is the dominant approach used by extension agents to reach farmers and includes face-to-face meetings, one-on-one encounters or interactions, group meetings and discussions, farm visits, home visits, agricultural training sessions, farmers' training, field demonstrations, and in-person group discussions. We found that these approaches allow for direct communication and practical demonstrations between the farmers and extension agents.
- **Mobile and Remote Communication:** Extension agents also utilize mobile technology to disseminate information through text messages, phone calls, and phone call advisories. The reason behind this approach was that it allowed for timely and potentially widespread reach.
- **Mass Media:** Radio is a significant channel employed for delivering agro-advisory information to farmers. The responses showed that it was often through verbal communication and sometimes combined with public education through information centers.
- **Other Methods:** Some farmers also mention mass sensitization, farm management advice, and occasional verbal communication.

Overall, the data suggests a multi-faceted approach to information dissemination, with a strong emphasis on direct, in-person contact supplemented by mobile and mass media channels.

# Information utilization and farmer typologies

### Do farmers implement the advisory information they receive and which do they implement?

Concerning how farmers utilize the information in their agricultural practices, we first examine whether farmers implemented the advisory or information they received. We found that out of the farmers that received advisory changes information, 66.9% implemented changes to their farming activities while 33.1% did not implement such changes (Fig 5).

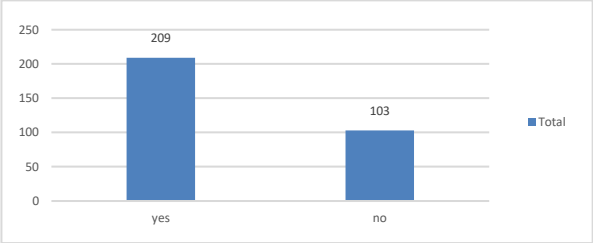


Fig 5. Implementation of changes after receiving agro-advisory information

The 66.9% implementation rate of advisory services confirms their effectiveness in driving change, highlighting the need for increased investment. However, the 33.1% non-implementation reveals significant barriers as stated earlier. Farmers cite lack of inputs and capital as primary challenges, followed by pests, diseases, and market access. Addressing these obstacles is crucial for realizing the full potential of advisory services. Targeted interventions are needed to overcome these barriers, ensuring all farmers benefit, and promoting sustainable agricultural development.

From the information they receive, we found that most of the advisory implemented by farmers predominantly include pruning, weed control, use of grafted seedlings, crop diversification and fertiliser application (see Fig. 6).

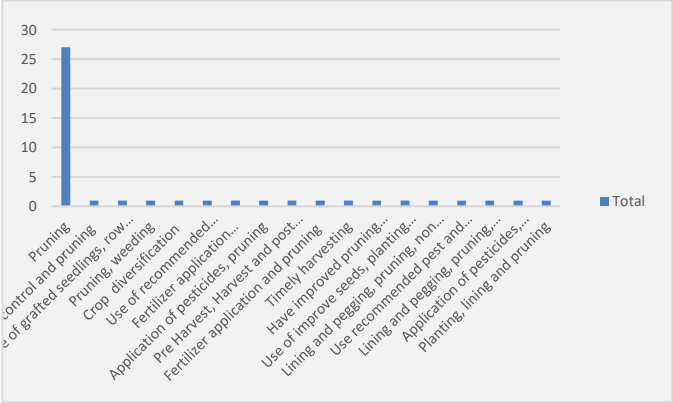


Fig 6. Type of advisory implemented

### When do farmers implement the advisory?

Furthermore, the majority of farmers (n=15) implemented the advisory recommendations within two years of receiving them, while a smaller group (n=5) acted immediately or within one year. Majority of the farmers (n=25) implemented the advisory after 5 years (Fig. 7). Notwithstanding, the fact that farmers are implementing the advisories, even with a delay, indicates that the advisory services are having an impact. However, the variation in implementation time (immediate to 2 years) raises questions about the consistency and effectiveness of the delivery.

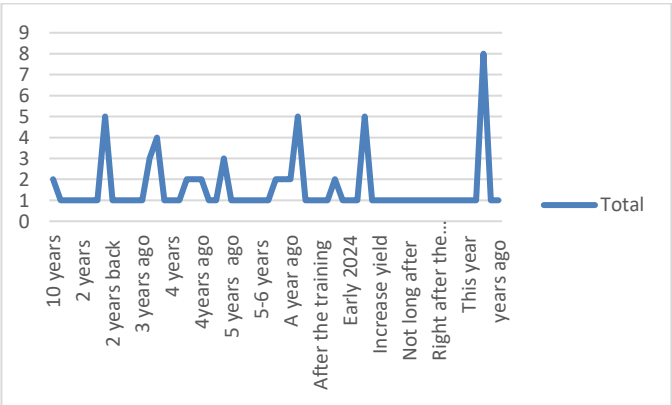


Fig 7. Period advisory was implemented

The data highlights a significant time lag between receiving advisory information and its implementation. This suggests potential bottlenecks in the adoption process. which include Lack of access to resources (financial, material), insufficient understanding of the advisory and risk aversion among farmers.

### Farmer information groups within the value chain

Our analysis identified two farmer group types: group-based extension and ICT-based extension. Group-based extension, utilizing demonstrations, farmer clusters, and radio forums, proved effective in disseminating agro-advisory information. From the extension officers profile and personas (page 12 on Human-centered design approach), extension officers favored the group approach, especially demonstrations and farmer cluster, noting its ability to foster farmer innovation and address local concerns, leading to behavioural change.

While ICT-based extension, including radio, mobile apps, SMS, social media, television, and the internet, offers cost-effective, high-impact dissemination, and its perceived potential varied. Radio was deemed ideal for most crops, but mobile app usage among extension agents was low and investment in these platforms should be well investigated. Notably, face-to-face visits remained the dominant practice, surpassing both radio and SMS.

## System preference and digital advisory use

### Digital Advisory Use

Analysis of farmer adoption of digital advisory tools (Fig. 8A) reveals that 70.8% do not use them, leaving only 29.2% as users. Within this user group (Fig. 8B), cashew and mango farmers constitute the largest segment. Figure 4C highlights the seasonal nature of digital tool usage, with 52.7% of farmers utilizing them daily followed by weekly (19.4%). Other usage frequencies include rarely (19.4%), monthly (11.8%), weekly (10.8%), and daily (5.4%). Finally, Figure 8D indicates that a substantial 90.4% of farmers use these tools independently, while only 9.6% require support from extension agents.

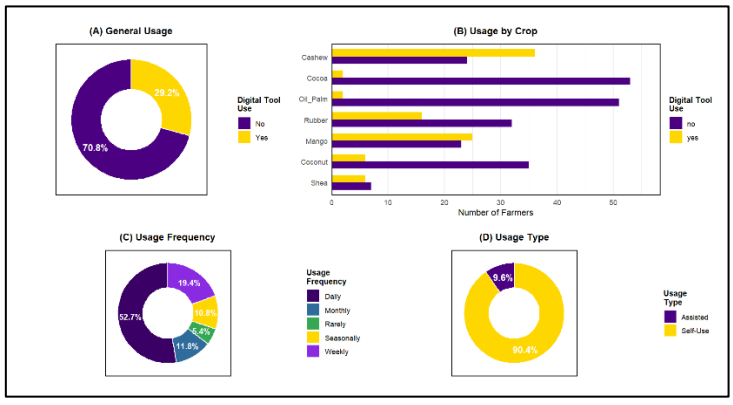


Figure 8: Digital tool usage among tree crop farmers

The fact that 70.8% of farmers don't use these tools highlights a substantial digital divide. Highlighting challenges with access to technology, internet connectivity, and digital literacy. Furthermore, the varying frequency of usage (mostly daily) indicates that digital tools should be integrated into farmers' daily practices. This calls for more interventions to promote daily consistent and effective use.

### Access to Agro-Climatic Information

Figure 8A shows that 73.6% of farmers do not currently receive agro-

climatic advice, while only 26.4% do. Radio is the most common medium (50.7%), followed by SMS (26.8%), television (8.3%), voice calls (2.8%), and public announcement systems (2.1%).

A significant majority (82%) of farmers expressed a preference for agro-climatic information that encompasses advisory for a range of crops, extending beyond the current focus on tree crops.

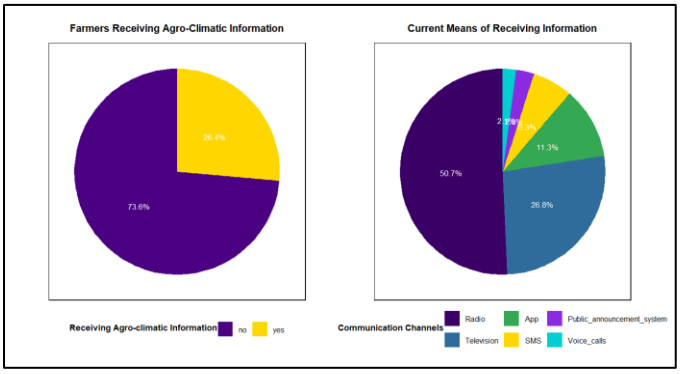


Figure 8A: Access to Agroclimatic Information

## Gender-Based Differences in Information Needs

The results indicate distinct patterns in the information needs of male and female farmers. Across nearly all categories, both genders expressed strong demand for agricultural information, but some differences are noteworthy (Figure 10). Pest and disease control and climate information or weather forecasts emerged as the top two information needs for both genders, with over 75% of respondents indicating interest. Male farmers (82.3%) showed slightly more interest in climate-related information than females (76.7%), while pest and disease control was almost equally prioritized by both (77.7% male, 76.7% female). When it came to planting and pruning, male farmers consistently reported higher needs (57.3% and 54.4%, respectively) compared to female farmers (52.6% and 52.4%). Similar trends were observed in harvesting and seed and variety information (Figure 10).

Interestingly, post-harvest handling and buyer information needs showed the most gender-based divergence. A significantly higher proportion of male farmers (42.8% and 31.2%) expressed interest in these areas compared to females (35% and 14.6%). This suggests that men may be more involved in post-production and market-related activities.

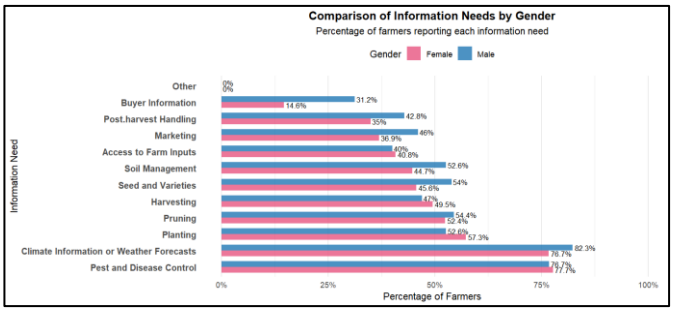


Fig 9. Gender differences in information need

## Farming years and need for extension services

From the data we found that farmers (n=103) with extensive farming years (i.e. 16 years and above) opted for extension services while farmers with less years of farming (1-5 years) received extension services (n=140) (Fig. 10). This suggests a positive relationship between farmers' extensive experience in agriculture and their demand for extension services and information.

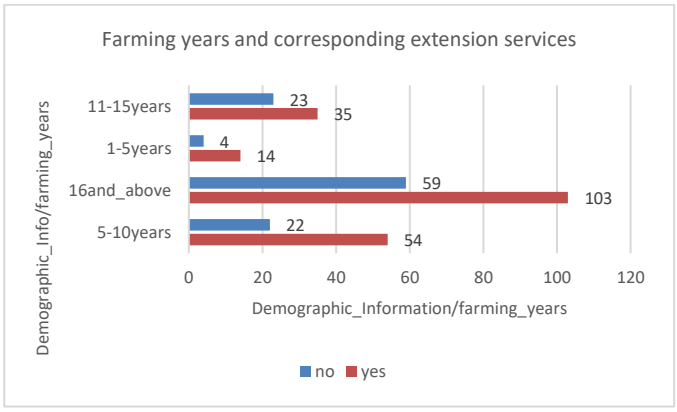


Fig 10. Farming years and corresponding extension services needs

In other words, more experienced farmers tend to seek out and utilize extension services and information more frequently than less experienced farmers.

## Frequency and Quality of Extension Services

Most farmers receive advice seasonally (54%) or on demand (26%). Weekly (10%) and annual (8.1%) advice are less common (Fig. 11). Farmers who received extension, rank the relevance of the information the highest at 4.3/5, followed by quality (4.29/5), format (4.17/5), and accuracy (4.14/5). Timeliness received the lowest rating, 3.95/5, indicating room for improvement. Farmers had the most trust for information or extension from government agriculture extensionists, mainly due to the good reputation of the Ministry of Food and Agriculture. Furthermore, the private sector is the second most trusted source of extension services; some private sectors have established a good reputation among some tree crop cultivation, which is why some farmers chose it as a trusted information source. The smaller numbers relying on private sector advisors and other farmers indicate that while these sources exist, they are not as widely utilized or trusted as the government services. This highlights the importance of continued investment and support for government extension programs to ensure farmers have access to reliable and up-to-date information.

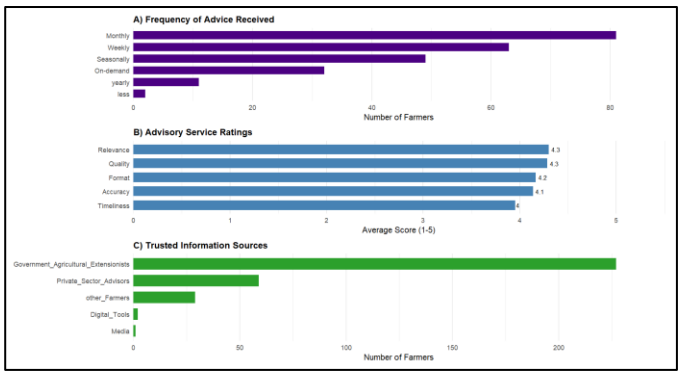


Figure 11: Frequency, quality and most trusted information sources

## Willingness to pay for Agroclimatic-Information

Key findings from our survey reveal that approximately half of the farmers (51.3%) are willing to pay for agro-climatic advisory services, while the other half (48.7%) are not (Figure 12). Shea, Mango and Oil Palm farmers demonstrated the highest willingness to pay for these services (97.3%, 81.2%, and 79.2% respectively), while cashew and Cocoa farmers showed a comparatively lower interest in paid agro-climatic advisory (26.3% and 12.7% respectively). Possible explanation is that shea, mango, and oil palm yields may be more directly and immediately impacted by short-term weather variations, as these crops often have critical growth periods that are highly vulnerable to specific climate conditions.

On the other hand, cocoa and cashew farming in Ghana may benefit from more established traditional knowledge networks (showing lower interest in paid agro-climatic advisory), as these crops have longer histories of cultivation, allowing for the accumulation of valuable local climate adaptation knowledge.

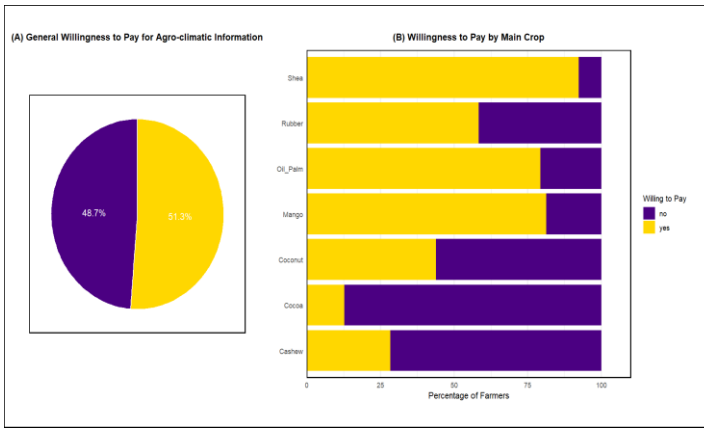


Figure 12: Willingness to pay for Agro-climatic information

### Farmers' Preferred Information Channels by Education Level

Education level significantly influenced farmers' preferred methods of receiving climate information (Figure 13). Farmers with secondary and tertiary education showed a strong preference for text messages (SMS), likely due to their higher literacy levels compared to those with only basic or no formal education. Among these groups, farmers with tertiary education also demonstrated a notable inclination toward using smartphone applications, indicating a readiness to engage with more advanced digital tools for accessing timely information.

Despite these differences, radio remained a commonly preferred source of climate information across all education levels. However, farmers with higher educational attainment were generally more inclined toward SMS and smartphone apps, suggesting a shift from scheduled radio programming to more flexible, on-demand digital platforms.

Conversely, farmers with no formal education tended to rely more heavily on public announcement systems delivered in local dialects. This preference highlights the importance of voice-based communication in native languages, which remains a more accessible and comprehensible medium for this segment of the farming population.

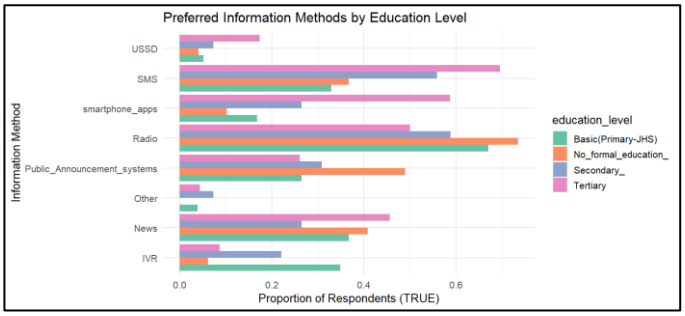


Figure 13: Preferred Information Channels by Different Education Levels

Thus, to reach the most marginalized groups, particularly those with no formal education, **voice-based communication channels**—such as community radio, public announcement systems, and extension services delivered in local dialects—should be strengthened and integrated into national climate information systems. At the same time, expanding digital literacy and smartphone access among rural populations can help bridge the information divide over the long term.

# Human-centered design approach for developing climate information service

To comprehend farmers' informational needs and preferences, we conducted face-to-face interviews with extension officers across the seven tree crop zones. These interviews aimed to understand extension officers' current information needs, challenges, preferred information systems, and how they rate technological tools that aid their work with farmers. This research was designed to help create an ideal information system for extension officers, leading to the development of extension officer profiles or user personas (Alliance, 2023). The following highlights the user personas generated for the seven crops under the Ghana Tree Crop Diversification Project.

## User research 1: User persona creation for extension officers in the oil palm sector

The team assigned to Kade conducted face-to-face interviews with four extension officers. These interviews led to the development of an extension officer profile or user persona (Profile 1): a fictional character crafted from insights gathered during user research to comprehend analysis categories such as information needs, preference and behaviours (Ofosu-Ampong et al, 2024). All four surveyed extension officers in the district are male (ages= 31, 35, 52, 57). The district employs five extension officers, all male and government employed. The agent-to-farmer ratio varies significantly, with each agent responsible for between 1,000 to 3,000 farmers, averaging approximately 1,750 farmers per agent.

Three-quarters of extension agents utilize some form of digital tools, though usage patterns differ. Specific apps and SMS services are each used by 25% of agents, while call centers are the most popular digital resource at 50% adoption. None of the agents currently use social media for their work.

As illustrated in Figure 7 is an overview of Ohene's goals, constraints, needs, information access challenges, ideal information system preferences, and ratings of technological tools used in the performance of his duties in Kade. Ohene's information access challenges, compounded by environmental constraints like galamsey, poor connectivity and road conditions, highlight the need for tailored technological solutions to support extension agents and farmers. Key barriers to effective extension services include insufficient staffing and equipment, limited training opportunities (75%), low digital literacy among farmers (25%), and alternative challenges such as reliance on verbal information dissemination (25%). One specific solution identified was the need for personal transportation due to unavailable or poorly maintained office vehicles. Information access challenges include data subscription costs, insufficient in-service training (notably mentioned as both a barrier and potential solution), and farmer inaccessibility due to time constraints.

Regarding "ideal systems for oil palm crop," all agents expressed preference for practical, hands-on approaches like demonstration sites. Additional suggestions included an invoice system, input motivation during meetings, and group gatherings. Desired features for an ideal information system encompass easy farmer access, video training resources, SMS capabilities, and demonstration systems/training. For farmer engagement, agents unanimously emphasized the importance of one-on-one interactions and group training, while digital outreach methods remain unutilized. Looking ahead, to strengthen agricultural extension services, it's essential to promote gender equality, ensure affordable access to information, and support a blended approach that combines digital and traditional methods tailored to farmers' diverse needs and value chains. This includes exploring and supporting varied service delivery models—engaging both governmental and non-governmental actors—while advocating for increased investment to improve farmer-to-agent ratios. Equally important is facilitating the effective adoption of digital tools through targeted training, infrastructure support, relevant content development, and the proactive removal of barriers to digital inclusion.


Profile 1. User persona representing an extension officer working in oil palm sector in Kade

## User research 2: User persona creation for extension officers in the mango sector

The team assigned to Yilo Krobo and Shai OsuDoku conducted face-to-face interviews with eight extension officers which led to the development of a user persona (Profile 2). Extension officers in this sector were all females (ages=33, 44, 51, 51, 57, 63, 66, 72) and is private sector dominated (7 officers). All eight extension officers (females)—five from the Eastern Region and three from Greater Accra, Ghana—with farmer loads of 10, 11, 5, and 10 in the Eastern Region, and 2, 8, and 58 in Greater Accra, prioritize improving farmer productivity as their primary goal, except for one officer (with a load of 50) who focuses on improving quality, revealing a potential divergence in strategic focus.

Consistently the officers reported a lack of resources as a major challenge, with one agent also citing communication barriers. Addressing the resource limitations, resolving communication barriers, and redistributing farmer loads are crucial steps to empower the extension agents and ensure sustainable improvements in mango farming practices and productivity in the region.

While all agents report no use of dedicated mobile applications, 4 of the private extension officers leverage SMS-based services. Furthermore, 6 of private extension officers utilize call centers and social media platforms to address farmer informational needs. The reliance on SMS and social media by private agents indicates potential for low-cost technologies which calls for a scaled up.

A substantial 75% of agents report low digital literacy among mango farmers, presenting a potential barrier to the effective implementation of digital extension strategies. Addressing the digital literacy challenge among farmers is crucial for maximizing the effectiveness of digital extension initiatives.

Looking ahead, there is a need to support initiatives that enhance digital infrastructure and connectivity in rural areas to improve access to digital extension services. Facilitate the integration of appropriate digital tools into government and private extension services, focusing on cost-effective solutions like SMS and social media.


Profile 2. User persona representing an extension officer working in mango sector in Yilo Krobo

## User research 3: User persona creation for extension officers in the cocoa sector

The extensionist in the cocoa sector were entirely male (11 individuals), aging between 26 to 44 years (ages=26, 28, 30, 34, 35, 36, 37, 37, 38, 38, 44). Both government (54.5%) and private (45.5%) extension bodies are active in the area. However, there's a significant disparity in the number of farmers assigned per extension officer. Government extension officers have a much higher load in terms of the number of farmers they serve (ranging from 1598 to over 1710; averagely 610), compared to private officials (ranging from 250 to 1059; averagely 1439).

Only two extension officers currently use digital tools and specific apps for crop information (one government extension officer and one private). SMS is used by one officer. Other digital channels like call centers and social media are not utilized by this group. A very high proportion of extension officers (10) face challenges due to low digital literacy among farmers.

Extension officers face challenges related to the lack of updated information and pictorial training materials and poor network connectivity (high priority). Delayed feedback from experts is also an issue for two officers.

Extension officers strongly prefer systems that are accessible on basic phones, affordable (ideally free), and easy to navigate, using simple language, visuals, and audio in local languages. They also emphasize the need for relevant and trustworthy, real-time, and contextualized cocoa-specific information from trusted sources. Interactive and responsive systems allowing two-way communication and feedback are also highly valued.

Specific features prioritized include simplicity and ease of use, audio accessibility in local languages, voice functionality (recording, listening, playback), and visual information (pictures and short videos).

Extension officers overwhelmingly prefer group training (100%) and one-on-one interactions (90.9%) over digital outreach (0%). Our interview with the officers led to the development of a user persona (Profile 3).


Figure 3. User persona representing an extension officer working in cocoa sector in Asante Akim South

## User research 4: User persona creation for extension officers in the coconut sector

Out of the six extension officers interviewed which led to the development of a user persona (Profile 4)., only one was female, aged 34. All the extension officers were employed by the government. While the female officer was 34 years old, her male counterparts ranged in age from 29 to 50 years. On average, each government extension officer is responsible for approximately 1,283 farmers per group.

Four out of the six officers reported using digital tools in their work; however, only one utilizes a dedicated mobile application for day-to-day activities. SMS, call centers, and social media platforms are currently not used by these officers. Key challenges in adopting digital tools include a lack of technical support staff, insufficient equipment, limited training opportunities, low digital literacy among farmers, and financial constraints in meeting the increasing demand for information.

Additional barriers to information access include difficulties in reaching farmers on time, network limitations, resource constraints, and a general lack of capital. The ideal information system for the coconut sector should prioritize on-farm problem-solving over phone-based support. It should also encourage group meetings and digital dissemination while enabling personalized, one-on-one interactions via digital platforms.

Preferred features of such a system include SMS and WhatsApp integration, support for free calls, location-specific content such as a digital address system, and digital training modules for farmers. Moreover, the platform should include market linkages by integrating buyers, as the current system is primarily limited to farmers, extension agents, and input dealers.

Farmer engagement is predominantly conducted through group-based learning sessions (such as farmer cluster trainings), with occasional one-on-one interactions. Notably, extension officers do not currently use digital platforms for outreach to farmers.

**KWAMINA**

**Age:** 45

**Location: Ellembelle**, Western Region

**Time in role: 10** years

**Language:** Twi, English

**Education**: BSc Agribusiness

**BIO**

Kwamina is a government extension officer based in Ellembelle and provides support to 2500 coconut farmers. He is keen on exploring digital outreach modalities to ease the cost and resources used for reaching farmers in the region.

**OBJECTIVES**

- Improving farmer productivity
- Promote sustainable practices to farmers
- Provide timely information and good agricultural practices to farmers

**CONSTRAINTS**

- Key challenges in adopting digital tools include a lack of technical support staff, insufficient equipment, limited training opportunities, low digital literacy among farmers, and financial constraints in meeting the increasing demand for information.

**IDEAL SYSTEM**

- Need a system with SMS and WhatsApp integration, support for free calls, location-specific content such as a digital address system

**TECHNOLOGICAL TOOLS**

- Access to climate information
- Ease of use
- Perceived usefulness

**INFORMATION ACCES**

- SMS, call centres and and social media platforms are currently not used
- Use digital platforms provide by the ministry to ascertain information but no special app design for the coconut sector
- difficulties in reaching farmers on time, network limitations

**PREFERENCE FOR INFO SYSTEMS**

- prioritize on-farm problem-solving over phone-based support. It should also encourage group meetings and digital dissemination while enabling personalized, one-on-one interactions via digital platforms.

**NEEDS**

- Need a platform should include market linkages by integrating buyers, as the current system is primarily limited to farmers, extension agents, and input dealers.

Profile 4. User persona representing an extension officer working in coconut sector in Ellembelle

## User research 5: User persona generation for extension officers in the shea sector

Out of the six extension officers interviewed which led to the development of a user persona (Profile 5), two were female, aged 35 and 40. Four of the officers were employed by the private sector. The male officers ranged in age from 35 to 38 years. Notably, the government-employed extension officer supported only one farmer, whereas private sector officers were, on average, responsible for approximately 91 farmers per group.

None of the six officers reported the consistent use of digital tools in their work. However, one officer indicated using a dedicated mobile application for daily activities. SMS, call centers, and social media platforms are currently not utilized by these officers. Key challenges hindering the adoption of digital tools include a lack of adequate equipment and devices, limited access to training, and low digital literacy among farmers. Additional barriers to information access include delays in receiving timely updates, poor network connectivity, resource constraints, long distances to service points, limited education, and a lack of access to phones, tools, and logistical support.

An ideal information system for the shea sector should emphasize in-person interactions, including trainer-of-trainer modules, phone calls, and live demonstrations. Radio programs are also considered valuable for outreach.

Preferred features of such a system include radio integration, visual content such as pictures and videos, locally tailored information, voice recordings, demonstrations by lead farmers, and instructional materials that showcase specific processes like packaging and shea product processing. Group-based learning is highly favoured by farmers over one-on-one interactions. According to one extension officer, digital outreach currently garners the least engagement, underscoring the ongoing importance of traditional extension methods alongside digital innovations.

Proposed solutions by the extension officers include increasing training opportunities, developing a unified platform featuring voice recordings, and enhancing both technical and digital skills. These insights highlight the need for sustained capacity building and the development of context-appropriate digital solutions for the shea sector.

**SADIA**

**Age:** 40

**Location:** Savulugu, Northern Region

**Time in role: 11** years

**Language:** Dagbani, Twi, English

**Education**: BSc Agriculture

**BIO**

Adwoa is a government extension officer based in Savulugu and provides support to 120 shea farmers. Information barriers she faces include delays in receiving timely updates, poor network connectivity, and long distances to service points.

**OBJECTIVES**

- Improving farmer productivity
- Promote sustainable practices to farmers
- Provide timely information and good agricultural practices to farmers

**CONSTRAINTS**

- Key challenges hindering the adoption of digital tools include a lack of adequate equipment and devices, limited access to training, and low digital literacy among farmers.

**IDEAL SYSTEM**

- An ideal information system for the shea sector should emphasize in-person interactions, including trainer-of-trainer modules, phone calls, and live demonstrations.
- Radio programs are also considered valuable for outreach.

**TECHNOLOGICAL TOOLS**

- Access to climate information
- Ease of use
- Perceived usefulness

**INFORMATION ACCES**

- SMS, call centers, and social media platforms are currently not utilized
- Delays in receiving timely updates, poor network connectivity, resource constraints, long distances to service points, limited education, and a lack of access to phones, tools, and logistical support.

**PREFERENCE FOR INFO SYSTEMS**

Preferred features of such a system include radio integration, visual content such as pictures and videos, locally tailored information, voice recordings, demonstrations by lead farmers, and instructional materials that showcase specific processes like packaging and shea product processing

**NEEDS**

- Proposed solutions by the extension officers include increasing training opportunities, developing a unified platform featuring voice recordings, and enhancing both technical and digital skills.

Profile 5. User persona representing an extension officer working in shea sector in Savulugu

## User research 6: User persona generation for extension officers in the cashew sector

In Wenchi, ten government-employed extension officers were interviewed, among whom two were female, aged 33 and 35. The male officers ranged in age from 32 to 54 years. The interview from the officers led to the development of a user persona (Profile 6).

Government extension agents in the area face an overwhelming workload, each responsible for between 600 and 8,000 farmers. On average, one extension officer supports approximately 2,440 farmer groups. One officer highlighted that this high farmer-to-agent ratio significantly limits the individual attention and tailored support that each farmer can receive, thereby affecting the overall effectiveness of extension service delivery.

Interestingly, while all extension agents working in the rubber industry reported using digital tools, none mentioned the use of specific applications. All officers indicated they rely on call centres and social media, with seven also using SMS as part of their outreach. A major challenge cited by all respondents was poor network connectivity, which impedes their ability to utilize digital tools effectively. Suggested solutions included improved network infrastructure and enhanced digital literacy training for both farmers and extension agents.

Additional information access challenges included:

- Costs associated with accessing climate information
- Unreliable network connections for service delivery
- Delayed communication from supervisors
- Farmers' inability to accurately report yields from the field

An ideal information system for both extension officers and farmers should integrate digital tools with physical training sessions. Such a system should promote group meetings and digital dissemination, incorporating a variety of communication modes, including:

- Verbal communication via farm visits and radio
- Visual and audio content in local dialects
- Live, face-to-face interactions
- Mobile applications
- Information sharing through trusted opinion leaders in the community

Preferred features for SMS and WhatsApp-based platforms include audio and text messaging, pictorial content, flexibility, bulk messaging capabilities, and support for multiple languages.

In terms of farmer engagement, group-based learning and one-on-one interactions are highly valued by farmers and serve as the primary methods used by extension officers in the cashew sector.

**WISE**

**Age:** 54

**Location: Wenchi**, Bono Region

**Time in role: 19** years

**Language: Fante**, Twi, English

**Education**: BSc Agricultural Extension

### BIO

Wise is a government extension officer based in Wenchi and provides support to 4000 **cashew** farmers. Ato information need is regular training on modern technologies especially pest and diseases, and planting calendar for cashew and mango. He hopes for a technology that can break the delays in getting information from superiors.

### OBJECTIVES

- Improving farmer productivity
- Promote sustainable practices to farmers
- Provide timely information and good agricultural practices to farmers

### CONSTRAINTS

- A major challenge is poor network connectivity, which impedes his ability to utilize digital tools effectively.
- delays in getting timely response and information from superiors

### IDEAL SYSTEM

- Verbal communication via farm visits and radio
- Visual and audio content in local dialects
- Live, face-to-face interactions
- Mobile applications
- Information sharing through trusted opinion leaders in the community

### TECHNOLOGICAL TOOLS

- Access to climate information
- Ease of use
- Perceived usefulness

### INFORMATION ACCES

- Costs associated with accessing climate information
- Unreliable network connections for service delivery
- Delayed communication from supervisors
- Farmers' inability to accurately report yields from the field

### PREFERENCE FOR INFO SYSTEMS

Preferred features for SMS and WhatsApp-based platforms include audio and text messaging, pictorial content, flexibility, bulk messaging capabilities, and support for multiple languages. Group-based learning and one-on-one interactions are highly valued by farmers

### NEEDS

- improved network infrastructure and enhanced digital literacy training for both farmers and extension agents.

Profile 6. User persona representing an extension officer working in cashew sector in Wenchi

## User research 7: User persona generation for extension officers in the rubber sector

In Ahanta West, six government-employed and two private extension officers were interviewed. Among them were two female officers, aged 27 and 37, while the male officers ranged in age from 34 to 41 years. The farmer-to-extension agent ratio varies considerably between sectors. Private extension agents manage a relatively manageable caseload of approximately 500 farmers each, whereas government extension officers are responsible for significantly higher numbers, ranging from 1,000 to 3,000 farmers, with an average of 1,950 per officer. This disparity may adversely affect the quality and effectiveness of support provided to farmers.

Most of the extension officers report using digital tools, and a few of them use specialized agricultural applications, indicating a growing trend toward digital adoption in agricultural practices. However, limited access to equipment remains a significant barrier, underscoring the urgent need to improve farmers' access to digital devices.

Proposed solutions to overcome these digital barriers emphasize the need for increased training, both in general digital literacy and specifically in the sustainable production of rubber. This reflects a demand for both technical competencies and crop-specific knowledge.

insufficient access to mobile devices for internet connectivity, a perceived disconnect between agricultural officers and research institutions, limited training opportunities, inadequate resources, and persistent issues with communication and misinformation.

The ideal agricultural information system is widely envisioned as a mobile application that provides accurate, crop-specific information on tree crops.

Desired features include images of crops and associated problems, tools for uploading pest or disease images, visual indicators of crop maturity stages, use of the official language (English), minimal data consumption, and video or visual content addressing key issues.

There is strong engagement with both one-on-one support and group training initiatives. Additionally, extension officers demonstrate notable interest in digital outreach, highlighting their openness to a variety of extension service delivery models. The interview from the officers led to the development of a user persona (Profile 7).

**KUKUA**

**Age:** 37

**Location:** Ahanta West, Western Region

**Time in role: 8** years

**Language:** Twi, English

**Education**: BSc Agriculture

**BIO**

Kukua is a government extension officer based in Ahanta West and provides support to 1200 rubber farmers. Kukua information need is a system that allows image upload strange pest and disease on the field and timely response to the issue. She hopes for an app that contains accurate information about different tree crops.

**OBJECTIVES**

- Improving farmer productivity
- Promote sustainable practices to rubber farmers
- Provide timely information and good agricultural practices to farmers

**CONSTRAINTS**

- Insufficient access to mobile devices for internet connectivity, a perceived disconnect between agricultural officers and research institutions, limited training opportunities, and persistent issues with communication and misinformation

**IDEAL SYSTEM**

- mobile application that provides accurate, crop-specific information on tree crops.
- Farmer extension interaction enabler
- Radio programs, farm visits and demonstrations enablers

**TECHNOLOGICAL TOOLS**

- Access to climate information
- Ease of use
- Perceived usefulness

**INFORMATION ACCES**

- No smart mobile devices (poor quality mobile device) to access internet services
- Close the gap between Agric officers and research bodies
- Inadequate training and resources
- Lack of communication and misinformation

**PREFERENCE FOR INFO SYSTEMS**

Preference include images of crops and associated problems, tools for uploading pest or disease images, visual indicators of crop maturity stages, use of the official language (English), minimal data consumption, and video or visual content addressing key issues. Group-based learning and one-on-one interactions are highly valued by farmers

**NEEDS**

Need for increased training, both in general digital literacy and specifically in the sustainable production of rubber.

Profile 7. User persona representing an extension officer working in rubber sector in Ahanta West

Extension officers also identified several broader challenges, including

# Discussion and next steps

The exploration of farmers and extension officers' information needs revealed a significant opportunity to support Ghana's cocoa, cashew, rubber, oil pam, coconut, shea and mango production across the eight survey regions.

The findings highlight the critical need for differentiated communication strategies that align with farmers' educational backgrounds. While digital platforms such as SMS and smartphone applications are effective among farmers with secondary or tertiary education, these tools are less accessible to those with limited literacy or no formal education. As such, climate information dissemination policies must adopt a multi-modal approach that ensures equitable access for all farmers, regardless of education level. To reach the most marginalized groups, particularly those with no formal education, voice-based communication channels—such as community radio, public announcement systems, and extension services delivered in local dialects—should be strengthened and integrated into national climate information systems.

The finding that nearly three-quarters (73.6%) of farmers do not receive agro-climatic advice signals a critical gap in the outreach and delivery of climate-related agricultural services. This limited coverage underscores the need for national and regional policies to expand the reach of agro-climatic advisory systems, particularly to underserved farming communities. While radio remains the most widely used channel, its current reach still excludes a large portion of the farming population. To improve coverage and effectiveness, investment in diversified communication channels—including SMS, voice calls, and public announcement systems—is essential. These platforms should be tailored to local preferences, literacy levels, and technological access, ensuring inclusivity across education and income groups. Additionally, the strong farmer preference (82%) for crop-diverse agro-climatic information points to the need for a broader, more inclusive advisory content that goes beyond tree crops. Policy frameworks should prioritize the development and dissemination of climate services that support a wider range of crops relevant to local farming systems.

The findings underscore the critical role of government agricultural extension services as the most trusted and widely used source of climate and agricultural information among farmers. This high level of trust is largely attributed to the Ministry of Food and Agriculture's strong reputation, suggesting that public sector extension systems remain central to effective knowledge dissemination. However, the relatively low ratings for timeliness—despite high marks for relevance, quality, format, and accuracy—point to a need for improving the frequency and responsiveness of advisory services. With most farmers receiving information either seasonally or on demand, and fewer benefiting from regular weekly or annual support, policies should focus on enhancing the consistency and timeliness of extension delivery, particularly in response to dynamic climate conditions.

Moreover, while private sector actors are emerging as trusted sources in specific value chains, their limited reach suggests an opportunity for greater public-private collaboration. Encouraging partnerships between government extension systems and reputable private providers could expand the reach and diversity of advisory services, especially in specialized crops and emerging technologies.

To strengthen resilience and improve decision-making at the farm level, policy interventions should prioritize:

- Investments in timely, frequent, and localized advisory services, especially during critical agricultural seasons;
- Capacity-building for government extensionists to enable more proactive engagement;
- Support for hybrid extension models that leverage both public trust and private innovation;
- Inclusion of feedback mechanisms to continuously assess and improve the effectiveness and timeliness of extension delivery.

Currently, the mixed levels of willingness to pay for agro-climatic advisory services suggest that a one-size-fits-all financing model may not be effective. While the overall interest is split almost evenly, significant variation exists across crop types. Farmers cultivating Shea, Mango, and Oil Palm show a high willingness to invest in paid advisory services, indicating strong perceived value and potential for cost-recovery or private-sector partnerships in delivering tailored climate information for these value chains. In contrast, the lower willingness to pay among Cashew and Cocoa farmers points to a need for continued public or donor-supported delivery of climate services in those sectors, at least in the short to medium term. This may be due to differing levels of profitability, market access, or past exposure to advisory services. Policy should therefore consider a differentiated approach to financing climate information services—one that reflects both the economic dynamics of specific crops and the perceived value of advisory support by farmers.

The use of human-centred design (HCD) in developing extension officer profiles underscores the importance of designing agricultural information systems that are grounded in the lived experiences, preferences, and operational realities of frontline actors. By directly engaging extension officers through face-to-face interviews, the project captured critical insights into their information needs, challenges, and preferred tools—laying the foundation for more responsive and user-friendly systems.

This approach has clear policy implications. First, agricultural innovation and technology deployment should begin with user research that captures the needs of both extension officers and farmers. Tailoring solutions to these user personas increases adoption, reduces implementation gaps, and ensures that tools are relevant and actionable in real-world contexts.

Second, the data reveals a concerning extension agent-to-farmer ratio, with one agent supporting up to 3,000 farmers. This signals a need for policy interventions that not only increase staffing but also invest in technological support systems that amplify the reach and efficiency of existing agents—particularly digital tools co-designed with their input.

Finally, incorporating HCD principles into national extension strategies can lead to more inclusive, context-aware innovations that are better suited to the diverse agroecological and sociocultural realities across the seven tree crop zones. Institutionalizing HCD in agricultural development policy can enhance the scalability and sustainability of extension reforms.

Limitation: There is low representation of farmers in the survey; however, the findings still provide valuable insights into regional agricultural practices and challenges in Ghana's tree crops. Despite this sampling limitation, the data reveals consistent patterns across participating demographics that align with tree crop experts' views and local extension agents profiles. Future research initiatives should prioritize broader farmer inclusion to validate these preliminary results and capture additional perspectives from underrepresented tree crops communities. The current findings, while acknowledging this constraint, offer actionable intelligence that can inform immediate policy considerations while more comprehensive data collection efforts are undertaken.

# Workshop on Ghana Tree Crop Diversification Project Consultative Forum on E-Extension Solution

On April 16-17, 2025, the Alliance of Bioversity International – CIAT, in collaboration with the Ghana Tree Crop Development Authority, convened a high-level workshop as part of the Ghana Tree Crop Diversification Project in Accra, Ghana. This event was generously supported by the World Bank and the Global Center on Adaptation (GCA). The workshop served as a critical platform for sharing key findings from the Alliance's project assessment on farmers and extension agents' information needs and use (facilitated by Kingsley Ofosu-Ampong) and fostering dialogue among stakeholders on the role of e-extension services in climate-smart agriculture.


*Sharing of research findings*

Experts representing Ghana's seven key tree crops—mango, cocoa, cashew, rubber, oil palm, coconut, and shea—presented insights on prioritizing climate-smart agricultural (CSA) investments. They also showcased how innovative e-extension solutions are supporting the transformation of tree crop value chains in the face of climate change. The participants were recruited from the following departments:

1. Ghana Cocoa Board (COCOBOD)

2. Tree Crop Development Authority (TCDA)

- All Value Chain Specialist
- Zonal Representatives

3. Ministry of Food and Agriculture (MOFA)

- Department of Extension Services
- Department of Crop Services

4. Regional Agric Directorate

5. Plant Protection Regulatory Service

6. Cocoa Research Institute of Ghana

7. CSIR-Oil Palm research Institute (OPRI)

8. Representatives from Value Chain Associations

9. Ghana Meteorological Agency (GMet)

**Feedback from Participants on Research Findings**

The participants actively engaged with the data presentation, contributing insightful perspectives and analytical feedback. The collaborative discussion that followed emphasized several key implications of the research that warrant further exploration.

The workshop highlighted several critical gaps in extension services for tree crop farmers. Participants acknowledged that the Tree Crops Development Authority (TCDA) and Ministry of Food and Agriculture (MoFA) have initiated collaboration to address extension service deficiencies, with tangible outcomes expected in the near future. It is imperative that TCDA incorporate key workshop findings into their strategic planning and operational activities.

Input availability emerged as a significant constraint for tree crop farmers. Stakeholders recommended that TCDA develop a comprehensive input distribution system for non-cocoa tree crops, modeled after the successful cocoa sector framework. This would help standardize access to quality inputs across different tree crop value chains.

Gender-specific information needs were identified during discussions. Women farmers often seek climate and agricultural information for purposes beyond crop production, particularly for water harvesting to meet domestic requirements. This suggests the need for more gender-responsive information services.

An interesting observation emerged regarding communication preferences among shea collectors. Despite relatively low literacy rates among this demographic, they demonstrated strong preference for SMS-based information services. Workshop participants suggested this may be attributed to household information-sharing dynamics, where literate family members, particularly children, serve as information intermediaries.

Oil palm farmers were identified as particularly underserved by current extension service provision, requiring dedicated attention in future programming.

Methodological limitations of the study were acknowledged, specifically the relatively small sample size per crop type. Participants recommended increasing funding to expand the sampling in future research to enhance larger representativeness.

A terminological clarification was suggested regarding "shea farmers." As shea trees in Ghana predominantly grow wild rather than being cultivated, the term "shea collectors" or "shea pickers" more accurately reflects the nature of this livelihood activity.

*Group picture of participants*

The workshop concluded with participants engaging in collaborative group exercises to thoroughly review and validate the comprehensive list of tree crop adaptation strategies. These structured activities enabled stakeholders to systematically prioritize interventions based on feasibility and impact, while verifying the contextual relevance of proposed solutions across diverse tree crop varieties and geographical regions. The validation process ensured that recommended adaptation measures reflected both scientific evidence and practical field experience.

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Contact:

**Kingsley Ofosu, Ampong, PhD, k.ofosu-ampong@cgiar.org**

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