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Extension Demonstrations and Field Days for Promoting Climate-Resilient Alley Cropping: A Case of Glen Arm, Maryland

Mouhamadou L. Diack[1*], Lila B. Karki[1], Suraj S. Thagunna[1]

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ABSTRACT

This study evaluated the effectiveness of an extension field day in increasing participants' knowledge, perception of sustainability, and willingness to adopt climate-resilient alley cropping (CRAC) in Glen Arm, Maryland. The field day included a tour to the demonstration site along with a classroom participatory discussion on key CRAC practices, including vegetables, fruit trees, cover cropping, water harvesting, composting, mulching, and integrated pest management. Of the 61 participants, 24 completed the survey. The majority of participants were Asian (87%), female (71%), and college-educated (71%). A Wilcoxon signed-rank test showed a significant gain in knowledge after participating in the field day ($p = 0.0023$). Overall, the program was well received by participants, with 83% reporting satisfaction and 75% showing interest in adopting CRAC practices. However, several factors were identified as barriers to adoption, including high initial costs (36%), limited extension services (27%), and low institutional support (23%). These findings suggest that experiential field days can increase knowledge and encourage willingness to adopt climate-resilient agricultural practices among diverse communities. However, addressing financial, extension, and institutional barriers is necessary to promote wider use of CRAC practices.

INTRODUCTION

Small-scale farmers in Maryland face growing challenges,including climate variability, high production costs, an aging farming population, and unstable markets (Manono, 2025). Climate-resilient alley cropping (CRAC), an agroforestry practice that combines fruit trees with annual vegetables, offers a practical way to address some of these challenges. CRAC can improve land use efficiency, enhance soil health, diversify farm production, and increase resilience to climate-related challenges (Wolz & DeLucia, 2018; Sahoo *et al.*, 2025). In this study, CRAC refers to planting location-specific fruit trees in rows, annual vegetables or herbs, and cover crops in the alleys to increase farm profitability, land-use efficiency, and carbon sequestration.Despite these (many) potential benefits, CRAC adoption remains limited. Farmers face several barriers, including inadequate hands-on training, limited access to demonstration sites, high establishment costs, and concerns about the risks involved in modifying current farming practices (Mishra *et al.*, 2026). Seeing these cropping systems in practice can help farmers better understand how they work under real-world conditions, which helps reduce uncertainty and build confidence in adopting them (Evans *et al.*, 2025). Extension field days can help address these challenges by offering hands-on learning opportunities. Participants can observe CRAC practices in real production settings, take part in hands-on activities, interact directly with specialists, and share experiences with other farmers and community members (Leon *et al.*, 2025). Field days can also serve as "transformative learning spaces," where observation and group discussion help participants rethink their existing assumptions and gain a clearer understanding of new practices. In addition, these events can reduce concerns about risk, provide direct practice evidence of performance, and build networks for sharing knowledge and experience among peers after the event (Marchand *et al.*, 2021). This study evaluated the short-term effects of an extension field day on participants' knowledge, perceptions, and willingness to adopt CRAC practices through collaboration between the University of Maryland Eastern Shore (UMES) and the local community in Glen Arm, Maryland. Specifically, the study aimed to;

1. Evaluate participants' pre- and post-knowledge about CRAC practices
2. Evaluate willingness to adopt CRAC practices
3. Identify the main barriers and willingness to adopt CRAC practices

LITERATURE REVIEW

Demonstration Sites as Learning Laboratories

Demonstration sites play an important role in promoting the adoption of new agricultural practices by allowing farmers to witness how a system performs under real production conditions (Sseguya *et al.*, 2021). Limited access to functioning alley-cropping demonstrations remains a major barrier to adoption, as farmers often want to see how trees and crops can be successfully grown together (Choden *et al.*, 2026). These sites can function as "living classrooms," providing farmers, students, and community members with opportunities to learn about CRAC system establishment, design, and management (Sutherland *et al.*, 2021). Farmers' interest in alley cropping also increases when they visit

[1] Department of Agriculture, Food and Resource Sciences, University of Maryland Eastern Shore, Princess Anne, MD 21853, USA
[*] Corresponding author's e-mail: mldiack@umes.edu

demonstration sites and observe different crop and tree combinations (Singh *et al.*, 2018). Demonstration plots also help farmers understand how alley-cropping systems change over time. Features such as tree growth, shading patterns, root competition, and compatibility with farm equipment can be difficult to explain through written materials alone but become easier to understand through demonstration plots (Quinkenstein *et al.*, 2009). In addition to providing examples of new agricultural practices, these demonstration sites can serve as educational centers for training, outreach, and applied research (Daily *et al.*, 2025). Sutherland and Marchand (2021) describe on-farm demonstrations as "transformative learning spaces" where advisors, farmers, and researchers exchange ideas, learn from one another, and develop new perspectives.

Field Days as Extension Tools

Field days are a practical extension strategy for increasing farmers' interest, awareness, and confidence in adopting new agricultural practices (Singh *et al.*, 2018). Unlike traditional classroom-based workshops, field days give participants direct experience in actual production settings, where they can observe how systems are performing, management practices, and discuss their experiences with other participants (Sutherland & Marchand, 2021). This direct experience can also increase farmers' confidence by reducing uncertainty associated with adopting unfamiliar practices (Sutherland & Marchand, 2021).Singh *et al.* (2018) found that field days can increase knowledge and willingness to adopt new practices by allowing participants to observe practices firsthand and interact with extension educators. This approach is especially useful for complex systems such as alley cropping, where farmers may benefit from opportunities to build trust, learn by doing, and engage in collaborative problem-solving (Tomlinson & Rhiney, 2018). By observing and discussing practices, field days also help participants develop their own understanding of new agricultural practices (Fagerbakke *et al.*, 2026).Another important benefit of field days is the opportunity for farmers to learn from each other. The connections and learning networks formed during these events can continue after the field day has ended (Singh *et al.*, 2018). Farmers value opportunities to share experiences, discuss what they observe, and connect with other farmers who face similar challenges (O'Connor *et al.*, 2026). Overall, field days demonstrate the performance of new practices, provide a practical way to reduce perceived risk, strengthen farmer-to-farmer knowledge exchange, and encourage and promote hands-on learning.

MATERIALS AND METHODS

Study Site

The study was conducted at the CRAC demonstration site in Glen Arm, Baltimore County, Maryland. The site was established through a collaboration between the Nepali American Cultural Center (NACC) and the University of Maryland Eastern Shore (UMES) Extension. The demonstration site included fruit trees, including fig, blueberry, pawpaw, and persimmon, planted with annual vegetables, such as bell peppers, tomatoes, bitter gourd, pumpkins, beans, and strawberries, as well as a few herbs, including stinging nettle, grown in the alleys (Figure 1).

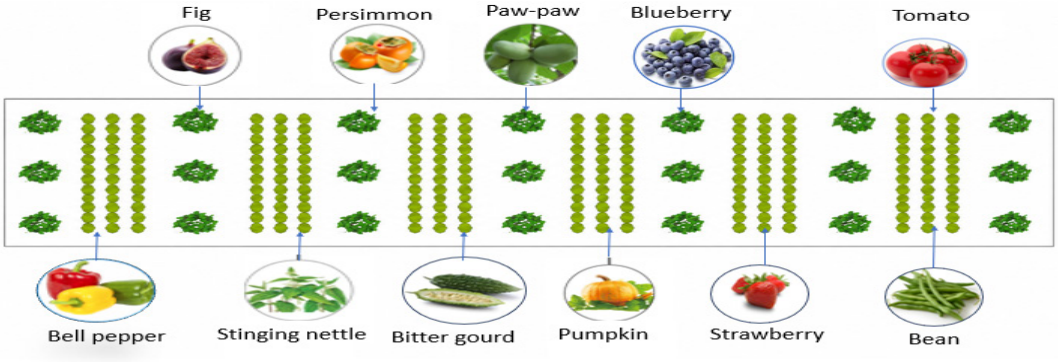

Figure 1: Layout of the Glen Arm CRAC demonstration model.
Source: Authors' presentation

Field Day Structure

The field day included two main components: an indoor classroom presentation and an outdoor demonstration. During the event, participants learned about several CRAC practices, including harvesting and efficient use of rainwater, covering crops with bermuda grass and clover, mulching with wood chips to suppress weeds and retain soil moisture, and composting with decomposed manure and other organic materials. The program also included integrated pest management, including the use of beneficial insects, insect traps, and neem oil, as well as beekeeping and pollination.

Data Collection

A structured survey with 24 questions was administered at the end of the field day. Of the 61 attendees, 24 completed the survey (39.3% response rate). The survey covered questions on participant demographics, including race, gender, education, and occupation. The survey also included 5-point Likert scale questions to assess the event's satisfaction; perceived benefits of CRAC; pre- and post-event knowledge; and readiness to adopt CRAC practices. Additionally, perceived barriers to adopting CRAC practices were collected.

Data Analysis

Data analysis was done using RStudio and Excel. Descriptive statistics of survey responses were analyzed to summarize participant characteristics. The knowledge gain scores were not normally distributed (Shapiro-Wilk p = 0.00078). A Wilcoxon signed-rank test was conducted to assess differences between pre- and post-event knowledge scores.

Table 1: Demographic characteristics of respondents (n = 24)

Characteristic	Category	Response (%)
Age	25-35	20.9
	35-45	37.5
	45-55	25.0
	55-65	8.3
	>65	8.3
Gender	Male	29.2
	Female	70.8
	High school or less	25.1
	Associate degree	8.3
Education	Bachelor's degree	37.5
	Master's degree	25.0
	Doctoral degree	4.2
Race	Asian	87.5
	Other	12.5

RESULTS AND DISCUSSION

Participant Demographics

Most participants were Asian (87.5%) (Figure 2), female (70.8%), and college-educated (70.8%). The largest age group was 35–45 years (37.5%), followed by 45–55 years (25.0%) (Table 1). In terms of occupation, 39.1% identified as farmers or beginning farmers, while 34.8% did not specify their occupation. Entrepreneurs and educators each accounted for 8.7% of participants, while agricultural professionals and students each represented 4.4% (Figure 3).

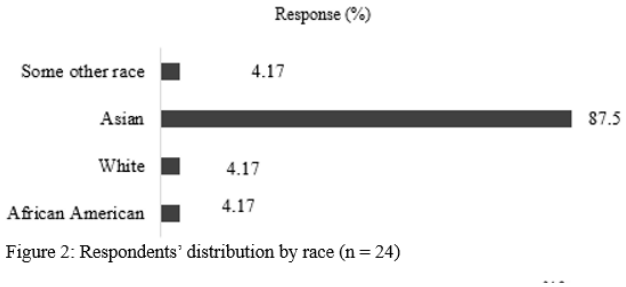

Figure 2: Respondents' distribution by race (n = 24)

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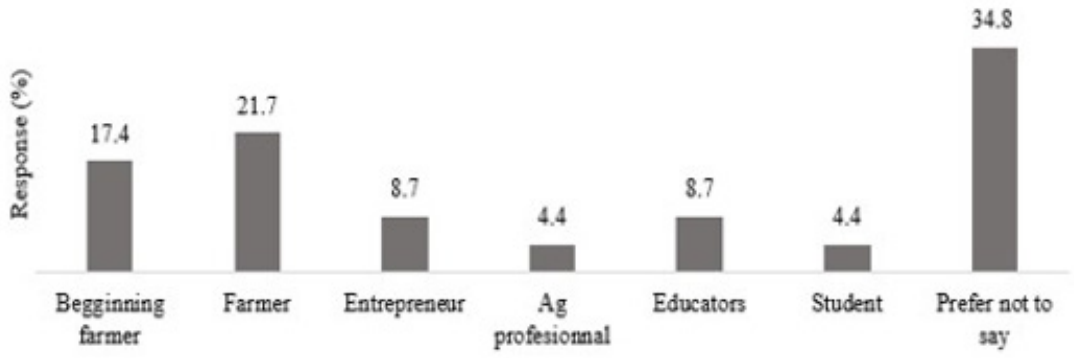

Figure 3: Respondents' distribution by occupation (n = 24)

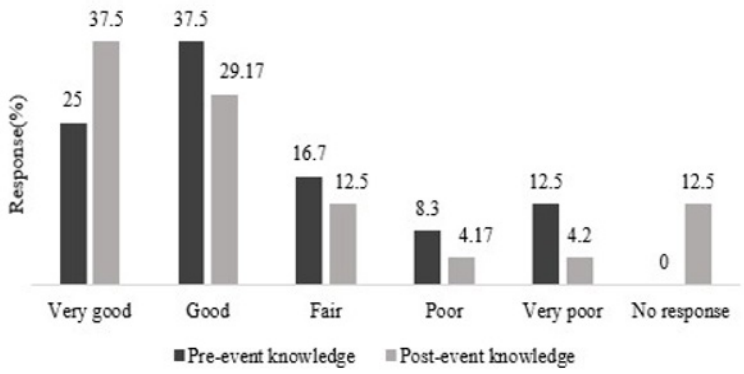

Figure 4: Respondents' pre-and post-event knowledge levels (n = 24)

Knowledge Gain

Respondents who rated their knowledge as "very good" rose from 25.0% before the event to 37.5% after the event. At the same time, respondents reporting "poor" or "very poor" knowledge decreased from 20.8% to 8.4% (Figure 4). The Wilcoxon signed-rank test confirmed a significant increase in respondents' knowledge following the field day (p = 0.0023) (Table 2).

Table 2: Statistical analysis of knowledge change of respondents following the field day (n = 24)

Analysis	Statistic	p-value	Interpretation
Shapiro–Wilk	W = 0.805	0.00078	Data was non-normal; therefore, a non-parametric test was applied.
Wilcoxon signed-rank	Paired test	0.0023	Significant increase in knowledge (p < 0.05)

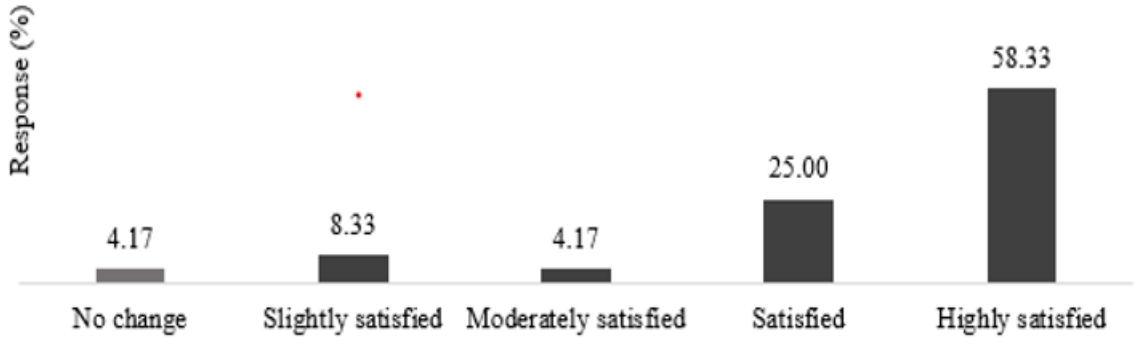

Figure 5: Respondents' event satisfaction (n = 24)

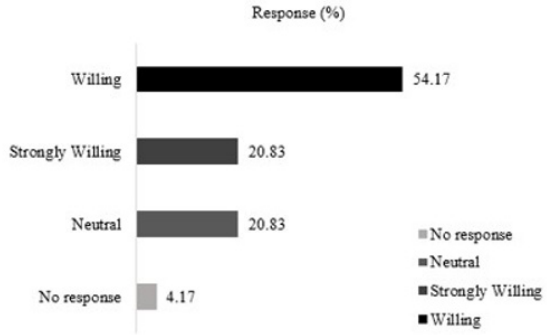

Figure 6: Respondents' willingness to adopt alley cropping (n = 24)

Event Satisfaction and Adoption Readiness

Over 95% of the participants reported satisfaction with the event (satisfied: 25%, highly satisfied: 58.33%, moderately satisfied: 4.17%, and slightly satisfied: 8.33%) (Figure 5).

Willingness to adopt CRAC practices was high, with 75% of respondents reporting they were willing or strongly willing to adopt the practices (Figure 6).

Perceived Benefits

For all five benefits, respondents rated mean ratings above 4.2 on the 5-point scale. Lower greenhouse gas emissions were rated highest (4.43), while increased income was rated lowest (4.25). The relatively low standard deviations (0.65–0.75) indicate that all participants' responses were generally consistent across the five benefits (Table 3).

Table 3: Respondents' Perceived CRAC benefits (1= strongly disagree and 5= strongly agree) (n = 24)

Benefit	Mean	SD
Lower greenhouse gas emission	4.43	0.66
Reduced fertilizer/chemical use	4.39	0.72
Increased productivity	4.38	0.65
Improved soil health	4.29	0.75
Increased income	4.25	0.74

Barriers to CRAC Adoption

High initial cost was the most frequently reported barrier to CRAC adoption (36.4%) by respondents, followed by limited extension services (27.3%), low institutional support (22.7%), and not currently a farmer (22.7%). Transition risk and knowledge limitations were reported less often, at 9.1% each (Figure 7). Overly complex practices, difficulty marketing products, and high implementation cost represent each a barrier for 4.6% of participants.

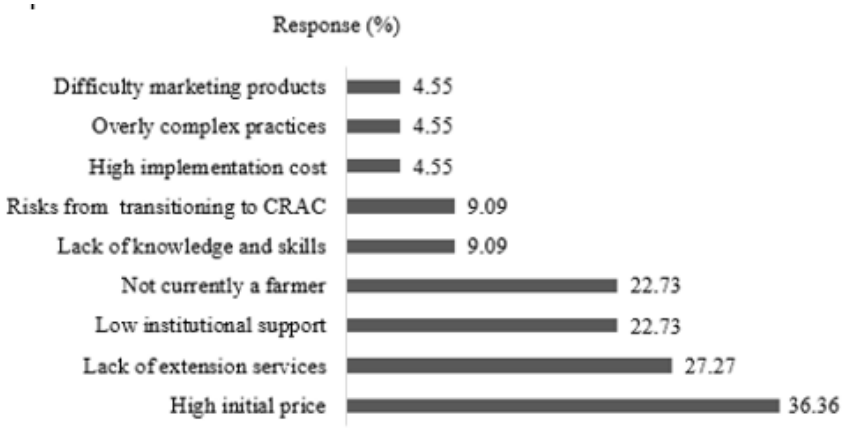

Figure 7: Respondents reported barriers to adopting CRAC (n = 24)
Note: Participants can choose multiple responses for this question

Discussion

Participant Characteristics and Implications

The participant group was predominantly Asian (87.5%), female (70.8%), and college-educated (70.8%), representing the NACC community in the greater Baltimore area. The findings also demonstrate that partnerships with community-based organizations can help extension programs reach community members who may otherwise be underserved. Women's high participation is noteworthy because women often play key roles in household food production while having less access to extension services (Bryan *et al.*, 2024). This finding suggests that using trusted community organizations to deliver extension programs can effectively engage women and community stakeholders in sustainable agriculture, including CRAC practices.

Participants also had diverse occupational backgrounds, including farmers (39.1%), educators (8.7%), entrepreneurs (8.7%), and students (4.4%). This diversity suggests that demonstration sites can attract people beyond traditional farmers. Most participants have a college education; around 37% have a bachelor's degree, and 25% have a master's degree. The high education level of participants may have contributed to their understanding of the technical information presented during the field day. However, it also suggests that the respondents may not represent community members with lower levels of formal education.

Knowledge Enhancement through Experiential Learning

The significant increase in knowledge ($p = 0.0023$) indicates that demonstration-based learning can be an effective extension method to promote CRAC practices. The difference between pre- and post-field day knowledge shows a 16.6% increase in participants reporting "very good/excellent" knowledge, together with the 12.4% decrease in those reporting "poor/very poor" knowledge. This demonstrates a significant improvement regarding CRAC practices such as mulching, composting, and cover cropping. These findings align with Kolb's (1984) experiential learning theory, which states that

learning occurs through concrete experience, reflection, conceptual understanding, and practical application. The field day provided participants with hands-on experiences by observing the CRAC practices, opportunities to discuss and reflect with specialists, building new concepts through classroom presentations, and exploring how the practices could be adopted (McLeod, 2026; McCarthy, 2016). Similarly, Cooreman *et al.* (2021) describe demonstration sites as "transformative learning spaces" where participants can reflect on their beliefs before the event and gain new perspectives. This supports our finding that participants' knowledge of CRAC significantly increased after visiting the demonstration site and participating in the field day ($p = 0.0023$). The percentage reporting "very good" knowledge increased, while the percentage reporting "poor" or "very poor" knowledge decreased. These results suggest that observing CRAC practices and group discussions with specialists and other participants helped participants understand the system.

The knowledge gain is especially relevant because CRAC is an emerging socio-economically and environmentally beneficial farming system that requires planning over several years, an understanding of tree-crop interactions, and appropriate species selection. Our study findings are in line with Quinkenstein *et al.* (2009), who stated that demonstration sites make complex tree–crop relationships easier to understand than written materials alone.

Participants' Satisfaction and Willingness to Adopt

Participants' high level of satisfaction (83.3%) aligns with findings from Fedesco *et al.* (2020), which showed that field-based programs can lead to high participant satisfaction through practical learning and interaction with Extension educators. The respondents' very high willingness to adopt CRAC (20.8%) and willingness to adopt CRAC (54.7%) are encouraging because they show that field day has a significant impact on willingness to adopt. These results should, however, be interpreted with caution since intention does not automatically translate into adoption (Bramlett & Radel, 2017). Despite this, the high willingness to adopt suggests that the field day helped improve participants' knowledge and increase participants' confidence in adopting CRAC practices.

The 75% willingness to share knowledge suggests potential for peer-to-peer diffusion. This may be especially important in immigrant communities, where people often share information and experiences through trusted community networks (Verdery *et al.*, 2018).

Such knowledge sharing could broaden the reach of extension programs beyond those who directly attended the field day.

Perceived Benefits and Motivation

Participants strongly agree with all five perceived benefits of CRAC, with mean scores above 4.2 (Table 3). This suggests that the field day clearly communicated the environmental and economic benefits of the practice. The highest-rated benefit was greenhouse gas emissions reduction (4.43), indicating increasing awareness of environmental concerns and the climate-mitigation potential of agroforestry systems (Quandt *et al.*, 2023). Participants strongly agreed that CRAC could reduce the use of chemicals and fertilizers (4.39), which is consistent with evidence that tree-based systems can improve nutrient use and cycling (Jariwala *et al.*, 2022).

The slightly lower rating for increased income (4.25) may reflect participants' understanding that tree-based systems take time to generate financial returns. Extension programs could address this issue by providing farm budgets, information about potential long-term returns, and guidance on available financial assistance opportunities. The participants' perspective on income benefit received the lowest mean score among the five benefits. This demonstrates that even though participants still strongly agreed that CRAC increases income ($M = 4.25$), they might have some concerns about the timing and value of financial returns from tree-based systems. Dunn *et al.* (2021) explained in their study that the economic performance of alley cropping is based on several factors, that are tree growth, tree spacing, crop productivity, and competition between trees and crops. For these reasons, Extension programs should provide farm budgets, expected timelines for returns, and information about financial assistance to help producers evaluate the short- and long-term economic benefits of CRAC.

Barriers and Extension Implications

High initial cost was the most frequently reported barrier (36.4%). This is consistent with Singh *et al.* (2018), who explained that demonstration sites and field days can support conservation-practice adoption by reducing uncertainty and improving access to practical implementation knowledge. Limited extension services (27.3%) and low institutional support (22.7%) also highlighted gaps in available resources. Collaboration with community organizations such as NACC can help extend the outreach of extension programs using existing community networks and relationships (Yadav, 2025). The CRAC program could be adopted across different scales of production, ranging from backyard and community gardens to commercial farms. Out of the survey participants, only 9.1% of participants chose concerns about adopting new practices and limited knowledge about CRAC as barriers. This might suggest that the field day was very efficient and informative. The field day helped address some of these concerns by helping participants see the practices in operation and experience the system firsthand. Understanding how to implement agricultural practices can have a dramatic impact on adoption. Gurung *et al.* (2026) stated that farmers in Maryland with a deeper understanding of how to implement climate-resilient agricultural practices were more likely to adopt these practices. This finding supports providing continued technical guidance after the

Glen Arm field day to help participants apply what they learned. However, the present study measured willingness to adopt rather than actual adoption, so follow-up assessments are needed to determine whether participants implement CRAC practices. Akanda *et al.* (2025) found that training and communication exposure had a positive impact on farmers' adoption rate of CRAC practices in coastal Bangladesh. This finding supports the results observed on the Glen Arm field day. Increased awareness of CRAC has a positive impact on the adoption rate.

Implications for Extension Practice

The findings suggest several ways UMES Extension and its partners can improve CRAC outreach and adoption:

1. Maintain and expand field days by integrating demonstration site visits with classroom instruction.
2. Provide follow-up support through seasonal workshops, farm visits, and farm budgeting tools.
3. Provide information on financial assistance opportunities to help farmers address high initial establishment costs.
4. Create different ways to engage diverse audiences, from backyard and community gardeners to commercial producers.
5. Strengthen peer-to-peer learning networks to support continued knowledge sharing after field day events.
6. Strengthen community partnerships to expand extension services to underserved communities.

Limitations and Future Research

This study has several limitations. The participants who filled out the survey were only 39.3% of the people who attended. The study was based on knowledge gain and willingness to adopt CRAC. The self-evaluation nature of the survey might have created some biased answers towards knowledge gain and willingness to adopt new practices. The study was conducted at a single demonstration site with a specific participant population, which may limit the broader application of the findings. Furthermore, the study did not include continued follow-up to determine whether participants adopted CRAC practices.

Future research should include studies across multiple sites with larger samples, follow-up with participants to assess actual adoption, and objective assessments of knowledge gain. Research comparing different field day approaches could help identify the most effective extension education methods. Finally, future studies should examine the economic benefits of adopting CRAC to understand its long-term costs and financial benefits better.

CONCLUSION

The Glen Arm extension field day led to a significant improvement in participants' knowledge ($p = 0.0023$), high satisfaction (83.3%), strong perception of CRAC benefits (all mean scores >4.2), and 75% of participants were willing or strongly willing to adopt CRAC practices. These findings suggest that local field days can help address knowledge gaps and increase participants' readiness to adopt climate-resilient alley cropping (CRAC). At the same time, several barriers continue to slow adoption. High initial cost was the most reported barrier (36.4%), followed by limited access to extension services (27.3%) and low institutional support (22.7%). Tackling these challenges will require targeted technical, financial, and institutional support. The partnership between the Nepali American Cultural Center (NACC) and UMES Extension also provides a promising model for culturally responsive extension programs. Furthermore, it demonstrates the value of working with trusted community organizations to engage underrepresented populations. With continued technical assistance and financial support, community-based demonstration sites and field days can support adoption of climate-resilient agricultural practices. Such programs can play a role in more sustainable food production, stronger community resilience, and greater capacity to adapt to climate change in Maryland and beyond.

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