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Engaging Agro-Pastoralists in Seed Business: Community-Based Onion Seed Production under Irrigated Conditions in Gelealo District, Afar

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ABSTRACT

Ethiopia's varied agro-ecological zones which support onion cultivation, contributing significantly to the economy. However, challenges persist within Ethiopia's seed supply system, particularly in regions like the Gelealo District, Afar, where agro-pastoral livelihoods predominate. To address these challenges, a community-based onion seed production activity was initiated, employing a comprehensive approach during the 2023/24 cropping season using Nafis variety. The activity involved the formation of PAPREGs, baseline assessments, capacity-building, onion seed production implementation, hands-on field day events for knowledge dissemination. The collected data were analyzed using SAS statistical software. Despite prevalent onion cultivation, experience in seed production was limited (93.33%), highlighting the need for skill enhancement via theoretical and practical training. Through practical sessions, about 40 participants gained insights into seed acquisition patterns and production techniques, stimulating discussions on community-based seed production to optimize agricultural outcomes. Statistical analysis comparing kebele groups within PAPREGs demonstrated significant differences in yield and yield-related traits, suggesting varying productivity potentials. The independent sample t-test of yield and yield related traits were showed advantage of Beidi over Debel PAPREGs. Accordingly, Beidi PAPREGs have an advantage of 200, 69.57, 36.68 and 51.37 percent over Debel for SYPP, NUPP, UD, and LMS, respectively. The activity attracted diverse stakeholders, and a cost-benefit analysis indicated substantial net profits, affirming the economic viability of onion seed production. In this case, the CBR of 4.976 reflects a favorable return, demonstrating that onion seed production is economically viable and yields substantial profits relative to the initial investment. Insights from PAPREGs emphasized their commitment to the project and underscored the importance of continued support from research centers. Lessons drawn highlighted the efficacy of utilizing underground water for irrigation, stakeholder integration, rapid learning capacities, and the value of local information dissemination systems. Future focuses include enhancing pest and animal controlling, and continuous training. In conclusion, the PAPREGs activity has laid a robust foundation for onion seed production enhancement, with recommendations poised to bolster onion productivity, economic stability, and resilience in the study area, emphasizing the vital of community engagement and innovation.

Keywords: PAPREGs, Income generation, Field Day, Demonstration, Seed Germination Percentage.

INTRODUCTION

In Ethiopia, with its diverse agro-ecological zones, onions thrive, offering both nutritional and economic benefits to local communities. The practice of community-based onion seed production has emerged as a pivotal component in enhancing agricultural productivity and ensuring food security in the region. However, the Ethiopian seed supply system remains inadequate, primarily focusing on a limited range of crops, thus failing to meet the diverse seed demands of smallholder farmers (Abebe Atilaw and Ligalem Korbu, 2011; ATA annual report, 2016).

The informal sector significantly contributes to the widespread distribution of seeds to numerous farmers. Local suppliers, unorganized markets, and imported seeds largely fulfill the demand for onion seeds, rather than the formal Ethiopian Seed Enterprise (ESE). Public sector entities, particularly the Ethiopian Institute of Agricultural Research (EIAR) of Werer Agricultural Research Center, primarily provide onion seeds to small-scale irrigation farmers for pre-scaling activities (Nigussie, et al., 2015).

Efforts by farmers' cooperatives have helped bridge the gap between seed demand and supply, with activities such as community-based seed production proving effective in delivering high-quality seeds adapted to local conditions (MacRobert, 2008; Hamsalu Ayana et al., 2013). Despite these advancements, challenges persist, particularly within the informal seed system, which plays a significant role in onion cultivation but lacks rigorous quality control measures, leading to the spread of pests and diseases (Megersa Habtamu, 2017; Mamaru Tesfaye, 2023).

To address these challenges, improved seed production and dissemination systems are essential, alongside efforts to educate farmers on the benefits of certified seeds and the development of resistant onion cultivars. This introduction underscores the urgency of addressing these issues to ensure the sustainable production of onions and the overall well-being of Ethiopia's agricultural sector. Access to quality seeds is vital for agricultural productivity and food security, making activities like the community-based onion seed production crucial for the region's development (Lemma Desalegn and Shimelis Akililu, 2003). Therefore, this research aims to address the challenges posed by the informal seed system in Ethiopia specially Gelealo district of Afar region, particularly concerning onion production, to ensure sustainable agriculture and the overall well-being of the agricultural sector. The limited availability of quality seeds, especially in regions like Gelealo District, Afar, characterized by agro-pastoral livelihoods and semi-arid climatic conditions, has negatively impacted onion yields and the income of agro-pastoralists. To mitigate these challenges, the study seeks to evaluate the implementation and outcomes of an agro-pastoral community-based onion seed production activity. This activity leverages irrigated farming practices to engage agro-pastoralists in seed business activities. The research focuses on assessing the effectiveness of this activity and its implications for sustainable agriculture and rural development. Additionally, the study aims to explore the need for improved seed production and dissemination systems that balance accessibility with quality control. Efforts to educate agro-

pastoralists on the risks associated with informal seeds and the benefits of certified seeds, as well as the demonstration of resistant onion cultivars and integrated pest management strategies, are crucial components. This report evaluates the implementation and outcomes of the activity, aiming to provide insights into its effectiveness and implications for sustainable agriculture and rural development.

Objectives

- To demonstrate community-based onion seed production using participatory approach
- To create awareness on community-based onion seed production and enhance agro-pastoralists' access to quality seed of superior variety,
- To evaluate the profitability of onion seed production under irrigated condition of Gelealo district.

METHODOLOGY

Description of the Study Area

The experiment was conducted in the Gelealo district during the 2023/24 cropping season. The area is situated in the Afar National Regional State, specifically in Zone-3 known as Gelealo, positioned 310 km northeast of Addis Ababa. Its altitude was approximately 740 meters above sea level (m.a.s.l.). The mean annual temperature was recorded at 34°C, with mean annual rainfall and evapotranspiration measured at 560 mm and 2600 mm, respectively. The weather was characterized by long, hot, and dry conditions, with rainfall being highly erratic.

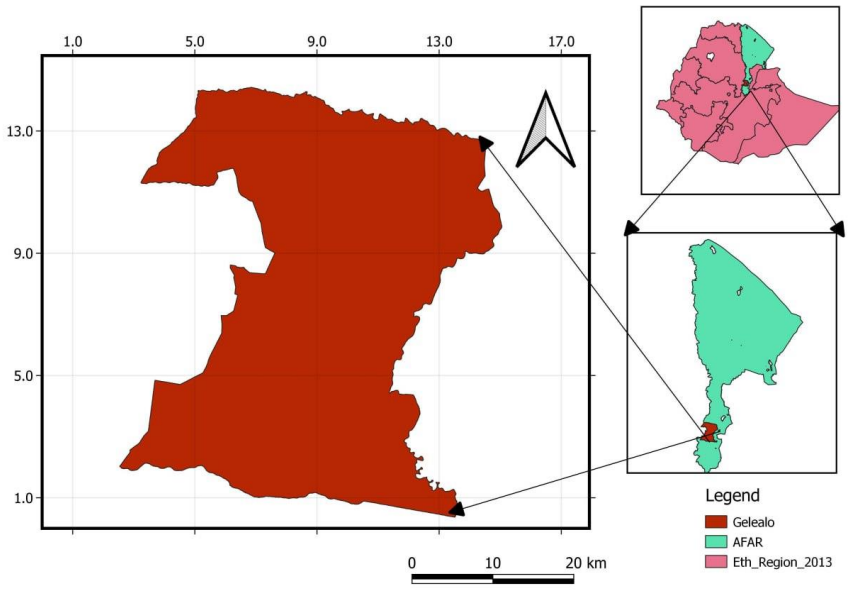


Figure 1: Location Map of Study Area

Pastoral and Agro Pastoral Research Extension Group (PAPREG) Establishment

Agro-pastoralists selected in the Gelealo districts were participants in the study. The study was conducted with a group of agro-pastoralists chosen arbitrarily. A Pastorals and Agro-pastorals, Research and Extension Groups (PAPREGs) were formed with the assistance of development

agents and agricultural experts from the kebeles and districts, respectively, following appropriate procedures involving innovative agro-pastoralists. About three groups of thirty (30) agro-pastoralists, comprising both men and women, were established as members of the PAPREGs. Instruction on onion seed production methods, data gathering, and PAPREG concepts were received by the district's agricultural experts, development agents, and PAPREG members. Finally, within the designated time frames, all PAPREG participants, including researchers, development experts, and agro-pastoralists, were given unrestricted access to their own evaluations.

Experimental Design and Data Collection

Trial Site Selection:

The careful consideration of several critical factors was required to ensure successful outcomes in selecting an optimal trial site. When locations such as Gelealo: Beidi, Debel, and Gefrem kebeles were evaluated, soil quality was identified as the starting point. The alignment of soil type and fertility with crop requirements was ensured to promote optimal growth. The pivotal role of climate conditions was approved; local temperature, rainfall, and humidity levels were assessed for suitability for the trial crop. Accessibility was considered another important criterion; the site was required to be easily reachable to facilitate regular monitoring, maintenance, and data collection. Additionally, water availability was deemed crucial, especially in drought-prone areas, and a reliable irrigation source was confirmed. Local expertise was leveraged to provide invaluable insights and aid in managing the trial effectively. Lastly, the engagement of the local community was vital to secure support and cooperation, significantly enhancing the trial's success. By thoroughly assessing these factors, an ideal trial site among Gelealo: Beidi, Debel, and Gefrem kebeles were selected.

Capacity Building Training:

The capacity-building activity commenced with comprehensive practical training sessions designed to enhance expertise in various areas crucial for seed quality, agronomic practices, integrated disease management, and postharvest handling techniques. These sessions were meticulously planned and delivered to members of the Pastoral and Agro-pastoral Research Extension Group (PAPREG), development agents (DA), and agricultural experts representing each Kebele within the district. The training curriculum was structured to cover all essential aspects of onion seed production, with a particular focus on recommended agronomic practices. Participants were provided with hands-on learning experiences, interactive demonstrations, and theoretical knowledge to empower them with the necessary skills and understanding to implement best practices effectively. Trainers, selected for their expertise in relevant fields, facilitated the sessions and ensured active participation and comprehension among the trainees. The overarching goal of the training was to equip agro-pastoralists with the knowledge and tools needed to optimize onion seed production while fostering sustainability and resilience within the agricultural ecosystem.

Experimental Treatments, Materials Used and Management:

The activity was carried out in agro pastoral fields, where three groups of agro pastoralists called PAPREGs were formed and tasked with implementation. In this experiment, one commercially available onion variety of Nafis was employed. Each group of agro pastoralists

planted the crop on an area that measured 20 meters long by 20 meters wide, with planting space consisting of 50cm wide rows, 20 cm on ridges, and 10 cm between bulbs. The yield and other essential information were gathered from the central rows using the quadrant method, ignoring the boundaries. NPS were applied at the rate of 242 kg ha-1 before transplanting, and urea at the rate of 100 kg ha-1 was applied at side dressed in split application: 50% after 21 days of transplanting and the remaining 50% at one and a half months after transplanting. Irrigation was applied at intervals of every 5 days for the first 4 weeks and every 7 days thereafter (Lemma and Shimeles, 2003). Every standard cultural practice was followed regularly as recommended. Disease and insect management practices were carried out according to the recommendations given for onion seed production in the country. Harvesting was done when the umbel/head exposed some black seeds but before shattering by hand. After harvest, the heads were dried on canvas under a ventilated shed or sun, following onion seed harvesting procedures.

Field Day:

Field days were organized as interactive sessions aimed at providing practical knowledge and hands-on experience to participants. The topics covered a wide range of stages throughout the cropping season, beginning with site selection and extending to field preparation, planting, fertilizer application, ridging, and management. Additionally, techniques for onion seed post-harvest handling were demonstrated and discussed. These field days were strategically scheduled to coincide with the full crop flowering stage, allowing for direct comparison between improved onion technologies and local practices. The events served as opportunities to bring stakeholders together, facilitating discussions on the progress of ongoing activities and fostering connections between seed growers and ware onion producers. Furthermore, the participation of both Pastoral and Agro-pastoral Research Extesnion Group (PAPREG) members and non-members in regional agro-pastorals' festivals and events were leveraged to promote onion innovations and raise awareness among various stakeholders, thus amplifying the impact of the field days beyond their immediate participants.

Data Collection:

Data on yield and yield-related traits were collected, including planting date, seed yield per plant and per hectare, number of stakes per plant, stake diameter (cm), length of main stake (cm), number of umbels per plant, as well as costs and benefits.

Roles of Pastoralists/Agro-Pastoralists, Extension Workers and Researchers

Agro-pastoralists:

The successful implementation and sustainability of managed trials involved a collaborative effort among various stakeholders, each with specific roles and responsibilities. The implementation and maintenance of the trials were carried out by agro-pastoralists on their farms, ensuring that the trial protocols were meticulously followed and the recommended practices and treatments were applied. The progress of the trials was regularly observed and monitored by agro-pastoralists, who noted any issues such as pest infestations or growth anomalies and shared this information with PAPRG members during meetings to discuss progress and any necessary adjustments. Insights and knowledge gained from the trials were shared by agro-pastoralists with other farmers in the community, explaining the benefits of

new practices and encouraging adoption through informal conversations and organized demonstrations. Additionally, field days and demonstration plots were organized by agro-pastoralists to visually showcase the results of the trials, making it easier for other farmers to understand and replicate successful practices.

Extension Workers:
The mobilization of necessary resources for the trials, such as chemicals, fertilizers, and equipment, was facilitated by extension workers, who ensured that these resources were delivered to the agro-pastoralists in a timely manner. The implementation of trial activities was also facilitated by extension workers by providing logistical support and ensuring that the trial protocols were correctly followed. As communication liaisons, extension workers acted as bridges between PAPRG members and agro-pastoralists, as well as researchers, facilitating effective communication and ensuring that feedback and concerns were promptly addressed. Comprehensive records of all trial activities and interactions were maintained by extension workers, ensuring that all data was accurately documented and easily accessible for analysis and reporting.

Researchers:
Researchers played a crucial role in the success of the trials by actively listening to the comments and feedback provided by agro-pastoralists, valuing their practical insights and experiences. Technical support was offered by researchers to help agro-pastoralists implement trial protocols correctly and address any technical challenges that arose. During situation analysis, researchers assisted agro-pastoralists in analyzing trial data and observations, helping them understand the implications and make informed decisions. The collected data was processed and analyzed by researchers to verify the effectiveness of the recommended practices, and this analysis was used to refine recommendations and develop evidence-based guidelines.

LLRP (Regional and Zonal):
At the regional and zonal levels, the LLRP conducted critical follow-up activities to ensure that the trials were implemented as planned. They monitored progress, identified any issues, and ensured that corrective actions were taken. The creation and management of social media platforms such as Telegram and Facebook by LLRP facilitated continuous monitoring and evaluation, providing a space for real-time communication, feedback, and sharing of progress among all stakeholders. By fulfilling their respective roles, agro-pastoralists, extension workers, researchers, and LLRP ensured that managed trials were effectively implemented, monitored, and evaluated, leading to successful outcomes and the dissemination of improved agricultural practices.

Data Analysis
Statistical analysis was conducted using SAS software, version 9.0 (SAS Institute Inc., 2002) and cost-benefit analysis was performed using Microsoft Excel.

RESULT AND DISCUSSIONS

Awareness Creation through Training on Community-Based Onion Seed Production

Table 1 provides a comprehensive overview of the Onion Seed Production Training Program conducted in 2024, detailing the participation of stakeholders from different Kebeles within the district. The data highlights the balanced representation of participants across Kebeles, with each locality contributing an equal number of trainees, ensuring geographical inclusivity and community engagement. Moreover, the training program attracted a diverse array of stakeholders, ranging from PAPREG members to Development Agents, Experts, Technical Assistants, District officials, and officials from the promotion department, indicating widespread interest and involvement in the activity. With a total of 40 individuals participating in the training, the program achieved significant turnout, reflecting its effectiveness in fostering collaboration and promoting capacity building in onion seed production within the PAPREG members.

Table 1: Number of PAPREG members participating on onion seed production training, 2024

Kebeles	Number of trainees							
	PAPREG Members		DA	Experts	TA	District officials	LRRP officials	Total
	Male	Female						
Biedi	7	3	1					11
Geferem	7	3	1					11
Debel	7	3	1					11
Total	21	9	3	1	1	4	1	40

The capacity building training sessions yielded significant achievements in enhancing the onion seed production capabilities of PAPREG members. Understanding Seed Acquisition Patterns highlighted a prevalent reliance on external seed sources, prompting discussions on the necessity of establishing community-based seed production activities to bolster seed security. Determinants of Seed Source Selection delved into economic factors influencing seed procurement decisions, stressing the need to balance cost with quality and availability for optimal agricultural outcomes. Seed Production Techniques equipped participants with practical knowledge on maximizing seed quality and yield through community-based approaches, including integrated pest and disease management. Establishing Seed Production Networks fostered collaboration among stakeholders to facilitate knowledge sharing and resource pooling, while Promoting Sustainability and Resilience emphasized the importance of adopting climate-smart practices and diversifying seed sources to mitigate risks associated with external dependencies. These achievements signify a transformative shift towards sustainable onion seed production practices, empowering PAPREG members to navigate challenges and enhance agricultural resilience in their communities.

Yield and Yield Related Traits

The T-test analysis aimed to compare average yield and yield-related traits between two kebele groups, Biedi and Debel, within Pastoral and Agro-pastoral Research Extension Groups (PAPREGs) in the Gelealo District, Afar. The traits analyzed included Seed Yield per Plant

(SYPP), Number of Seeds per Umbel (NSPU), Seed Yield per Umbel (SYPU), Number of Umbels per Plant (NUPP), Umbel Diameter (UD), Length of Main Stem (LMS), Thousand Seed Weight (THSW), and Germination Percentage (GP). The independent sample t-test results indicated significant differences in SYPP, NUPP, UD, and LMS between the two kebele groups, while NSPU, SYPU, THSW, and GP did not show significant differences.

Seed Yield per Plant (SYPP):
The average SYPP of Biedi kebele (M = 0.09 kg/plant, SD = 0.03) was significantly higher than that of Debel (M = 0.03 kg/plant, SD = 0.01); t (8) = 4.48, p = 0.0001. This significant difference indicates that Biedi has a much higher seed yield per plant compared to Debel, suggesting that the agronomic practices or environmental conditions in Biedi are more favorable for onion seed production, leading to greater productivity. Higher SYPP can directly contribute to overall seed yield and economic returns for farmers (Smith et al., 2011).

Number of Umbels per Plant (NUPP):
The average NUPP was significantly higher in Biedi (M = 7.8, SD = 1.64) compared to Debel (M = 4.60, SD = 1.14); t (8) = 3.58, p = 0.01. The greater number of umbels per plant in Biedi indicates better reproductive performance and suggests that plants in this kebele are healthier and more vigorous. This trait is crucial as a higher number of umbels per plant can enhance seed production efficiency and total yield (Jones et al., 2013).

Umbel Diameter (UD):
Biedi exhibited a significantly larger average umbel diameter (M = 7.08 cm, SD = 0.97) compared to Debel (M = 5.18 cm, SD = 0.36); t (8) = 4.10, p = 0.001. Larger umbel diameter in Biedi suggests the potential for producing larger seed heads, which can result in more seeds per umbel and potentially higher seed quality. This trait is critical for improving seed yield and production efficiency (Kumar & Sharma, 2012).

Length of Main Stem (LMS):
The average LMS was significantly longer in Biedi (M = 88.40 cm, SD = 4.93) than in Debel (M = 58.40 cm, SD = 3.05); t (8) = 11.75, p < 0.0001. The significantly longer main stem in Biedi plants indicates more robust and possibly healthier plant architecture. This trait can support better nutrient transport and overall plant resilience, contributing to higher productivity (Yadav & Singh, 2014).

Table 2: T-test analysis of average yield and yield-related traits over five samples among PAPREGs in Gelealo District, Afar

PAPREGs	Statics	SYPP	NSPU	SYPU	NUPP	UD	LMS	THSW	GP
Biedi	Mean	0.09[a]	558.20	2.63	7.80[a]	7.08[a]	88.40[a]	4.92	91.62
	Min	0.05	382.00	2.05	6.00	5.80	82.00	3.06	85.60
	Max	0.11	740.00	3.05	10.00	8.20	95.00	5.96	95.00
	SD	0.03	144.29	0.51	1.64	0.97	4.93	1.29	4.68
Debel	Mean	0.03[b]	412.20	2.03	4.60[b]	5.18[b]	58.40[b]	4.96	85.98
	Min	0.02	389.00	1.93	3.00	4.80	55.00	4.13	75.80
	Max	0.05	498.00	2.08	6.00	5.70	62.00	5.30	95.40

	SD	0.01	47.98	0.06	1.14	0.36	3.05	0.48	6.96
Diff (1-2)	Mean	0.06**	146.00	0.61	3.20*	1.90**	30.00**	-0.03	5.64
	SD	0.02	107.52	0.36	1.41	0.73	4.10	0.97	5.93
Equality of Variance	F-value	5.00	9.04	73.17	2.08	7.46	2.61	7.19	2.22
	Pr>F	0.15	0.06	0.00	0.50	0.08	0.37	0.08	0.46
Equality of mean	DF	8	8	4	8	8	8	8	8
	t-value	4.48	2.15	2.66	3.58	4.10	11.57	-0.05	1.50
	p-value	0.00	0.06	0.06	0.01	0.00	<.0001	0.96	0.17

SYPP= Seed Yield per Plant (g), NUPP= Number of Umbel per Plant, UD= Umbel Diameter (cm), LMS= Length of Main Stem (cm), NSPU= Number of Seeds per Umbel, SYPU= Seed Yield per Umbel (g), THSW= Thousand Seed Weight (g), and GP= Germination Percentage (%)

For the traits Number of Seeds per Umbel (NSPU), Seed Yield per Umbel (SYPU), Thousand Seed Weight (THSW), and Germination Percentage (GP), the T-test analysis did not show statistically significant differences between the two kebele groups, Biedi and Debel. Specifically, the observed means were 485.2 seeds per umbel for NSPU, 2.33 grams per umbel for SYPU, 4.94 grams for THSW, and 88.8% for GP. Despite the lack of statistical significance, the numerical values indicate a trend where Biedi marginally outperformed Debel in these traits.

Number of Seeds per Umbel (NSPU):
Although the difference in NSPU was not statistically significant ($p = 0.06$), Biedi exhibited a higher average number of seeds per umbel compared to Debel. This trend suggests that Biedi's umbels may have a greater potential seed output, which could translate into higher overall seed yields under optimal conditions. Previous studies have indicated that higher NSPU is correlated with better reproductive performance in onion crops (Smith et al., 2011).

Seed Yield per Umbel (SYPU):
The SYPU did not differ significantly between Biedi and Debel ($p = 0.06$), yet Biedi demonstrated a higher mean SYPU. This finding aligns with the broader pattern of superior seed production traits observed in Biedi, suggesting that even non-significant differences might contribute to cumulative advantages in seed yield (Jones et al., 2013).

Thousand Seed Weight (THSW):
The THSW did not significantly differ between Biedi and Debel ($p = 0.96$), indicating a similar seed mass between the two groups. THSW is a critical trait for determining seed quality and planting value. The similarity in THSW suggests that both groups are producing seeds of comparable size and weight, which is crucial for maintaining consistency in planting and germination outcomes (Kumar & Sharma, 2012).

Germination Percentage (GP):
The GP showed no significant difference between Biedi and Debel ($p = 0.17$). However, Biedi displayed a higher mean germination percentage, suggesting better seed viability and potential for successful crop establishment. High germination rates are indicative of good seed health and vigor, essential traits for effective agricultural practices (Yadav & Singh, 2014).

Although the differences in NSPU, SYPU, THSW, and GP between Biedi and Debel were not statistically significant, the numerical trends favor Biedi. These trends suggest that Biedi might have slight advantages in seed production traits that could be beneficial under specific conditions. The observed trends, even in the absence of statistical significance, highlight the potential for Biedi to achieve marginally higher yields and better seed quality. This analysis underscores the importance of considering both statistically significant and non-significant results when evaluating agricultural performance (Rao et al., 2015).

Field Day

The participation data presented in Table 3 offers a comprehensive overview of the Onion Seed Production Field Day Program conducted in 2024, delineating attendees by their affiliations and gender across various Kebeles within the district. Analysis of Kebele-wise participation indicates a uniform turnout, with each location hosting 11 participants, encompassing both PAPREG members and non-members. This uniform distribution suggests an equitable representation across different areas, facilitating broad access to the Field Day event and its associated benefits. Furthermore, the data highlights the gender representation among attendees, with 21 male and 9 female PAPREG members participating. While a higher proportion of male participants are evident, deliberate efforts were made to ensure gender diversity by including both male and female attendees from each Kebele.

Beyond PAPREG members, the event attracted a diverse array of stakeholders, including Development Agents (DAs), Experts, Researchers, Technical Assistants (TAs), District officials, and officials from the Lowland Livelihood Resilience Project (LLRP) department. This diverse stakeholder representation underscores the importance of engaging multiple actors in agricultural events, facilitating knowledge exchange, collaboration, and partnership building across various sectors. The total participation of 55 individuals reflects a significant turnout from diverse backgrounds and affiliations, indicating the success of the Field Day program in attracting stakeholders from across the agricultural landscape.

The participation data presented in Table 6 provides valuable insights into the reach and impact of the Onion Seed Production Field Day Program, emphasizing its role in promoting knowledge dissemination, capacity building, and collaboration within the agricultural community. By fostering a collaborative and inclusive learning environment, the event succeeded in engaging PAPREG members, agricultural experts, officials, and other stakeholders in discussions and activities related to onion seed production. Moving forward, efforts should be directed towards sustaining and expanding such activities to ensure continued engagement and participation from all relevant stakeholders.

This will be crucial for advancing agricultural development and enhancing food security in the district, ultimately contributing to the overall prosperity and resilience of agricultural communities. The concept of field day events in agricultural sectors is supported by several studies, which highlight their importance in disseminating agricultural technologies, facilitating knowledge exchange, and promoting farmer participation in extension activities. Wolfe and Taylor (2018) conducted a study on on-farm field days, emphasizing their educational value and the positive perceptions of producers towards such events. Similarly, Muthuri and

Tsingalia (2015) examined the role of field days in disseminating agricultural technologies, focusing on the Katumani Field Day as a case study and highlighting its significance in technology transfer. Ashenafi (2014) explored the role of field days in agricultural extension in Ethiopia, particularly focusing on the case of Haramaya University, demonstrating their effectiveness in promoting agricultural practices among farmers. Gilbert (2016) provided evidence from Kenya on the effectiveness of field days in agricultural extension, emphasizing their role in promoting technology adoption and knowledge dissemination. Additionally, Dlamini and Thelingwani (2019) assessed farmers' participation in field days organized by the Department of Agriculture, Forestry and Fisheries in South Africa, highlighting their importance in enhancing farmer knowledge and engagement in agricultural activities. These studies collectively underscore the significance of field day events as platforms for technology transfer, knowledge sharing, and farmer empowerment in agricultural sectors.

Table 3: Number of PAPREG members participating on onion seed production field day program, 2024

Kebeles	Number of Participants									
	PAPREG Members		Non PAPAREG	DA	Experts	Researchers	TA	District officials	LRRP officials	Total
	Male	Female								
Biedi	7	3		1						11
Geferem	7	3		1						11
Debel	7	3		1						11
Total	21	9	12	3	1	2	1	4	2	**55**

Costs-benefits Analysis

The cost-benefit analysis of onion seed production per hectare reveals promising results, indicating a substantial net profit of 1,032,500.00 Ethiopian Birr (Table 4). The total cost of cultivation, including expenses for bulb procurement, ploughing, bed preparation, irrigation, pesticide application, fertilizers, and harvesting, amounts to 207,500.00 Birr. Despite these costs, the total income generated from the seed yield is noteworthy, reaching 1,240,000.00 Birr. This signifies a favorable return on investment, with a cost-benefit ratio (CBR) of 4.976. A CBR above suggests that for every unit of currency invested, there is a return of more than one unit of currency, indicating profitability. In this case, the CBR of 4.976 reflects a favorable return, demonstrating that onion seed production is economically viable and yields substantial profits relative to the initial investment.

Table 4: Cost-Benefit analysis of onion production per hectare (ETBIRR/ha)

No.	Item descriptions	Cost (Birr)
1	Bulb for planting (500 kg)	40,000.00
2	Ploughing	5,000.00
3	Fine ploughing	5,000.00
4	Making beds (ridge)	5,000.00
5	Canal and bed correction	6,000.00
6	Planting (drilling, planting and covering)	20,000.00
7	Hoeing and Weeding (Four times)	20,000.00
8	Irrigation (Six times)	24,000.00

9	Pesticides	40,000.00
10	Fertilizer (UREA 2 Quintals)	15,000.00
11	Fertilizer (DAP 1 Quintals)	7,500.00
12	Harvesting (Harvesting, Drying, Seed extraction and storing)	20,000.00
	Total Cost of Cultivation	207,500.00
	Attain Onion Seed Yield (kg ha-1)	620
	Price per kg	2,000.00
	Total Income	1,240,000.00
	Net Profit	1,032,500.00
	Cost - Benefit Ratio (CBR)	4.9759

Opinion of PAPREGs: Insights and Experiences

During the demonstration, agro-pastoralists shared their valuable experiences and newfound knowledge regarding onion seed production. A significant revelation for many participants was learning about the flowering process of onions, a critical aspect of seed production that they had not previously encountered. This newfound understanding has inspired a commitment among the agro-pastoralists to engage in onion seed production as a viable future business venture, promising to enhance their income and economic stability.

The agro-pastoralists expressed a strong desire to produce onion seeds independently, recognizing the potential for this activity to become a sustainable source of revenue. They acknowledged the importance of continued support and guidance from the Werer Agricultural Research Center, seeking assurance that the center would assist them in overcoming any future challenges related to onion cultivation and seed production. This partnership is seen as crucial for the success of their new endeavors.

In discussing the advantages and disadvantages of the introduced technology, the agro-pastoralists provided valuable feedback that will inform future technology dissemination efforts. They highlighted several benefits, including the potential for improved crop yields, enhanced quality of onion seeds, and increased resilience against pests and diseases through integrated pest management practices. However, they also noted potential challenges, such as the need for ongoing education and support, access to quality inputs, and the initial investment required for establishing community-based seed production systems.

The information collected from these discussions will play a vital role in refining and optimizing the technology dissemination process. By incorporating the insights and experiences of the agro-pastoralists, future activities can be better tailored to meet their needs, ensuring broader adoption and greater impact on agricultural productivity and community livelihoods. This collaborative approach underscores the importance of engaging local communities in the development and implementation of agricultural technologies, fostering a sense of ownership and empowerment among the agro-pastoralists.

Important Lesson Drawn

The activity to enhance onion seed production among the agro-pastoralists in Gelealo District, Afar, has provided several important lessons that can be applied to future agricultural projects

in similar contexts. These lessons highlight the effectiveness of specific practices and the importance of community integration and continuous learning.

Efficient Use of Underground Water for Irrigation in Water-Scarce Time:
One of the critical lessons learned is the effectiveness of utilizing underground water for irrigation, especially in semi-arid regions like Afar. Implementing irrigation systems that use minimum water resources has proven to be sustainable and efficient. This approach not only conserves water but also ensures that crops receive adequate hydration, leading to better yields and quality. By tapping into underground water sources, agro-pastoralists can mitigate the challenges posed by water scarcity and enhance their agricultural productivity.

Integration of PAPREGs, Development Agents, Extension Services, and Administration:
The success of the onion seed production activity underscores the importance of integrating various stakeholders, including PAPREG members, development agents, extension services, and local administration. This collaborative approach ensures that all parties are aligned with the project's goals and can provide support where needed. Development agents and extension services play a crucial role in providing technical assistance and training, while the local administration helps in facilitating resources and addressing any bureaucratic hurdles. Such integration fosters a cohesive and supportive environment, essential for the project's sustainability and scalability.

Rapid Learning and Adaptation by PAPREGs:
The agro-pastoralists demonstrated remarkable capacity for rapid learning and adaptation. Their ability to quickly grasp new concepts and techniques related to onion seed production highlights the potential for scaling such activities. This fast-learning curve can be attributed to the practical, hands-on training sessions and the relevance of the techniques to their immediate needs. Recognizing and harnessing this adaptability can significantly enhance the effectiveness of agricultural training programs.

Responsiveness and Proactive Engagement:
The proactive engagement and responsiveness of the PAPREG members to each activity were pivotal to the activity's success. Their willingness to participate, ask questions, and implement new practices demonstrated a strong commitment to improving their agricultural practices. This responsiveness not only facilitated the smooth implementation of the project but also ensured that the agro-pastoralists could quickly address any issues that arose, leading to continuous improvement and better outcomes.

Continuous Meetings and the "DAGU" Information Dissemination System:
Continuous meetings and the use of the local information dissemination system known as "DAGU" were instrumental in maintaining communication and ensuring the flow of information among participants. Regular meetings provided a platform for discussing progress, sharing experiences, and addressing challenges. The DAGU system, a traditional method of spreading news and information within the community, proved effective in ensuring that all members were kept informed and engaged. This system facilitated timely updates and reinforced a sense of community involvement and collective effort.

Future Focus, Emerging challenges and Opportunity

Future Focus:

The future focus for the agro-pastoralist communities in the Gelealo District should include strategies to mitigate the emerging challenges while leveraging the opportunities to enhance agricultural productivity and sustainability. Key areas of focus include:

1. **Enhanced Pest and Managing Home Animals in Agriculture Farming Systems:** Implementing measures to protect onion fields from animal attacks, especially during the critical flowering period. This could involve the use of fencing, or other innovative solutions to prevent complete crop losses.
2. **Irrigation Infrastructure Development**: Addressing irrigation water deficiency, particularly in areas like Gefrem kebele. Efforts should be made to improve irrigation infrastructure, including the development and maintenance of irrigation channels and the potential for alternative water sources.
3. **Community Engagement and Education**: Continuously educating agro-pastoralists on best practices for seed production, pest management, and water conservation. This can be facilitated through ongoing training programs, demonstrations, and workshops.
4. **Research and Innovation**: Promoting research to develop drought-resistant onion varieties and efficient irrigation techniques that can thrive in the semi-arid conditions of the district.
5. **Sustainability:** Overall, the sustainability of the activity is underpinned by its capacity to empower and educate the community, promote the use of quality seeds, and establish a collaborative platform for ongoing engagement and improvement in agro-pastoralist communities. Through these sustainable mechanisms, the activity has the potential to contribute to the long-term advancement of agricultural practices and the overall well-being of the region with little support for scale out.

Emerging Challenges

Several challenges have emerged that threaten the sustainability of onion production in the region. These include:

1. **Interference of home animals in agriculture farms**: Interference of home animals in agriculture farms can have various negative effects on crop production. This interference can come in the form of trampling, grazing, and browsing on crops, leading to significant yield losses. Frequent animal attacks on onion fields, particularly during flowering time, result in significant crop damage and complete losses. This issue requires urgent attention to prevent future crop devastation.
2. **Irrigation Water Scarcity:** The deficiency of irrigation water is a pressing issue, especially in Gefrem kebele sub PAPREG were the activity discontinued. The lack of sufficient water for irrigation is hindering agricultural productivity and causing significant crop losses specially for vegetables those planted with no true seeds.
3. **Infrastructure Gaps**: The district, despite having vast fertile lands suitable for cultivation, lacks proper irrigation infrastructure, including the diversion of water from the Awash River. This limitation is a major bottleneck in realizing the full agricultural potential of the area.

Opportunities

Despite the challenges, there are several opportunities that can be harnessed to improve the agricultural landscape of the Gelealo District:

1. **Irrigation Development**: There is a vast expanse of fertile land in the district that can be effectively utilized for agriculture through improved irrigation techniques. Developing a comprehensive plan for the diversion of the Awash River and optimizing underground water use can significantly boost agricultural productivity.
2. **Collaborative Efforts**: The integration of PAPREGs, district agricultural experts (DAs), extension services, and local administration presents an opportunity for a coordinated approach to tackle agricultural challenges. This collaboration can enhance resource sharing, knowledge dissemination, and support systems for agro-pastoralists.
3. **Technology Adoption**: The adoption of new technologies and farming practices, such as drought-resistant crop varieties and efficient irrigation systems, can help mitigate the effects of water scarcity and enhance resilience to climatic changes.
4. **Economic Empowerment**: By focusing on onion seed production as a business venture, agro-pastoralists can create additional income streams, thereby improving their economic stability and livelihoods. This activity can also contribute to the local economy and food security.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The interventions within the Pastoral and Agro-pastoral Research and Extension Group (PAPREG) in the Gelealo District have highlighted the significant potential for enhancing onion seed production. Capacity-building training and field experiments have demonstrated notable improvements in onion seed production efficiency, and the cost-benefit analysis confirms the economic viability of these efforts.

Ongoing community engagement and collaborative activities have fostered a supportive environment essential for future projects. To further enhance onion seed production, it is crucial to improve irrigation infrastructure, enhance pest and Managing Home Animals in Agriculture Farming Systems strategies, and promote research and innovation for resilient crop varieties. By leveraging these opportunities and addressing challenges, the agro-pastoralists of Gelealo District can significantly boost their agricultural productivity, economic stability, and overall resilience.

The lessons learned emphasize the importance of integrating various stakeholders, fostering rapid learning and adaptation, and maintaining continuous communication through traditional and modern dissemination systems. Sustained efforts in community engagement, education, and technological adoption will be key to realizing the full agricultural potential of the region, contributing to the prosperity and resilience of the farming communities.

The research findings and outcomes have the potential to drive sustainable agriculture, address seed supply challenges, and contribute to food security in the region. The participatory approach employed in community-based onion seed production can serve as a model for enhancing agricultural productivity and livelihoods in similar agro-pastoralist communities.

Recommendations

1 Enhanced Pest and Managing Home Animals in Agriculture Farming Systems: Implement protective measures such as fencing to safeguard onion fields from animal attacks, particularly during the flowering period.
2 Irrigation Infrastructure Development: Address irrigation water shortages, especially in areas like Gefrem kebele, by enhancing and maintaining irrigation systems and exploring alternative water sources.
3 Ongoing Education and Training: Provide continuous education on best practices for seed production, pest management, and water conservation through training programs, demonstrations, and workshops.
4 Research and Innovation: Promote research to develop drought-resistant onion varieties and efficient irrigation techniques tailored for semi-arid regions.
5 Leveraging Technology and Collaboration: Foster the adoption of new technologies and encourage collaboration among PAPREGs, agricultural experts, extension services, and local administration to effectively address agricultural challenges.
6 Economic Empowerment: Develop onion seed production as a business venture to enhance economic stability and livelihoods, thereby contributing to the local economy and improving food security.

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