

Awareness & Training on Sustainable Agricultural Practices in Laamu Atoll



Report on Awareness & Training on Sustainable Agricultural Practices in Laamu Atoll *Prepared by Enhancing National Development through Environmentally Resilient Islands (ENDhERI) Project for the Ministry of Tourism and Environment.*

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Awareness & Training

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**Demonstration of Alternative
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Awareness & Training



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List of Abbreviations

AgroNAT	Agro National Corporation
ENDhERI	Enhancing National Development through Environmentally Resilient Islands
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
MoFMRA	Ministry of Fisheries, Marine Resources and Agriculture
MECCT	Ministry of Environment, Climate Change and Technology
MGAP	Maldives Good Agricultural Practices
MoAAW	Ministry of Agriculture and Animal Welfare
WDC	Women Development Committee

Executive Summary

Enhancing National Development through Environmentally Resilient Islands ENDhERI project financed by Global Environment Facility (GEF) aims to assist the government of Maldives in its implementation of new governmental policies and transition towards natural adoption of green growth atoll development that will sustain marine natural capital and strengthen the resilience and recovery of reef ecosystems. In this regard one of its outputs is to target island communities sensitized and increasingly apply eco-technologies for sustainable food production and disposal of domestic waste.

Hence, a call for consultancy service was announced by Ministry of Environment, Climate Change and Technology (MECCT) to train and increase awareness to the communities of Laamu on sustainable farming practices to ensure that these practices are carried through by support and understanding of the communities. There were two main activities in this project; to train and create awareness and also to showcase a demonstration plot showing these best practices. This report is focused on the training and awareness sessions that were conducted in this regard to the Laamu community.

1. Introduction

Agriculture or farming is one of the main income generating occupations in the islands. There are more than 7000 farmers registered in Ministry of Agriculture and Animal Welfare (MoAAW). Most often these are subsistence farmers or part-time farmers who does farming to earn an additional income (Van Driessche, 2023). Sometimes the crops are grown in the backyard of the house or in fields, and quite often crops are grown for household consumption in the backyard and then the excess are sold to earn a revenue. The percentage of women in agriculture sector is estimated to be around 53% (National Fisheries and Agriculture Policy 2019-2029). The majority of the crops cultivated are watermelon, papaya, cucumber, melon, brinjal, lettuce, butternut, pumpkin, banana and other horticultural crops (Agriculture Survey Report, 2019).

The exact production data for agricultural produce is limited as MoAAW currently records the produce brought to Male' market only. This does not give an accurate representation of the actual production in the atolls as most produces are sold within the atolls and other nearby islands. Hence, it could be argued that the current Gross Domestic Product (GDP) contribution from agriculture sector is not credible. Therefore, the need to improve the mechanism to collect agriculture production data from the islands is critical.

Additionally, the farmers registry was formed when subsidies were being given to the farmers. Since the registration was tied to a financial benefit, there is a concern on the authenticity of the registry which was a case in point during the stakeholder consultation meeting held with the Ministry of Fisheries Marine Resources and Agriculture (MoFMRA). The registry also lacks the information on the type of farming, crops being grown, farming land ownership and whether they are full time or part time farmers. This is an indication that there is a need for the farmers registry to be updated and validated regularly.

Another area that needs improvement is to increase farmers knowledge on the proper use of fertilizer and pesticides with a focus on environmentally safe and sustainable agricultural practices.

Hence, taking into consideration these factors, the main objectives of this assignment as specified in the Terms of Reference of this project were (1) to increase general public and farmers knowledge on the best practices that can be adopted, emphasising the use of sustainable food production techniques and (2) finding a good mechanism to aid collect agriculture data in the islands. Therefore, following this basis, the list below indicates the focus for the training and awareness sessions that were conducted for this project.

1. Increase farmers knowledge on the proper use of pesticides, Good Agricultural Practices (GAP) and Integrated Pest Management (IPM) practices.
2. To increase public and youth (students) knowledge on the harmful effects of pesticides.
To discuss a mechanism for agriculture data collection at islands.

2. Training & Awareness Sessions

Table 1 shows the focus areas for each training and awareness session that were carried out.

Table 1: Focus Areas for Training and Awareness Sessions

Target Audience	Focus area
Farmers	<ul style="list-style-type: none"> - The detrimental effects of the use of chemical pesticides on human health, other organisms and environment. - Integrated pest management (IPM) techniques which aim to promote sustainable agricultural practices by using all available methods for control of pest and diseases prior to resorting to the use of chemical pesticides. - Maldives Good Agricultural Practices (MGAP), Agribusiness skills and proposal writing.
School students and general public	<ul style="list-style-type: none"> - Information on the detrimental effects of chemical pesticides on human health, other organisms and environment.
Councils and WDCs	<ul style="list-style-type: none"> - Importance of agricultural data collection along with a group activity to get their suggestions on an effective mechanism for agriculture data collection from farmers.

The trainings were conducted over three trips to Laamu atoll. The travel dates for the islands are shown in Table 2.

Table 2: Islands and Training Periods of Islands

Islands	Training Period
L. Isdhoo and L. Kalaidhoo	17 th Jan – 20 th Jan 2024
L. Dhan'bidhoo and L. Kunahandhoo	24 th Jan – 27 th Jan 2024
L. Fonadhoo and L. Gan	14 th Feb – 17 th Feb 2024

3. Methodology and Training Outline

As the content which had to be delivered to farmers was more intensive than the other audiences, two sessions were planned for farmers. The session for community members, students, island councils and Women's Development Committee (WDC) members were finished in one sitting. Powerpoint slides were prepared for each topic taught and they were shared with Ministry of Environment, Climate Change and Technology (MECCT) for approval prior to conducting the sessions.

The detailed topics that were taught in the respective training and awareness sessions are attached in Appendix A - Training Outlines.

In addition to the PowerPoint presentations, different group activities were carried out to generate interest of participants during the training sessions which assisted the participants to understand the subject much better. Additionally, a practical session was also incorporated to help them apply the knowledge in their work which was most essential for farmers. In the case of IPM techniques that were covered, the group activity consisted of making an IPM plan so the participants can understand how different techniques taught in the training session can be applied when targeting a certain pest. Similarly, a small audit activity was incorporated into the MGAP session to provide an idea on some criteria that are audited during MGAP certification.

Furthermore, an information sheet with a list of bio-pesticides which targets different pests commonly encountered while growing crops in Maldives was handed over during the farmers sessions. These sheets highlighted eight bio-pesticides that could be used to control pest and diseases. As bio-pesticides are safe for humans, other organisms and the environment, it was encouraged to use bio-pesticides instead of chemical pesticides. When implementing IPM control techniques, chemical pesticides are the last resort of action.

Similarly, to enhance the interest of the students' session, the presentation was delivered in the form a story, aiming to engage them and maintain their interest throughout the session. The storytelling approach was adopted to ensure their active participation and sustained attention. Furthermore, a small experiment was also carried out during the session. A white flower with stem was placed in a coloured solution. In time, the colour, along with the water, is transported to the white petals of the flower through the xylem. This caused the petals to become coloured in red patches or slowly turn red. This experiment was used to depict to the students that systemic pesticides will be taken up in a similar manner through the xylem. Since flowers turn into fruits, this shows that the use of systemic pesticides will cause fruits to carry this pesticide inside it. Although the human eye cannot see this when we harvest the fruit or vegetable, the pesticide residue will be present in the produce. One of the main aims of the experiment was to harness awareness in the students at an early age, thereby creating a better future in agriculture for the nation.

4.Details of the trainings participants

Listed below are the training participant details (see Table 3).

Table 3: Training Participant Details

Island	Community		Farmers		Council and WDC		Students	
	Men	Women	Men	Women	Men	Women	Men	Women
L. Isdhoo	-	-	-	-	3	14	37	31
L. Kalaidhoo	14	31	10	10	9	8	22	20
L. Dhanbidhoo	3	7	3	7	8	5	15	13
L. Kunahandhoo	3	9	6	12	-	4	-	-
L. Gan	3	17	7	6	3	2	69	60
L. Fonadhoo	1	4	5	-	0	0	1	-
Total per gender	24	68	31	35	23	33	144	124
TOTAL	92		66		56		268	

Error! Reference source not found. and Error! Reference source not found. below shows the details of men and women for each training and awareness session held.

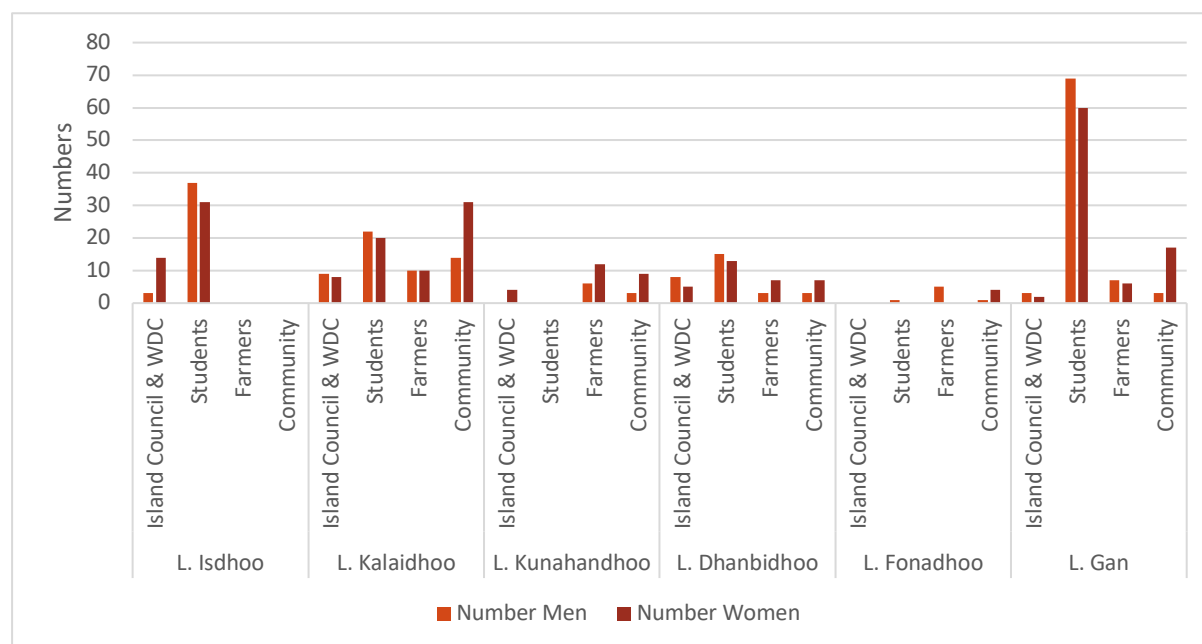


Figure 1 Gender Distribution Among Participants in Individual Islands

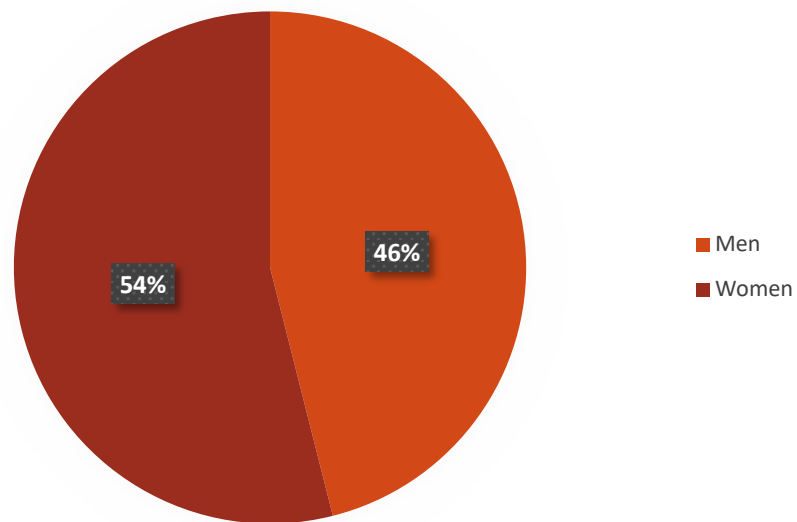


Figure 2 Overall Gender Distribution of Training Participants

5. Details of the sessions

5.1 Training and awareness sessions in L. Isdhoo

5.1.1. Session for farmers and general public

L. Isdhoo, was one of the first two islands covered in the first visit to Laamu Atoll. With the recommendation by the Island Council, it was decided to carry out the session for the general public and the farmers together since it was identified that the attendees would be the same for both sessions. It was also decided that the first topic for farmers being the use of chemical pesticides, members from general public who are non-farmers may leave after the first topic is completed. However, due to some unforeseen circumstances which are detailed in 6 of the Report, the training for farmers and general public could not be held in Isdhoo.

5.1.2 Session for School students

To ensure maximum attendance, a session for school students at Isdhoo was scheduled after their regular school hours, from 11:30 am to 12:30 pm. A total of 68 students participated in the session. In order to capture and maintain the attention of the students, the presentation was delivered in a manner similar to story-telling, and they were asked thought-provoking questions as well. This was thought to aid in their comprehension too. Additionally, a small experiment was conducted to demonstrate how pesticides are absorbed by plant roots, transported through the stem to the leaves and flowers, and eventually found in the fruits we consume. The students showed great interest during the session, indicating that they gained insights into the impact of pesticides on human health, other organisms, and the environment.



Picture 1: Isdhoo school students with the trainers



Picture 2: L. Isdhoo students' awareness session

5.1.3 Session for Council and WDC

Eighteen individuals took part in a session organized for members of the Isdhoo Council and WDC. The presentation emphasized the significance of agricultural statistics. A group exercise was carried out, dividing participants into three groups to gather their insights on a viable approach for gathering agriculture data at the island level. As the Council and WDC members reside on the island, work in close collaboration with farmers, and are involved in data collection, their suggestions could offer a practical and insightful solution.

Some suggestions from the group activity included mandating the submission of regular data from farmers by incorporating it as a requirement when leasing or allocating land for farming from the Island Council. Additionally, it was suggested to implement this at a policy level by enhancing Ministry policies to tackle the matter by incorporating data submission as a part of the agreement for farmers leasing land. Moreover, they emphasized the significance of educating farmers on the importance of statistics through awareness sessions.



Picture 3: L. Isdhoo Council and WDC members with the trainers



Picture 4: L. Isdhoo Council and WDC training session

5.2. Training and awareness sessions in L. Kalaiadhoo

5.2.1. Session for farmers and general public

The session, designed to accommodate both farmers and the public, was a combined event attended by 20 farmers and 45 participants from the general public. The initial session took place on January 19, 2024, serving both groups, with a subsequent session held later that evening at 20:30.

Engagement was maintained by posing relevant questions to the participants. They were also tasked with completing two group activities, which they did while showing good spirits. The first involved creating an IPM plan, while the second required a small MGAP audit of their farm. Groups were formed for the IPM plan, and each group presented their work. Similarly, the MGAP activity provided insights into audit criteria, with many farmers meeting most of the requirements. These were among the list of criteria considered for MGAP Certification.

At the end of the session, the training was evaluated by the training participants.



Picture 5: L. Kalaidhoo Farmers and Island Community with the trainers



Picture 6: L. Kalaidhoo Farmers and Island Community training and awareness session

5.2.2 Session for school students.

The student session was conducted on January 2024 at 14:00, with 42 students in participation. The session mirrored the format of the previous one in Isdhoo, where students actively interacted with the trainer's inquiries throughout the presentation. Overall, the session received positive feedback, with students learning significantly from the experience.



Picture 7: L. Kalaidhoo students' session

5.2.3 Session for council and WDC

The Council and WDC session took place on January 20, 2024, at 10:00 am, with 17 members in attendance from both groups, including the Council President. Following the presentation on agriculture statistics, participants were divided into three groups for a collaborative activity. Valuable suggestions were shared by the members, including the importance of establishing a farmers registry and developing policies to enhance agriculture.



Picture 8: L. Kalaidhoo Council & WDC participants with the trainers



Picture 9: L. Kalaidhoo Council and WDC training session

5.3. Training and awareness sessions in L.Dhan'bidhoo

5.3.1 Session for farmers and general public

The initial session, which was open to farmers and the general public, took place on January 24, 2024, at 16:00 hours. Following this, a second session, specifically targeted for farmers was conducted on the same day at 20:30 hours. A total of eight farmers participated in the training session, where they were actively engaged. In addition to providing agriculture related information during the session, to enhance the session's engagement level, an extra activity was introduced starting from this session. A volunteer among the participants was asked to wear safety gear used by farmers during chemical pesticide handling, preparation, and spraying. Furthermore, to encourage best practices, a safety kit containing personal protective equipment, gloves, mask, and goggles, was awarded to the participant with the highest number of correct answers in the end-of-session questionnaire.



Picture 10: L. Dhan'bidhoo Farmers training session

5.3.2 Session for students

A session was arranged for school students in Dhan'bidhoo on January 25, 2024 at 13:30 hours, following consultation with the school's principal. The session, attended by a total of 28 students, included one foreign student, was conducted in English to cater to all participants. To enhance student engagement, the presentation predominantly featured images with minimal text on the slides. The session, which included a safety kit dress-up activity, was well received by the students who were also treated to refreshments afterward.

The active involvement of the school Principal was crucial for the success of the session. The principal not only attended the session but was also keen to facilitate all arrangements.





Picture 11: Dhan'bidhoo Students session

5.3.3 Session for Council and WDC

The meeting for Dhan'bidhoo Council and WDC took place on January 25, 2024, at 10:00 am. Thirteen participants were present during the session. Following a presentation, a group activity was conducted. The attendees were split into two groups and tasked with brainstorming an effective method for collecting agricultural data. The participants shared insightful ideas during the session.

Group one recommended conducting an awareness session for farmers to emphasize the significance of record-keeping, a practice that is seldom followed by farmers. They also suggested establishing a farmers' registry within the Council, which is currently not in use. Moreover, both groups proposed the idea of hiring a dedicated staff member to closely collaborate with farmers and gather the necessary data on a monthly basis. The data collected could then be shared on the Council's website. Additionally, to encourage farmers to participate in data collection, it was suggested to recognize and appreciate those farmers and Council members who consistently submit data during an official ceremony.

The second group suggested additional ideas, such as implementing a licensing system for farmers. This license would require farmers to submit data regularly and comply with specified rules. Failure to adhere to the rules could result in the cancellation of the license. The group also recommended recognizing farmers who consistently submit their data.





Picture 12: L. Dhanbidhoo Council and WDC training session

5.4 Training and awareness sessions in L.Kunahandhoo

5.4.1 Session for farmers and general public.

The initial session for farmers and the public took place on January 26, 2024, at 14:30, followed by a second session later that evening at 20:30. In the first session, 18 farmers and 12 members of the public attended. The event included scheduled presentations, group activities, a group presentation, and a dress-up activity, all of which were well-received. Participants displayed keen interest in the training sessions and actively engaged throughout.





Picture 13: L. Kunahandhoo Farmers training session

5.4.2 Session for students

The awareness session for Kunahandhoo school students was scheduled for January 27, 2024 at 09:00 am. The timing was decided in consultation with the school, following the same practice as other student sessions. Despite this, regrettably there were no attendees for this session. The primary reason for the absence was the concurrent primary elections of a political party being held at the school on the same day. Consequently, the Consultant was unable to conduct the awareness session for the students in Kunahandhoo.

5.4.3. Session for Council and WDC

The session for Kunahandhoo Council and WDC took place on the January 27, 2024 at 10:30 am. There were only four attendees present due to the primary elections of a political party which was ongoing on the same day. The participants were assigned a single group presentation. During the session, participants proposed gathering information on current farmers and maintaining a farmers' registry within the Council. They suggested collecting data from farmers every three months and sharing it with MoAAW. Emphasizing the importance of acknowledging farmers who consistently provide data was also discussed.



Picture 14: L. Kunahandhoo Council and WDC training session

5.5 Training and awareness sessions in L.Fonadhoo

5.5.1 Session for Farmers

The initial session for L.Fonadhoo farmers was scheduled for February 14 2024, at 16:00. Unfortunately, no attendees showed up. Subsequently, the Council was informed of the session details, and social media posts were shared in Viber community groups in Fonadhoo to attract more participants. A second session was arranged for the same evening. The Consultant attempted to contact farmers directly using lists from AgroNational Corporation (AgroNAT) and the Fonadhoo Council, but faced challenges due to the lack of contact numbers on the lists. Only three farmers attended the rescheduled evening session, and it was decided not to proceed with the session due to the lack of participants. The Consultant planned to visit farms and meet local suppliers on the island the next day to boost participation. Hence, the session was rescheduled for the following day.

Despite the efforts to reach a wider audience, only five participants were present at the training session on February 15, 2024. The trainer covered all the topics with the attendees and facilitated a group activity.

As L. Fonadhoo is the second most productive farming islands in the atoll, it was regrettable that more farmers could not attend the session. Details and reasons for the lack of participation are listed in Section 6 of this report.



Picture 15: L. Fonadhoo farmers training session

6.5.2. Session for School students and public

The session at Laamu Atoll Education Centre (LAEC) in Fonadhoo took place on February 15, 2024, at 14:00 hours. Due to a low turnout of the public, parents were encouraged to join the session with the students. The session timing was coordinated with the school's focal point and shared on the official school Viber group. Despite the efforts, only one student and five parents attended. The expected target turnout from LAEC was 200 participants. Nevertheless, it was decided to proceed with the session with the attendees.

6.5.3. Session for Council and WDC

The session for Fonadhoo Council and WDC was scheduled for February 14, 2024 at 14:00 hours. This timing was decided after consultation with the Island Council. However, no participants attended the session for reasons detailed in Section 6. Unfortunately, due to conflicting schedules among all parties, the session could not be rescheduled.

5.6 Training and awareness sessions in L.Gan

5.6.1 Training session for farmers

The training session for farmers in L. Gan took place on the February 16, 2024 at 20:30. Thirteen attendees were present, with eight farmers from Gan and five from the neighbouring island of Mundoo. Although 14 farmers from Gan had registered for the session through the Consultant's social media post, only a portion attended despite being informed of the timings.

The Consultant proceeded with the training with the attendees, concluding all topics with group activities. The participants engaged well in the group presentation





Picture 16: L. Gan & L. Mundoo farmers training session

5.6.2 Session for school students

The school session took place at Ihahdhoo School in L. Gan on February 15, 2024, from 12:00 to 13:00, immediately following the school day. A total of 129 students, along with 20 parents, participated in the session. The students showed great engagement and interaction throughout the session, leading to a successful and participative event.



Picture 17: Ihahdhoo School students' session

5.6.3. Session for Council and WDC

The Gan Council and WDC session took place on February 15, 2024, at 10:00 hours. The session time was confirmed after consulting with the Council. Despite a late turn-out, a total of 5 staff members joined the session. Although the Consultant held reservations due to the absence of a WDC and Council member, it was decided to proceed with the session. As L.Gan holds the record for the highest number of farmers in the country, the lack of support from the Island Council and WDC for the session was concerning. This is further explored in Section 6. The insights and feedback from the Council and WDC members would have been crucial in formulating an effective agriculture data collection mechanism.

The group activity proceeded, and a few suggestions were made. One idea was to create a specific section for agriculture within the Council. Moreover, a proposal was put forth for MoAAW to draft a sample agreement that farmers would need to sign and distribute it to all councils. This agreement could include a provision requiring farmers to submit data to the councils every three months.



Picture 18: L. Gan Council and WDC Training session

6. Challenges & Findings

6.1. Unavailability of a reliable farmers registry or list

The primary challenge encountered during the training and awareness session was the low turnout of participants. In the case of farmers, this was mainly due to the absence of a formal farmers' registry. Efforts were made through Stakeholder Consultations and subsequent communications with Island Councils to obtain a list of farmers for the training. However, most island Councils did not possess a comprehensive list, and the ones provided were often lacking contact details. Despite one island Council offering a list, the individuals contacted claimed not to be farmers and were upset about being approached for the session. Another list from L. Fonadhoo Council lacked contact numbers, making it difficult to reach out. Similarly, a list of farmers associated with AgroNAT was acquired, but it also lacked any contact information.

Due to the lack of contact details, the Consultant had to depend on the Island Councils for their assistance in disseminating the details of the sessions to residents on the island. Furthermore, a social media post was created and shared on ENDhERI project's social media channels, as well as distributed to community Viber groups through the Councils. Moreover, assistance from the Laamu Coordinator was enlisted to ensure the message reached a wider audience. It should be noted that some island councils, such as the L. Kunahandhoo council, have gone above and beyond by disseminating session details to households on the island through printed materials.

In certain islands, efforts were made to reach out to farmers who did not attend training sessions by visiting their farms in person. The aim was to reschedule the sessions in the hope of increased attendance. Unfortunately, these attempts often proved unsuccessful.

The Consultant believes that many locals are accustomed to numerous training sessions and did not prioritize attending these particular ones, assuming they would not directly benefit much from the sessions. Some farmers specifically questioned the immediate advantages of participating in the sessions, showing a lack of motivation to engage solely for the sake of gaining knowledge.

6.2. Session time coinciding with other major events on the island

In most cases, the same individuals on the island participate in its main activities. Often, our session schedules overlapped with other island events. Despite numerous attempts to adjust the timing, this often did not lead to a significant turnout of participants.

For instance, in Isdhoo, the initial session for farmers and the public was scheduled for January 17, 2024 at 20:00 hours. Unfortunately, an unexpected incident, which was out of Consultant's control, on the same evening led to the session being postponed. Despite being prepared, the Consultants were present at the venue on the January 17, 2024 but no attendees showed up, prompting a rescheduling to the evening of the January 18, 2024. However, even with the new timing, there were no attendees due to a conflicting political event held at the same time on the island. The majority of the island's population was either participating in or preparing for the political gathering, resulting in low turnout for the session. Despite personal invitations by the Consultant and the Client's representative, efforts to attract attendees were unsuccessful.

In Fonadhoo, all Councils and WDC were involved in the preparations for the "Sawadheeththa Dhathuru" event hosted by the Ministry of Tourism. However, in certain instances, the Consultant noted that these organizations did not prioritize these sessions. For instance, during the Gan Council session, participants mentioned that Council members typically do not attend such sessions, making it challenging for the Consultant to convince them to participate.

7. Conclusion

Although the participant turnout for some of the sessions were less than the targeted amount, the Consultant and project staff made every possible effort to maximize session attendance and ensure optimal utilization of project resources. Despite this, it is believed that the sessions have had a far-reaching impact on farmers, community members, students and councils and WDC members from these islands. More people from within these groups have become aware of the dangers associated with chemical pesticides, and will be equipped with the knowledge of alternative measures to reduce pests and diseases in crops. In addition to this, the Consultant has gained valuable insights into the current level of awareness, and the situation of farming in these islands, as well as the best ways to proceed in order to improve agricultural data collection.

During the conducted sessions, farmers were provided with valuable insights into alternative best practices for managing pests and diseases. Many farmers acknowledged the harmful effects of pesticides, yet some still felt that no other solutions were available. To address this, information sheets on bio-pesticides, a safer alternative for chemical pesticides, which are safe for humans, other organisms, and the environment, were distributed. This aligns with the Integrated Pest Management (IPM) approach covered in the training sessions. Monitoring the adoption of biopesticides by farmers in the future would be a valuable follow-up step to this project.

Similarly, participants from the public and students showed significant interest in the awareness session about the detrimental effects of pesticides.

Finally, the suggestions and proposals from the Council and WDC sessions are expected to be valuable in establishing a system for collecting agricultural data.

The training and awareness sessions were well received by the participants, with positive feedback shared during the sessions. Additionally, farmers filled out feedback forms where they rated specific aspects of the training on a scale of one to five. The average score given by farmers was four or higher. Some participants also suggested extending the session duration, having more sessions, and incorporating practical field visits into the training.

8. Recommendations

Showcase and demonstrate the effectiveness of bio-pesticides to farmers. One suggestion is to showcase the effectiveness of bio-pesticides or provide samples to instil confidence in these alternative measures. The Consultant's demonstration project that follows these sessions will emphasize the practicality of the solutions proposed.

Reach and educate a wider audience about the impacts of pesticides using social media. Since the awareness sessions took place only in Laamu Atoll, creating short videos about the harmful effects of pesticides could be beneficial to reach a wider audience through social media platforms.

Extend trainings to include expatriates working in the agricultural sector. The pressing need to reduce chemical pesticide usage became evident during the training sessions and field visit in Isdhoo. During a farm visit by the Consultant, an inexperienced expatriate was observed working in the papaya fields, using "starkle G" (Dinotofuran) to combat papaya mealy bugs. It was noticeable that the plants bore fruits that would ripen in approximately seven days. Dinotofuran, classified as a systemic pesticide, is absorbed by plants through the roots, stems, leaves, and eventually into the fruits, maintaining its effects for over three to four weeks. Despite this knowledge, the farmer showed disregard when warned about the consequences of misusing this pesticide. Hence, it is suggested to extend training sessions not only to Maldivian farmers but also to expatriates in the agricultural sector. Alongside such trainings, it is essential for relevant authorities to implement improved policies to drive the necessary changes.

Introduce a comprehensive agriculture law in order to regulate the various aspects of the agriculture sector including improving data submission and monitoring of agricultural work in islands. Presently, there are two distinct laws enacted: the Plant Protection Law and the Pesticide Law. These laws focus on safeguarding plants from pests and diseases and regulating pesticide use. It may be beneficial to introduce a comprehensive agriculture law to have broader authority over various aspects of the agriculture sector. Through legislation or regulations, there can be provisions to require farmers to regularly submit data. Some Councils have suggested this approach to develop policies by the Ministry of Agriculture and Animal Welfare to improve agriculture data. Previous attempts to collect data voluntarily by the Ministry have been unsuccessful. Therefore, this could be a progressive step towards obtaining consistent agriculture data.

Review MGAP criteria to encourage farmers feasibly achieve the certification and mandate certain MGAP standards for farmers. Furthermore, it is proposed that certain MGAP standard criteria should be made compulsory for farmers by utilizing the legislative power bestowed by the general agriculture bill. The MGAP standard, established in 2015, has yet to see widespread adoption. While it remains voluntary, some have attempted to certify their farms without success, mainly due to the perceived complexity of implementation. Consequently, a revision of the standard is necessary. Moreover, the critical criteria related to food safety within the MGAP should be obligatory for all farmers. This is crucial as the haphazard use of chemical pesticides requires immediate attention, given its adverse impacts on human health and the environment. While training and awareness are fundamental, substantial policy efforts are required to drive the necessary change effectively.

9. References

Agriculture Survey (2019), Maldives Bureau of Statistics

National Fisheries and Agriculture Policy 2019-2029, Food and Agriculture Organization (FAO)

Van Driessche, P. A. (2023). Agricultural Producer Markets in the Maldives: How Poor Market Connectivity Between Farmers and the Markets can be Enhanced. *International Journal of Rural Management*, 0(0). <https://doi.org/10.1177/09730052231161897>

10. Appendices

Appendix A - Training Outlines

Training program for farmers

session 1:			
Time	Topic	Delivery	Trainer
45 minutes	<p>Agrochemicals used for pest control</p> <ol style="list-style-type: none"> 1. What are pesticides? 2. How are pesticides prepared? 3. Types of pesticides 4. Categories of pesticides. 5. Important things to consider when using pesticides. 6. How pesticides persist in the environment. 7. Effect of chemical pesticides on human health, other organisms and the environment. 8. Bio-pesticides, what is it and types of bio pesticides available in the market 	PowerPoint presentation and an information consisting of 12 different bio-pesticides and sticky traps that are available in Maldives which could be used for pest control.	Aminath Aroosha
1 hour 30 minutes	<p>Integrated Pest Management (IPM)</p> <ol style="list-style-type: none"> 1. What is a pest? 2. What is integrated pest management? 3. Why is integrated pest management important? 4. How is pest controlled in an 	PowerPoint presentation and group activity to prepare an IPM plan.	Aminath Aroosha

	<p>integrated pest management?</p> <p>5. Different methods of pest control in IPM – cultural, mechanical, biological)</p> <p>6. Bio-pesticides and its importance.</p> <p>7. Group activity – Making an IPM plan</p> <p>8. Some examples of successful pest control using IPM techniques in Maldives.</p> <p>9. Advantages of IPM</p>		
Session 2			
45 minutes	<p>Maldives Good Agricultural Practices</p> <ol style="list-style-type: none"> 1. What is MGAP? 2. MGAP scheme 3. Scope of MGAP 4. MGAP modules 5. MGAP logo 6. Who can participate in MGAP? 7. How to participate in MGAP? 8. Modules of MGAP 9. Advantages of MGAP scheme. 	PowerPoint Presentation and Group activity (Farmers are given a sheet with few criteria that are audited during MGAP certification, so they could have an idea of the process of MGAP certification).	Aminath Aroosha
45 minutes	Agribusiness and Proposal writing skills	PowerPoint presentation	Aminath Aroosha

Awareness session to Public

Time	Topic	Delivery	Trainer
45 minutes	<p>Agrochemicals used for pest control</p> <ol style="list-style-type: none"> 1. What are pesticides? 2. How are pesticides prepared? 	PowerPoint presentation and an information consisting of 12 different bio-pesticides and sticky traps that are available in Maldives which	Aminath Aroosha

	3. Types of pesticides 4. Categories of pesticides. 5. Important things to consider when using pesticides. 6. How pesticides persist in the environment. 7. Effect of chemical pesticides on human health, other organisms and the environment. 8. Bio-pesticides, what is it and types of bio pesticides available in the market	could be used for pest control.	
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Awareness session to Students

Time	Topic	Delivery	Trainer
1 hour	Effects of pesticide on human health, other organisms and environment. <ul style="list-style-type: none"> a. A story b. Important facts from the story which includes <ul style="list-style-type: none"> - Plants are affected by pest and diseases. - Chemical pesticides are used to control pest and diseases. - How pesticides persist in the environment? - The effect of pesticides on human, other 	PowerPoint presentation and an information consisting of 12 different bio-pesticides and sticky traps that are available in Maldives which could be used for pest control.	Aminath Aroosha

	<p>organisms and environment.</p> <ul style="list-style-type: none"> - Pesticide residue. - There are much safer methods which can be used to control pest and diseases. - Important precautions when using chemical pesticide. 		
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Awareness to Council and Women's Development Committee (WDC)

Time	Topic	Delivery	Trainer
1 hour	<p>Importance of Agriculture data</p> <ol style="list-style-type: none"> 1. Introduction 2. Difficulties faced due to unavailability of agriculture data. 3. Difficulties that arise when taking agriculture data. 4. Group activity 	PowerPoint presentation and group activity (to discuss an effective mechanism that for agriculture data).	Aminath Aroosha

Appendix B – Training feedback

A feedback from the farmers session participants were obtained. Participants ranked five aspects of the delivery of the training from 1-5 (five being the highest score). Below in the form of a bar graph and pie chart is the collective feedback from all the farmers sessions held.

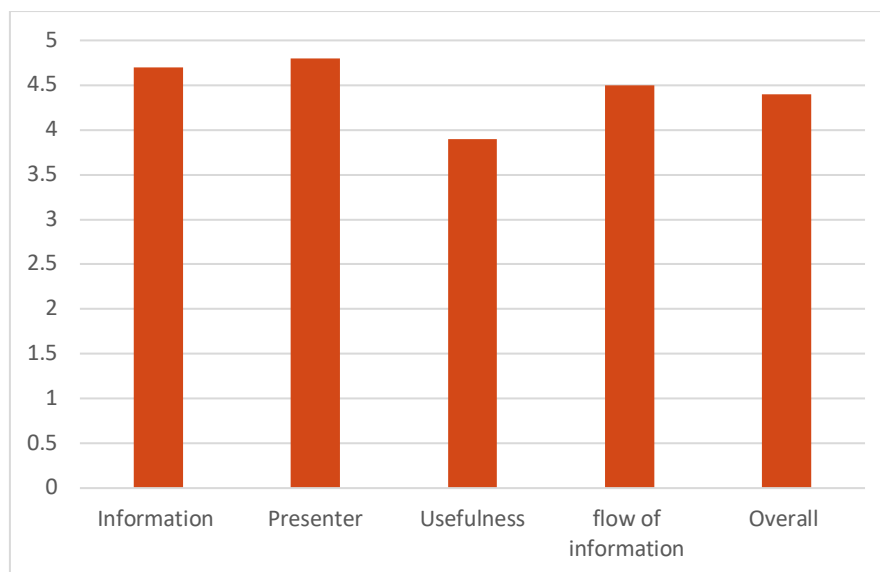


Figure 3: Feedback from farmers session

General feedback

Received very positive feedback from the participants, they have mentioned that they had gained new, previously unknown information from the program. Moreover, all the participants highlighted that applying the knowledge they acquired would be beneficial in the field. Some participants requested adding more images of pests and diseases, conducting a comprehensive study on pesticide usage in various islands, and including a field visit along with theory classes. Additionally, some participants stated the need to extend the duration of the sessions or to carry out more of these trainings.

Appendix C – Biopesticides Information Sheet

Biopesticides information sheet handed over to the farmers

Checkmite

Checkmite is a biopesticide made using a fungus. This can be used to control mites on plants. It helps control mites by infecting the mites when it is sprayed to the plants. This can be used to control all types of mites, hence this is very effective in controlling all types of mites. And since this is a biopesticides, this can be used in all stages of growth. This is safe for human health, environment and other beneficial organisms. But it is always recommended to use masks and gloves when handling any pesticides and to take a bath and change clothes.

Spinosad

This is a biopesticide that can be used to control different types of pests that attack the plants. Different types of sucking pests like aphids can be controlled using Spinosad. In addition, larvae and beetles can also be controlled using this. Spinosad is absorbed into the plant parts, so its effects last for about 10 days. And since this is a biopesticides, this can be used in all stages of growth. This is safe for human health, environment and other beneficial organisms. But it is always recommended to use masks and gloves when handling any pesticides and to take a bath and change clothes.

Bacillus Thuringiensis – BT

This is a biopesticide made using a bacterium. There are different strains of this bacteria which can be targeted for different pests. This bacterium infects the larval stage when it is sprayed to the plants. The bacteria do this by secreting a protein into the larvae which is toxic to the larvae. This is safe for human health, environment and other beneficial organisms. But it is always recommended to use masks and gloves when handling any pesticides and to take a bath and change clothes.

Metarrhizium

This is a biopesticide that can be used to control different types of larvae and sap sucking pests. Thrips, mites, different types of larvae can be controlled using Metarrhizium. This is safe for human health, environment and other beneficial organisms. But it is always recommended to use masks and gloves when handling any pesticides and to take a bath and change clothes.

Trichoderma Viridae

This is a biopesticide which is made using a fungus that can be used to control different types of fungus diseases that affect plants.

When used in the soil, this helps to reduce the number of disease-causing fungus in the soil such as the organisms that causes damping off, root rot. Also, this biopesticides helps to control nematodes. Since this is a biopesticide, it is safe for human health, environment and other

beneficial organisms. But it is always recommended to use masks and gloves when handling any pesticides and to take a bath and change clothes.

Trichoderma Herzhanium

This is a biopesticides containing a beneficial fungus that helps control fungal diseases. In this regard, damping off, different types of root rot can be controlled using this biopesticide. Since this is a biopesticide, it is safe for human health, environment and other beneficial organisms. But it is always recommended to use masks and gloves when handling any pesticides and to take a bath and change clothes.

Bacillus Subtilis

This is a biopesticide which contains a beneficial bacterium that can be used to control plant fungal diseases. In addition, this also helps to increase plant's immunity towards fungal diseases by inhibit the growth of the disease-causing fungal spores. Powdery mildew, Bacterial leaf spot and other bacterial and fungal diseases can be controlled using this biopesticide. Since this is a biopesticide, it is safe for human health, environment and other beneficial organisms. But it is always recommended to use masks and gloves when handling any pesticides and to take a bath and change clothes.

Baveria Bassiana

This is a biopetecide that cab be used to control different types of larvae, grubs, beetle and borers that affect plants. Since this is a biopesticide, it is safe for human health, environment and other beneficial organisms. But it is always recommended to use masks and gloves when handling any pesticides and to take a bath and change clothes.

Yellow sticky trap

This is a yellow sheet with a sticky substance on it, which helps to control and monitor different types of flying pests. The sheets can be placed near the plants to monitor and detect pests early. It can help reduce the inset population to some extent. In this regard, aphids, thrips, whitefly, fruitfly can be controlled using this.

How to use: This can be placed near the plants at 10sq feet intervals.

Blue sticky trap

This is a blue sheet with a sticky substance on it which can be used to monitor and control flying pests. Thrips are usually controlled using blue sticky traps.

How to use: This can be placed near the plants at 7 feet intervals.

Appendix D

Questionnaire for the farmers session

ئۇلارنىڭ سىزگە بىر قانچە سوئالغا جاۋاب بېرىشىنى ئۈمىد قىلىمىز. بۇ سوئاللارنىڭ جاۋابىنى بىزنىڭ ئىشلىرىمىزغا ياردەم بېرىدۇ. سىزنىڭ بىزگە بېرىدىغان جاۋابىڭىزنىڭ سىزنىڭ ئىشلىرىڭىزغا بىر قانچە ياردەم بېرىدۇ.

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Appendix F

Feedback form for farmers session

فردا در جلسه سید و خانم های محترم در جلسه سید و خانم های محترم در جلسه سید و خانم های محترم

(سید)

(خانم)

در جلسه سید و خانم های محترم در جلسه سید و خانم های محترم در جلسه سید و خانم های محترم

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در جلسه سید و خانم های محترم در جلسه سید و خانم های محترم در جلسه سید و خانم های محترم

1. آری

2. نه

در جلسه سید و خانم های محترم در جلسه سید و خانم های محترم در جلسه سید و خانم های محترم

1. آری

2. نه



Demonstration of Alternative Eco-Technology Agriculture Plot



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List of Abbreviations

ENDhERI - Enhancing National Development through Environmentally Resilient Islands

MCCEE - Ministry of Climate Change, Environment & Energy

LAFA- Laamu Farmers Association

IPM - Integrated Pest Management

PPE - Personal Protective equipment

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Executive Summary

This report outlines a demonstration project in Laamu Atoll, Maldives, showcasing climate-smart agriculture through a 1000-square-foot greenhouse for cucumber cultivation under the Enhancing National Development through Environmentally Resilient Islands ENDhERI project. Funded by GEF and supported by UNEP, the project aimed to minimize pesticide use, optimize fertilizer, and reduce groundwater pollution.

Despite challenges, the greenhouse produced high-quality cucumbers using sustainable methods like drip irrigation and Integrated Pest Management (IPM). Community engagement activities provided training on climate-resilient farming.

The project demonstrated the environmental and economic viability of climate-smart agriculture, offering insights for future initiatives and scaling sustainable practices in the region.

1. Introduction

The agriculture sector in the Maldives is essential to the economy and local livelihood contributing significantly to both economic growth and social wellbeing.

According to the baseline report on agricultural practices in Laamu atoll, agriculture is the main economic activity that contributes to livelihood of the local community on larger islands in Laamu Atoll such as the islands of Gan, Isdhoo and Kalaidhoo. However, unsustainable agricultural practices such as unregulated chemical fertilizers and pesticide application are a major concern to health impact on the natural environment and biodiversity. (Rifga, Baseline report on agricultural practices in laamu atoll, 2023)

This project aimed to demonstrate climate-smart, eco-friendly farming techniques using a 1000-square-foot greenhouse in Laamu Atoll. The greenhouse was designed to optimize fertilizer use, reduce chemical inputs, and implement Integrated Pest Management (IPM) techniques. Drip irrigation was introduced to improve efficiency and reduce water consumption. The greenhouse met all requirements outlined in the project's Terms of Reference (ToR).

Cucumbers were chosen for their marketability, economic value, and suitability for greenhouse cultivation in the Maldivian climate. The selected variety, Cucumber Riches from the 'Known-You Seeds' brand, is known for its high yield and a growth cycle of 60 to 70 days. Cocoponic bags were used as the growing medium. In order to attract local farmers, letters were sent to Laamu Gan and Laamu Fonadhoo Island Councils to identify interested participants. However, despite outreach efforts, only one farmer, Abdulla Nishthar from Fonadhoo expressed interest and participated in the demonstration. This farmer managed the greenhouse under project team guidance, aspiring to implement similar practices independently.

2. Methodology

This section outlines the methodology used to implement the demonstration greenhouse project. As specified in the ToR and the Inception Report, the demonstration project was established as a 1000 square feet greenhouse.

To complete the demonstration, the following key tasks were undertaken.

1. Site Selection and Preparation

Select a site in coordination with the island councils of Fonadhoo and Gan

2. Greenhouse Installation

Install a 1000 square feet greenhouse to create a more controlled environment to conducive and consistent growth and monitoring

3. Planting layout and Cultivation

Design a structured planting layout and cultivation practices to maximize space efficiency and plant health

4. Irrigation and Fertigation system

Setup irrigation and fertigation system to effectively deliver water and nutrients, ensuring that the plant receive an equal amount of care.

5. Data Collection and Monitoring

Data collection and monitoring were carried out to track the plant health and development and the effectiveness of the system.

6. Community Engagement and Knowledge Sharing

Communicate with community members and interested farmers to engage in the demonstration process and conduct knowledge sharing sessions.

7. Assessment and Reporting

Conducted a comprehensive assessment and the results were documented to evaluate the outcomes.

3. Execution

3.1 Site selection and preparation

During stakeholder meetings held for the Inception Report, the Ministry of Climate Change, Environment & Energy (MCCEE) proposed setting up the demonstration plot in Gan or Fonadhoo to maximize outreach based on population. LAFA was identified as one of the stakeholders to engage during the inception stage, and subsequent discussions led to the selection of their land for the greenhouse. Letters were sent to the island councils of Fonadhoo and Gan to secure land for the greenhouse. Due to time constraints and delayed responses, the Laamu Farmers Association (LAFA) was identified as a suitable partner for establishing the greenhouse. As an existing beneficiary of the ENDhERI project, LAFA agreed to provide land in Fonadhoo for the greenhouse.

A 1000-square-foot greenhouse equipped with gutters to harvest rainwater was installed, aligning with climate-smart agricultural practices. The installation was completed in August 2024. A Memorandum of Understanding (MoU) was signed with LAFA, detailing the responsibilities of each party. The MoU also stipulated that after completing one demonstration cycle, the greenhouse would be handed over to LAFA.

3.2 Greenhouse installation

It was decided to that the green model would be a saw-tooth design as this has proven to be one of the best models that is suitable to the Maldivian tropical climate. The saw-tooth roof provides extra ventilation and keeps the greenhouse cooler than the conventional designs which without sawtooth ventilation.



Picture 1: Demonstration plot



Picture 2: Demonstration Plot

The greenhouse was constructed using a saw-tooth design, which is well-suited to the Maldivian tropical climate due to its improved ventilation capabilities. The structure was covered with 250 mm thick UV-resistant polythene, while the sides were enclosed with insect-proof netting to protect against pests. Gutters were installed to collect rainwater, supporting the climate-smart objectives of the project.

The greenhouse was installed adjacent to an existing greenhouse on LAFA's land, following discussions with LAFA to ensure compatibility with existing infrastructure. The greenhouse orientation was adjusted to align with the existing setup, though this was expected to cause issues with uniform sunlight exposure. Installation was completed in August 2024, allowing the demonstration cycle to commence as planned.

Materials Procured

The demonstration plot was designed to teach best practices in greenhouse agriculture. Personal protective equipment (PPE), including masks, goggles, and other safety gear, was procured for handling pesticides. A limited quantity of chemical pesticides was also obtained, intended for emergency use only if pest levels exceeded the control capacity of biopesticides. Fortunately, no such situations arose during the demonstration cycle, and chemical pesticides were not required.

Details of the materials procured for the demonstration plot are included in Appendix B. In addition to these items, materials required to install the greenhouse and set up the drip irrigation system was also procured.

3.3 Planting layout and Cultivation

The ground inside the greenhouse was levelled and a weed mat was placed to cover the entire area. This measure aimed to prevent the weed growth and reduce the incidence of soil borne pathogens. An irrigation system was established, with dippers positioned to facilitate fertigation and irrigation of the plants.



Picture 3: Leveling the ground and putting the weed mat



Picture 4: Leveling the ground and putting the weed mat

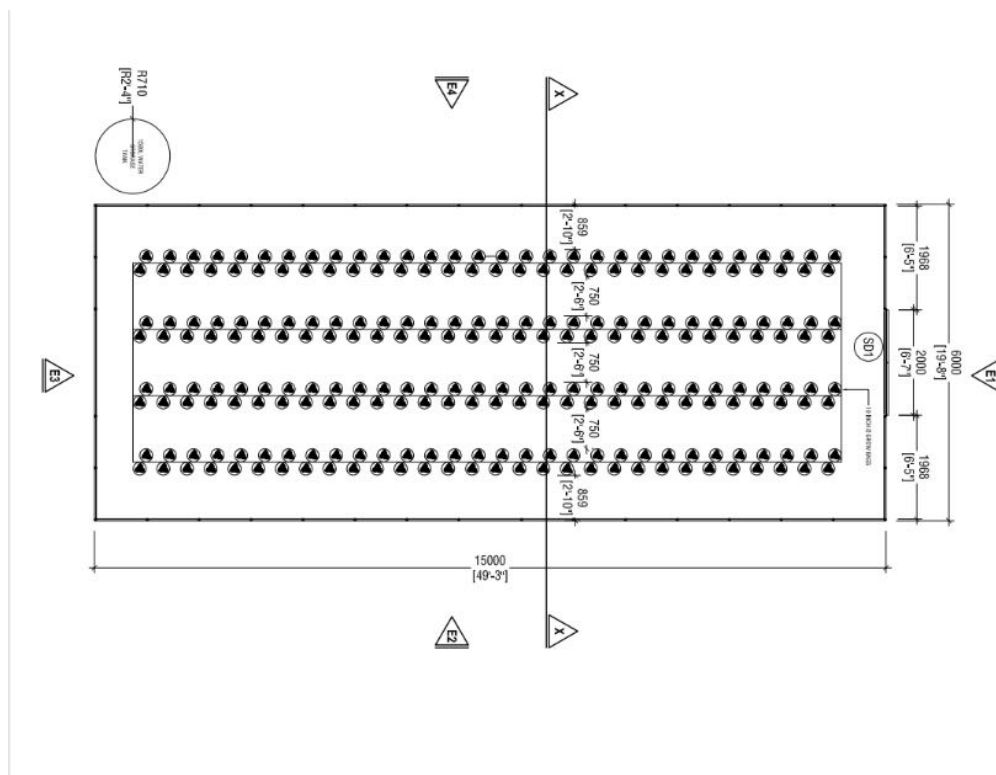


Picture 5 Fixing the irrigation system



Picture 6 Fixing the irrigation system

The plants were arranged in four rows in the greenhouse. In each row plants were placed in double rows in a zigzag pattern. This configuration allowed for a total of 60 plants per row, with plants spaced 18 inches apart within the rows and 2 feet 8 inches apart in between the rows. As a result, the greenhouse was capable of accommodating 240 cucumber plants.



Picture 7 Greenhouse floor plan



Picture 8: Preparing the cocopeat



Picture 9: Arranging cocopeat bags in the greenhouse

Prior to planting, the cocopeat was drenched using a fungicide to prevent any seed borne fungal infections.



Picture 10: Drenching the cocopeat before sowing seeds



Picture 11: Drenching the cocopeat before sowing seeds

The greenhouse was prepared for planting and the seeds were sowed on 30th August 2024 directly into cocoponic bags. The seeds were placed at a depth of $\frac{1}{4}$ inch, covered with cocopeat and thoroughly watered. Additional seeds were sowed to compensate for any ungerminated seeds. During the initial three days, moisture levels in the cocopeat were closely monitored to ensure adequate hydration, promoting favourable conditions for germination.



Picture 12: Sowing seeds



Picture 13: Sowing seeds

3.4 Irrigation and Fertigation

A drip irrigation was established to provide water and nutrients directly to the base of each plant. A dripper was inserted to each cocopeat bag. Initially desalinated water from the island's water supply was used to irrigate and fertigate the crops. However, later it was changed to rainwater and well water due to the high EC and salt concentration of the desalinated water.

Grow green A and B were utilized as the hydroponic nutrient solution. The stock solution was prepared by adding the content of each packet to a 20-liter bucket and dissolving it completely. The fertigation tank was prepared by adding water and incorporating equal amounts of the stock solutions A and B to achieve the required EC for the specific growth stage of the cucumber plants.

The pH of the nutrient solution was regularly monitored and maintained between 6 -7, which is the ideal pH for the growth of cucumber plants. Similarly, EC levels were checked and recorded consistently and adjusted as needed.



Picture 14: Preparing the stock solution



Picture 15: Fertilizer



Picture 16: Preparing the stock solution



Picture 17: Stock solution

Below is the table showing the EC and the amount of nutrient solution and water that is used on plants at different growth stages.

Age of plant	Amount of nutrient solution/ ml	EC of nutrient solution / mS/cm	Water/ml
5-14 days	150-250ml	1.0 – 1.5	150 – 200ml
15 days till the end of crop cycle	300 – 500ml	1.5 – 2.0	300 – 1000ml

Table 4: Amount of Nutrition and Water used

Trellising ropes were placed at 18-inch interval in 8 rows to support the growth of cucumber plants vertically. The ropes were tied to the cocoponic bags and allowing the plants to grow upward while being supported by the trellising system. The tendrils of the vines are cut off regularly.



Picture 18: Hanging trellising rope

The drippers were routinely checked for uniformity to ensure that all plants received an equal amount of water and nutrients. This is essential to help all the plants grow consistently.



Picture 19: Checking the drippers



Picture 20: Checking the drippers

3.5 Data Collection and Monitoring

A theory class was conducted for participants to provide information on how to grow cucumbers in a greenhouse. Since this activity is carried out with practical classes in the greenhouse, detailed information on those practices that are adopted in the greenhouse were given during the theory class. Additionally, a crop guide outlining the daily activities which were needed for the successful cucumber cultivation was handed over to the farmer responsible for the taking care of the plants in the greenhouse. In addition, irrigation, fertigation and pest and disease monitoring record sheets were also given to the farmer. Daily updates, including pictures were shared in a common WhatsApp group, and technical advice was given through the entire crop cycle.



Picture 21: Theory class



Picture 22: Theory class

The seeds germinated and plants sprouted three days after sowing. During the initial three to four days plants were watered using watering can. Manual watering and fertigation were required due to a malfunction of the filter connected to the fertigation tank which was rectified.



Picture 23: Plants sprouting three days after planting



Picture 24: Plants sprouting three days after planting

Irregular growth patterns were later observed, attributed to uneven dispensing of water and nutrients from the drippers. To address this issue, pressure compensating drippers were replaced with the standard non-pressure dripper. Until the pressure drippers were fixed, watering and nutrients were given manually to each plant. Although this method was a tedious and time-consuming, the farmer offered to do this to make sure the plants grew well.



Picture 25: Irregular plants growth due to irregular dispensing of water and nutrients from drippers

Initially, LAFA used desalinated water from the island's water supply for irrigation in their greenhouse as well. Due to the absence of a groundwater well, cucumber plants in the demonstration greenhouse were also fertigated and irrigated with desalinated water. But due to the desalinated water's high salinity (0.05%) and high EC content (0.9), the plants started showing stunting and necrosis along the leaf edges.



Picture 26: Necrosis along leaf edges

Since the plants started showing these symptoms and continuing to use desalinated water would affect the yield, a well was dug to irrigate the plants. At this stage there was no rainwater harvested to irrigate the plants. After harvesting rainwater at the later stages, a combination of well water and rainwater was used to irrigate and fertigate the plants until the end of this cycle. The plants were also sprayed with foliar fertilizer to speed up growth and to correct these symptoms.



Picture 27: Plants recovered after using rain & well water



Picture 28: Plants recovered after using rain & well water



Picture 29: Cucumber flowers



Picture 30: Cucumber flowers



Picture 31: Cucumbers

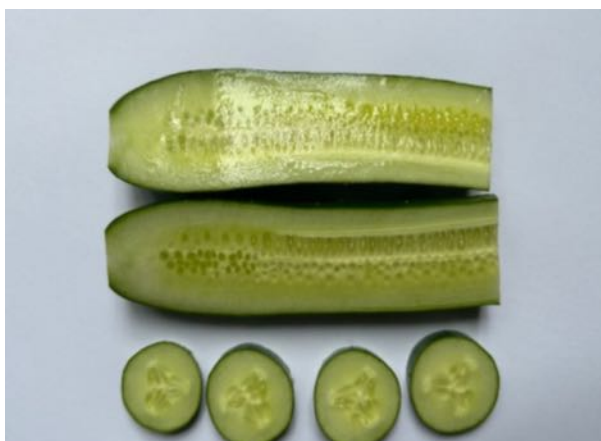


Picture 32: Cucumbers

The first harvest of cucumbers was on 11th October 2024, 41 days after sowing. The selected variety, Cucumber Riches by Known-You brand, was harvested when the cucumbers reached a length of approximately 23 to 25 cm, with an average weight of around 250 grams per cucumber. Harvesting occurred before the seeds fully formed, resulting in a crunchier texture and enhanced flavor, making the cucumbers both crisp and tasty.



Picture 33: First cucumber harvest (28.156 Kg)



Picture 34: Cucumbers sliced

The harvest size of cucumber may vary depending on market demand. Smaller cucumber can be harvested if there is a higher preference for them. As long as the seeds inside the cucumber have not developed, it will retain good market value.



Picture 35: Cucumber harvest



Picture 36: Cucumbers packed for selling

The designated farmer recorded harvest details in the provided data sheet, which was then used to calculate the total yield from the demonstration plot. This data will contribute to a cost-benefit analysis of cucumber cultivation using the climate-smart greenhouse model, assessing the viability of broader adoption by local farmers.

The incidence of pests and diseases was minimal, largely due to the use of insect netting, which effectively prevented pest entry. Yellow and blue sticky traps were also placed throughout the greenhouse to monitor any potential pest presence. Regular plant monitoring was conducted, and any observations regarding plant health were promptly communicated through a dedicated WhatsApp group, allowing for immediate action to prevent the spread of pests or diseases.



Picture 37: Hanging yellow sticky traps



Picture 38: Yellow and blue sticky traps hanged in the greenhouse at regular intervals

Sticky traps were used for the initial trapping as well as monitoring of any pest entry. Throughout the crop cycle, no pests were recorded on the sticky traps.



Picture 39: Blue sticky trap



Picture 40: Yellow sticky trap

Plants were regularly monitored and Integrated Pest Management (IPM) practices were used to manage any pest and diseases encountered. On one occasion, a larva was spotted on a leaf of a cucumber plant. This may have been the result of a moth which may have entered from an opening in the greenhouse net which was later patched. The larva was removed, and BT was sprayed as a precaution. BT is a biopesticide that controls different types of larvae.

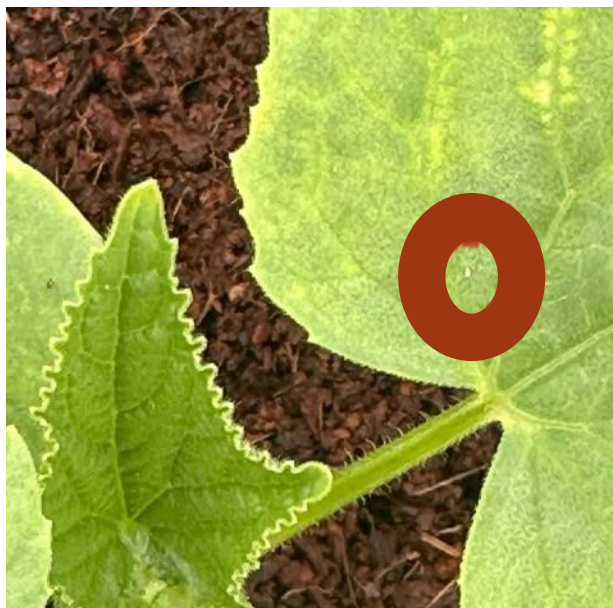


Picture 41: Opening on the roof polythene

Similarly, before the greenhouse roof opening was fixed, a few whiteflies were also observed on the leaves. This was controlled with the use of the bio pesticide neem oil and after the roof opening was fixed, no further whitefly was observed inside the greenhouse.



Picture 42: Larvae on the leaves



Picture 43: Whitefly on the leaf

3.6 Community Engagement and Knowledge Sharing

To engage the community in the demonstration plot initiative, we personally reached out to the farmers list provided by the Fonadhoo Island Council. Unfortunately, only one farmer participated in the training session. The limited participation from farmers and the broader community reduces the overall effectiveness and impact of such awareness programs.

For the future implementation, we recommend that the Island Council and local NGOs to take a more proactive role in promoting these programs at the island level. Their involvement can help raise awareness of the importance of such initiatives and encourage greater community participation. Additionally, establishing and regularly updating a registry of active farmers on the island is crucial for better outreach and engagement.

To improve the dissemination of information, in addition to social media platforms, program details should be displayed in public gathering places on the island. This approach ensures broader visibility and accessibility to community.

Despite the low participation, it is noteworthy that the farmer who attended the training program and the students who visited the green house from a school in Fonadhoo acquired valuable knowledge about eco-technology farming practices.



Picture 44: Knowledge sharing visit to the demo plot by school students

3.7 Assessment and Reporting

The farmer handling the greenhouse reported on a daily and as needed basis in the common WhatsApp group created for the purpose of reporting. Ongoing communications were held on this group while phone calls were made to further assess and provide guidance to the farmer.

The continuous reporting by the farmer assisted in understanding the issues faced and in resolving them on a timely manner. This also helped keep track of the harvests from the greenhouse.

During the visits to the greenhouse by the Team Leader, these matters were closely inspected and a more interactive discussions were held with the farmer.

4.Challenges faced

Following are the main challenges faced for the demonstration project.

4.1 Difficulty in acquiring a land

Securing land for the demonstration plot required extensive communication with local councils, involving numerous calls and discussions. Despite these efforts, to acquire land were unsuccessful. In the end, discussions were held with the Laamu farmers Association (LAFA), but reaching an agreement incurred additional time which delayed the installation of the greenhouse beyond the original schedule.

4.2 Difficulty in finding farmers to train in the demonstration plot

To reach out the farmers correspondence and calls were made with the L.Gan and L.Fonadhoo Island Councils to identify farmers interested in participating in the demonstration training. Although a farmers list was provided by Fonadhoo Island Council, no farmers from this list attended the demonstration project training. Despite continued efforts to invite more farmers to the training, no farmers attended the trainings through the entire crop cycle.

4.3 High EC and salinity of the desalinated water

The high EC and salinity of the desalinated water caused numerous issues in the growth of plant. As stated earlier, necrosis along the leaf edges were noted and there was a significant reduction in the growth of plants. However, upon switching to rainwater and well water, the plants showed improvement and resume healthy growth.

4.4 Discrepancies that arise due to one farmer handling the demo plot

Since there was only one farmer who volunteered to take care of the plants, who is to be applauded for the efforts. It was challenging for an individual farmer to manage all the activities of the demonstration plot. This was especially due to the added tasks associated with irrigation and fertigation issues at the start of the cycle. Furthermore, the fact that only one person is involved in data collection may have led to errors in the recording of information.

5. Conclusion & Recommendation

Despite the challenges encountered, the demonstration plot provided valuable experience and learning opportunities. While initial expectations for smooth operations were not fully realized, the project highlighted the importance of adaptability in overcoming unforeseen obstacles. The lessons learned through managing these challenges and applying effective solutions contributed to a favorable outcome, demonstrating the resilience and viability of climate-smart agriculture.

The yield met initial expectations, totaling 665 kg of cucumber harvests, representing a strong return given the circumstances. The results will be used in the cost-benefit analysis, details of which are included in the cost-benefit report.

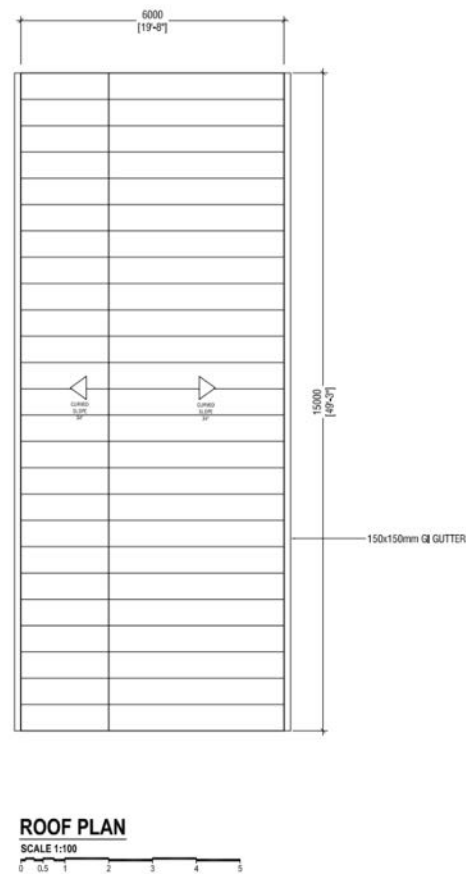
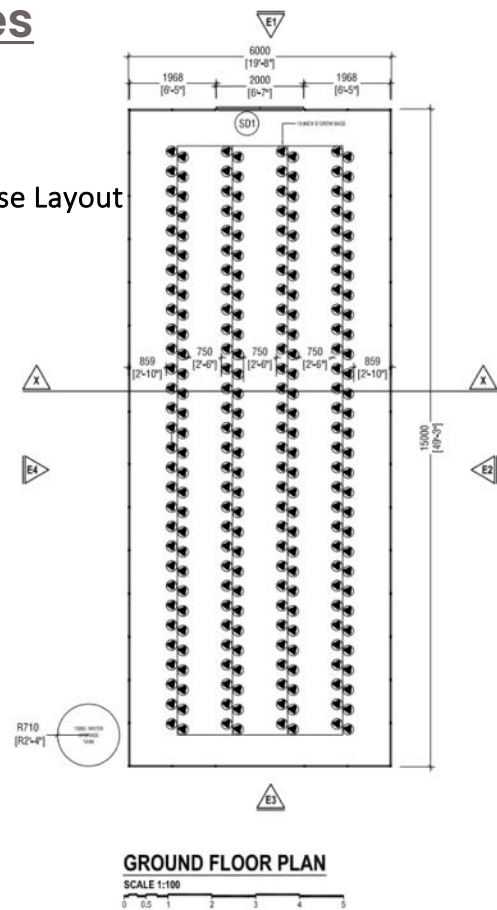
Based on observations during the demonstration, it is recommended that future initiatives prioritize engaging smaller island communities, such as the islands of Kalaidhoo and Kunahandhoo in Laamu atoll, where interest and participation levels were notably higher. Targeting communities that show a greater intrinsic interest in sustainable agricultural practices is likely to result in stronger engagement and more successful outcomes.

6. References

Rifga, M. (2023, 03 05). *Baseline Report on Agricultural Practices in Laamu Atoll*. Retrieved from <https://www.environment.gov.mv>: <https://www.environment.gov.mv/v2/wp-content/files/publications/20230305-pub-baseline-report-on-agricultural-practices-in-laamu-atoll-1.pdf>.

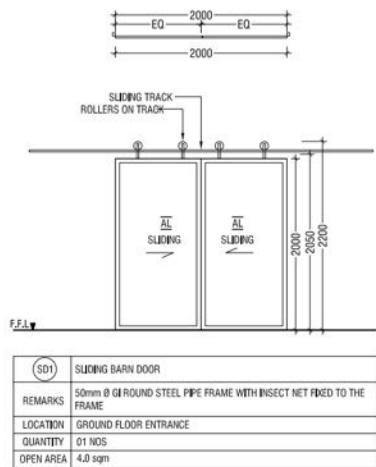
7. Appendices

Appendix A: Greenhouse Layout

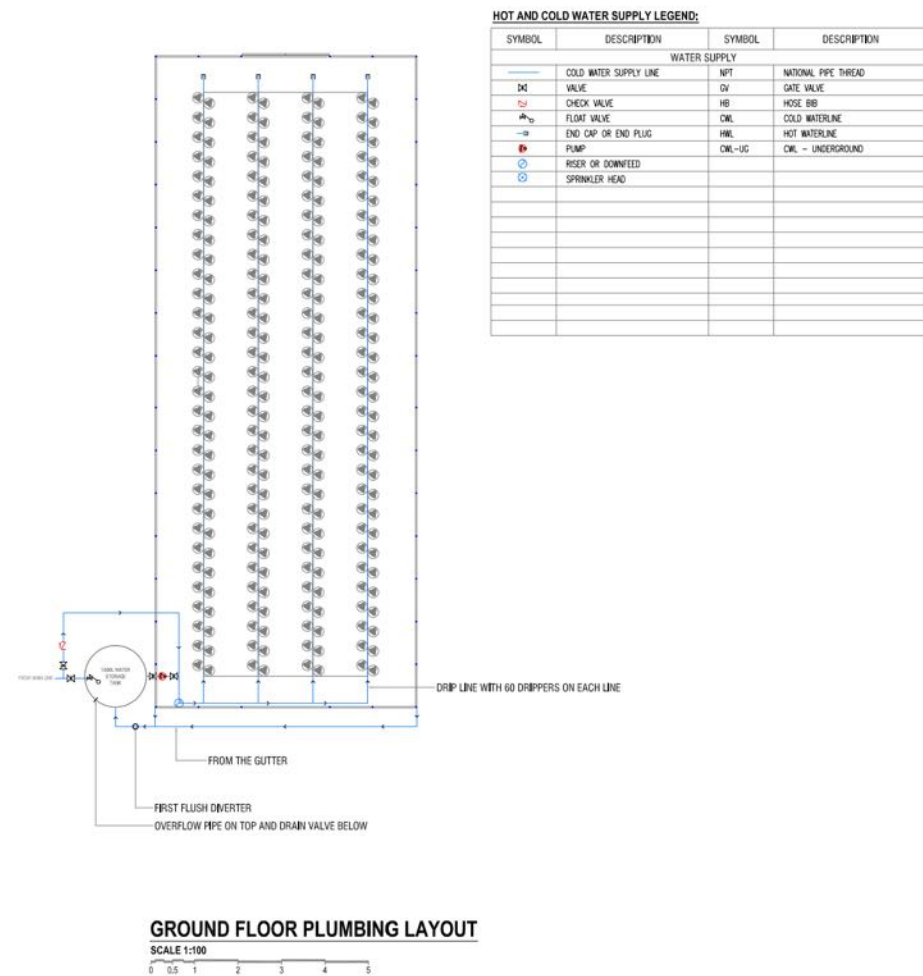


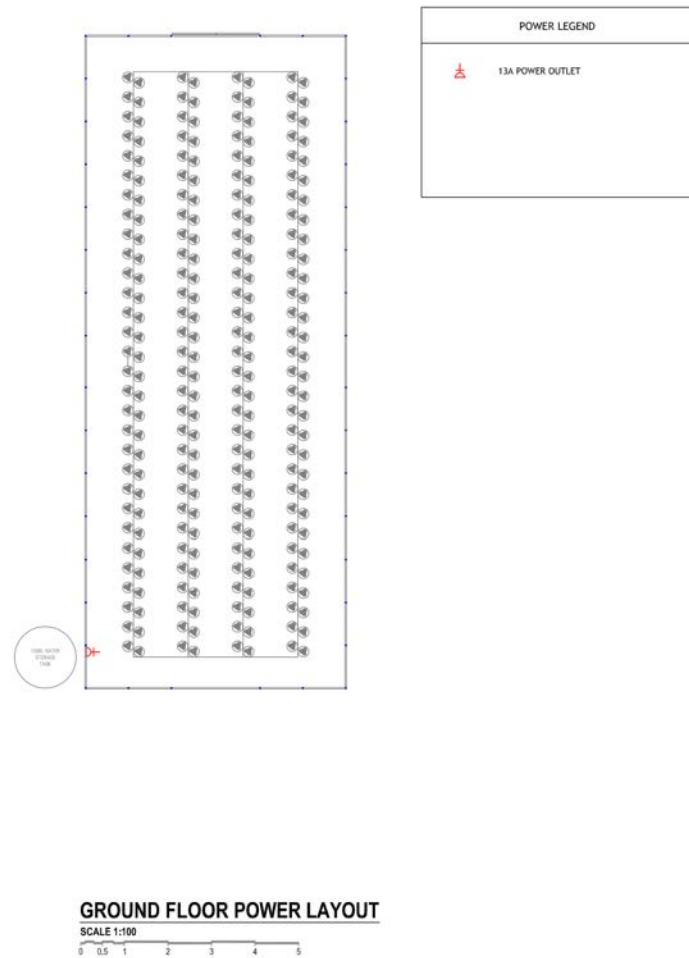


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DOOR SCHEDULE
SCALE 1:50





Appendix B: List of materials procured

#	Items	Amount
1	Cocoponics bag	250
2	Cucumber "Thumb sweet"	2pkt
3	Cucumber "riches"	2pkt
4	Hydroponic fertilizer A and B (separate pkts for A and B solution) Growgreen is a good hydroponic fertilizer	4 packets
5	Epsom salt	100g
6	Water soluble NPK fertilizer 20 20 20	500g
7	Water soluble NPK fertilizer 12 36 12	500g
8	Water soluble NPK fertilizer 12 12 36	500g
9	Vitamin B1	100ml
10	Ferroforte (iron supplement)	50g
11	Sulphur	100g
12	Copper oxychloride	100g
13	Neem oil (NOT NEEM EXTRACT)	50ml
14	Spinosad	50ml
15	Maxicrop	50ml
16	Thiram	50g
17	Abamectin	100ml
18	Starkle G	100g
19	box Surgical Gloves (medium size)	1
20	box Surgical Mask	1
21	Weed mat	55 x 25 ft
22	pH up solution	50ml
23	pH down solution	50ml
24	Bacillus subtilis	100g
25	Blue sticky sheet	30
26	Yellow sticky sheet	20
27	Portable electric conductivity meter	1
28	Bucket (dark color preferably black) 20L	2
29	PPE (coated with butyl rubber, neoprene, PVC, polyethylene)	2

30	Gumboot (grey color) pairs	2
31	Safety glasses	2
32	Pair of gloves - Liquid proof - neoprene, butyl , PCV or nitrile which extends until the forearm.	2
33	pH meter (with EC, TDS and Salinity measuring meter)	1
34	Trellising rope	1500ft
35	Sprayer 5 liter with adjustable knob	1
36	Baskets with handle L=56cm, W=39cm, H =30cm	4
37	Baskets with handle L=41cm, W=29cm, H =26cm	5
38	Micro clean	50ml
39	Garden rake	3
40	Ladder 8 steps	1
41	Pruning Shear	3
42	PVC water hose ½” green 50 feet	1
43	Weighing scale 30kg	1
44	Digital weighing scale 0.01g/200g	1
45	Watering can 5L	1
46	Plastic beaker 250ml	2
47	Plastic beaker 30ml	2
48	Battery Sprayer 12 L	1
49	Broom with dustpan	1



Cost Benefit Analysis



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List of Abbreviations

ENDhERI	Enhancing National Development through Environmentally Resilient Islands
GEF	Global Environment Facility
MCCEE	Ministry of Climate Change, Environment & Energy
NGO	Non-Government Organizations
ROI	Return on Investment
UNEP	United Nations Environment Program

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Executive Summary

This report assesses the economic feasibility of operating a 1000-square-foot demonstration greenhouse for cucumber cultivation, focusing on practical recommendations to make it viable for Maldivian farmers based on the demonstration greenhouse project run in Laamu atoll. This project is part of the Enhancing National Development through Environmentally Resilient Islands (ENDhERI) project which is funded by Global Environment Facility (GEF) and supported by United Nations Environment Program (UNEP). This demonstration project aimed to minimize pesticide use, optimize fertilizer, and reduce groundwater pollution. Actual yield and revenue data from a demonstration project are used as a baseline, with an analysis of potential best case and worst case scenarios. The findings provide insights into cost recovery and profitability enhancement strategies.

8. Introduction

Greenhouse cultivation presents an opportunity for Maldivian farmers to adopt sustainable agriculture practices and increase crop yield, reducing the reliance on pesticides, optimizing fertilizers and irrigation. However, initial investment costs and operating expenses remain significant. This report evaluates the economic performance of a demonstration project run in a 1000 square-foot greenhouse for cucumber cultivation and proposes steps to enhance feasibility and further adoption and replication of similar greenhouses for farmers in Laamu atoll and across Maldives.

This report builds on the Report on Successful Demonstration of the Alternative Eco-Technology Agriculture Pilot and Cost-Benefit Analysis (Riyan, 2024).

9. Actual Yield and Financial Performance

This section outlines the baseline financial performance of the greenhouse based on actual yield data. It includes details on the costs involved in setting up and operating the greenhouse for a single cucumber growth cycle.

The 1000 square-foot greenhouse was used to cultivate 240 cucumber plants, producing a total yield of approximately 644.968 kg. The cucumbers were sold at two unit prices: MVR 25 per kg and MVR 20 per kg, depending on the market demand and size of the cucumbers. This yield generated a total revenue of MVR 14,872.05 for the cycle. Although the yield was lower by about 30% than initial projections, the greenhouse demonstrates potential for revenue generation with refined cultivation practices. Enhanced strategies in crop management, irrigation, and pest control could significantly improve the output, leading to better financial outcomes.

With actual yield below initial projections, the generated revenue was modest, resulting in a longer payback period. The findings highlight the need for strategies to enhance profitability to make greenhouse cultivation more accessible and feasible for local farmers. These strategies include refining cultivation techniques, reducing operational costs, and exploring premium markets for produce. Implementing these measures will ensure that the greenhouse model is both accessible and economically viable for broader adoption.

Description	Amount
Greenhouse Setup Cost	MVR 98,000.00
Tools and Equipment (one-time cost)	MVR 15,800.00
Operational Costs (Fertilizers, Pesticides, and Nutrients) per cycle	MVR 11,016.15
Revenue per Cycle	MVR 14,872.05
Net Profit per Cycle	MVR 3,855.90

Table 5 - Key Financial Metrics based on Actual Performance of the Demonstration Greenhouse

Based on actual yield, the greenhouse achieved a revenue of MVR 14,872.05 in the demonstration cycle. However, high initial setup costs and operational expenses resulted in a long payback period of approximately 25 cycles to recover the investment, which is challenging for small-scale farmers with limited resources. Details of the above calculations are included in Appendix A.

Return on Investment (ROI)

To assess the greenhouse's profitability, the Return on Investment (ROI) was calculated based on the net profit generated per cycle and the initial investment. With a net profit of MVR 3,855.90 per cycle and assuming four cycles per year, the greenhouse produces an annual net profit of MVR 15,423.59. Given the initial setup cost of MVR 98,000, the ROI is approximately **15.74% annually**. This rate of return suggests that, while the initial investment is substantial, the greenhouse can offer sustainable profitability for a local farmer, especially with optimized operations to maximize yield per cycle. Detailed ROI calculations are provided in Appendix B.

10. Various Scenarios and its Outcomes

10.1 Best Case Scenario – 30% Yield Increase

The demonstration project faced challenges in the initial stages of the plant cycle which delayed the first harvests and affected the total yield. It is estimated that this resulted in a loss of approximately 30% of the estimated harvests from a complete cycle of cucumber plants. A 30% increase in yield would substantially improve the financial performance of the greenhouse by increasing revenue and enhancing the overall profitability per cycle. This section examines the best case scenario with the effects of a 30% increase in yield on revenue, net profit per cycle, and return on investment, illustrating the potential for quicker cost recovery and improved feasibility for local farmers.

Revenue per Cycle	MVR 19,333.67
Net Profit per Cycle	MVR 8,317.51
Payback Period	12 cycles

Table 6 - Key Financial Outcomes with Best Case Scenario - 30% Increase in Yield

With a 30% increase in yield, the greenhouse would produce approximately 838.458 kg of cucumbers per cycle. Assuming the same unit prices as the harvests from the demonstration project was sold at, the revenue would increase accordingly.

- 1. Increased Revenue and Profit per Cycle**
 - With a 30% increase in yield, revenue per cycle would rise from MVR 14,872.05 to **MVR 19,333.67**.
 - Net profit per cycle would improve from MVR 3,855.90 to **MVR 8,317.51**, more than doubling the profitability of each cycle.
- 2. Annual Financial Impact**
 - Assuming four cycles per year, the annual revenue would increase to **MVR 77,334.68**, while annual net profit would reach **MVR 33,270.05**
- 3. ROI**
 - The ROI would increase significantly from 15.74% to **33.95% annually**, indicating a strong potential for sustainable returns.
- 4. Reduced Payback Period**
 - The payback period would decrease from 25 cycles to approximately **12 cycles**, allowing farmers to recover the initial investment in almost half the duration.

This best-case scenario demonstrates that achieving a 30% yield increase through optimized growing practices can make greenhouse cultivation a more feasible and profitable option for small-scale Maldivian farmers.

10.2 Worst Case Scenario – 50% Lower Yield than Best Case Scenario

In the worst-case scenario, the yield is assumed to be 50% lower than the best-case scenario detailed in section 3.1. This scenario represents significant challenges, such as suboptimal

growing conditions, pest or disease issues, or other environmental constraints that could severely impact cucumber production.

Yield and Revenue Impact

With a 50% reduction in yield from the best-case scenario, the total yield per cycle would be approximately **419.229 kg** (50% of 838.458 kg). The revenue per cycle, based on current market prices (MVR 25 per kg and MVR 20 per kg), is recalculated as follows:

- Revenue per cycle: **MVR 9,666.83**

Cost and Profitability Analysis

Operational costs remain constant at **MVR 11,016.15** per cycle, as these do not decrease proportionally with yield. This results in a negative net profit per cycle:

- Net loss per cycle: **MVR 1,349.32**

Financial Implications

The negative profitability in this scenario would significantly extend the payback period, rendering the investment not a feasible one for small-scale farmers under such conditions. Key financial metrics are summarized below:

Metric	Value
Yield per Cycle	419.229 kg
Revenue per Cycle	MVR 9,666.83
Operational Costs	MVR 11,016.15
Net Loss per Cycle	MVR 1,349.32
Payback Period	Not feasible

Table 7 - Key Financial Outcomes with Worst Case Scenario - 50% Reduction in Yield

Return on Investment (ROI)

With negative profitability, the ROI cannot be calculated as there is no return on the initial investment.

Observations and Recommendations

1. **Risk Management:** To mitigate risks associated with this worst-case scenario, farmers should implement robust pest and disease control measures, as well as adaptive techniques to manage unexpected environmental challenges.
2. **Diversification:** Exploring other crops with shorter growth cycles or higher resilience could offset risks and improve financial viability.
3. **Crop Insurance:** Insure the crops to mitigate the financial risks of poor yields due to pests, diseases, or natural disasters.

This scenario underscores the importance of efficient farming practices, proper planning, and external support to ensure the sustainability of greenhouse projects, even under adverse conditions.

11. Recommendations to Improve Further Adoption and Replication

This section outlines the recommendations which could improve the further adoption and replication of similar greenhouses with the eco-technology model.

1. Increase Yield and Efficiency

- **Improved Cultivation Practices:** Utilize efficient irrigation, fertigation, and pest management practices to maximize output within the greenhouse.
- **Optimize Crop Varieties:** Consider testing higher-yielding or faster-growing cucumber varieties adapted to the Maldivian climate conditions.

2. Reduce Operational Cost

- **Bulk Purchasing of Inputs:** Purchase fertilizers, pesticides, and nutrients in bulk to take advantage of lower per-unit costs.
- **Explore Organic Alternatives:** Use locally available organic fertilizers and pest control methods to reduce dependency on expensive imported inputs.

3. Enhance Revenue per Kilogram

- **Value-Added Products:** Sell cucumbers as part of premium or packaged products to increase per-unit revenue.

4. Explore Funding and Support Options

- **Government Grants and Subsidies:** Seek grants or financial aid for sustainable agriculture from government or Non-Government Organizations (NGO) sources, reducing the financial burden on setup costs.
- **Educational Demonstration Revenue:** Charge a small fee for tours or training sessions to educate other local farmers, school groups and tourists on sustainable greenhouse practices.

5. Scale Up for Additional Profitability

- **Multiple Crop Cycles:** Run multiple crop cycles annually to generate more revenue and enhance the return on investment. This can be done by choosing cucumber varieties (or other crops) with shorter growth cycles, ideally maturing in 60-70 days. This allows for at least 4-5 cycles per year. In addition, efficient planning and harvesting practices such as staggered planting in phases in order to always keep producing translates into steady revenue and reduces downtime between cycles. Preparing for the next cycle immediately after harvesting by cleaning, preparing soil or cocopeat, and applying pre-growth treatments like fertilizers or fungicides can also help in quick turnaround between cycles.

12. Conclusion

This analysis demonstrates that while the actual yield from the demonstration greenhouse presented challenges for a short-term return, achievable improvements in yield, cost control, and revenue strategies can make greenhouse farming viable for local farmers. Increasing yield and optimizing sales channels significantly improve profitability, reducing the payback period and making a 1000 square-foot greenhouse a feasible investment small-scale farmer in Maldives.

6. References

Riyan, P. L. (2024). *Report on Successful Demonstration of the Alternative Eco-Technology Agriculture Pilot and Cost-Benefit Analysis.*

7. Appendices

Appendix A: Detailed Cost Breakdown per Cycle

	Value (MVR)	Value (MVR)	Value (MVR)
Total Revenue per Cycle			14,872.05
Total Cost for Fertilizers, Pesticides, and Nutrients		22,056.82	
<i>Less: Items Not Entirely Consumed in a Single Cycle</i>			
Cost for Cocopeat	(10,000.00)		
Cost of Nutrient Solution	(5,832.00)	(15,832.00)	
Cost of Fertilizers, Pesticides and Nutrients for a Single Cycle before Adjustments		6,224.82	
<i>Add: Amortized cost for cocopeat and nutrients for a single cycle</i>			
Cocopeat cost amortized over 3 cycles	3,333.33		
Nutrients cost amortized at 25% per Cycle	1,458.00	4,791.33	
Adjusted Cost per Cycle			11,016.15
Net Profit per Cycle			3,855.90

With a net profit of MVR 3,855.90 per cycle, the number of cycles needed to recover the initial startup cost of MVR 98,000 is calculated as follows:

Startup Cost	98,000.00
Net Profit per Cycle	3,855.90
Number of Cycles	25.42

Approximately 25 cycles would be required to recover the initial startup cost of MVR 98,000, based on the revised costs and revenue.

Detailed Breakdown of Actual Revenue

Date	Unit of Measure	Quantity Sold	Unit Price in MVR per KG	Total Revenue in MVR
11-Oct-24	KG	6.000	25.00	150.00
11-Oct-24	KG	1.000	25.00	25.00
11-Oct-24	KG	2.000	25.00	50.00
11-Oct-24	KG	2.000	25.00	50.00
11-Oct-24	KG	2.000	25.00	50.00
11-Oct-24	KG	2.000	25.00	50.00
11-Oct-24	KG	4.000	25.00	100.00
11-Oct-24	KG	7.000	20.00	140.00
13-Oct-24	KG	15.000	20.00	300.00
13-Oct-24	KG	2.000	25.00	50.00
13-Oct-24	KG	2.000	25.00	50.00
13-Oct-24	KG	1.000	25.00	25.00
13-Oct-24	KG	2.000	25.00	50.00
13-Oct-24	KG	3.000	25.00	75.00
13-Oct-24	KG	10.000	20.00	200.00
13-Oct-24	KG	3.995	25.00	99.88
14-Oct-24	KG	8.015	20.00	160.30
14-Oct-24	KG	2.000	25.00	50.00
14-Oct-24	KG	2.000	25.00	50.00
16-Oct-24	KG	2.000	25.00	50.00
16-Oct-24	KG	2.000	25.00	50.00
16-Oct-24	KG	5.000	25.00	125.00
20-Oct-24	KG	1.000	25.00	25.00
20-Oct-24	KG	15.000	20.00	300.00
20-Oct-24	KG	15.000	20.00	300.00
20-Oct-24	KG	9.743	25.00	243.58
20-Oct-24	KG	2.700	25.00	67.50
20-Oct-24	KG	1.000	25.00	25.00
20-Oct-24	KG	1.000	25.00	25.00
20-Oct-24	KG	3.000	25.00	75.00
20-Oct-24	KG	1.000	25.00	25.00
20-Oct-24	KG	5.000	25.00	125.00
21-Oct-24	KG	4.000	25.00	100.00
21-Oct-24	KG	15.000	20.00	300.00
21-Oct-24	KG	2.000	25.00	50.00
21-Oct-24	KG	1.000	25.00	25.00
21-Oct-24	KG	2.000	25.00	50.00
21-Oct-24	KG	36.500	20.00	730.00
23-Oct-24	KG	1.000	25.00	25.00
24-Oct-24	KG	60.000	20.00	1,200.00

Date	Unit of Measure	Quantity Sold	Unit Price in MVR per KG	Total Revenue in MVR
24-Oct-24	KG	25.000	25.00	625.00
26-Oct-24	KG	20.000	20.00	400.00
26-Oct-24	KG	1.000	25.00	25.00
26-Oct-24	KG	27.000	25.00	675.00
27-Oct-24	KG	2.000	25.00	50.00
29-Oct-24	KG	10.165	20.00	203.30
29-Oct-24	KG	10.750	20.00	215.00
29-Oct-24	KG	3.000	25.00	75.00
29-Oct-24	KG	1.000	25.00	25.00
31-Oct-24	KG	50.000	25.00	1,250.00
31-Oct-24	KG	15.000	20.00	300.00
31-Oct-24	KG	4.000	25.00	100.00
2-Nov-24	KG	5.000	25.00	125.00
2-Nov-24	KG	3.000	20.00	60.00
3-Nov-24	KG	20.600	25.00	515.00
3-Nov-24	KG	10.000	20.00	200.00
3-Nov-24	KG	29.000	25.00	725.00
5-Nov-24	KG	2.000	25.00	50.00
5-Nov-24	KG	2.000	25.00	50.00
5-Nov-24	KG	2.000	25.00	50.00
5-Nov-24	KG	2.000	25.00	50.00
5-Nov-24	KG	9.000	25.00	225.00
5-Nov-24	KG	32.000	25.00	800.00
7-Nov-24	KG	49.500	25.00	1,237.50
9-Nov-24	KG	15.000	25.00	375.00
9-Nov-24	KG	33.000	25.00	825.00
TOTAL		644.968		14,872.05

Detailed Breakdown of Actual Cost of Fertilizers, Pesticides, and Nutrients

#	Description	Unit of Measure	Quantity	Unit Rate in MVR	Amount in MVR
1	Albert Solution Stock A+B (Leafy Vegetables) 3.1kg - Haifa	Box	4	372.60	1,490.40
2	Greenleaf 20.20.20 1kg Biolchim	Packet	1	105.00	105.00
3	Wesco: 12-12-36 - 1kg	Packet	1	130.00	130.00
4	Ferro Forte 200g - Pavoni	Nos	1	90.00	90.00
5	Sulphur 1kg - Sortus	Packet	1	200.01	200.01
6	Copper Oxychloride 50% WP (Dhanucop) 500g	Packet	1	355.00	355.00
7	Spinosaad 2.5% SC (Success) 250ml - Dow Agro	Bottle	1	350.00	350.00
8	Maxicrop 200ml	Bottle	1	90.00	90.00
9	Thiram 80% WG 100g-TH	Can	1	120.00	120.00
10	Abamectin 100ml	Bottle	1	79.93	79.93
11	Starkle G 100g	Packet	1	50.00	50.00
12	Vitamin B-1 100ml	Bottle	1	40.00	40.00
13	Bacillus subtilis strain 100g	Bottle	1	125.00	125.00
14	Coco peat grow bags -1kg	Bags	250	40.00	10,000.80
15	FERTISOL 12+36+12 2kg	Pack	1	150.00	150.00
16	Neem Oil - 1ltr	Bottle	1	165.00	165.00
17	Barrix Magic Sticker - Yellow	Nos	20	60.00	1,200.10
18	Gro Green Albert Solution - set of A (5kg) and B (5kg)	Nos	4	1,458.00	5,832.00
19	Blue sticky trap	Nos	15	15.00	225.02
20	Respiratory Mask	Pieces	2	150.00	300.00
21	Rubber gloves	Pieces	2	35.00	70.01
22	Safety goggles	Pieces	2	74.28	148.56
23	PPE Full Kit	Set	2	350.00	700.00
24	Measuring Cups	Pieces	2	20.00	40.00
Total					22,056.82

Appendix B: Return on Investment Calculations

To calculate the Return on Investment (ROI) for the greenhouse based on actual financial performance, we can use the following formula:

$$\text{ROI} = \left(\frac{\text{Net Profit}}{\text{Total Investment}} \right) \times 100$$

Given Data

- Total Investment (Setup Cost): MVR 98,000 (Greenhouse installation)
- Net Profit per Cycle: MVR 3,855.90 (from actual yield and costs)

Since ROI typically considers annual returns, it is assumed that there would be four cycles per year based on optimal scheduling and quick turnaround.

1. Annual Net Profit:
 - a. Net Profit per Cycle \times 4 Cycles = MVR 3,855.90 \times 4 = MVR 15,423.58
2. ROI Calculation:

Annual Net Profit	15,423.59
Initial Investment	98,000.00
ROI	15.74%

Appendix C: Financial Comparison for Best Case & Worst Case Scenarios

Best Case Scenario

Following is the updated analysis with the revised revenue increase of 30% considered to be the best case scenario

Details	MVR	MVR
Total Revenue per Cycle	14,872.05	
30% Increase	4,461.62	
Total Revenue with 30% Increase		19,333.67
Adjusted Cost per Cycle		11,016.15
Net Profit per Cycle		8,317.51

With a net profit of MVR 8,317.51 per cycle, the number of cycles needed to recover the initial startup cost of MVR 98,000 is:

Startup Cost	98,000.00
Net Profit per Cycle	8,317.51
Number of Cycles	11.78

Approximately 12 cycles would be required to recover the initial startup cost, given a 30% increase in revenue per cycle. This significantly shortens the time needed to break even.

ROI Calculation:

Annual Net Profit	33,270.05
Initial Investment	98,000.00
ROI	33.95%

Detailed Breakdown of Revenue in Best Case Scenario

Date	Unit of Measure	Quantity Sold	Unit Price in MVR per KG	Total Revenue in MVR
11-Oct-24	KG	7.800	25.00	195.00
11-Oct-24	KG	1.300	25.00	32.50
11-Oct-24	KG	2.600	25.00	65.00
11-Oct-24	KG	2.600	25.00	65.00
11-Oct-24	KG	2.600	25.00	65.00
11-Oct-24	KG	2.600	25.00	65.00
11-Oct-24	KG	5.200	25.00	130.00
11-Oct-24	KG	9.100	20.00	182.00
13-Oct-24	KG	19.500	20.00	390.00
13-Oct-24	KG	2.600	25.00	65.00
13-Oct-24	KG	2.600	25.00	65.00
13-Oct-24	KG	1.300	25.00	32.50
13-Oct-24	KG	2.600	25.00	65.00
13-Oct-24	KG	3.900	25.00	97.50
13-Oct-24	KG	13.000	20.00	260.00
13-Oct-24	KG	5.194	25.00	129.84
14-Oct-24	KG	10.420	20.00	208.39
14-Oct-24	KG	2.600	25.00	65.00
14-Oct-24	KG	2.600	25.00	65.00
16-Oct-24	KG	2.600	25.00	65.00
16-Oct-24	KG	2.600	25.00	65.00
16-Oct-24	KG	6.500	25.00	162.50
20-Oct-24	KG	1.300	25.00	32.50
20-Oct-24	KG	19.500	20.00	390.00
20-Oct-24	KG	19.500	20.00	390.00
20-Oct-24	KG	12.666	25.00	316.65
20-Oct-24	KG	3.510	25.00	87.75
20-Oct-24	KG	1.300	25.00	32.50
20-Oct-24	KG	1.300	25.00	32.50
20-Oct-24	KG	3.900	25.00	97.50
20-Oct-24	KG	1.300	25.00	32.50
20-Oct-24	KG	6.500	25.00	162.50
21-Oct-24	KG	5.200	25.00	130.00
21-Oct-24	KG	19.500	20.00	390.00
21-Oct-24	KG	2.600	25.00	65.00
21-Oct-24	KG	1.300	25.00	32.50
21-Oct-24	KG	2.600	25.00	65.00

Date	Unit of Measure	Quantity Sold	Unit Price in MVR per KG	Total Revenue in MVR
21-Oct-24	KG	47.450	20.00	949.00
23-Oct-24	KG	1.300	25.00	32.50
24-Oct-24	KG	78.000	20.00	1,560.00
24-Oct-24	KG	32.500	25.00	812.50
26-Oct-24	KG	26.000	20.00	520.00
26-Oct-24	KG	1.300	25.00	32.50
26-Oct-24	KG	35.100	25.00	877.50
27-Oct-24	KG	2.600	25.00	65.00
29-Oct-24	KG	13.215	20.00	264.29
29-Oct-24	KG	13.975	20.00	279.50
29-Oct-24	KG	3.900	25.00	97.50
29-Oct-24	KG	1.300	25.00	32.50
31-Oct-24	KG	65.000	25.00	1,625.00
31-Oct-24	KG	19.500	20.00	390.00
31-Oct-24	KG	5.200	25.00	130.00
2-Nov-24	KG	6.500	25.00	162.50
2-Nov-24	KG	3.900	20.00	78.00
3-Nov-24	KG	26.780	25.00	669.50
3-Nov-24	KG	13.000	20.00	260.00
3-Nov-24	KG	37.700	25.00	942.50
5-Nov-24	KG	2.600	25.00	65.00
5-Nov-24	KG	2.600	25.00	65.00
5-Nov-24	KG	2.600	25.00	65.00
5-Nov-24	KG	2.600	25.00	65.00
5-Nov-24	KG	11.700	25.00	292.50
5-Nov-24	KG	41.600	25.00	1,040.00
7-Nov-24	KG	64.350	25.00	1,608.75
9-Nov-24	KG	19.500	25.00	487.50
9-Nov-24	KG	42.900	25.00	1,072.50
TOTAL		838.46		19,333.67

Worst Case Scenario

Following is the updated analysis with the revised yield of 50% of the best case scenario which is considered to be the worst case scenario.

Details	MVR
Total Revenue	9,666.83
Adjusted Cost per Cycle	11,016.15
Net Loss per Cycle	-1,349.32

Detailed Breakdown of Revenue in Worst Case Scenario

Date	Unit of Measure	Quantity Sold	Unit Price in MVR per KG	Total Revenue in MVR
11-Oct-24	KG	3.900	25.00	97.50
11-Oct-24	KG	0.650	25.00	16.25
11-Oct-24	KG	1.300	25.00	32.50
11-Oct-24	KG	1.300	25.00	32.50
11-Oct-24	KG	1.300	25.00	32.50
11-Oct-24	KG	1.300	25.00	32.50
11-Oct-24	KG	2.600	25.00	65.00
11-Oct-24	KG	4.550	20.00	91.00
13-Oct-24	KG	9.750	20.00	195.00
13-Oct-24	KG	1.300	25.00	32.50
13-Oct-24	KG	1.300	25.00	32.50
13-Oct-24	KG	0.650	25.00	16.25
13-Oct-24	KG	1.300	25.00	32.50
13-Oct-24	KG	1.950	25.00	48.75
13-Oct-24	KG	6.500	20.00	130.00
13-Oct-24	KG	2.597	25.00	64.92
14-Oct-24	KG	5.210	20.00	104.20
14-Oct-24	KG	1.300	25.00	32.50
14-Oct-24	KG	1.300	25.00	32.50
16-Oct-24	KG	1.300	25.00	32.50
16-Oct-24	KG	1.300	25.00	32.50
16-Oct-24	KG	3.250	25.00	81.25
20-Oct-24	KG	0.650	25.00	16.25
20-Oct-24	KG	9.750	20.00	195.00
20-Oct-24	KG	9.750	20.00	195.00
20-Oct-24	KG	6.333	25.00	158.32
20-Oct-24	KG	1.755	25.00	43.88
20-Oct-24	KG	0.650	25.00	16.25
20-Oct-24	KG	0.650	25.00	16.25
20-Oct-24	KG	1.950	25.00	48.75
20-Oct-24	KG	0.650	25.00	16.25

Date	Unit of Measure	Quantity Sold	Unit Price in MVR per KG	Total Revenue in MVR
20-Oct-24	KG	3.250	25.00	81.25
21-Oct-24	KG	2.600	25.00	65.00
21-Oct-24	KG	9.750	20.00	195.00
21-Oct-24	KG	1.300	25.00	32.50
21-Oct-24	KG	0.650	25.00	16.25
21-Oct-24	KG	1.300	25.00	32.50
21-Oct-24	KG	23.725	20.00	474.50
23-Oct-24	KG	0.650	25.00	16.25
24-Oct-24	KG	39.000	20.00	780.00
24-Oct-24	KG	16.250	25.00	406.25
26-Oct-24	KG	13.000	20.00	260.00
26-Oct-24	KG	0.650	25.00	16.25
26-Oct-24	KG	17.550	25.00	438.75
27-Oct-24	KG	1.300	25.00	32.50
29-Oct-24	KG	6.607	20.00	132.15
29-Oct-24	KG	6.988	20.00	139.75
29-Oct-24	KG	1.950	25.00	48.75
29-Oct-24	KG	0.650	25.00	16.25
31-Oct-24	KG	32.500	25.00	812.50
31-Oct-24	KG	9.750	20.00	195.00
31-Oct-24	KG	2.600	25.00	65.00
2-Nov-24	KG	3.250	25.00	81.25
2-Nov-24	KG	1.950	20.00	39.00
3-Nov-24	KG	13.390	25.00	334.75
3-Nov-24	KG	6.500	20.00	130.00
3-Nov-24	KG	18.850	25.00	471.25
5-Nov-24	KG	1.300	25.00	32.50
5-Nov-24	KG	1.300	25.00	32.50
5-Nov-24	KG	1.300	25.00	32.50
5-Nov-24	KG	1.300	25.00	32.50
5-Nov-24	KG	5.850	25.00	146.25
5-Nov-24	KG	20.800	25.00	520.00
7-Nov-24	KG	32.175	25.00	804.38
9-Nov-24	KG	9.750	25.00	243.75
9-Nov-24	KG	21.450	25.00	536.25
TOTAL		419.229		9,666.83