3.4. 栽培実証試験プロトコル

MIAD と作成した栽培実証試験プロトコルは以下の通りである。

(1)コメ

EVALUATION OF BIO-STIMULANTS ON GROWTH AND RICE YIELDS IN MWEA IRRIGATION SCHEME

1. Background

Rice is a significant crop in Kenya, both as a staple food and as a cash crop, and its production has been growing steadily. Currently, approximately 70% of the rice produced in the country is grown in the Mwea Irrigation Scheme (MIS), which is the largest rice-growing region. Additionally, more than 95% of the rice produced in the country is through irrigated systems, while the remainder is rainfed. Given this context, there is a need to enhance the productivity of this important cereal crop to increase yield per unit area. This is crucial because the annual local production of milled rice is approximately 130,000 metric tons, while consumption is around 650,000 metric tons, making Kenya a net importer of rice.

Plants require macro- and micro-nutrients as well as plant growth-promoting substances to survive and reproduce. Soils contain various levels of these elements; however, the amounts are often insufficient to sustain optimum crop growth. Additionally, these elements sometimes occur in forms that are not readily available to plants. Consequently, it is common practice to use commercial fertilizers and other substances to supplement nutrients and other elements in the soil. Nutrient use efficiency based on yield refers to the increase in yield per unit of nutrient fertilizer applied, while efficiency based on plant uptake may be described as good, average, or poor. In farmers' fields, nitrogen nutrient use efficiency may be poor due to low nutrient uptake. Low uptake is usually attributed to losses due to ammonia volatilization, nitrification-denitrification, leaching, immobilization, and ammonium fixation. One method of improving nutrient uptaKShoil workability, transplant survivability, and irrigation efficiency is through the use of improved technology in the manufacture of plant nutrient products, thereby minimizing these losses.

By adopting these improved technologies and practices, Kenya can enhance rice production and reduce its reliance on imports, contributing to greater food security and economic stability.

To promote rice production in Kenya, the National Irrigation Authority (NIA) and the Mwea Irrigation and Agricultural Development (MIAD) are collaborating with Mitsubishi UFJ Research and Consulting to test biostimulant products. This trial will evaluate the efficacy of the Mycorrhizal fungi product, MYKOS® and the Beer yeast, CW1 biostimulant products on irrigated rice crop, comparing them to currently used formulations in terms of yield and cost efficiency.

2. Objectives

i. To evaluate the efficacy of two Biostimulant products , MYKOS® from RTI and CW1 from Asahi Biocycle Co., Ltd. on the performance of paddy rice in Kenya
ii. To evaluate the performance of the products on rice yield compared to conventional practice

3. Materials and methodology

Experimental site: The trial will be carried out for one season at Mwea Irrigation Agricultural and Development (MIAD) Centre research fields located at Kandongu, Kirinyaga County. The area lies at an altitude of 1200 metres above the sea level. Rainfall pattern is bimodal with an annual mean of about 930 mm. The average temperature is 22°C. The soils in the trial site are predominantly nitisols (red soils) for the upland field and vertisols (black cotton soils) for the paddy field.

Experimental design: Randomized Complete Block Design (RCBD) involving three replications with two treatments for the upland field trial and four replications with four treatments for the paddy filed trial included in the replications.

Treatments:

The trial will consist of two treatments for the upland field trial, which include;

S/ No.	Treatment	
1.	T1	Seed treatment MYKOS® and CW1) and foliar spray at the panicle initiation and heading stage (CW1)
2.	T2	Mwea practice

The trial will consist of four treatments for the paddy field trial, which include;

S/ No.	Treatment	
1.	T1	Seed treatment (MYKOS® and CW1)
2.	T2	Seed treatment MYKOS® and CW1) and foliar spray at the panicle initiation and heading stage (CW1)
3.	T3	Seed treatment (CW1) and foliar spray at the panicle initiation and heading stage (CW1)
4.	T4	Mwea practice

Season: Long rains 2025 season

Rice variety: Basmati 370

Plot size: 4 m × 4 m with tillage by subsoiler and rotary for the upland trial and 5 m × 4 m without tillage for the paddy filed trial

Number of Replications: Three (3) for the upland trial and four (4) for the paddy filed trial

Methods of crop establishment: Direct seeding (upland and paddy field trials) and transplanting (paddy field trials only)

Seedling age at transplanting: 21 Days old

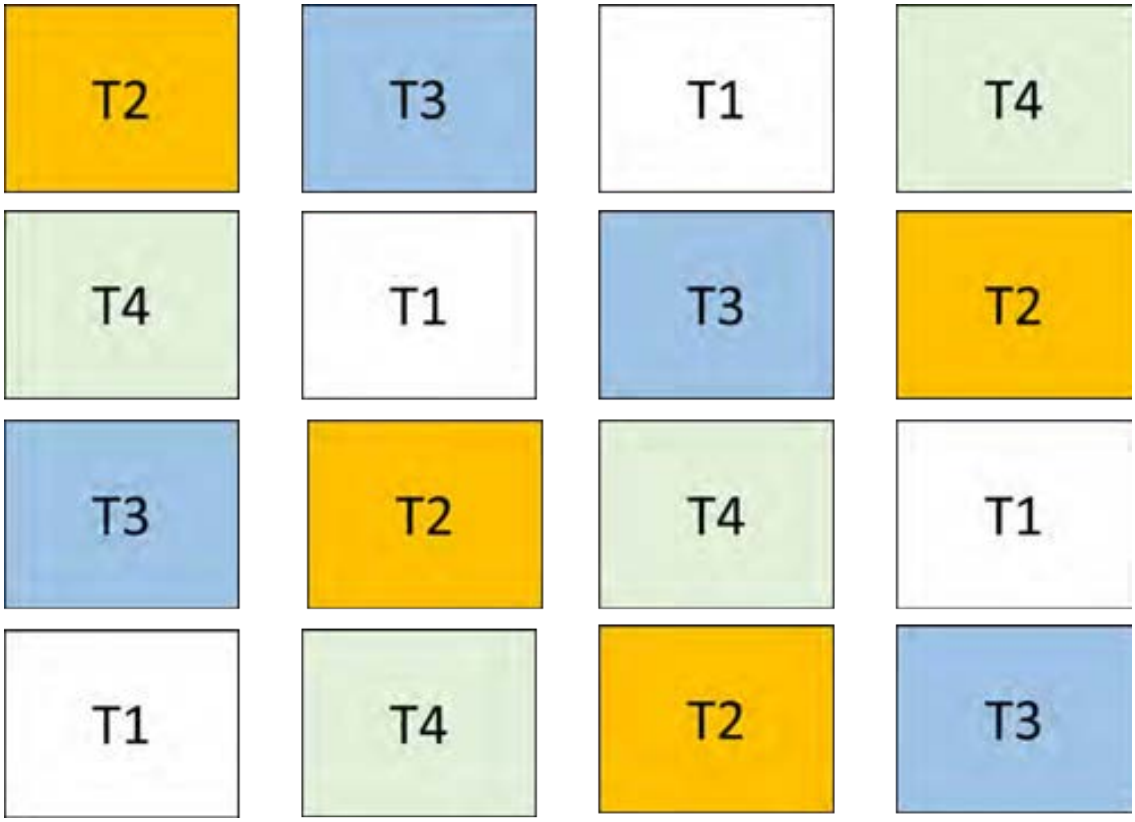


Figure 1: Schematic representation of the experimental design. The design applies for both transplanted and direct seeded trial in paddy fileds.

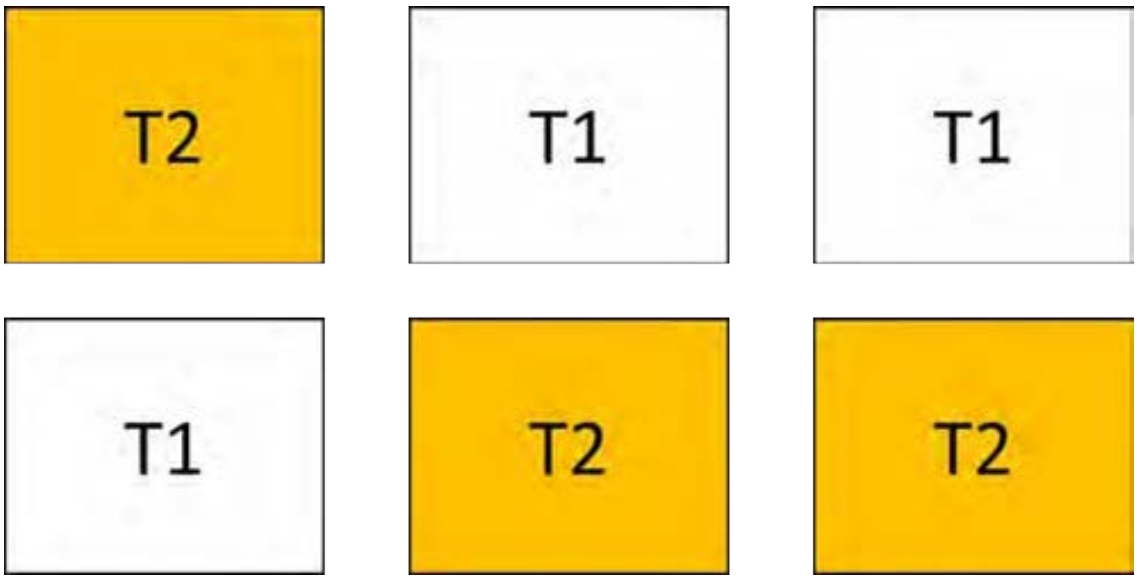


Figure 2: Schematic representation of the experimental design. The design applies for direct seeded trial in upland fileds.

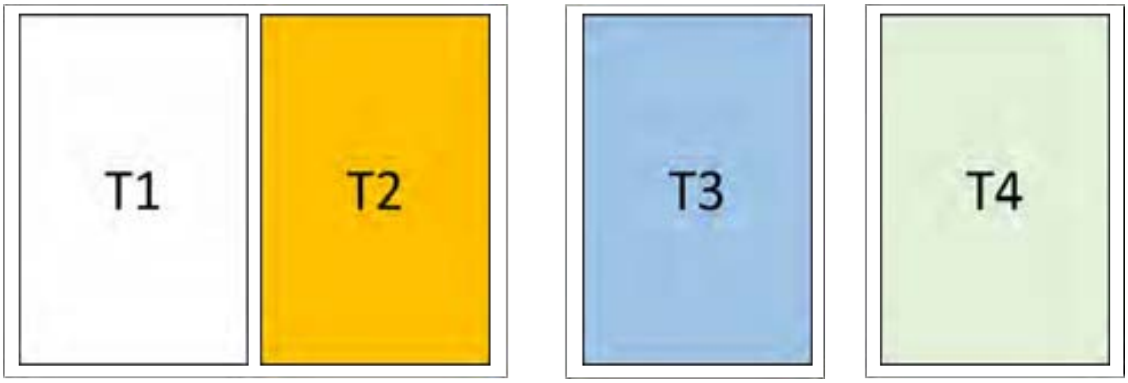


Figure 3: Schematic representation of the nursery for transplanted trial.

4. Cultural Management

1) **Seed treatment:**

- Treatment 1 and 2: Using MYKOS® and CW1
- Treatment 3: Using CW1 only

2) **Nursery:**

- Treatment 1 and 2 : In a separate plot using MYKOS® and CW1
- Treatment 3 : In a separate plot using CW1 only
- Treatment 4: In a separate plot using standard Mwea practice

3) **Treatment application:**

- MYKOS® and CW1 treatments will be applied at seed treatment and CW1 at foliar application at the recommended rates and timing of application.
- Seed treatment: for **transplanted rice**, seed treatment will be applied by soaking the seed in CW1 solution for 24 hours, then coating the seed with MYKOS® wettable powder before sowing in the nursery. For **direct seeded rice**, CW1 solution will be applied by soaking the seed in CW1 solution for 24 hours then coating the seed with MYKOS® wettable powder applied before sowingin the field.
- Treatments 2 and 3 will have foliar application of CW1 administered at panicle initiation and heading stage of the rice.
- Treatment 4 will not have the test products applied.

4) Irrigation:

- For direct seeded plots, irrigation will be at an interval of 10 to 14 days
- For the transplanted plots, irrigation will be maintained as per Mwea recommendation necessary (ref. *Wanjogu et al., 1996*).

5) **Seedling age at Transplanting:** 21 DAS

6) **Spacing:** 20 cm × 20 cm in all plots, 5-6 seedlings per hill.

7) **Nutrient application (for all treatments):** Recommended dose of nutrient as per Mwea practice (80:60:50 Kg NPK/Ha) will be applied uniformly in three splits
   a) 30% N & 100% P_2O_5 respectively through Di-ammonium phosphate-DAP during transplanting together with 50% Potash through muriate of potash (MoP)
   b) Application of 35% N through sulfate of ammonia (SA) at 10 DAT
   c) Application of 35% N through sulfate of ammonia (SA) at 42 DAT together with 50% MoP

8) **Weed management: for direct seeded rice**, non-selective herbicide will be applied 7 to 10 days after sowing. Post-emergence herbicide (e.g. Topshot) will be applied twice, depend on weed infestation. For transplanted rice the herbicide will be applied at 10-18 days after transplanting as recommended for Mwea.

9) **Fungicide & Insect pest management:** Recommended management as per Mwea conditions if signs of the disease occur.

10) Other cultural practices

All other necessary cultural practices will be undertaken as recommended for Mwea.

5. Data collection

i. Photos of plants, weeds and field's overview (evey week)
ii. Soil moisture content measurement (for information of when to irrigate the direct seeded plots)
iii. Germination count after seed treatment
iv. Plant height in centimeter (cm) at 14, 28, 42, 56 and 84 DAT for ten (10) hills randomly

selected

v. Tiller count at 14, 28, 42, 56 and 84 DAT for ten (10) hills randomly selected

vi. Root biomass (fresh and dry weight) a) before transplanting (about 21 days after sowing), b) before foliar application of CW1 (panicle initiation ~ heading stage) and c) at harvest

vii. Shoot biomass (dry weight)

viii. Whole plant biomass at harvest

ix. Yield Components:

From 10 sample hills per plot, the following will be determined.

- Number of tillers/hill
- Number of productive tillers/hill
- Number of filled grains/panicle
- Number of empty grains/panicle
- Panicle length (cm)
- 1000 grain weight (at 14% MC)

6. Statistical Analysis

The collected data will be subjected to analysis of variance and means separated by least significant difference method.

（2)メイズ

EVALUATION OF BIO-STIMULANTS ON GROWTH AND MAIZE YIELDS IN MWEA IRRIGATION SCHEME

1. Background

Plants require macro- and micro-nutrients as well as plant growth-promoting substances to survive and reproduce. Soils contain various levels of these elements; however, the amounts are often insufficient to sustain optimum crop growth. Additionally, these elements sometimes occur in forms that are not readily available to plants. Consequently, it is common practice to use commercial fertilizers and other substances to supplement nutrients and other elements in the soil. Nutrient use efficiency based on yield refers to the increase in yield per unit of nutrient fertilizer applied, while efficiency based on plant uptake may be described as good, average, or poor. In farmers' fields, nitrogen nutrient use efficiency may be poor due to low nutrient uptake. Low uptake is usually attributed to losses due to ammonia volatilization, nitrification-denitrification, leaching, immobilization, and ammonium fixation. One method of improving nutrient uptaKShoil workability, transplant survivability, and irrigation efficiency is through the use of improved technology in the manufacture of plant nutrient products, thereby minimizing these losses. By adopting these improved technologies and practices, Kenya can enhance maize production, contributing to greater food security and economic stability.

To promote maize production in Kenya, the National Irrigation Authority (NIA) and the Mwea Irrigation and Agricultural Development (MIAD) are collaborating with Mitsubishi UFJ Research and Consulting to test biostimulant products. This trial will evaluate the efficacy of the Mycorrhizal fungi product, MYKOS® and the Beer yeast, CW1 biostimulant products on maize crop, comparing them to currently used formulations in terms of yield and cost efficiency.

2. Objectives

i. To evaluate the efficacy of two Biostimulant products, MYKOS® from RTI and CW1 from Asahi Biocycle Co., Ltd. on the performance of maize in Kenya
ii. To evaluate the performance of the products on maize yield compared to conventional practice

3. Materials and methodology

Experimental site: The trial will be carried out for one season at Mwea Irrigation Agricultural and Development (MIAD) Centre research fields located at Kandongu, Kirinyaga County. The area lies at an altitude of 1200 metres above the sea level. Rainfall pattern is bimodal with an annual mean of about 930 mm. The average temperature is 22°C. The soils in the trial site are predominantly nitisols (red soils).

Experimental design: Randomized Complete Block Design (RCBD) involving four replications with three treatments included in the replications.

Treatments: The trial will consist of three treatments, which include;

S/ No.	Treatment	
1.	T1	Seed treatment MYKOS® and CW1)
2.	T2	Seed treatment (CW1) only
3.	T3	Conventional practice

Season: Long rains 2025 season

Maize variety: DK 777

Plot size: 5 m × 4 m

Number of Replications: Four (4)

Methods of crop establishment: Direct seeding

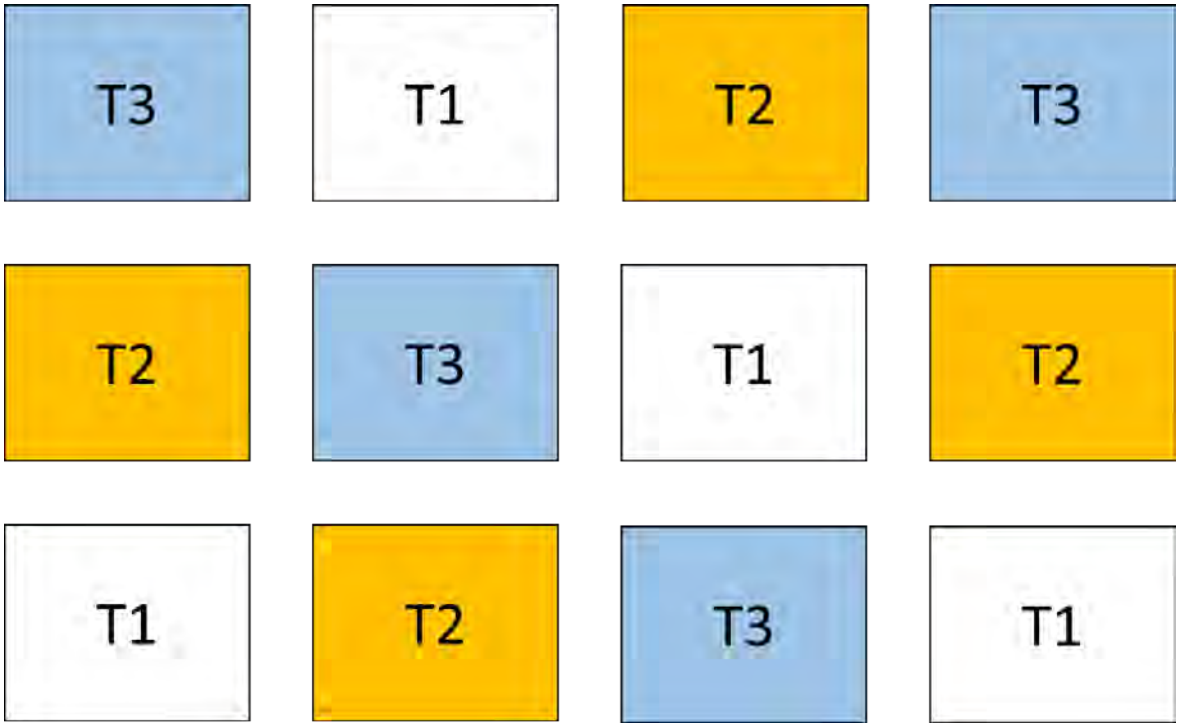


Figure 1: Schematic representation of the experimental design.

4. Cultural Management

1) **Seed treatment:**

- Treatment 1: Using MYKOS® and CW1
- Treatment 2: Using CW1 only

2) **Treatment application:**

- MYKOS® and CW1 treatments will be applied at seed treatment at the recommended rates and timing of application.
- CW1 solution will be sprayed on the seed and MYKOS® wettable powder applied before sowing in the field.
- Treatment 3 will not have the test products applied.

3) **Irrigation:**

- Irrigation will be applied as necessary.

4) **Spacing:** 60 cm × 30 cm in all plots, 2 seeds per hill.

5) **Nutrient application (for all treatments):** Recommended dose of nutrient will be applied uniformly in three splits

   a) N & P_2O_5 respectively through Di-ammonium phosphate-DAP during planting at the rate of 50 kgs per acre（20 kgs per ha）

   b) Application of N through Calcium Ammonium Nitrate (CAN) at the rate of 50-100 kgs per acre（20-40 kgs per ha）

6) **Weed management: Pre-emergence and** post-emergence herbicides will be applied after sowing and 2-3 weeks after germination.

7) **Fungicide & Insect pest management:** Recommended management as per Mwea conditions using locally available pesticides.

8) **Other cultural practices**

All other necessary cultural practices will be undertaken as recommended for maize production in Kenya.

5. Data collection

i. Photos of plants, weeds and field's overview (evey week)
ii. Root biomass (fresh and dry weight) at harvest
iii. Photos of roots at vegetative stage- one and half months after germination and flowering stage
iv. Shoot biomass (dry weight) at harvest
v. Yield Components:

From a quadrant of $1m^2$ per plot, the following will be determined.

- Number of ears/m^2
- Number of kernel rows per ear- for 20 ears randomly selected
- 1000 grain weight
- Moisture content

The yield will be calculated based on the formula below:

Yield (kg/ha) = ((number of kernel rows per ear × number of ears per m^2/100) × (weight of 1000-kernel (g)/1000) × 10,000)

6. Statistical Analysis

The collected data will be subjected to analysis of variance and means separated by least significant difference method.

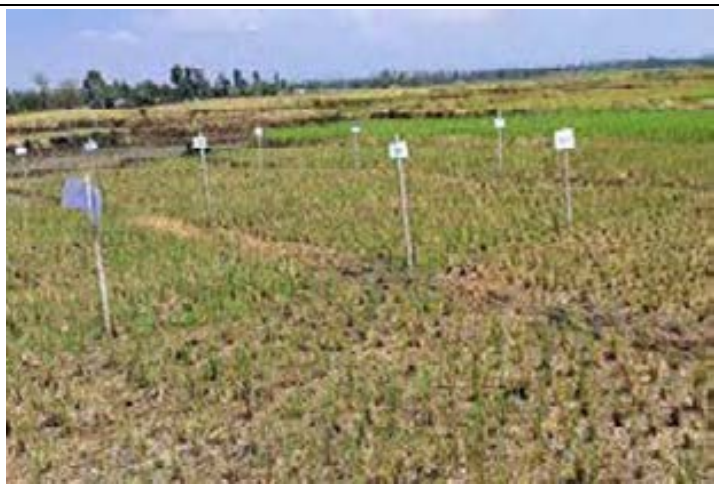
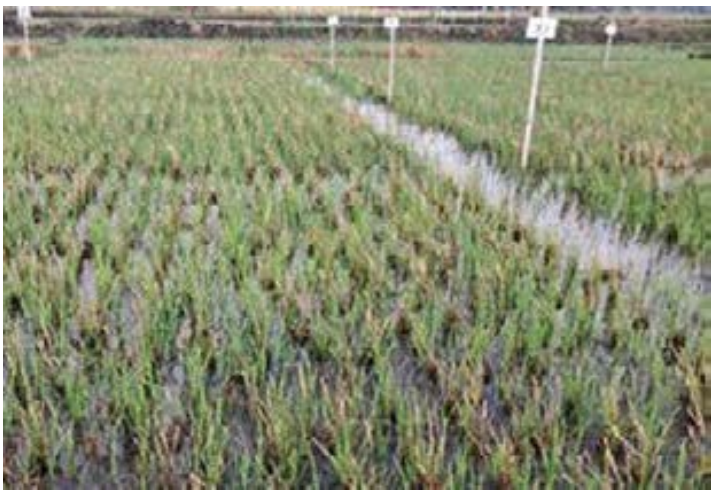
3.5. 生育データ(圃場写真)

1)水田圃場(イネ)

i. 乾田直播区

日時	写真	備考
2/6 播種		
2/12	 	発芽を確認 刈り取り後、残っていた前作の二番穂に対し、非選択性除草剤（グリホサート）の散布を実施（対象面積：0.06ha、濃度：200mL/16L）

2/18	 	
2/27		二番穂が枯れ切っておらず、株間の播種イネの生育にバラツキがみられた ※隣接する水路の通水により一時的に湛水状態となっているが、その後排水が行われた

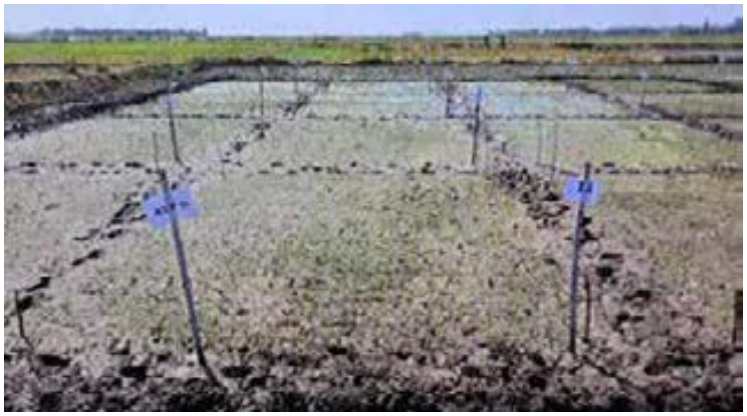
3/8	 	
3/17		二番穂は手作業で株本で刈り取りを行った（3/18）。 ※降雨により一時的に湛水状態となっているが、その後排水が行われた

ii. 移植区

日時	写真	備考
2/6 播種		
2/12		発芽を確認

		
2/18		
2/26		

2/27 移植		
3/8	 	※写真撮影後、灌水を行った

3/17	 	選択性除草剤（トップショット）散布を実施

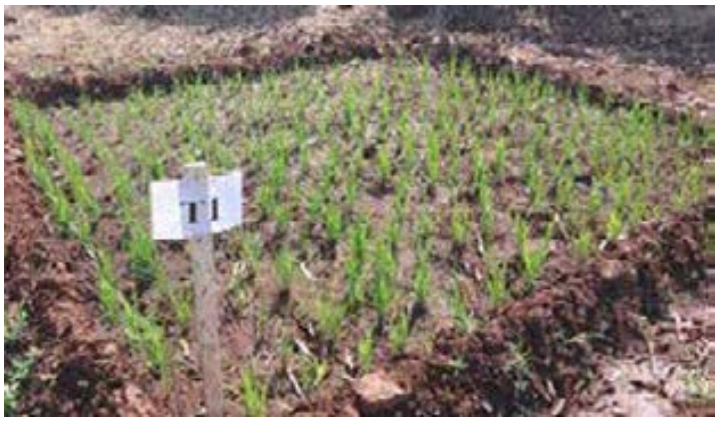
2）畑地圃場

i.　イネ

日時	写真	備考
2/6 播種		

2/12		発芽を確認
2/18	 	選択性除草剤（トップショット）の散布を実施
2/21		

		
2/26	 	

3/8	 	
3/17	 	雑草の手作業での除去を行った。

ii.　メイズ

日時	写真	備考
2/6 播種		
2/12		発芽を確認
2/18	 	

2/21	  	

2/26	  	

3/8	  	
3/17		雑草の手作業での除去を行った。

3.6. 作業記録表

本事業では契約期間の関係上、2025 年 2 月から開始した栽培実証試験の途中までのデータしか得ることができなかったが、試験は MIAD 研究員によって収穫後の収量調査まで継続される予定であり、次年度以降の事業等で確認する必要がある。

表 3-8　作業記録表

日時	作業内容・記録
2 月 5 日（水）9：30～	種子処理（MYKOS、CW1）
2 月 6 日（木）11：00～19：00	播種
2 月 8 日（土）	不耕起イネ：走り水
2 月 12 日（水）11：00	発芽確認
	畑地イネ・メイズ：地上部約 5cm~8cm
	不耕起イネ：約 3mm
2 月 12 日（木）	不耕起イネ　グリホサート散布
2 月 18 日（火）	畑地イネ・メイズ　トップショット散布
2 月 20 日（木）※播種 14 日後	生育調査実施
2 月 21 日（金）	畑地イネ・メイズ　追肥
2 月 26 日（水）※播種 20 日後	生育調査実施
2 月 27 日（木）※播種 21 日後	イネ移植
3 月 3 日（月）	不耕起イネ　追肥
	畑地イネ　追肥
3 月 8 日（土）	不耕起イネ　トップショット散布
3 月 10 日（月）	畑地メイズ　追肥
3 月 17 日（月）	移植イネ　トップショット散布
	畑地イネ・メイズ　手作業での雑草除去
3 月 18 日（火）	不耕起イネ　二番穂刈り取り
3 月 20 日（木）※播種 42 日後	（予定）生育調査
4 月 3 日（木）※播種 56 日後	（予定）生育調査
5 月 1 日（木）※播種 84 日後	（予定）生育調査
4 月 12 日～頃？幼穂形成期	（予定）CW1 茎葉散布（1000 倍）
5 月 12 日～頃？出穂期	（予定）CW1 茎葉散布（1000 倍）
6 月 26 日～頃？収穫期	（予定）生育調査・収量調査