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Research Article

Characterization and Conservation of Native Banana Germplasms Available in Salt Ecosystem

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Abstract

This study aimed to assess, conserve, and characterize banana germplasms in Bangladesh's coastal salt ecosystem, with the goal of improving cultivation resilience and sustainability under challenging environmental conditions. Thirty-five banana germplasms were subjected to *in situ* investigation, with 11 germplasms undergoing morphological characterization, revealing significant variations in key parameters. Additionally, 11 germplasms representing *Musa* species were collected for *ex situ* conservation at the Germplasm Center, Department of Horticulture, PSTU, with three, four, and four germplasms falling under *Musa paradisiaca*, *Musa acuminata*, and *Musa sapientum*, respectively. Notably, *M. paradisiaca* (kacha kola), *M. acuminata* (atia kola), and *M. sapientum* (table banana) exhibited promising traits in terms of morphological characteristics, total yield, and shelf-life. Among these, germplasm MP01 (*M. paradisiaca*), MA17 (*M. acuminata*), and MS09 (*M. sapientum*) demonstrated superior potential for maximizing production and profitability within the coastal salt ecosystem region. These findings offer valuable insights for banana cultivation in similar challenging environments, contributing to enhanced agricultural sustainability and livelihoods.

Introduction

Banana, belonging to the genus *Musa* within the family Musaceae, holds a distinguished status as one of the most significant fruit crops worldwide. Revered for its rich flavor, nutritional richness, and year-round availability, banana stands as an ancient cultivated plant esteemed for its multifaceted benefits (Britannica, 2020 and Kumar *et al.*, 2012). In Bangladesh, bananas are cultivated extensively across diverse regions, with notable concentrations in Rangamati, Barishal, Rangpur, Dinajpur, Noakhali, Faridpur, Tangail, and Khulna. This tropical fruit occupies a pivotal position in the nation's agricultural landscape, emerging as one of the foremost economically important crops, complementing staples like rice, wheat, and maize (FAO, 2020).

Despite its widespread cultivation, challenges persist in optimizing banana production, especially in addressing varietal adaptability and microclimatic variations across different regions (Hossain, 2014). Factors such as the absence of selected varieties suited to various agro-ecological zones, inadequate modern production technologies, and susceptibility to diseases and pests, including Fusarium wilt, nematodes, and weevil borers, impede production, particularly in coastal inundated saline regions (Gaidashova *et al.* 2008).

However, intriguingly, certain indigenous banana races in these saline-affected areas exhibit remarkable resilience, thriving even without proper cultivation practices. Despite limited cultivation by local communities, these promising local varieties possess superior taste, size, color, and adaptability to adverse conditions, presenting a compelling subject for further research and development initiatives.

In situ conservation emerges as a vital strategy for preserving species diversity and genetic variability, albeit hindered by challenges such as limited botanical knowledge for accurate species identification and difficulties in accessing remote locations, particularly in tropical and subtropical areas like Southeast Asia (Liu *et*

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al., 2002 and Sardos *et al.*, 2018). Bridging this gap requires selecting suitable varieties, developing updated technologies, and providing quality planting materials tailored to the coastal ecosystem (Rasmussen *et al.,* 2015, Merritt *et al.*, 2014, Flanagan *et al.*, 2019, and Hunter & Heywood, 2011).

While commercial banana production is increasing, research efforts focused on enhancing local varieties in Bangladesh remain insufficient, particularly in addressing the unique challenges of salt-affected regions. Addressing these gaps holds the potential to significantly boost banana production, benefiting both farmers and commercial growers. Against this backdrop, the present study aims to contribute to the advancement of banana cultivation in Bangladesh. Through a comprehensive approach encompassing surveying, *in situ* conservation with GPS coordination, and characterization of promising *Musa* spp., alongside *ex-situ* conservation efforts at the PSTU germplasm center, the research endeavors to lay the foundation for sustainable and resilient banana production in the coastal salt ecosystem.

Materials and Methods

Baseline information and in situ conservation approach

As the baseline information, *Musa* species were noted during their collection and conservation. Passport data regarding local/ Bengali, English, and scientific names of banana germplasms/accessions, and places of identification with their Global Positioning System (GPS) coordination were done using 'Vivo Y12A' model. *In situ* conservation activities were carried out in 30 farmer's homesteads within Kalapara upazila, Patuakhali, situated along the south coast of Bangladesh. A comprehensive survey was conducted to identify native *Musa* species such as *Musa paradisiaca, Musa acuminata,* and *Musa sapientum*. Various banana accessions were grown in these areas, selected, and labeled for further evaluation. Horticultural Genetic Recourses (HGR) conservation strategies (Figure 1) pertinent to the research were implemented, following guidelines outlined by Malik *et al.* (2010).

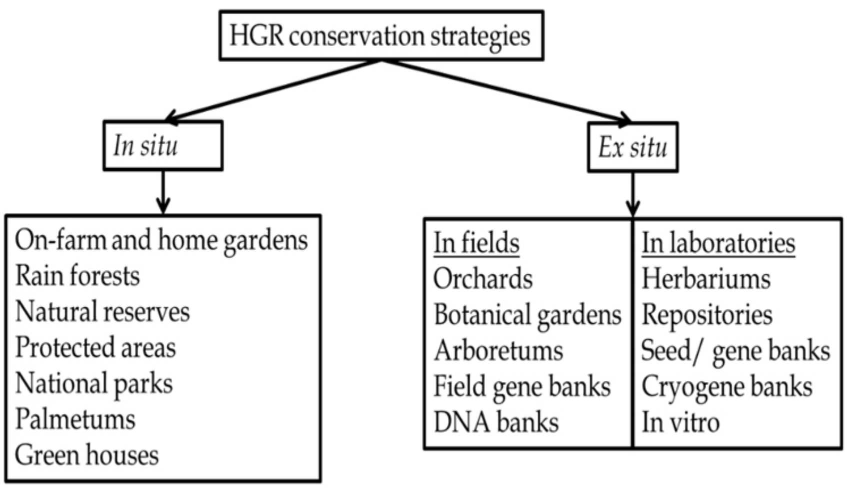

Figure 1. The conservation approaches of HGR.

Species richness (SR) and Relative prevalence (RP)

The species richness is the number of species within an area, giving equal weight to each one as suggested by Chao and Chiu (2016). The percentage of homesteads containing a particular species is one of the indicators of the relative prevalence of that particular species in that area. The percent of homesteads having the fruit species was calculated for all the species then the relative prevalence of a species was calculated using the formula:

$$\text{RP} = \text{Population of the species per homestead} \times \%\ \text{homestead with the species}$$

The relative prevalence value was calculated to rank the species into different groups according to Millat-e-Mustafa (1997).

Morphological characterization

The number of leaves was counted from the sample plants and their average was taken as the number of leaves per plant. To identify the days required for bunch maturity the date of emergence of inflorescence and those of the harvesting were recorded. Total crop duration was calculated by the summation of days required for flowering and flowering to bunch maturity. The number of hands per bunch was counted after harvest. The number of fingers per bunch was counted at the time of recording hands per bunch. At the time of harvest, the bunch was cut with 10 cm long peduncle above the first hand. Then the bunch was weighed in a balance and recorded in kilograms (kg). The yield per hectare was calculated from the weight of the bunch multiplying by the number of plants per hectare (tons/ha). The pulp and skin tissues of ripe banana were separated by means of a stainless-steel knife and weighed separately. The ratio of pulp weight and skin weight was calculated by dividing the fresh weight of pulp by the weight of skin of a single fruit.

Shelf life

To calculate the shelf life of banana germplasms, the days from harvesting up to the last edible stage were taken into account.

Ex situ conservation approach

The *ex situ* conservation of native *Musa* species was done in the field gene bank or Germplasm Center (GPC), PSTU. In *ex situ* investigations, all the collected germplasms were planted in different blocks of GPC. Banana suckers were collected from collection sources for *ex situ* conservation and tagged with names. A systematic approach has been taken to characterize, evaluate, use, and propagate the collected germplasms obtained at GPC.

Statistical analysis

The data collected from each experiment were statistically analyzed as per the design of the experiment using the RStudio software. The means for all treatments were calculated and the analyses of variances for all the traits under consideration were performed by the 'F variance test'. The significance of the difference between the pair of means was performed by the Least Significant Difference (LSD) test taking the probability level of 5% as a minimum unit of significance.

Results and Discussion

In situ conservation of native Musa species

The total variety of native *Musa* species found in the study area was noted in Table 1. 35 germplasms under *Musa* species were found in the study area. A passport database of these 35 germplasms was recorded. Promising *Musa* species germplasms were conserved *in situ* conditions (Table 1).

Table 1. Passport data of 35 banana germplasms conserved *in situ* in salt ecosystem

Musa spp.	Germplasm Code	Local name	Latitude (North)	Longitude (East)
Musa paradisiaca **(**Kacha kola**)**	MP01	Kacha kola	22º01’41’’	90º18’21’’
	MP02	Kacha kola	22º01’48’’	90º18’22’’
	MP03	Kacha kola	22º01’56’’	90º14’33’’
	MP04	Kacha kola	22º01’56’’	90º14’33’’
	MP05	Kacha kola	22º01’36’’	90º16’34’’
Musa acuminata **(**Atia kola**)**	MA01	Jhama Atia	22º01’36’’	90º16’34’’
	MA02	Jhama Atia	22º01’42’’	90º16’34’’
	MA03	Jhama Atia	22º01’42’’	90º16’34’’
	MA04	Jhama Atia	22º01’42’’	90º16’42’’
	MA05	Jhama Atia	22º01’43’’	90º16’35’’
	MA06	Jhama Atia	22º01’42’’	90º16’42’’
	MA07	Jhama Atia	22º01’43’’	90º16’35’’
	MA08	Daud Atia	22º01’41’’	90º18’21’’
	MA09	Daud Atia	22º01’41’’	90º18’21’’
	MA10	Daud Atia	22º01’43’’	90º16’35’’
	MA11	Daud Atia	22º01’41’’	90º18’21’’
	MA12	Puita Atia	22º01’48’’	90º18’22’’
	MA13	Puita Atia	22º01’56’’	90º14’33’’
	MA14	Puita Atia	22º01’43’’	90º16’35’’
	MA15	Tula Atia	22º01’41’’	90º18’21’’
	MA16	Tula Atia	22º01’41’’	90º18’21’’
	MA17	Tula Atia	22º01’42’’	90º16’42’’
	MA18	Tula Atia	22º01’43’’	90º16’35’’
	MA19	Tula Atia	22º01’42’’	90º16’42’’
	MA20	Tula Atia	22º01’42’’	90º16’42’’
Musa sapientum (Table banana)	MS01	Sobri Kola	22º01’41’’	90º18’21’’
	MS02	Sobri Kola	22º01’48’’	90º18’22’’
	MS03	Sobri Kola	22º01’56’’	90º14’33’’
	MS04	Sobri Kola	22º01’56’’	90º14’33’’
	MS05	Sobri Kola	22º01’36’’	90º16’34’’
	MS06	Sobri Kola	22º01’36’’	90º16’34’’
	MS07	Sobri Kola	22º01’42’’	90º16’34’’
	MS08	Sobri Kola	22º01’42’’	90º16’34’’
	MS09	Sobri Kola	22º01’42’’	90º16’42’’
	MS10	Sobri Kola	22º01’43’’	90º16’35’’

Species richness and relative prevalence

Musa species were noted during their collection and conservation based on species richness and relative prevalence. According to the survey based on species richness and relative prevalence, the population, sample, and morphotype of MP01, MP02, MP05 under *Musa paradisiaca*, MA07, MA11, MA14, MA17 under *Musa acuminata* and MS02, MS04, MS07, MS09 under *Musa sapientum* were higher than others and those were considered for characterization to find out which one was more suitable and profitable under each *Musa* species respectively in the salt ecosystem region (Table 2).

Table 2. Species richness and relative prevalence of *Musa* species

***Musa* spp.**	**Germplasm code**	**Population**	**Sample**	**Morphotype**
Musa paradisiaca	MP01	1300	3	153
	MP02	1250	3	149
	MP03	1000	2	111
	MP04	950	2	126
	MP05	1250	2	142
Musa acuminata	MA01	1000	2	140
	MA02	800	2	138
	MA03	950	2	142
	MA04	1050	2	130
	MA05	700	2	128
	MA06	800	2	134
	MA07	1350	3	146
	MA08	650	2	135
	MA09	500	2	125
	MA10	750	2	124
	MA11	1250	3	150
	MA12	1050	2	122
	MA13	1100	2	143
	MA14	1300	3	144
	MA15	550	2	122
	MA16	800	2	113
	MA17	1250	3	152
	MA18	950	2	111
	MA19	900	2	110
	MA20	600	2	129
Musa sapientum	MS01	1200	2	146
	MS02	1250	2	147
	MS03	850	2	144
	MS04	1370	2	149
	MS05	1050	2	141
	MS06	1100	2	140
	MS07	1250	2	145
	MS08	1000	2	122
	MS09	1260	2	148
	MS10	950	2	122

Morphological characterization

The number of leaves per plant at the flowering stage exhibited significant variation among different banana cultivars (Table 3). In *Musa paradisiaca*, the cultivar MP01 demonstrated the highest number of leaves per plant (10.45), whereas the lowest count was observed in MP05 (9.83). Among *Musa acuminata* cultivars, MA17 displayed the highest leaf count per plant (13.12), while the lowest count was recorded in MA14 (11.22). Similarly, within *Musa sapientum*, the cultivar MS09 exhibited the maximum number of leaves per plant (9.33), with the minimum count noted in MS02 (8.51). These findings corroborate previous studies by Wilberforce *et al.* (2015) and Hoque (2008).

Table 3. Growth and Development attributes of *Musa paradisiaca, Musa acuminata and Musa sapientum* germplasms in salt ecosystem

Musa paradisiaca				*Musa acuminata*				*Musa sapientum*			
Germplasm Code	No. of leaves per plant	Days to bunch maturity	Crop duration (Days)	Germplasm Code	No. of leaves per plant	Days to bunch maturity	Crop duration (Days)	Germplasm Code	No. of leaves per plant	Days to bunch maturity	Crop duration (Days)
MP01	10.45	91.33	365	**MA07**	11.67	96.56	355	**MS02**	8.51	87.83	350
MP02	10.12	88.35	353	**MA11**	12.23	101.14	364	**MS04**	8.89	88.23	351
MP05	9.83	85.82	342	**MA14**	11.22	92.79	334	**MS07**	9.02	90.18	353
-	-	-	-	**MA17**	13.12	108.50	391	**MS09**	9.33	92.46	354
LSD at 5%	1.21	2.80	4.12	LSD at 5%	1.35	2.13	3.89	LSD at 5%	1.39	1.65	2.85
Level of sig.	*	*	*	Level of sig.	*	*	*	Level of sig.	*	*	*
CV (%)	7.39	1.79	1.72	CV (%)	7.57	1.92	1.89	CV (%)	6.18	1.35	1.54

* = Significant at 5% level of probability; CV = Coefficient of Variation

The time required for bunch maturity varied significantly among different banana cultivars, indicating distinct maturity patterns (Table 3). In *Musa paradisiaca*, the cultivar MP01 exhibited the longest time to reach maturity, with an average of 91.33 days, while MP05 demonstrated the shortest time, with an average of 85.82 days. Among *Musa acuminata* cultivars, MA17 displayed the highest time for bunch maturity, averaging 108.50 days, whereas MA14 required the shortest time, averaging 92.89 days. Similarly, within *Musa sapientum*, the cultivar MS09 required the maximum time for bunch maturity, averaging 92.46 days, while MS02 showed the shortest time, averaging 87.83 days. These findings are consistent with previous research by Wilberforce *et al.* (2015), Tigabu *et al.* (2015), and Gaidashova *et al.* (2008).

Crop duration varied significantly among different banana cultivars, with distinct life cycles observed within each species (Table 3). Among *Musa paradisiaca* cultivars, MP01 exhibited the longest crop duration, averaging 365 days, while MP05 showed the shortest duration, averaging 342 days. In *Musa acuminata*, the cultivar MA17 displayed the maximum crop duration, averaging 391 days, whereas MA14 had the minimum duration, averaging 334 days. Similarly, within *Musa sapientum*, the cultivar MS09 demonstrated the highest life cycle, averaging 354 days, while MS02 exhibited the shortest duration, averaging 350 days. These findings align with previous studies by Hoque (2008), Krishnamoorthy and Kuma (2004), Halder *et al.* (2003), and Noupadja and Tomekpe (2001).

The number of hands per bunch varied significantly among different banana cultivars, indicating distinct bunch characteristics within each species (Table 4). In *Musa paradisiaca*, the cultivar MP01 produced the highest number of hands per bunch (12.47), while MP05 yielded the lowest (11.70). Among *Musa acuminata* cultivars, MA17 exhibited the maximum number of hands per bunch (12.60), while MA14 showed the minimum (10.78). Similarly, within *Musa sapientum*, the cultivar MS09 displayed the highest number of hands per bunch, averaging 10.33, whereas MS04 exhibited the lowest, averaging 8.92. These findings are consistent with prior research by Tigabu *et al.* (2015), Yoseph *et al.* (2014), and Gervacio *et al.* (2008).

Table 4. Hands per bunch and number of fingers per hand of *Musa paradisiaca, Musa acuminata, and Musa sapientum* germplasms in salt ecosystem

Musa paradisiaca			*Musa acuminata*			*Musa sapientum*		
Germplasm Code	Hands per bunch	No. of fingers per hand	Germplasm Code	Hands per bunch	No. of fingers per hand	Germplasm Code	Hands per bunch	No. of fingers per hand
MP01	12.47	17	**MA07**	11.44	15	**MS02**	9.43	14
MP02	12.04	16	**MA11**	11.75	14	**MS04**	8.92	15
MP05	11.70	16	**MA14**	10.78	13	**MS07**	9.78	16
-	-	-	**MA17**	12.60	15	**MS09**	10.33	16
LSD at 5%	1.16	1.45	LSD at 5%	2.37	1.74	LSD at 5%	1.63	1.74
Level of sig.	*	*	Level of sig.	*	*	Level of sig.	*	*
CV (%)	6.90	5.92	CV (%)	6.37	4.21	CV (%)	9.67	5.20

*=Significant at 5 % level of probability; CV = Coefficient of Variation

A significant variation was observed in the number of fingers per hand (Table 4). In *Musa paradisiaca*, MP01 showed the highest (17) number of fingers per hand while MP05 showed the lowest (16). On the other hand, in case of *Musa acuminata*, MA07 and MA17 showed the highest (15) number of fingers per hand while MA14 showed the lowest (13). Moreover, in *Musa sapientum*, MS07 and MS09 found with highest (16) fingers while MS02 was found with the lowest (14) fingers. The findings are supported by Wilberforce *et al.* (2015), Tigabu *et al.* (2015), and Yoseph *et al.* (2014).

The yield per plant showed significant variation (Table 5 and Plate 1) due to the effect of different cultivars. Among the cultivars for *Musa paradisiaca*, the highest yield (22.23 kg per plant) was recorded in MP01 while the MP05 showed the lowest yield (20.62 kg per plant) of banana. On the other hand, the highest yield (20.41 kg per plant) of *Musa acuminata* was recorded in MA17 while the MA14 showed the lowest yield (17.46 kg per plant). In *Musa sapientum*, the maximum yield (17.58 kg per plant) was obtained from MS09 whereas MS02 showed the minimum yield (15.98 kg per plant). The findings align with previous studies by Sagar *et al.* (2017), Shaibu *et al.* (2012), and Chang *et al.* (2011).

Table 5. Yield per plant and pulp to peel ratio of *Musa paradisiaca*, *Musa acuminata*, and *Musa sapientum* germplasms in salt ecosystem

Musa paradisiaca			***Musa acuminata***			***Musa sapientum***		
Germplasm Code	Yield (Kg per plant)	Pulp: peel ratio	Germplasm Code	Yield (Kg per plant)	Pulp: peel ratio	Germplasm Code	Yield (Kg per plant)	Pulp: peel ratio
MP01	22.23	6.0	**MA07**	19.80	5.6	**MS02**	15.98	4.1
MP02	21.23	5.7	**MA11**	19.03	5.4	**MS04**	16.54	4.2
MP05	20.62	5.6	**MA14**	17.46	5.0	**MS07**	17.12	4.2
-	-	-	**MA17**	20.41	5.8	**MS09**	17.58	4.3
LSD at 5%	1.93	0.26	LSD at 5%	1.35	0.76	LSD at 5%	1.65	0.98
Level of sig.	*	*	Level of sig.	*	*	Level of sig.	*	*
CV (%)	7.42	3.14	CV (%)	6.42	2.23	CV (%)	9.34	8.44

*=Significant at 5 % level of probability; CV = Coefficient of Variation

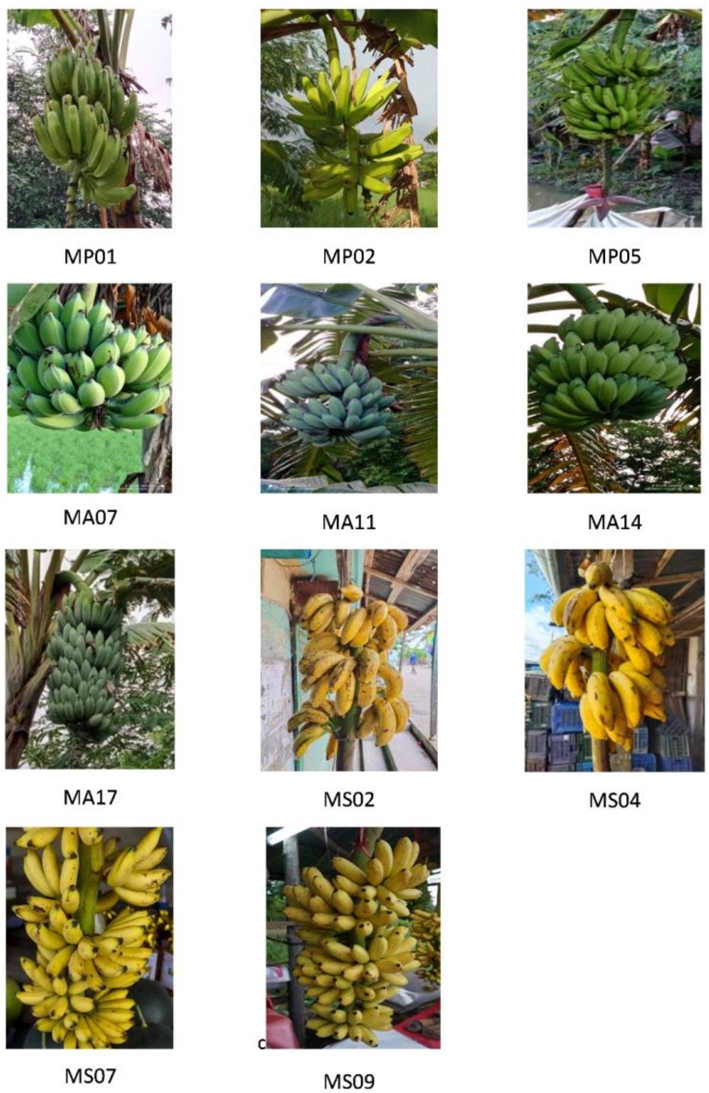

Plate 1. Fruits *Musa* species (MP01, MP02, MP05 = *Musa paradisiaca*), (MA07, MA11, MA14, MA17= *Musa acuminata*), (MS02, MS04, MS07, MS09= *Musa sapientum*)

In *Musa paradisiaca*, MP01 produced the highest yield per hectare (68.45 tons/ha) while it was the lowest (63.53 tons/ha) in MP05 (Figure 2). Moreover, in *Musa acuminata*, MA17 produced the highest yield (65.83 tons/ha) while it was the lowest (56.30 tons/ha) in MA14 (Figure 2). Furthermore, in *Musa sapientum,* MS09 produced the maximum yield (54.87 tons/ha) whereas it was the lowest (49.86 tons/ha) in MS02 (Figure 2). The findings are supported by Wilberforce *et al.* (2015), Sagar *et al.* (2017), and Chang *et al.* (2011).

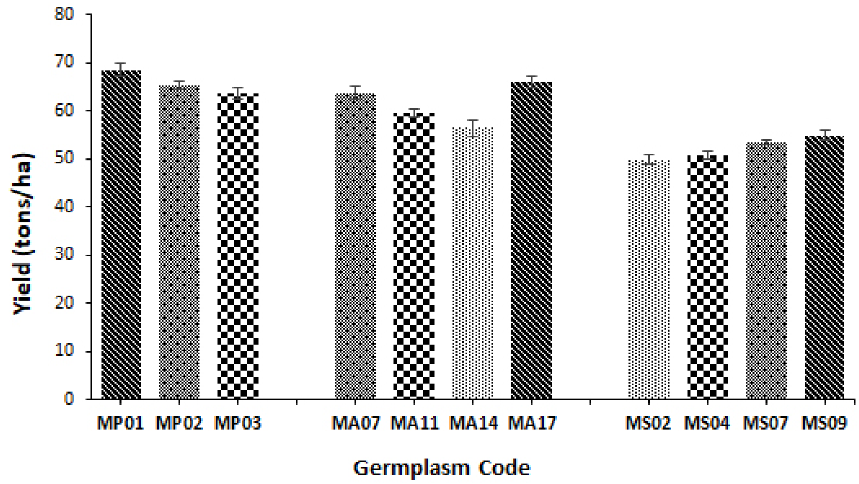

Figure 2. Yield (tons/ha) of different *M. paradisiaca, Musa acuminata* and *Musa sapientum* germplasms. Vertical bars represent standard error.

In table 5, for *Musa paradisiaca*, MP01 gave the highest pulp: peel ratio whereas the lowest pulp: peel ratio was MP05 (5.6). In *Musa acuminata*, the maximum pulp: peel ratio was found from MA17 (5.8) while the minimum pulp: peel ratio was recorded from MA14 (5.0). Furthermore, in *Musa sapientum*, MS09 gave the highest pulp/: peel ratio (4.33) whereas the lowest pulp: peel ratio was from MS02 (4.1).

Shelf life

Shelf life duration varied significantly among different banana cultivars, with notable differences observed within each species (Figure 4). In *Musa paradisiaca*, MP01 exhibited the longest shelf life, 19.56 days, while MP03 displayed the shortest shelf life, 18.20 days. Among *Musa acuminata* cultivars, MA17 demonstrated the longest shelf life, 19.08 days, whereas MA14 showed the shortest shelf life, 16.32 days. Similarly, within *Musa sapientum*, MS09 displayed the maximum shelf life, 17.11 days, while MS04 exhibited the minimum shelf life, 14.62 days. These findings are consistent with prior studies by Mimi (2013), Rashid (2013) and Bugaud *et al.* (2005), providing further support for the observed variations in shelf life duration among banana cultivars.

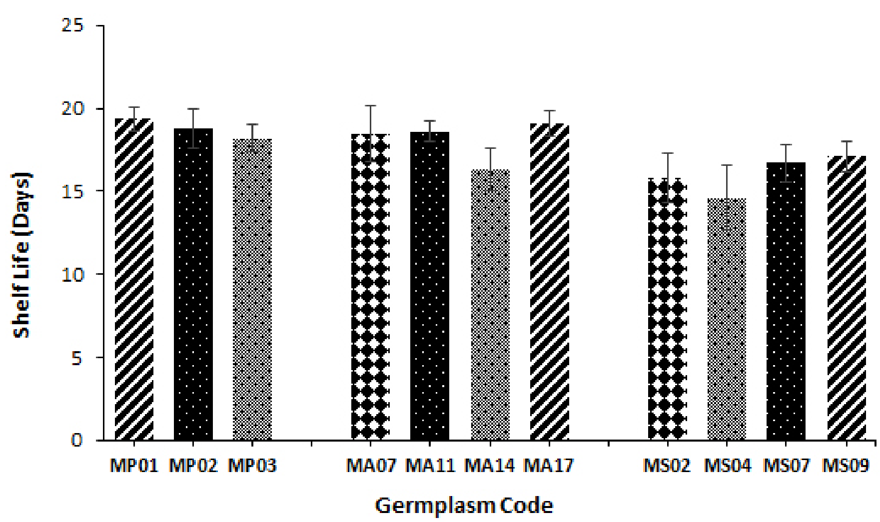

Figure 3. Shelf-life of different *Musa paradisiaca*, *Musa acuminate* and *Musa sapientum* germplasms. Vertical bars represent standard error.

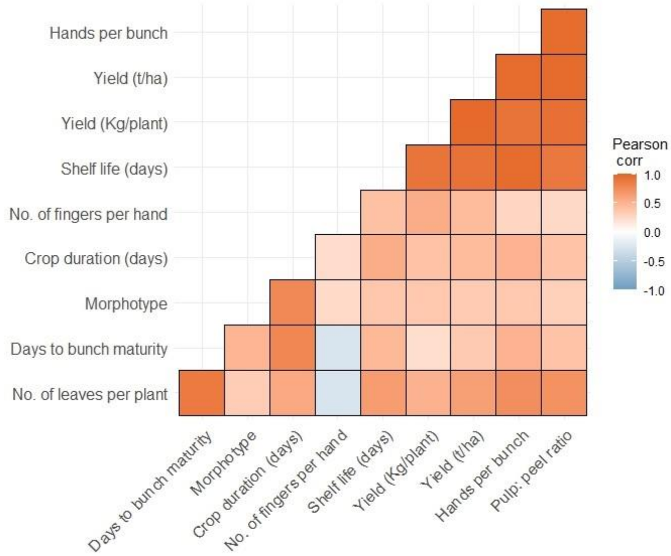

Figure 4. Correlation coefficient for morphotype, morpho-physical characterization attributes, and shelf life in the selected banana for the salt ecosystem.

Table 6. *Ex situ* conservation of *Musa* species at PSTU Germplasm Center

Musa spp.	Germplasm Code	Germplasm No.
M. paradisiaca	MP01	1
	MP02	1
	MP05	1
M. acuminate	MA07	1
	MA11	1
	MA14	1
	MA17	1
M. sapientum	MS02	1
	MS04	1
	MS07	1
	MS09	1

Ex situ conservation of Musa species at Germplasm Center (GPC)

Collection of germplasm propagules for the *ex situ* conservation was done at the GPC in situated with Global Positioning System (GPS) coordination at 22º27’56" north latitudes and 90º23’10’’ east longitudes. Germplasm propagules such as suckers were used for conservation at GPC. Eleven promising banana germplasms were collected and conserved *ex situ* conditions at GPC. Among them; 3 germplasms belonged to *M. paradisiaca,* 4 germplasms belonged to *M. acuminata* and 4 germplasms belonged to *M. sapientum* (Table 6). It represents a proactive approach to mitigate the threats posed by pests, diseases, and environmental changes to banana cultivation. By conserving a diverse array of germplasm, GPC aims to support ongoing research efforts aimed at developing resilient and productive banana varieties, thereby contributing to sustainable agriculture and global food security.

Correlation coefficient analysis

Correlation matrix revealed both strong positive and negative correlation among the variables (Figure 4). Notably, strong positive correlations were identified between crop duration, morphotype, and bunch maturity (R^2= 0.78, 0.79), suggesting that an increase in crop duration corresponds with elevated values in these parameters. Additionally, a notable correlation was found between the number of leaves per plant and bunch maturity (R^2= 0.88), indicating that an increase in leaves per plant prolongs the time to bunch maturity. Further analysis revealed significant correlations (R^2= 0.91, 0.93, 0.96, 0.89) among shelf life, yield, hands per bunch, and pulp: peel ratio, emphasizing their interdependence. Interestingly, a strong positive correlation (R^2= 0.96) was observed between hands per bunch and pulp: peel ratio, while a negative correlation (R^2= -0.37, -0.37) was evident between the number of fingers per bunch, number of leaves per plant, and bunch maturity, suggesting that an increase in the number of fingers per bunch may lead to decreased values in these parameters.

Conclusion

In conclusion, a diverse range of Musa species was identified in the salt ecosystem of Bangladesh, with 35 germplasms noted in the study area. Promising cultivars for banana production in this challenging coastal environment were highlighted through integral conservation approaches encompassing both *in situ* and *ex situ* methods. It was found that *Musa paradisiaca* MP05, *Musa acuminata* MA17 and *Musa sapientum* MS09 demonstrated superior attributes for maximum production and profitability in terms of various parameters including leaves per plant, hands per bunch, yield, and shelf life. These cultivars show potential for cultivation by farmers in coastal salt ecosystem regions to attain high-quality banana production. Such investigations will provide valuable insights for optimizing banana cultivation practices in these challenging environments, ultimately benefiting both farmers and the agricultural sector as a whole. However, further studies are recommended to comprehensively understand the growth activity, production potentiality, adaptability capability, and fruit quality of these identified germplasms in salt ecosystem regions.

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References

Britannica, T. 2020. Banana. Encyclopedia Britannica. https://www.britannica.com/plant/banana-plant.

Bugaud, C., and Lassoudiore, A. 2005. Variability in the green shelf life of bananas in real conditions of production. *Fruits*, 60(4): 1-10.

Chang, G., Li Guo, D., Gui Mei, L., and Dai Dong, W. 2011. A comparative experiment on field performance of new banana varieties. *Journal of Southern Agriculture*, 42(9): 1116-1118.

Chao, A., and Chiu, C.H. 2016. Species Richness: Estimation and Comparison. Wiley StatsRef: Statistics Reference Online, John Wiley & Sons.

FAO (Food and Agriculture Organization), 2020. Banana Statistical Compendium 2019.

Flanagan, N.S., Chavarriaga, P., and Mosquera-Espinosa, A.T. 2019. Conservation and sustainable use of vanilla crop wild relatives in Colombia. In: D. Havkin-Frenkel, F.C. Belanger (Eds), Handbook of Vanilla science and technology, 2nd Edn. pp. 85–109. John Wiley & Sons.

Gaidashova, S.V., Karemera, F., and Karamura, E.B. 2008. Agronomic performance of introduced banana varieties in lowlands of Rwanda. *African Crop Science Journal*, 16(1): 9-16.

Gervacio, D.D., Dawi, N.M., Fabrcgar, E.G., Molina, A.B., and Den Bergh, I.V. 2008. Agronomic performance of selected local and introduced banana cultivars (Musa spp.) under commercial management practices in Davao, Philippines, *Philippine Journal of Crop Science,* 33(3): 71-81.

Halder, I.K., Faziul Kabir, A.H.M., Sarker, J.U., Sultana, D., and Islam, Z. 2003. Growth and yield of banana cultivars in relation to nitrogen fertilization in brown hill soils. *Asian Journal of Plant Sciences*, 2: 963-967.

Hoque, M.A. 2008. Banana research and development in Bangladesh. Proceedings of the 6th BAPNET (Biodiversity international) steering Committee meeting in Tiruchirapalli, held on 22-25 October 2008, Tamil Nadu, India.

Hossain, M.F. 2014. A study of banana production in Bangladesh area, yield, and major constraints. *Journal of Agricultural and Biological Science*, 9(6): 206-210.

Hunter, D., and Heywood, V.H. 2011. Crop wild relatives: A manual of in situ conservation. Earthscan Publications.

Krishnamoorthy, V., and Kuma, N. 2004. Evaluation of parental banana varieties and new hybrids regarding potential yield and resistance to Sigatoka and nematode in India. *Fruits*, 59(3): 159-168.

Kumar, K.P.S., Bhowmik, D., Duraivel, S., and Umadevi, M. 2012. Traditional and medicinal uses of banana. *Journal Pharmacognosy and Phytochemistry*, 1: 51-63.

Liu, A.Z., Li, D.Z., and Li, X.W. 2002. Taxonomic notes on wild bananas (Musa) from China. *Botanical Bulletin of Academia Sinica*, 43: 77–81.

Malik, S.K., Chaudhury, R., Dhariwal, O.P., and Bhandari, D.C. 2010. Genetic Resources of Tropical Underutilized Fruits in India. National Bureau of Plant Genetic Resources, Pusa campus, New Delhi, India.

Merritt, D.J., Hay, F.R., Swarts, N.D., Sommerville, K.D., and Dixon, K.W. 2014. Ex situ conservation and cryopreservation of orchid germplasm. *International Journal of Plant Sciences*, 175(1): 46–58.

Millat-e-Mustafa, M. 1997. Floristic and indigenous management techniques of home gardens in Bangladesh. In Alam *et al.* (ed.). Agroforestry: Bangladesh perspective. APAN/ NAWG/BBARC. pp. 34-63.

Mimi, M.A. 2013. Study of shelf life and quality of different banana varieties. MS Thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh.

Noupadja, P., and Tomekpe, K. 2001. Agronomic performance of IITA's improved Musa germplasm at CRBP, Njombé, Cameroon. *African Crop Science Journal,* 9: 481-486.

Rashid M.H. 2013: Effects of different postharvest treatments and varieties on quality of banana, MS Thesis, Department of Horticulture, Bangladesh Agricultural University Mymensingh.

Rasmussen, H.N., Dixon, K.W., Jersakova, J., and Tesitelova, T. 2015. Germination and seedling establishment in orchids: a complex of requirements. *Annals of Botany*, 116: 391–402.

Sagar, B.S., Raju, B., and Sahithya, B.R. 2017. Evaluation of banana genotypes under northern dry zone of Karnataka for yield and returns. *International Journal of Current Microbiology and Applied Sciences*, 6(6): 255-262.

Sardos, J., Christelova, P., Cizkova, J., Paofa, J., Sachter-Smith, G.L., Janssens, S.B., Rauka, G., Ruas, M., Daniells, J.W., Dolezel, J., and Roux, N. 2018. Collection of new diversity of wild and cultivated bananas (*Musa* spp.) in the Autonomous Region of Bougainville, Papua New Guinea. *Genetic Resources and Crop Evolution*, 65: 2267–2286.

Shaibu, A.A., Maji, E.A., and Ogburia, M.N. 2012. Yield evaluation of plantain and banana landraces and hybrids in humid agro ecological zone of Nigeria. *Journal of Agricultural Research and Development*, 2(3): 074-079.

Tigabu, B., Fisseha, M., Tilahun, M., and Kebedom, A. 2015. Participatory evaluation of banana (*Musa paradisiaca* L var. *sapiertum*) production constraints and scaling up of improved banana cultivars in Gedeo Zone Southern Ethiopia. *International Journal of Life Sciences*, 4(4): 197-201.

Wilberforce, T., Michael, T., Moses, N., Robooni, T., Alex, B., Ssalil, T., Jerome, K., Jim, L., and Rony, S. 2015. Performance of NARITA banana hybrids in the preliminary yield trial, Uganda. Ugandan National Agricultural Research Organization (NARO) and the International Institute of Tropical Agriculture (IITA), pp. 1-33.

Yoseph, T., Shiferaw, W., Sorsa, Z., Simon, T., Shumbullo, A., and Solomon, W. 2014. Adaptability study of banana (*Musa paradisiaca* var. *sapiertum*) varieties at Jinka, Southern Ethiopia. *American Journal of Agriculture and Forestry*, 2(6): 250-255.