



The Other Eggplant: Breeding African Eggplant (*Solanum aethiopicum*) Through Diversity, Genetics and Adaptation

*Solanki Bal

Assistant Professor, School of Smart Agriculture, Adamas University, Kolkata, India

*Corresponding Author's email: solanki.b@adamasuniversity.ac.in

African eggplant (*Solanum aethiopicum*) comprises four diverse groups—Gilo, Shum, Kumba and Aculeatum—differing in plant architecture, fruit and leaf traits, and use. This variability provides raw material for breeding, with morpho-agronomic studies identifying key discriminators among accessions. Systematic germplasm characterization and multi-environment evaluation are essential to distinguish genetic from environmental effects and organize material into functional categories: high-yielding, early-maturing, stress-resilient, leafy types and diverse parents for hybridization. Reproductive biology varies among genotypes, influencing crossing success; thus, flowering time, pollen viability and compatibility should be evaluated before hybridization. Selection builds on farmer preferences for yield, leaf quality, pest and drought tolerance, while hybridization combines complementary traits unattainable through selection alone. African eggplant serves as a donor for disease resistance and adaptation in other eggplants via pre-breeding and backcrossing. Leaf traits offer additional breeding objectives, particularly for Shum types. Multi-trait selection integrating stress response, reproductive stability and horticultural value is crucial for climate resilience. Genomic resources, including a draft genome and millions of SNPs, support marker-assisted selection but must complement field phenotyping. A coordinated breeding pipeline should assemble diversity, characterize morphologically and physiologically, screen for stresses, evaluate reproduction, select parents, hybridize, advance lines through selection and backcrossing, validate with farmers and consumers, and integrate genomics. Genome editing remains a future possibility after foundational breeding establishes trait inheritance. African eggplant's strength lies in its diversity, which should be utilized intelligently rather than erased for uniformity, transforming it from a farmer-maintained resource into a systematically bred crop for hotter, variable environments.

A Crop Defined by Diversity

African eggplant is traditionally grouped into four categories—Gilo, Shum, Kumba and Aculeatum—each differing markedly in plant architecture, leaf characters, fruit size, shape, colour, texture and use. Gilo types are primarily fruit crops with fleshy, variably shaped fruits. Shum types are grown mainly for their tender leaves and bear relatively small fruits. Kumba types produce broad, often deeply grooved fruits and are also valued as leafy vegetables. Aculeatum types are prickly forms of interest for breeding and rootstock research (Figure 1).

This variation is not botanical curiosity; it is the raw material for breeding (Bal et al. 2019; Bal et al. 2020, Bal et al. 2022). Morpho-agronomic studies have identified fruit length, calyx length, leaf length and related traits as key discriminators among accessions, revealing substantial phenotypic plasticity and geographical variation (Bal et al. 2019). Rather than searching for a single "best" African eggplant, breeders should ask what each accession can contribute: high yield, earliness, drought resilience, leaf quality, pest tolerance or desirable fruit characteristics.

From Germplasm to Breeding Material

Genetic diversity becomes valuable only when systematically characterized and evaluated (Bal et al. 2020, Bal et al. 2021). Accessions must be tested under comparable conditions so that genetic differences can be distinguished from environmental effects. Repeated, multi-environment evaluation is essential because a genotype performing well in one setting may behave differently under combined stresses (Bal et al., 2022; Bal et al. 2023, Amir et al. 2023). A practical breeding programme can organize germplasm into functional categories: high-yielding fruit types, early-maturing lines, long-duration types, large- and small-fruited forms, high-fruit-set genotypes, leafy vegetable types, heat- and drought-resilient material, pest- and disease-tolerant accessions, and genetically diverse parents suitable for hybridization (Bal et al., 2022; Bal et al. 2023, Amir et al. 2023). This shifts the question from "Which accession is superior?" to "What can this accession contribute?"

Flowering Biology as a Breeding Trait

African eggplant also offers an interesting system for studying reproductive biology. Research examining eight genotypes found variation in floral morphology, phenology and cross-compatibility. The species is predominantly self-pollinating and self-compatible, with heterostylous flowers, but some cross combinations show incompatibility linked to pollen–pistil interactions. This has practical implications. Before establishing large hybridization programmes, breeders should evaluate flowering time, floral morphology, pollen viability, stigma receptivity, pollen germination, pollen-tube growth, fruit set and seed set (Bal et al. 2025). Such information makes crossing programmes more efficient and suggests that reproductive biology itself can become a breeding trait (Bal et al. 2024, Bal et al. 2025). For instance, if one genotype flowers early and another late, synchronization may be necessary; if pollen viability varies strongly, appropriate pollen donors and pollination windows must be identified.

Selection: The First Breeding Tool

African eggplant has a long history of farmer selection. Farmers have chosen plants based on yield, leaf production, fruit characteristics, taste, pest and disease response, drought tolerance and market preference (Bal et al. 2022). Studies of farmer preferences in the Shum group show that pest resistance, disease resistance, drought tolerance, leaf yield and leaf texture strongly influence genotype choice. Formal breeding programmes can build on this foundation. Selection can begin with individual-plant selection within heterogeneous populations, followed by progeny testing (Bal et al. 2021, Bal et al. 2022). Superior plants are advanced through successive generations, with emphasis on traits that remain stable across environments (Bal et al. 2020, Bal et al. 2021, Bal et al. 2022). For quantitative characters such as yield and fruit number, selection should be based on replicated, multi-environment evaluation. The goal is not simply to select an attractive plant but to identify a genotype whose desirable performance can be reproduced (Bal et al. 2025).

Hybridization: Combining What Selection Cannot

Selection is powerful when desirable traits already occur together, but what happens when they do not? Suppose one accession has excellent fruit quality but poor drought tolerance, another maintains fruit set under heat but produces unpalatable fruits, and a third has useful pest tolerance but late maturity. No single selection contains all three traits. Hybridization addresses this by combining complementary traits (Bal et al. 2025, Bal and Sharangi 2025). A basic breeding pathway involves crossing Parent A with Parent B to produce an F_1 , advancing to F_2 and subsequent generations, selecting within segregating populations and developing elite lines. Success depends on choosing parents for complementary rather than merely contrasting traits (Bal et al. 2024, Bal et al. 2025). Genetic divergence can assist parent selection, but divergence alone should never become the breeding objective; a genetically distant parent is useful only when it contributes a desirable trait (Bal et al. 2026).

For African eggplant, crossing could be designed around specific combinations: heat tolerance plus fruit quality, drought tolerance plus high fruit set, early maturity plus high yield, disease resistance plus desirable fruit type, leaf yield plus leaf quality, or pest resistance plus market-preferred fruit characteristics. This trait-combination approach transforms enormous diversity into a structured breeding resource.

Breeding for Pest and Disease Response

African eggplant has attracted interest as a source of disease resistance in other solanaceous crops, with reports of useful responses to several pests and diseases. The draft genome of *S. aethiopicum* identified numerous disease-resistance-related genes, while resequencing of *S. aethiopicum* and *S. anguivi* genotypes generated millions of SNPs, including variants within disease-resistance genes. However, identifying a resistance-associated gene is not the same as producing a resistant variety (Bal et al. 2024; Bal, 2025). The breeding pathway still requires screening, confirmation, inheritance analysis, donor identification, hybridization, selection and validation (Bal and Sarangi, 2026). Resistance must also be combined with horticultural performance; a highly resistant plant with poor fruit quality has little value to farmers or consumers. The real breeding target is resistance plus acceptability.

African Eggplant as a Donor for Eggplant Improvement

Perhaps the most interesting aspect of *S. aethiopicum* is that its value extends beyond developing improved African eggplant varieties. It can also contribute to broader eggplant improvement. The close relationship among cultivated and related *Solanum* species has encouraged efforts to transfer useful traits between eggplant relatives. In particular, *S. aethiopicum* has been used as a source of resistance traits in breeding involving *S. melongena*, including efforts related to *Fusarium* wilt resistance. This places African eggplant within the larger concept of pre-breeding. Pre-breeding does not necessarily aim to produce a commercial cultivar immediately; instead, its purpose is to capture a useful trait from genetically diverse material and make that trait available in a breeding-friendly background. The pathway involves crossing an African eggplant donor with an elite eggplant, generating a segregating population, selecting for the target trait, backcrossing or recombining to recover the desirable horticultural background and developing advanced breeding lines. This is especially valuable when the donor has an important adaptive trait but poor commercial characteristics. A donor does not need to be a perfect variety; it only needs to carry something worth saving.

Backcross Breeding for Trait Introgression

When a specific trait has been identified, backcross breeding provides a practical route for transferring it into an elite background. For example, consider an African eggplant genotype showing strong resistance to a particular pathogen but having undesirable fruit characteristics. The breeder could cross an elite cultivar with the resistant donor, then repeatedly backcross the resulting F_1 to the elite parent while selecting for the resistance trait. With each generation, the breeder aims to recover more of the elite parent's horticultural background while retaining the desired donor-derived character, following the sequence $F_1 \rightarrow BC_1 \rightarrow BC_2 \rightarrow BC_3 \rightarrow \text{selection} \rightarrow \text{elite-derived resistant line}$ (Figure 2). The exact number of backcrosses depends on the trait, inheritance pattern and breeding objective. Where molecular markers are available, they can make this process more precise by assisting selection for the target genomic region and monitoring recovery of the elite background (Bal, 2025).

The Hidden Value of Leaf Traits

African eggplant also challenges the conventional definition of what an eggplant variety should look like. In many breeding programmes, the fruit receives most of the attention, but some *S. aethiopicum* groups are cultivated substantially for their leaves. The Shum group, in particular, is strongly associated with leafy vegetable use.

This opens another breeding pathway. Instead of focusing exclusively on fruit yield plus fruit quality, breeding objectives can include leaf yield, leaf tenderness, leaf texture, repeated harvest ability, nutritional quality and pest resistance. This is particularly relevant in regions where leafy vegetables provide an important component of household nutrition. Therefore, African eggplant improvement should not simply copy the breeding model developed for *S. melongena*; the breeding objective should reflect how the crop is actually used.

Multi-Trait Breeding for a Changing Climate

Future African eggplant varieties will need to perform under increasingly variable environments. Climate adaptation is rarely controlled by a single trait; a useful genotype may need to combine heat tolerance, drought adaptation, stable flowering, good pollen function, high fruit set, acceptable fruit quality, pest and disease resistance, efficient water use, stable yield and farmer and consumer preference. These traits may not be genetically associated in a favourable way, and selection for one character can sometimes produce undesirable changes in another. Breeding should therefore gradually move towards multi-trait selection. A simple conceptual breeding index could combine reproductive performance, stress response and horticultural value rather than selecting only for fruit yield. For example, an adaptation score might integrate stress performance, fruit-set stability, yield, quality and resistance, with weighting depending on the breeding target and production environment (Bal and Sharangi, 2025). The important point is that adaptation should be treated as a combination of traits rather than as a single visual character.

Molecular Diversity: From Morphology to Genomics

Morphological characterization remains indispensable, but molecular tools can reveal diversity that may not be obvious from field observation alone. Earlier studies established substantial variation among African eggplant materials using morphological and genetic approaches. More recently, genomic resources have expanded considerably: a draft genome of *S. aethiopicum* of approximately 1.02 Gb was assembled with more than 37,000 predicted gene models, resequencing of 65 *S. aethiopicum* and *S. anguivi* genotypes identified more than 18 million SNPs, and a pan-genome analysis further expanded the known gene repertoire. These resources change the breeding landscape. Molecular markers can help breeders assess genetic relationships, confirm parental identity, identify duplicates in germplasm collections, characterize population structure, track donor segments, construct genetic maps, identify genomic regions associated with important traits and support marker-assisted selection. However, molecular information should complement field evaluation rather than replace it; a SNP does not produce a variety, and a breeder still has to grow the plant.

A Breeding Pipeline for African Eggplant

A practical breeding programme could integrate these approaches into a single pipeline. First, assemble diverse *S. aethiopicum* material representing Gilo, Shum, Kumba and Aculeatum groups. Second, conduct morphological characterization by recording plant architecture, leaf traits, flowering behaviour, fruit size, shape, colour, maturity and yield. Third, perform physiological screening by evaluating selected accessions for heat, drought and combined-stress responses. Fourth, carry out reproductive evaluation by measuring flowering time, pollen viability, stigma receptivity, fruit set and seed production. Fifth, conduct pest and disease screening to identify accessions with reproducible resistance or tolerance to priority biotic stresses. Sixth, select parents based on complementary traits rather than simply maximum genetic distance. Seventh, generate F₁ and segregating populations from carefully selected parental combinations through hybridization. Eighth, select plants combining adaptation, reproductive stability, yield and quality. Ninth, where a valuable trait occurs in an agronomically poor donor, use backcrossing or recurrent selection to transfer it into an elite background through pre-breeding. Tenth, use SNPs and other genomic resources to understand diversity and assist selection through molecular characterization. Eleventh, test

advanced lines across environments and seasons through multi-environment evaluation. Twelfth, evaluate not only yield but also traits that determine actual adoption—taste, fruit appearance, leaf quality, harvest duration and market preference—through farmer and consumer validation. This last step is particularly important. A breeder may define a successful genotype differently from a farmer. For the breeder, it may be a high-yielding, genetically uniform line; for the farmer, it may be the plant that survives drought, produces repeatedly and sells well; for the consumer, taste and appearance may matter most. A successful variety has to bring these perspectives together.

Genome Editing: A Future Possibility, Not the Starting Point

Genome editing may eventually become relevant to African eggplant improvement. Once the genetic basis of important traits becomes sufficiently understood, targeted editing could theoretically be used to modify specific genes associated with disease resistance, plant architecture, fruit quality, flowering or stress responses. But genome editing should not be the first step. For an underutilized crop, the immediate priorities are more fundamental: collect, characterize, phenotype, understand inheritance, identify useful variation and develop breeding populations. Only after these foundations are established can advanced molecular approaches be used efficiently. The availability of genome and SNP resources makes this future increasingly realistic, but field-based breeding remains essential.

The Bigger Opportunity: Breeding the "Other Eggplant"

African eggplant does not need to become another *Solanum melongena*. Its strength lies precisely in being different. Its diversity includes fruit types that differ dramatically from conventional brinjal; some forms are valued primarily for leaves, some have distinctive fruit morphology and others possess traits that have attracted interest for resistance breeding and adaptation. The objective should therefore not be to erase this diversity in the name of uniformity. Instead, breeding should use diversity without losing it. That means maintaining representative germplasm, identifying useful donors, documenting farmer preferences, developing breeding populations and preserving unusual traits that may become valuable under future climates. The genetic diversity of African eggplant is not merely a collection of different-looking plants; it represents different combinations of genes, physiological responses and adaptation strategies.

Future Directions

A coordinated breeding strategy for *S. aethiopicum* could focus on five interconnected areas. First, build better core collections by characterizing large germplasm collections and developing representative core sets to make systematic screening more manageable. Second, connect morphology with physiology by evaluating fruit and leaf traits together with physiological indicators of heat and drought adaptation. Third, breed for reproductive stability by giving greater attention to flowering, pollen viability and fruit-set behaviour, particularly under high-temperature environments. Fourth, strengthen pre-breeding by transferring useful resistance and adaptation traits into elite genetic backgrounds rather than leaving them confined to unadapted donors. Fifth, integrate genomics with field breeding by using SNP resources, genome information and molecular markers to accelerate parent selection, genetic mapping and trait introgression while remaining closely linked with field phenotyping. Together, these approaches can transform African eggplant from a largely farmer-maintained genetic resource into a more systematically utilized breeding crop.

Conclusion

African eggplant (*Solanum aethiopicum*) differs fundamentally from familiar brinjal, shaped by farmers and environments into four diverse groups—Gilo, Shum, Kumba and Aculeatum. Its greatest breeding value lies not in novelty but in variability, offering opportunities for selecting fruit quality, yield, maturity, leaf production, stress adaptation and disease resistance. Physiological screening reveals how genotypes maintain growth and reproduction under heat and drought, while reproductive biology influences hybridization success. Beyond

its own improvement, African eggplant serves as a donor for resistance and adaptation traits in other eggplants. Modern genomics, including draft genomes and extensive SNPs, enhances breeding precision, but intelligent use of diversity remains central. Morphology, genetics and genomics together enable breeders to assemble resilient, high-performing varieties for increasingly demanding production environments.

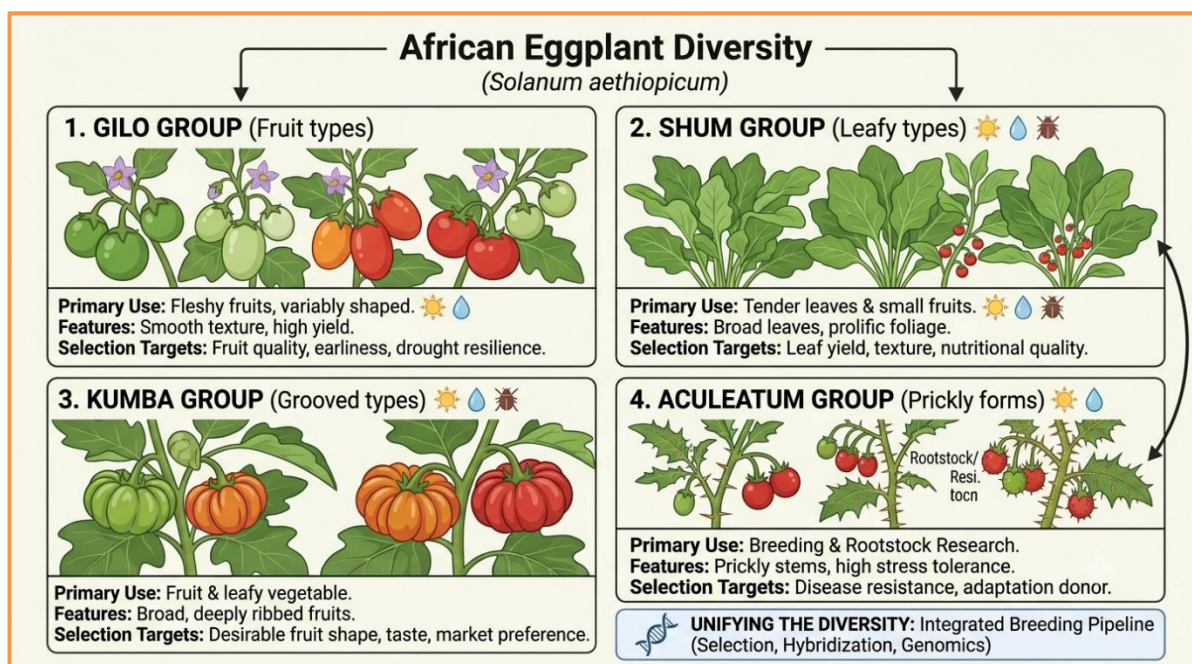


Figure 1: Cultivar Groups and Diversity Spectrum of *Solanum aethiopicum*

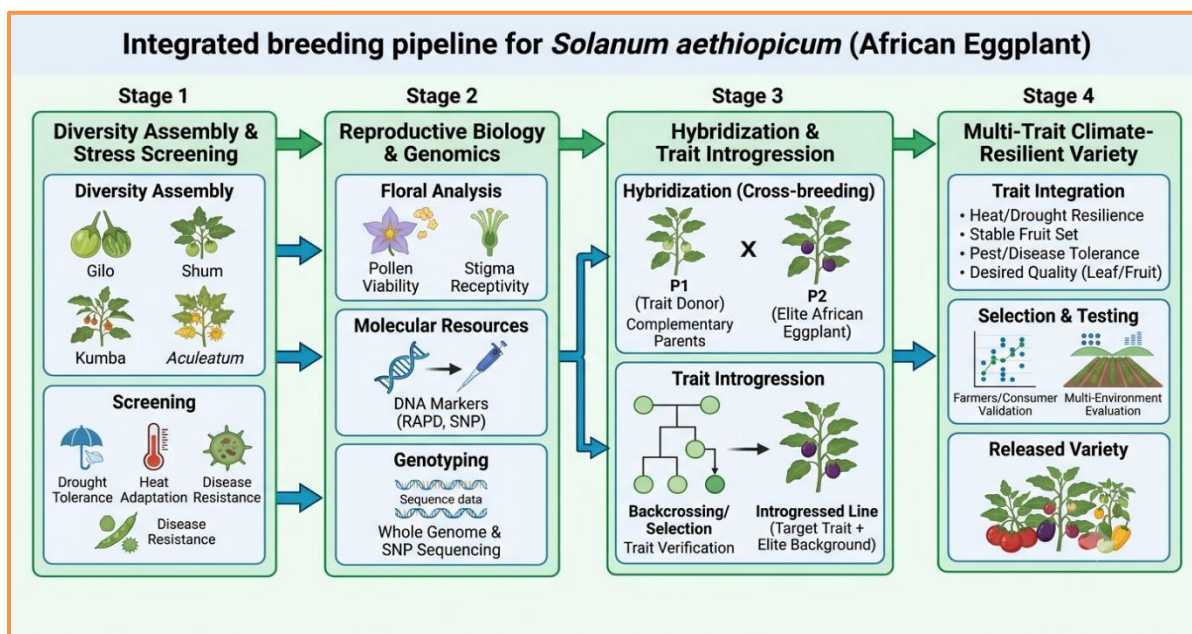


Figure 2: Integrated Breeding Pipeline and Trait Introgression

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