
**ISSN Print:** 2664-844X
**ISSN Online:** 2664-8458
NAAS Rating (2025): 4.97
IJAFS 2025; 7(12): 776-780
www.agriculturaljournals.com
Received: 11-11-2025
Accepted: 13-12-2025

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# Beejamrit: An Eco-Friendly Seed Biopriming Tool for Sustainable Agriculture

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**DOI:** https://www.doi.org/10.33545/2664844X.2025.v7.i12i.1106

**Abstract**
Agriculture today increasingly depends on sustainable practices that boost productivity while reducing reliance on chemical inputs. Bio liquid fertilizers have emerged as environmentally friendly alternatives capable of improving soil health and crop performance. Within this category, seed treatments play a pivotal role in ensuring uniform germination and vigorous early growth. Beejamrit, a traditional cow-based bio liquid formulation, used in natural and zero-budget farming systems has gained attention as a potential low-cost, eco-friendly seed treatment. Despite its widespread traditional use, scientific literature on Beejamrit remains scattered, limited, and largely unstandardized, with key research gaps such as inadequate microbial profiling, absence of standardized preparation, minimal mechanistic studies, and limited evaluation under stress conditions. This review consolidates available knowledge on Beejamrit's composition, microbiological properties, mechanisms of action, and effects on seed physiology, positioning it as a promising yet underexplored traditional biostimulant for sustainable seed management and low-input agriculture while underscoring the need for rigorous scientific validation.

**Keywords:** Agriculture, Beejamrit, Cowpathy, Seed biopriming

## Introduction
The global agricultural sector faces the dual challenge of meeting rapidly increasing food demand while simultaneously mitigating the severe environmental degradation caused by intensive, chemical-based farming practices. Decades of reliance on synthetic fertilizers, pesticides, and growth regulators have led to widespread deterioration of soil health, loss of microbial biodiversity, water contamination, and a decline in the nutritional quality of produce.

Seed health and early seedling vigour are among the most critical determinants of crop success, influencing germination rate, uniform establishment, early growth, and ultimately yield. Conventional seed treatments often rely on chemical fungicides or synthetic growth promoters, which may carry environmental, ecological and health risks. In recent years, there has been growing interest in using traditional, natural seed-treatment formulations that are economical, sustainable, and biologically active.

Cows play an important role in our lives and biodiversity. Its offspring and cowpathy have a wide range of applications, including sustainable agriculture, human health and nutrition, biofertilizer production, non-conventional energy production, and ecosystem biodiversity preservation. Different local formulations were found to be effective in various crops, resulting in improved plant development and, as a result, agricultural output. Among these, Beejamrit is a traditional cowpathy preparation, has emerged as a powerful seed-biopriming agent with significant potential for ecological agriculture. In the current scenario of declining soil fertility, rising input costs, and environmental degradation, Beejamrit represents a promising, science-supported alternative (Anjali and Kaushal, 2022) [1].

In the Sanskrit language, *Beejamrit* refers to *Beej* (meaning seed) dipped into *Amrit* (meaning magical liquid). It is a homemade organic input primarily made up of cow dung and cow urine. This dairy excreta-based preparation is further enriched overnight with virgin forest soils, and in some cases, with limestone. An earlier report has shown that the *Beejamrit* formulation is a consortium of different types of microflora, including several plant growth-promoting bacteria, and is also capable of producing plant growth regulators (Sreenivasa *et al.*, 2009; Sharma *et al.*, 2021) [15-13].

In India, the final organic formulation is widely recommended for seed treatment to protect seeds from pathogens. In addition, Beejamrit has also been reportedly keeping the young roots and rootlets away from disease-causing microbes and hence is classified as an organic pesticide (Sreenivasa *et al.,* 2009) [15]. Apart from its role as a seed protectant, this organic tonic is also recommended as a foliar spray on agricultural farms, particularly for vegetables and fruit crops (Chadha *et al.,* 2012; Devakumar *et al.,* 2014) [3, 5]. Despite its growing use in natural farming, scientific research on Beejamrit remains limited. This review compiles current knowledge on Beejamrit its preparation, properties, and effects on germination, seedling vigour, crop growth and soil health while noting key research gaps such as formulation variability. By bringing these insights together, it provides a clear scientific basis for strengthening and expanding the use of Beejamrit in sustainable agriculture.

## Origin and Concept of Beejamrit

The origins of Beejamrit are deeply rooted in India's traditional agricultural wisdom, particularly the ancient science of Vrikshayurveda, which translates to "the science of plant life." Vrikshayurveda texts, some dating back over a millennium, describe holistic methods to enhance soil fertility, improve seed vitality, and protect crops using naturally available materials derived from plants, animals, and the environment. (Nayak, 2019) [10]. These early treatises emphasize that healthy crops begin with healthy seeds, underscoring the importance of beeja-shuddhi (seed purification) and beeja-sansthana (seed energization) through biological preparations.

Beejamrit emerges from this philosophical foundation. Although its current formulation popularized through natural farming movements such as those led by Subhash Palekar is modern in structure, the underlying concept aligns seamlessly with Vrikshayurveda's principles of restoring life forces (prana) within seeds. From a Vrikshayurveda perspective, Beejamrit functions as both a seed purifier and a seed protector, much like the traditional practices of soaking seeds in herbal extracts, cow-based formulations, or plant ash described in classical texts such as Surapala's Vrikshayurveda and Kashyapiya Krishi-Sukti. These texts highlight the importance of revitalizing the seed's internal energy and ensuring its resilience against diseases before sowing. Thus, Beejamrit represents the continuation of an ancient ecological philosophy, blending traditional Vrikshayurveda knowledge with contemporary natural farming. It reflects a holistic understanding that seeds, soil, and microorganisms must function in harmony to promote healthy, sustainable, and chemical-free agriculture. Emerging interest in natural and regenerative agriculture, including movements such as Zero Budget Natural Farming (ZBNF), has brought renewed attention to Beejamrit. Under these systems, Beejamrit is promoted as a low-cost, accessible, and biologically active alternative to chemical seed treatments. Its widespread adoption highlights its cultural significance, traditional knowledge base, and its potential role in supporting sustainable crop production. (Mohan *et al.,* 2024; Patel *et al.,* 2025) [8, 11]

## Composition, Preparation and Storage of Beejamrit

Beejamrit is a fermented, cow-based bio-input prepared using naturally available materials, most of which originate from indigenous cow-based farming systems. Its composition includes five major components: cow dung, cow urine, a small quantity of local soil, accompanied by lime and water to support microbial activation and fermentation (Vrushabh *et al.,* 2023; Kumar *et al,* 2022) [17, 7]. Each ingredient contributes specific microbiological or biochemical functions that make Beejamrit an effective seed-priming agent.

### Composition

a) **Cow dung:** Serves as the natural source of micronutrients, macronutrients, and beneficial bacteria, enhancing soil quality and providing seeds with essential nutrients for growth It also provides organic carbon and micronutrients.
b) **Cow urine:** Acts as a source of nitrogenous compounds, minerals, and antimicrobial agents such as urea, phenols, and salts. It stimulates microbial multiplication during fermentation.
c) **Local soil (preferably forest soil):** Adds native microbial diversity and introduces beneficial spores that enrich the microbial consortium.
d) **Calcium Carbonate (Limestone):** Helps maintain pH balance, supports microbial activity, and improves the stability of the formulation.
e) **Water:** Provides the medium for microbial fermentation and mixing of all components.

**Table 1:** Composition of Beejamrit (Choudhary, 2023) [4]

| Sr. No. | Ingredients | Quantity |
|---|---|---|
| 1) | Indigenous (Desi) Cow Dung | 5kg |
| 2) | Cow Urine | 5L |
| 3) | Lime | 50g |
| 4) | Soil | 50g |
| 5) | Water | 20L |

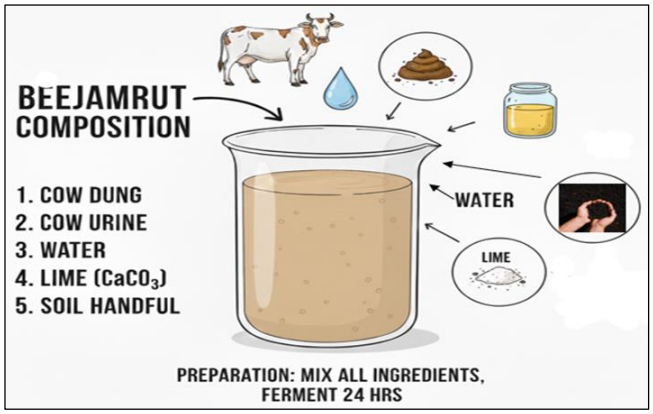


**Fig1:** Composition of Beejamrit

### Preparation Method

The standard preparation of Beejamrit involves simple mixing and short-term fermentation **(**Bhoi *et al.,* 2025; Mukherjee *et al.,* 2022) [2, 9]. A commonly recommended procedure is as follows:

a) **Mixing:** Add approximately 5kg of fresh cow dung into 20 litres of water in a clean container. Stir thoroughly to create a uniform slurry.
b) **Addition of ingredients:** After preparing the dung water slurry, 5litres of cow urine are added to stimulate microbial growth, followed by the addition of a handful (50g) of local or forest soil to enhance microbial

diversity. Finally, about 50 g of lime, previously dissolved in a small amount of water, is incorporated into the mixture to help stabilize the pH and support overall microbial activity.

c) **Fermentation:** The incubation process was conducted in a closed container under static conditions at ambient temperatures ranging from 25 to 30 °C. The mixture is stirred in both clockwise and anticlockwise directions for 2-3 minutes twice daily and subsequently allowed to ferment for 24-48 hours in a shaded environment. This fermentation period facilitates active microbial proliferation and enhances the enzymatic activity of the formulation.

d) **Filtering:** Before application, the solution is typically filtered using a fine cloth or sieve to remove any large organic particles, which prevents clogging of spraying or application equipment.

e) **Application:** After fermentation, the seeds are either soaked in the Beejamrit solution for 30-40 minutes or uniformly coated before sowing, and the formulation is best used fresh to ensure maximum effectiveness.

**Storage and Shelf Life**

**Storage:** Beejamrit should be stored in cool, shaded conditions in the non-metallic container, maintaining aeration to prevent the establishment of anaerobic conditions, which could harm aerobic beneficial bacteria. (Mukherjee *et al.*, 2022) [9].

**Shelf Life**

While traditional practice often suggests a very short shelf life (sometimes only 24 to 48 hours) to ensure the microbial population is at its most active, scientific studies have shown that the solution, when stored properly, can retain significant microbial load for a longer duration. However, for maximum potency and field performance, it is generally recommended to use Beejamrit within 2 days of preparation. Using freshly prepared Beejamrit ensures that the plant is exposed to the highest possible number of viable, active Plant Growth-Promoting Bacteria (PGPB) and Phytohormones. (Mukherjee *et al.*, 2022) [9].

**Biochemical and Microbial Composition of Beejamrit**

The efficacy of Beejamrit is fundamentally rooted in its complex and dynamic biochemical and microbial composition, moving beyond anecdotal evidence to verifiable scientific validation. Research conclusively characterizes Beejamrit as a potent consortium of beneficial microflora, sourced primarily from the naturally diverse ecosystem of desi cow dung, cow urine, and local field soil. Scientific investigations consistently confirm that the formulation constitutes an enriched microbial niche containing a significant population of Plant Growth-Promoting Bacteria (PGPB). Specifically, it is highly abundant in key functional groups crucial for sustainable agriculture, including Free-Living Nitrogen Fixers (FNFs) and Phosphate Solubilizing Bacteria (PSBs). Authentic data from microbial studies indicates that the population density of these beneficial bacteria is maximized, reaching its peak effectiveness, after approximately 24 to 48 hours of incubation, emphasizing the critical role of the incubation period. (Mukherjee *et al.*, 2022) [2]. Furthermore, Beejamrit functions as an effective natural bio-stimulant due to its rich biochemical profile. Analysis has demonstrated it to be a viable source of endogenous Phytohormones and essential growth compounds. Most notably, the formulation yields significant quantities of Indole Acetic Acid (IAA), a powerful auxin and critical Plant Growth Regulator (PGR). The presence of IAA directly supports crucial physiological processes such as cell elongation, enhanced root architecture, and improved seed germination viability. Consistent with the microbial findings, the highest concentration of IAA is also observed following 4 to 5 days of microbial decomposition, suggesting a direct synthesis of this vital hormone by the proliferating beneficial bacteria. Thus, Beejamrit is accurately recognized as a sophisticated, microbe-based biological starter culture that not only protects the seed but actively programs it for optimal growth. (Vrushabh *et al.*, 2023; Mukherjee *et al.*, 2022) [17, 9]

**Table 2:** Nutrient content of Beejamrit (Sreenivasa *et al.*, 2009) [15]

| Sr. No. | Parameter | Content |
|---|---|---|
| 1. | pH | 8.2 |
| 2. | EC | 5.5dSm$^{-1}$ |
| 3. | Total Nitrogen | 40ppm |
| 4. | Total Phosphorous | 155.3ppm |
| 5. | Total Potassium | 252.0ppm |
| 6. | Total Zinc | 2.96ppm |
| 7. | Total Copper | 0.52ppm |
| 8. | Total Iron | 15.35ppm |
| 9. | Total Manganese | 3.32ppm |

**Significance of Beejamrit**

a) **Enhancing Seed Germination & Early Growth:** Beejamrit enhances seed germination and early seedling growth by delivering a rich load of beneficial microbes that activate the seed surface. These microbes improve water uptake, trigger key enzymes, and promote faster root initiation, resulting in quicker, stronger, and more uniform seedling emergence. Studies on crops like green gram and cowpea consistently show superior vigour and early establishment in Beejamrit-treated seeds. (Mukherjee *et al.*, 2022; Sreni *et al.*, 2023) [9, 16].

b) **Protection Against Fungal Diseases:** Beejamrit protects seeds and seedlings against fungal diseases through its microbial and biochemical components. Beneficial microbes compete with pathogens and produce antimicrobial compounds, while cow urine adds natural fungicidal activity, reducing damping-off and seedling infections. This combined action enhances seedling survival and early plant health. (Mukherjee *et al.*, 2022) [9]

c) **Low-Cost Alternative to Chemical Seed Treatments:** Beejamrit offers a low-cost, eco-friendly alternative to chemical seed treatments by combining beneficial microbes, natural nutrients, and bioactive compounds. It enhances seed germination, protects against pathogens, and stimulates early growth, all without the environmental or health risks associated with synthetic chemicals. Its affordability and accessibility make it particularly valuable for smallholders and organic farming systems. (Vrushabh *et al.*, 2023) [17]

d) **Supporting Natural & Zero-Budget Farming Systems (ZBFS):** Beejamrit supports natural and zero-budget farming systems by offering a locally prepared, sustainable seed treatment that reduces reliance on synthetic chemicals. It enhances seed germination, strengthens early plant growth, improves soil microbial

health, and fits seamlessly into eco-friendly agricultural practices promoted in organic and regenerative farming models. (Shyamsunder and Menon, 2021; Patel *et al.*, 2025) [14, 11].

**e) Microbial Inoculation / Bio-Priming:** Beejamrit functions as a natural microbial inoculant, coating seeds with a diverse community of beneficial bacteria and fungi. This bio-priming enhances nutrient availability, stimulates enzymatic and hormonal activity, improves seed germination, and strengthens early seedling vigor. By establishing a healthy seed and rhizosphere microbiome, Beejamrit supports faster, more uniform growth and improves overall crop establishment (Mukherjee *et al.*, 2022) [9].

f) **Root Acceleration:** The phytohormones (like IAA) produced by the microbial consortium immediately available to the seed lead to an accelerated and robust root proliferation. This rapid root development is critical for efficient establishment and nutrient scouting in the initial weeks of growth (Vrushabh *et al.*, 2023; Prakash *et al.*, 2024) [17, 12].

## Limitations and Research Gaps of Beejamrit

Despite its widespread use and promising benefits, Beejamrit has several limitations and areas where research is still lacking. First, the composition and microbial population vary depending on the source of cow dung and urine, soil type, and preparation methods, leading to inconsistent efficacy. Second, there is limited standardization of preparation protocols, fermentation duration, and application doses, which affects reproducibility in different agro-ecological zones. Third, large-scale and multi-location field trials are scarce, restricting the ability to generalize findings across crops and environmental conditions. Moreover, the long-term effects on soil microbiome dynamics, nutrient cycling, and crop yield are not fully understood. While some studies indicate hormonal and enzymatic stimulation, the mechanisms of action under stress conditions (drought, salinity, pathogen pressure) remain poorly documented. Additionally, comparative studies between Beejamrit and other biofertilizers, chemical seed treatments, or modern microbial inoculants are limited. Addressing these gaps through systematic, standardized, and large-scale research will help optimize Beejamrit's preparation, application, and integration into sustainable and regenerative farming systems.

## Conclusion

Beejamrit, a key formulation within Cow Pathy and Vedic natural farming, represents a sustainable and culturally grounded alternative to chemical-intensive agriculture. Its multifaceted benefits including enhanced seed germination, suppression of soil-borne pathogens, and enrichment of soil microbial diversity position it as a valuable input for regenerative farming systems. Notably, the application of Beejamrit aligns with several United Nations Sustainable Development Goals (SDGs). It contributes to Zero Hunger (SDG 2) by improving crop establishment and productivity; Good Health and Well-Being (SDG 3) by reducing farmers' and consumers' exposure to hazardous agrochemicals associated with long-term health risks; and Responsible Consumption and Production (SDG 12) by encouraging low-input, environmentally sound cultivation practices. Furthermore, Beejamrit supports Climate Action (SDG 13) through its role in minimizing greenhouse gas emissions and enhancing soil carbon sequestration, while also promoting Life on Land (SDG 15) by restoring soil biodiversity and safeguarding terrestrial ecosystems. Together, these contributions underscore Beejamrit's potential as a holistic, eco-friendly agricultural input for advancing sustainability and resilience in modern farming.

In contrast, chemical fertilizers and pesticides have been widely documented to cause soil, water, and air pollution, while also contributing to rising incidences of non-communicable diseases through contaminated food chains. Thus, Beejamrit and other cowpathy formulations not only revitalize soil health and safeguard farmer livelihoods but also ensure safe food systems aligned with global sustainability targets. Integrating these traditional bio-inputs into modern agronomic practices is therefore not merely a return to heritage but a scientifically validated pathway toward sustainable agriculture, healthier communities, and ecological resilience.

## Future scope

Beejamrit remains unexplored in modern horticultural systems such as hydroponics, aquaponics, and vertical farming. Its integration could provide eco-friendly seed treatments, enhance microbial diversity, and improve resilience against abiotic stresses. With potential biotechnological applications for standardized formulations and biofertilizers, Beejamrit offers a promising bridge between indigenous organic wisdom and futuristic sustainable farming.

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