

Community-Based Crop-Residue Management for Open-Burning Prevention, Soil Restoration, and Climate Resilience: The BIO-NO BURN™ Case Study in Thailand

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ABSTRACT

Background

Open burning remains a low-cost but environmentally damaging method of managing crop residues in Thailand. Community enterprises may provide a locally governed alternative when residue collection, processing, quality control, and evidence systems are designed together. Objective: This case study describes the BIO-NO BURN™ model, its implementation context and management architecture, and the evidence chain used to distinguish documented organizational activity from modelled estimates and future targets.

Methods

A retrospective descriptive review was conducted using the enterprise's official performance report, registration and governance records, summarized operational records, and a 2026 project-design package. The case was examined through five evidence domains: organizational setting and geographic scope, implementation process, operational records, investigation/data checks, and documented versus prospective outcomes. Claims were classified as documented activity, modelled estimate, or planned target. No proprietary microbial formula, inoculum ratio, cultivation method, or propagation procedure was examined or disclosed.

Results

The enterprise reports a 2,500-rai pilot area in fiscal year 2025/2026, adoption of a 100% no-burn policy for that pilot, initiation of GPS/polygon data collection, and a reported 92% per-rai reduction in 46-0-0 fertilizer use relative to its internal project baseline. These results remain self-reported and require reconciliation with plot, purchase, issue, weighbridge, production, and inspection records. The case architecture specifies a six-function operating chain from participant enrolment and residue-source identification through processing, quality control, field application, and review/corrective action. A separate 12-month demonstration is designed for 100 households, approximately 220 rai (35.2 ha), four community compost hubs, 20 demonstration plots, at least 300 tonnes of residue diversion, and at least 180 tonnes of quality-controlled compost; these are prospective targets, not achieved results.

Conclusion

BIO-NO BURN™ offers a replicable governance and traceability architecture rather than a single technology. Its main contribution is the integration of community no-burn agreements, distributed processing, batch records, field application records, safeguards, and adaptive review. Environmental and greenhouse-gas claims should remain provisional until baselines, activity data, emission factors, leakage assumptions, and independent verification are completed.

Keywords: Agricultural Residues; Open Burning; Community Enterprise; Composting; Soil Restoration; Climate Resilience

INTRODUCTION

Fine particulate air pollution is a major public-health concern, and the World Health Organization emphasizes that adverse health effects occur at concentrations lower than previously understood [1]. In agricultural landscapes, deliberate burning of crop residues contributes smoke, particulate matter, greenhouse gases, and the loss of organic material that could otherwise be retained within the farm system [2–5]. Thailand faces a particularly complex implementation problem because rice and sugarcane residues are produced at large scale, the harvest-to-land-preparation window can be short, and collection, labour, machinery, transport, and alternative-use markets are unevenly available [3–5].

A burning prohibition by itself may therefore be insufficient. Evidence from Thailand indicates that implementation costs, operational delays, farmer incentives, and access to alternatives materially influence the effectiveness of open-burning controls [3,5]. A workable community response must make non-burning practices physically accessible, economically understandable, and socially accountable. It must also avoid transferring pollution from air to soil or water through poorly controlled feedstock, leachate, or rejected compost.

Returning suitable organic material to managed soil systems can contribute to soil cover, organic-matter supply, aggregation, nutrient retention, infiltration, and water-holding functions, although outcomes depend on soil, climate, residue quality, processing, application, and complementary agronomic practices [6,7]. These potential benefits should not be assumed from residue diversion alone. They require direct measurement and comparison over time.

BIO-NO BURN™ was developed by the Community of Bio-Organic Fertilizer Plant Enterprise Chaiphaphum as a community-based system linking no-burn agreements, residue logistics, composting and biological processing, farmer learning, quality checks, and plot-level traceability. The name identifies the project and innovation; the ™ symbol does not assert registered-trademark status. The system's proprietary microbial formulas and detailed cultivation or propagation procedures are internal know-how and fall outside this article.

This article has three objectives: (1) to describe the system architecture and its governance logic; (2) to present preliminary organizational evidence without converting self-reported activity or modelled estimates into verified environmental impact; and (3) to define an MRV and safeguards pathway for a bounded community demonstration and later scale-up. The article is intentionally framed as a case study and technical perspective, rather than an impact evaluation.

MATERIALS AND METHODS

Case Setting and Organizational Context

The implementing organization is a registered Thai community enterprise based in Phakdi Chumphon District, Chaiphaphum Province. Enterprise registration no. 4-36-1402/1-0045 records registration on 17 August 2023 and an official issue/certification date of 15 May 2024. The enterprise is governed by an eight-member community committee with separated

leadership, technical, field-coordination, finance, and monitoring functions [8].

The enterprise's public mission covers community no-burn crop-residue management, production and promotion of bio-organic soil inputs, soil restoration, safe agricultural production, farmer learning, and coordination with public, private, and technical partners. Public organizational information and selected project materials are maintained through the enterprise website [11]. The website is used as a communication and knowledge channel and is not treated in this study as independent verification of performance.

Two related but analytically separate geographic scopes were reviewed. The broader organizational programme reports activity in Phakdi Chumphon, Nong Bua Daeng, and Kaset Sombun districts of Chaiphaphum Province [9]. A prospective 12-month demonstration has been designed for nine villages in Sa Kaeo Subdistrict, Bueng Sam Phan District, Phetchabun Province, linked operationally to the enterprise base across the adjoining provincial interface [8]. The proposed demonstration had not generated grant-financed results at the manuscript date.

Case-Study Design and Evidence Sources

A retrospective descriptive case-study design was used. The review covered records available to the author on 10–11 August 2026: the official BIO-NO BURN™ performance and expansion report; the organization's registration and governance records; summarized operational records; and the final revised project-design package prepared for a prospective community demonstration [8,9]. Scientific and policy context was drawn from World Health Organization, Intergovernmental Panel on Climate Change, Food and Agriculture Organization, Thai air-pollution literature, and Thailand-focused implementation studies [1–7,10].

The author is the organization's president and project director. To reduce the risk of promotional overstatement, every quantitative statement was assigned to one of three evidence classes shown in Table 1. The review did not treat internal estimates as independently verified outcomes. Where source records explicitly required reconciliation or validation, the same qualification was retained.

Case Implementation Context and Process

The case was examined as an operating system rather than as a single intervention. The implementation sequence documented in the project materials is: (i) voluntary participant enrolment and no-burn commitment; (ii) identification of residue sources and baseline conditions; (iii) collection, weighing, transport, and temporary storage; (iv) controlled shredding, composting or approved biological processing by batch; (v) quality testing, release and field application; and (vi) record reconciliation, community review, grievance handling, and corrective action. This sequence is reflected in the proposed No-Burn Ledger, which links plot or residue source, date, residue type, measured weight, transport, processing batch, quality check, compost disposition, and field application. The purpose of documenting this chain is to make material flows traceable and to reduce double counting, while recognising that a ledger, GPS record,

or policy statement is not by itself proof of environmental performance.

The geographic boundary was deliberately separated into two scopes. The broader organizational programme covers reported activity in Phakdi Chumphon, Nong Bua Daeng, and Kaset Sombun districts of Chaiyaphum Province. The separate

prospective demonstration in Sa Kaeo Subdistrict, Bueng Sam Phan District, Phetchabun Province, was treated only as a future evidence-generating platform because it had not generated grant-financed results at the manuscript date. This separation prevents prospective demonstration targets from being interpreted as outcomes of the broader programme.

S.No	Evidence class	Meaning in this article	Permitted interpretation
1	Documented organizational activity	An activity or quantity recorded in official organizational documents or operational records.	May be reported as self-documented activity, with source and verification limitations stated.
2	Modelled estimate	A calculated value based partly on project assumptions, provisional factors, or incomplete reconciliation.	May illustrate the current model; must not be described as verified impact, certified reduction, or carbon credit.
3	Planned target	A future output, beneficiary number, area, or performance threshold in a proposal or expansion plan.	May be reported only as a target or design parameter, not as an achieved result.

Table 1: Evidence Classification used in this Case Study

System Architecture

The BIO-NO BURN™ architecture is organized around six linked functions: (1) voluntary community agreements and participant enrolment; (2) residue-source identification and acceptance rules; (3) collection, weighing, transport, and temporary storage; (4) shredding, composting or approved biological processing under batch control; (5) quality testing, field application, demonstration, and farmer learning; and (6) traceable records, public review, grievance handling, and corrective action. The design uses distributed hubs to shorten

access distances and assigns named community custodians for equipment, safety, batch records, and financial oversight [8].

A proposed “No-Burn Ledger” links plot or residue source, date, residue type, measured weight, transport, processing batch, quality check, compost disposition, and field application. This chain is intended to make material flows auditable and to prevent the same residue quantity from being counted more than once. GPS points and polygons support plot identification and traceability; they do not in themselves prove no-burning compliance, land ownership, carbon-credit eligibility, or conformity with an external certification scheme.

S.No	Stage	Core action	Minimum evidence
1	Enrol and agree	Confirm voluntary participation, land-use rights, roles, no-burn commitment, and grievance access.	Participant register; consent; plot ID; land-use document check; signed community agreement.
2	Establish baseline	Record crop, area, residue practice, input use, fuel use, and prior burning conditions.	Dated baseline form; GPS/polygon; photographs; purchase/use records; hotspot and inspection context.
3	Receive material	Accept eligible agricultural residues and reject contaminated or ecologically inappropriate feedstock.	Source ticket; residue type; measured weight; contamination check; date and transporter.
4	Process by batch	Shred, compost or biologically process under controlled site and safety procedures.	Batch ID; input weight; moisture/temperature checks; turning/action log; incident log.
5	Test and apply	Assess compost quality and document distribution or plot application.	Laboratory/field test; release decision; output weight; recipient; field application record.
6	Review and correct	Compare records, investigate anomalies, disclose progress, and adapt operations.	Monthly reconciliation; quarterly community review; corrective-action register; archived evidence.

Table 2: BIO-NO BURN™ Operational Chain and Minimum Evidence**Data Handling and Analysis**

Descriptive values were extracted as reported in the official records. Area values were retained in rai, the unit used by participating farmers; 1 rai equals 0.16 ha. Percent changes were not recalculated where the underlying transaction-level data were unavailable. Greenhouse-gas values were reviewed only to determine their evidence status and MRV requirements. No inferential statistics, causal attribution, remote-sensing verification, laboratory reanalysis, or independent assurance were performed.

The analysis applied four tests to each claim: source traceability, temporal status, boundary clarity, and verification status. “Source traceability” asked whether a record could be linked to a plot, transaction, batch, or signed report. “Temporal status” distinguished completed activity from future intent. “Boundary clarity” separated the 2,500-rai organizational programme from the proposed 220-rai demonstration. “Verification status” distinguished internal documentation, model output, and independent confirmation.

Investigations and Evidence Checks Performed

The investigation component consisted of documentary and consistency checks rather than independent field verification. First, organizational and governance records were reviewed to establish the implementing entity, roles, registration status, and stated operating responsibilities. Second, the geographic scope of reported implementation was checked against the separate prospective demonstration boundary. Third, reported operational claims were classified according to their source and temporal status. Fourth, the available evidence chain was examined for links to plots, transactions, batches, or signed reports. Fifth, the preliminary greenhouse-gas calculation was reviewed for its baseline, project-emission, leakage, factor-source, and reconciliation requirements. Where underlying transaction-level, inspection, laboratory, or independent verification records were not available in the reviewed package, the corresponding claim was retained as provisional and was not upgraded to a verified outcome.

Safeguards and Intellectual-Property Boundary

The system design includes feedstock screening, no habitat conversion, retention of agronomically necessary soil cover, covered and drained processing areas, buffer distances, personal protective equipment, supervised machinery, traffic controls, hygiene procedures, incident records, and a plan for rejected material [8]. Voluntary written site agreements are required; no land acquisition, involuntary restriction, displacement, or resettlement is proposed. Participation and benefit records are intended to be disaggregated by sex, age, and disability where voluntarily disclosed.

This article describes governance, material flow, quality control, and evidence requirements. It does not disclose microbial strains, formulas, cultivation media, inoculum ratios, propagation procedures, or other confidential know-how. Reproducibility in this case therefore concerns the community operating and MRV architecture, not replication of proprietary biological formulations.

RESULTS**Reported Organizational Activity**

For fiscal year 2025/2026, the official performance report records a 2,500-rai pilot area under implementation and the start of GPS/polygon data collection [9]. It also records announcement of a 100% no-burn policy for the pilot and a 92% per-rai reduction in 46-0-0 fertilizer use against the organization’s internal baseline. These are enterprise-reported results. The records available for this manuscript did not provide complete plot-level source data, matched purchase-and-issue ledgers, no-burn inspection coverage, or an independent evaluation. Accordingly, the statements demonstrate the current scope and management direction but do not establish causal or independently verified environmental outcomes.

The enterprise’s operational model combines residue recovery with local soil-amendment production and farmer engagement. The value of this early experience is institutional: the organization has a registered governance structure, defined roles, a field-facing operating concept, and a canonical report that explicitly reserves unverified claims. Its limitation is that summary values remain ahead of a fully reconciled evidence package.

Management Measures and Documented Outcomes

Management evidence in the reviewed records centres on governance, material-flow control, and traceability. The enterprise has defined community roles for technical, field-coordination, finance, and monitoring functions; the operating architecture specifies residue acceptance rules, batch identification, quality checks, field-application records, monthly reconciliation, and community review. The documented FY2025/2026 outcomes are limited to the organizational records reported in Table 3: a 2,500-rai area reported under implementation, announcement of a 100% no-burn policy for the pilot, initiation of GPS/polygon data collection, and a reported 92% per-rai reduction in 46-0-0 fertilizer use against the internal baseline. These outcomes are presented as enterprise-reported activity/results and not as independently verified impacts. The available package does not establish complete no-burn inspection coverage, transaction-level fertilizer reconciliation, independent laboratory confirmation, or causal environmental effects. Accordingly, the principal documented outcome at this stage is the establishment of a structured management and evidence architecture with preliminary operational indicators.

Reported item	Value/status	Evidence class	Required qualification
Pilot area, FY 2025/2026	2,500 rai (400 ha)	A	Organization-reported implementation area; plot register and polygon completeness should be audited.
No-burn policy	100% policy announced for pilot area	A	A policy is not equivalent to verified absence of burning; inspection and hotspot protocols are required.
46-0-0 fertilizer use	92% reduction per rai versus internal baseline	A/B	Requires reconciliation of baseline definition, purchases, issues, returns, plot use, and period.
Compost quantity in current model	1,000 t for 2,500 rai at 2 t per 5 rai	B	Model quantity; weighbridge and production records are explicitly pending reconciliation.
Estimated GHG reduction	1,237,995 kgCO ₂ e (94.14%)	B	Not assurance-level: factors, residue characteristics, leakage, boundaries, and source versions require validation.

Table 3: Preliminary Evidence from the Broader Organizational Programme

Prospective Bounded Demonstration

The prospective 12-month demonstration provides a more clearly bounded platform for generating future evidence. Its design covers 100 farming households across approximately 220 rai (35.2 ha), with four distributed compost hubs and 20

demonstration plots. Planned outputs include at least 300 tonnes of agricultural residues diverted from open burning or low-value disposal, at least 180 tonnes of quality-controlled compost, 80 soil tests, 12 compost tests, four training courses, and a monthly No-Burn Ledger [8]. All values in this paragraph are targets. No claim is made that the demonstration had begun, received funding, or achieved these outputs as of 11 August 2026.

Target	Planned value	Verification point before reporting achievement
Participating households	100	Unique enrolment, consent, attendance, and active participation records.
Area under improved practice	Approx. 220 rai (35.2 ha)	Non-overlapping verified plot polygons and documented land-use rights.
Community compost hubs	4	Signed host agreements, equipment registers, commissioning checks, and operating logs.
Demonstration plots	20	Baseline, treatment description, dated field records, and comparison protocol.
Residues diverted	≥300 t	Calibrated weights, unique source tickets, batch linkage, stock reconciliation, and no double counting.
Quality-controlled compost	≥180 t	Batch output weights, sampling plan, test results, release criteria, and disposition records.
Soil and compost tests	80 soil; 12 compost	Chain of custody, accredited or documented method, dates, units, detection limits, and raw results.

Table 4: Prospective 12-Month Demonstration Targets and Verification Points

Current Status of Greenhouse-Gas Estimates

The investigation found that the official performance report contains a preliminary greenhouse-gas model for the 2,500-rai pilot. It uses an accounting form of emission reduction equal to baseline emissions minus project emissions minus leakage. The

current model provisionally sets leakage to zero and applies project factors for 46-0-0 fertilizer, diesel, residue burning, and composting [9]. The same report states that several factor sources and versions must be locked and that residue type, moisture, activity data, and production quantities require supporting evidence. The estimate is therefore presented in Table 3 only as a model requiring validation, not as a verified reduction, issued carbon credit, saleable environmental attribute, or evidence that net zero has been achieved.

A defensible future inventory would require a written methodology, spatial and temporal boundaries, crop- and residue-specific baselines, calibrated activity data, justified emission factors, uncertainty treatment, leakage assessment, data-quality scoring, version control, and independent validation or verification where an external claim is intended. Plot polygons and photographs can strengthen traceability but cannot substitute for these requirements.

DISCUSSION

What the Case Contributes

The main contribution of BIO-NO BURN™ is an operating architecture that treats residue burning as a coordination and evidence problem, not only a technology problem. Farmers need an accessible route for residue handling; hub teams need defined responsibilities and safe procedures; compost users need quality information; and external partners need records that can be traced from source to field application. Linking these functions can make community accountability part of the material flow.

This approach aligns with findings that Thailand's burning challenge is shaped by cost, timing, logistics, enforcement, and the availability of practical alternatives [3,5]. Distributed hubs may reduce access barriers, while monthly reconciliation and public review can expose stock imbalances or participation problems early. However, the case does not yet show that four hubs are the optimal number, that the model is financially self-sustaining, or that participants will maintain no-burning practices when labour, residue supply, weather, or market conditions change.

Soil, Water, and Climate Pathways

The project's soil and water rationale is plausible but must be measured. Appropriate residue retention and organic-matter management can support soil structure, nutrient cycling, infiltration, moisture conservation, and reduced erosion [6,7]. Composting can also provide a managed alternative to burning. Yet residue removal can be harmful if it strips necessary soil cover or nutrients, and poor composting can create odour, leachate, methane, contamination, or occupational risks. The design therefore requires feedstock rules, a site drainage plan, moisture and temperature monitoring, quality testing, and agronomic decisions about how much residue should remain in place.

For the 20 proposed demonstration plots, a practical minimum dataset should include soil texture and management history; pre- and post-season soil organic carbon or organic matter using a consistent method; pH; electrical conductivity; key nutrients;

bulk density where feasible; infiltration or field water-retention indicators; input quantities; crop yield; and dated weather information. A comparison group or matched baseline would improve interpretation. One season may be sufficient to test operations, but it is generally insufficient to establish durable changes in soil carbon or long-term resilience.

Responsible Claims and Verification

The explicit separation of activity, estimate, and target is essential. A no-burn announcement is evidence of organizational intent; it is not proof that every plot remained unburned. A compost application rate is a planning rule; it is not proof that the quantity was produced or applied. A spreadsheet estimate is not a verified emission reduction. Maintaining these distinctions protects farmers, partners, readers, and the enterprise itself from premature claims.

A staged assurance pathway is recommended. Stage 1 should reconcile organizational records and define data owners. Stage 2 should test the ledger and sampling procedures in the bounded demonstration. Stage 3 should conduct internal quality review and correct missing or inconsistent records. Stage 4 should commission an independent technical review of the baseline, emission factors, safeguards, and calculations before any quantified external impact claim. Stage 5, if carbon-crediting is pursued, should use an applicable approved methodology and complete the required validation, verification, registration, and rights checks. Nothing in the current case constitutes a carbon credit or guarantees eligibility.

Governance, Inclusion, and Durability

The community-enterprise form can support continuity because local actors retain equipment, records, learning materials, and relationships after a short project cycle. Durability will nevertheless depend on transparent cost allocation, equipment maintenance, seasonal labour, compost demand, quality consistency, and equitable benefit sharing. The proposed use of women and youth in hub governance, recordkeeping, finance oversight, and communication should be evaluated through actual decision-making roles and benefit distribution, not attendance counts alone.

Before scale-up, each hub should document a realistic cost-recovery or service arrangement and distinguish cash expenses, in-kind labour, grant-financed assets, and market revenue. Expansion from 100 to 1,000 households should be conditional on demonstrated data quality, safe operations, sufficient staffing, and a viable unit-cost model. Growth should not be inferred from environmental ambition alone.

LIMITATIONS

This case study has important limitations. First, the author is the enterprise president and project proponent, creating an inherent risk of positive reporting. Second, the analysis relies substantially on organization-produced records and did not independently inspect farms, reconcile transactions, repeat laboratory tests, or interview participants. Third, the broader 2,500-rai programme and the prospective 220-rai demonstration have different boundaries and evidence maturity. Fourth, key performance values—including fertilizer

reduction, compost quantities, no-burn compliance, and greenhouse-gas estimates—require additional underlying evidence or validation. Fifth, environmental, health, livelihood, yield, soil, and water outcomes cannot be causally attributed from the available descriptive records.

These limitations do not invalidate the operational model; they define the next research task. The strongest near-term contribution is a transparent, bounded prospective evaluation with pre-specified indicators, data dictionaries, unique identifiers, comparison logic, uncertainty reporting, and independent review.

The evidence hierarchy established in this case should be retained in any future reporting. Documented organizational activity can demonstrate implementation and management progress; modelled values can inform planning and identify data requirements; prospective targets can define the next evaluation boundary. None should be conflated with independently verified environmental impact. The current case therefore supports a credible implementation framework and a defined pathway for stronger evidence generation, while leaving causal impact questions open for subsequent evaluation.

CONCLUSION

BIO-NO BURN™ illustrates how a Thai community enterprise can organize crop-residue management around local agreements, distributed hubs, controlled processing, farmer learning, safeguards, and traceable records. The enterprise reports a 2,500-rai pilot, a 100% no-burn policy, the start of plot mapping, and a large reduction in 46-0-0 fertilizer use relative to its internal baseline. These statements are preliminary and self-reported; they should not be interpreted as independently verified environmental impact.

The proposed 100-household, 220-rai demonstration offers a practical next step because it sets bounded targets and an evidence chain from residue source to batch and field application. Its value will depend less on the ambition of headline numbers than on the completeness, consistency, safety, and independent review of the underlying records. Until that work is completed, greenhouse-gas reductions, PM2.5 benefits, soil improvements, water benefits, and livelihood gains should remain hypotheses or provisional estimates rather than certified outcomes.

The broader lesson is that community circular agriculture needs both physical infrastructure and evidence infrastructure. When governance, safeguards, material accounting, and learning are designed together, a no-burn initiative can become more credible, adaptive, and scalable without overstating what has already been achieved.

DECLARATIONS

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The author acknowledges the enterprise committee, participating farmers, community representatives, and local counterparts whose operational experience informed the BIO-NO BURN™ model. Recognition does not imply that any

named or unnamed organization has endorsed the findings or verified the reported results.

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CONFLICTS OF INTEREST

The author is President of the Community of Bio-Organic Fertilizer Plant Enterprise Chaiyaphum and leads BIO-NO BURN™. This organizational and professional interest is disclosed. No carbon credits, certification, or independent verification are claimed in this article.

ETHICS STATEMENTS

This descriptive organizational case study reviewed project and administrative records and did not assign a research intervention, collect clinical information, or analyse identifiable personal data. Formal research-ethics approval was therefore not sought. Future farmer surveys, interviews, or individual-level research will require appropriate consent, privacy safeguards, and ethics review where applicable.

DATA AVAILABILITY

The summarized evidence classifications and target definitions are contained in this article. Underlying organizational records may be made available by the corresponding author for legitimate review, subject to participant privacy, land and commercial confidentiality, document-control requirements, and protection of proprietary know-how. Microbial formulas, inoculum ratios, cultivation media, and propagation procedures are not publicly available.

AUTHOR CONTRIBUTIONS

S.M.: Conceptualization, project administration, investigation, resources, data curation, methodology, writing, original draft, writing review and editing, and accountability for the final manuscript.

USE OF GENERATIVE ARTIFICIAL INTELLIGENCE

During preparation of this manuscript, the author used OpenAI ChatGPT for English-language editing, document structuring, evidence-classification support, and formatting. The author reviewed the source records, verified the manuscript's statements against the available evidence, revised the output, and takes full responsibility for the submitted content.

INTELLECTUAL-PROPERTY NOTICE

BIO-NO BURN™ identifies the enterprise's project and innovation; ™ does not represent a claim of registered-trademark status. Public materials intentionally exclude proprietary microbial formulas, cultivation methods, inoculum ratios, propagation procedures, and other confidential know-how. © 2026 The Community of Bio-Organic Fertilizer Plant

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