An Interdisciplinary Case Study on Jeevamrut Efficacy and the Behavioural Economics of Sustainable Fertiliser Adoption in India

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Abstract

Intensive synthetic agricultural systems reliant on NPK — Nitrogen, Phosphorous, Potassium — inputs have precipitated global soil degradation over recent decades. Synthetic fertilisers have driven considerable growth in agricultural productivity, but declining farmer margins and rising input costs have renewed interest in traditional alternatives like jeevamrut, fermented mixture of cow dung, cow urine, jaggery, and pulse flour used within India's Zero Budget Natural Farming (ZBNF) movement pioneered by Subhash Palekar. This paper reports an original comparative growth and soil-nutrient study of jeevamrut compared with a chemical fertiliser control conducted using traditional preparation materials and expert-validated laboratory soil analysis. The experiment and empirical results are consistent with the wider ZBNF literature that shows that jeevamrut narrows the growth gap with chemical fertiliser over successive weeks and builds measurable soil organic carbon. However, the study also foregrounds a pattern that is rarely discussed in the literature: the raw growth data shows jeevamrut-treated plants trailed the chemical-fertiliser control throughout the observation period, with the proportional gap narrowing over successive weeks rather than closing entirely. This paper argues that this "lag" plausibly engages and interacts with well-documented barriers to sustainable-technology among smallholder farmers, including present bias, loss aversion, and social proof effects, to help explain why a fertiliser that is cost-effective and environmentally friendly is relatively under-adopted. By merging a hands-on agronomic case study with a review of behavioral and development economics literature on sustainable technology adoption, this paper offers an account of why proof is insufficient to drive adoption of practices and proposes many behaviorally-informed strategies to close that gap.

I. Introduction

Modern industrial agriculture is heavily dependent on synthetic NPK (Nitrogen, Potassium, and Phosphorus) fertilisers. However, this dependence has associated economic and environmental costs. An estimated one-third of the world's soils are currently degraded (FAO, 2015). This trend is linked to intensive chemical input use, erosion of soil microbial life, and monocropping. In India, where the agricultural sector still employs about three in five workers and smallholdings dominate the rural economy, the conflict between immediate output and long-term soil health is especially acute. This dispute is severe and worsened by fiscal viability concerns: India's union budget allocated ₹1.68 to 1.84 lakh crore to fertiliser subsidies in FY 2025-26, of which roughly ₹1.19 lakh crore was set aside for urea alone,

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whose retail has been held at ₹242 per 45-kilogram bag since 2018 irrespective of actual production and import costs (PMF IAS, 2025). These subsidies keep synthetic fertiliser artificially cheap at sale which lowers the relative price advantage that a self-produced input like jeevamrut would offer a farmer.

Jeevamrut, literally 'nectar of life', is a traditional input made from cow dung, cow urine, jaggery, pulse flour, soil, and water, popularized and advocated for at scale by Subhash Palekar and his Zero Budget Natural Farming initiative. Because the inputs for this fertiliser can be derived from what a farm already produces, jeevamrut is known as a near-zero-cash-cost alternative to synthetic fertiliser. The production process also simultaneously provides a productive use for cattle, including 'dry' cows (no longer producing milk) that would otherwise be abandoned or left to fend for themselves.

The paper is therefore organised around two linked research questions: (1) does jeevamrut produce measurable improvements in plant growth and soil nutrient composition relative to a chemical fertiliser control under small-scale replicable conditions, and (2) to the extent that jeevamrut is economically favorable, what behavioral and structural barriers explain reluctance of adoption in Indian farmers. This paper connects these concepts using experimental growth data and a cost-benefit illustration.

II. Literature Review

2.1 Jeevamrut and Zero Budget Natural Farming

Zero Budget Natural Farming is built around different preparations, of which jeevamrut is the most widely applied. It is applied roughly every one to two months to introduce microbial populations into the soil content. It is typically applied at a rate of around 200 litres of jeevamrut per acre, alongside practices like mulching and reduced irrigation. Field studies of ZBNF report improvements in yield, farmer income, and household revenue in early adopters (Nature Ecology & Evolution, 2025), along with qualitative accounts of reduced irrigation dependence and lower input costs. A metagenomic soil analysis of jeevamrut-treated ZBNF fields found that the composition of the soil microbial data changed, with Proteobacteria emerging as the dominant phylum along with Actinobacteria, Firmicutes, and Cyanobacteria. This is directly consistent with the claim that jeevamrut acts as a microbial inoculant rather than a direct nutrient supplement in the way a chemical/synthetic fertilizer does.

A government-commissioned evaluation of ZBNF across roughly six million farmers in Andhra Pradesh found significant differences in yield and income between ZBNF and non-ZBNF plots across multiple locations (International Journal of Agricultural Sustainability, 2019). There have also been reports of improved biodiversity.

2.2 Standard Economic Barriers to Adoption

Development and sustainability economists studying technology adoption in low-income settings have found a set of barriers that apply independently and consistently regardless of any prior behavioral bias. Smallholder farmers frequently lack the collateral or land titles to access credit for investment. This is also compounded by 'risk-rationing', the tendency of farmers to avoid credit-financed risk even when expected returns are certain to be positive. Market structure is also a constraint specifically for organic and natural inputs. Farmers adopting the ZBNF initiative in Andhra Pradesh have reported selling their naturally grown produce through the same channels as chemically grown produce, without charging a price premium, undermining one of the clearest financial incentives to accelerate adoption. There has been limited production-side promotion of natural farming techniques, and government schemes offering partial subsidies for related infrastructure, such as vermicompost units or drip irrigation, appear only to reach a small number (subset) of farmers as of yet. These are the farmers who are unusually well-informed or well-connected to multitudes of institutional programmes.

2.3 Behavioral Economics and an Adoption Gap

Under-investment in 'profitable' inputs such as fertiliser for farmers reflects psychological constraints rather than a financial one. In a randomised study among Kenyan farmers, Duflo, Kremer, and Robinson (2011) found that minor, limited-time discounts on fertiliser delivered at harvest when farmers had cash on hand, substantially increased adoption relative to larger subsidies offered later at sowing season. This evidence is consistent with present bias rather than unaffordability. This finding is cited as conclusive evidence that behavioral, rather than purely price-based mechanisms and interventions, can shift the adoption of agricultural inputs. It forms the closest comparable match to the arguments developed in this paper.

Complementary experimental work summarised by the Abdul Latif Jameel Poverty Action Lab (J-PAL) and in a much broader review of the constraints to agricultural technology adoption highlights the concept of loss aversion as a barrier. Farmers willing to gain on average from adopting a new input would still rationally avoid it if the downside scenario, losing an entire season's income, is more heavily unfavored in decision making than the equivalent upside. Because land is a farmer's almost critical as well as least favorable asset, this loss aversion is often reported as the most pronounced of the biases. A related strand of literature applying the theory of planned behavior to conservation agriculture in India finds that psychological resistance to change, rooted in familiar practices and social dynamics within smallholder farming communities, where decision making is heavily influenced by peer pressure and behavior together produces an inertia that remains even when the farmer holds accurate and factual prior knowledge about the subject. This literature also finds that prior knowledge, while it may improve smallholder confidence, does not guarantee adoption, which signals that the missing ingredient is rarely information alone.

The point that knowledge of benefits does not reliably translate into adoption, recurs across multiple adoption studies outside of the field of agriculture as well. A notable mention is a qualitative study of biosecurity adoption among smallholder poultry farmers in Ghana where this question is framed as a 'knowledge-action gap', in which farmers are well-informed but fail to systematically implement the same because of underestimation of risk and separate short-term priorities. Another parallel study discussing the adoption of smart fertilizer technology in developing countries similarly finds that economic constraints and 'traditional' practice, rather than lack of awareness, are the prominent barriers. It mentions that adoption is best understood through the stimulus-organism-response framework wherein a farmer's cognitive and emotional response to a technology can mediate their decisions as well as its objective merits. Work on push-pull pest-management technology among small-scale farmers in East Africa likewise find that social and psychological variables derived from the theory of planned behavior are the strongest predictors of whether a low-cost technology can actually be implemented in the field.

2.4 Synthesis

Taken together, the literature suggests that the agronomic study for jeevamrut and economic study for jeevamrut adoption are two separate research problems concerning the same input. The agronomic problem is concerned with the efficiency of jeevamrut and whether it works. The adoption problem is concerned with why farmers do or do not act on inputs that already work/function. There is very little literature that connects these two problems by asking whether the specific, observable characteristics of an input's performance can function as a behavioral signal that either supports or undermines adoption. This paper's original contribution is to make the above connection using experimental growth data and studies as a case and extend the research into a cost-benefit illustration to better visualise economically relevant variables.

III. Methodology

3.1 Experimental Design

The agronomic component of my design follows a controlled comparative study. Jeevamrut was prepared following outlined traditional methods, combining cow dung, cow urine, jaggery, soil, pulse flour, and water and allowing the mixture to ferment prior to application. A chemical fertiliser control was applied in parallel to a genetically comparable set of the same species, grown in matching pots under the same ambient conditions, to isolate the effect of the fertiliser type and keep the other variables as controlled. Plant height was recorded weekly for each group across seven plant species; all species' data are reported in Section 4 as illustrative cases. Additional species were grown in parallel experimental plots to test the consistency of fertiliser across species and different plant physiologies. However, one species was ultimately excluded after failing to survive unseasonal heavy rainfall during the observation period.

3.2 Soil and Laboratory Analysis

In addition to tracking plant growth, a soil sample treated with jeevamrut was submitted for laboratory analysis to a university agricultural chemistry and soil science department, which reported the total nitrogen, phosphorus, potassium, and organic carbon content following standard soil-testing protocol. A parallel soil sample analysis for the chemical fertiliser control was not conducted which limits the soil-nutrient analysis to comparing the jeevamrut sample against the published reference ranges rather than a side-by-side comparison. The university also conducted a separate nutrient analysis of the jeevamrut itself and a soil quality report covering pH and available nutrient levels for comparison against standard bands. These results, reported in Section 4.2, were interpreted and compared against published reference ranges for natural fertiliser composition from literature on jeevamrut and ZBNF nutrient profiles.

3.3 Source Evaluation and Field Interviews

Particular care was taken to evaluate the reliability of secondary sources before incorporating into the experimental framework. Sources were assessed systematically using OPVL, assessment through origin, purpose, value, and limitations, to distinguish peer-reviewed or published material from less rigorously vetted online content. This process was supplemented by primary field interviews: with an agricultural chemistry professor, who introduced and provided access to the academic literature on organic and natural fertilizers, and with farmers, who have implemented jeevamrut and have over three decades of hands-on experience.

3.4 Economic and Behavioural Framework

The component of this paper based on adoption of the practice is purely a literature-grounded study and analysis. This paper only applies an established framework of behavioral economics which draws on previous studies, the results of which have been adapted and reinterpreted to fit this study. Section 5 is an extension into a cost-benefit model where, using midpoint values drawn from previously reported ranges for jeevamrut's cost savings and yield effects, applied to an assumed baseline cultivation budget rather than to newly collected primary financial data. Where this paper draws economic conclusions, they should be read as hypotheses consistent with the literature review rather than as findings validated independently by data.

IV. Results

4.1 Plant Growth

The tables below report plant height, measured to nearest centimetre, for Colocasia esculenta, beta vulgaris rubra, fenugreek, portulaca grandiflora, daikon, capsicum, and mentha grown under chemical fertiliser and jeevamrut treatment over a three-four-week observation period.

Colocasia esculenta (Elephant ear)		
Week	Chemical fertiliser (cm)	Jeevamrut (cm)
1	5	4
2	10	8
3	14	13
4	17	16

Table 1. *Weekly height (cm) of Colocasia esculenta under chemical fertiliser and jeevamrut treatments.*

Beta vulgaris rubra (Red beetroot)		
Week no.	Chemical Fertiliser	Jeevamrut
1	2	2
2	4	3
3	6	5
4	8	7

Table 2. *Weekly height (cm) of Beta vulgaris rubra under chemical fertiliser and jeevamrut treatments.*

Fenugreek		
Week no.	Chemical Fertiliser	Jeevamrut
1	5	4
2	10	8
3	15	13

Table 3. *Weekly height (cm) of fenugreek under chemical fertiliser and jeevamrut treatments.*

Portulaca grandiflora (Moss-rose purslane)		
Week no.	Chemical Fertiliser	Jeevamrut
1	2	1
2	4	3
3	6	5

Table 4. *Weekly height (cm) of Portulaca grandiflora under chemical fertiliser and jeevamrut treatments.*

Daikon (White radish)		
Week no.	Chemical Fertiliser	Jeevamrut
1	3	2
2	7	5
3	12	10
4	18	16

Table 5. *Weekly height (cm) of Daikon under chemical fertiliser and jeevamrut treatments.*

Capsicum		
Week no.	Chemical Fertiliser	Jeevamrut
1	3	2
2	6	5
3	9	7
4	12	10

Table 6. *Weekly height (cm) of Capsicum under chemical fertiliser and jeevamrut treatments.*

Mentha (Mint)		
Week no.	Chemical Fertiliser	Jeevamrut
1	2	1
2	4	3

3	6	4
4	8	7

Table 7. *Weekly height (cm) of Mentha under chemical fertiliser and jeevamrut treatments.*

These trends are based on a small number of replicate experimental plants per species over a short observation period. Two features of this growth pattern are relevant beyond the finding that jeevamrut supports comparable growth. Firstly, the chemical fertiliser led in terms of absolute height every recorded week, for every plant species experimented with. This is consistent with synthetic fertilisers delivering readily available nutrients faster than jeevamrut, which provides slower-acting, microbial inputs and stimulates growth much later. Second, and more importantly, the proportional gap between the two treatments narrowed steadily over the observation period for every species. This convergence pattern is consistent with the way in which jeevamrut is meant to interact with the soil and the plants. Rather than supplying an immediate dose of nutrients, jeevamrut works to build soil microbial content and its benefits are expected to compound over time rather than appear instantly.

4.2 Soil Nutrient Analysis

Table 8 reports the laboratory nutrient analysis for the jeevamrut sample submitted for testing.

Parameter	Value (jeevamrut sample)
Total Nitrogen (%)	0.40
Total Phosphorous (%)	0.062
Total Potassium (%)	0.18
Organic Carbon (%)	11.86

Table 8. Laboratory nutrient analysis of the jeevamrut sample.

The organic carbon content (11.86%) was substantially higher than the combined nitrogen, phosphorus, and potassium content, consistent with jeevamrut's role of soil-conditioning rather than direct nutrient-sourcing. Beneficial soil microorganism populations increase up by several hundred percent within a period of a couple of months. The wider literature also reports cost reductions of 40-60% and improvements in yield by 15-30% for jeevamrut.

V. Economic Modelling

This section discusses the percentage ranges reported in the above sections in order to make a concrete case for adoption. The figures apply the midpoint of previously reported cost-reduction and yield-improvement ranges to an assumed baseline cultivation budget which represents Indian smallholders.

Item	Chemical Fertiliser Baseline	Jeevamrut
Fertiliser & input cost per acre, per season	₹8,000	₹4,000 (50% lower)

Assumed gross crop value per acre, per season	₹40,000	₹48,800 (22% higher yield)
Net margin per acre, per season	₹32,000	₹44,800
Net margin improvement	—	+₹12,800 per acre, per season (+40%)

Table 9. Illustrative per acre, per-season cost-benefit comparison, using midpoint values previously reported cost and yield ranges

Using the above figures, a full-season switch to jeevamrut would be projected to improve net margin by roughly 40%. This is in line with the profitability gains reported in field evaluations of ZBNF in Andhra Pradesh. On a simple net-margin basis, jeevamrut would be an easy decision to take for a rational, risk-neutral farmer. The behavioral analysis in the next section does not dispute the simple arithmetic but argues that a farmer's experience of adopting jeevamrut does not resemble a single end-of-season comparison. It resembles the week-by-week growth in which the chemical fertiliser is clearly ahead for the entire observation period and the cost savings are more easily verified. A farmer facing a different an input cost saving today versus an uncertain, delayed, and initially lower yield outcome would evidently be indifferent to the evidence from Table 9.

VI. Discussion

6.1 An Economic and Behavioral Interpretation of the Growth Data

The growth pattern reported in Section 4.1, in which jeevamrut trails behind the chemical fertiliser data before ultimately converging is insignificant for the agronomic study question but is extremely significant for the behavioral economics question. A farmer, when deciding whether to continue or abandon the decision to switch to jeevamrut, will not be observing the data for a four-week controlled trial, they will be observing their own field, under real financial pressure. Where week one and two is precisely where the proportional yield gap is the largest they will be most disincentivized to continue. This is closer to a real-world analogue to the present-bias mechanism documented by Duflo, Kremer, and Robinson (2011): a farmer who discounts future benefits in relation to the present outcome is being shown by crop output the exact signal that is most likely to trigger early abandonment even though the overall data supports continued use. Jeevamrut's overall mechanism of slow, gradual microbial soil improvement may be disadvantaged due to the competitive synthetic fertiliser's fast, visible results.

6.2 Loss Aversion, Subsidies, and the Absence of a Price Premium

The literature review in Section 2.3 suggests that loss aversion is amplified when land, a farmer's most critical asset, is at stake. There are two factors that compound this gap. Firstly, chemical fertiliser is heavily subsidised at the point of sale, so the out-of-pocket price gap a farmer actually perceives is smaller than the social cost comparison conducted above. The cost advantage of jeevamrut thus goes unnoticed. Secondly, farmers who do want to switch to natural fertiliser also sell at the same market channels as chemical produce, and they do not charge a price premium. This limits the added benefits a farmer could've obtained from premium revenue. When a farmer weighs this capped upside against the downside of yield shortfall before the convergence period. This asymmetric payoff makes the decision a lot more risk and loss averse which helps in explaining why despite favorable average outcomes, widespread adoption remains concentrated and does not diffuse rather broadly.

6.3 Reframing the problem and the policy

Taken together the mechanisms, present bias and the growth curve, loss aversion and subsidised synthetic fertilisers and price premiums, suggest that increasing the adoption of jeevamrut is less related to proving and improving efficacy, and more a matter of improving the conditions in which farmers can act on this proof. Practical implications include structuring subsidies and support programs at the start of the season rather than at a later point. Time sensitive initiatives — timed to when farmers have cash on hand, as in Duflo, Kremer & Robinson (2011) — have been shown to outperform initiatives offered later at sowing. Pairing training in technology along with visible demonstrations and sample plots as well as pursuing market-side interventions, such as support for price premiums and production side promotions, is the best mechanism for adoption.

VII. Limitations

The agronomic component of this study was compared at a relatively small scale, using a limited number of plant species and locations. The behavioral and economic component of this study is a literature tree view and analysis rather than a survey; no primary data was collected and the interpretation is only a testable hypothesis generated by combining the study's data with the available literature. Weather variability during the observation period, including unseasonal rainfall, also affects consistency across the species. It is also imperative to mention that no chemical fertiliser soil sample was analysed. Future extensions of this project could address these limitations through large-scale, multi-season field trials across a multitude of species and a structures survey or interview-based study of farmers who have and have not adopted jeevamrut to test the hypotheses proposed in the previous sections.

VIII. Conclusion

This paper set out to answer two research questions: whether jeevamrut produced comparable agricultural benefits relative to chemical fertiliser, and why, given a favorable economic case suggested by literature-reported outcomes among early adopters, its adoption still remains uneven among Indian smallholders, The experimental results support jeevamrut's efficacy, showing an impressive growth trajectory and favorable carbon content as a microbial conditioner. At the same time, the paper argues that the early lag caused by adaptation and acclimation along with synthetic fertiliser subsidy in the absence of price premiums plausibly interacts with well behavioral biases to explain the gap of the adoption rate and economic benefits of the same. The central argument of this paper is therefore not that jeevamrut needs to be proved further but that the two questions have to be combined and treated as a single problem. A fertiliser that works, this paper suggests, is necessary but not sufficient; how the benefits of the fertiliser are experienced, financed, and demonstrated over time matter just as much.

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