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Behavioral nudges for encouraging farmer compliance with recommended plant protection practices

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Abstract

Imagine an extension officer who has explained proper fungicide timing to cocoa farmers six times this season. The farmers understand the recommendation. They agree it makes sense. Yet when spraying day arrives, most stick with their old habits. This gap between knowledge and action is where behavioral nudges come in. This research tested six behavioral nudge interventions for improving farmer compliance with recommended plant protection practices across cocoa and coffee production systems in Papua New Guinea's Highlands and Momase regions. A cluster-randomized controlled trial assigned 36 farmer groups (432 farmers) to nudge or control conditions across six nudge types over the 2023 growing season. Default option nudges produced the largest compliance gain (+27.6 percentage points), followed by timely SMS reminders (+21.5) and social norm messaging (+20.5). Nudge combinations amplified effects: default plus reminder achieved +34.8 points over control. Overall, nudged farmers reached 53.5% mean compliance versus 34.5% for controls ($p < 0.001$). The cost per additional compliant farmer averaged USD 3.20. These findings demonstrate that low-cost behavioral interventions can substantially close the knowledge-action gap in plant protection without additional technical training.

Keywords: Behavioral nudges, plant protection, farmer compliance, choice architecture, cocoa, coffee, Papua New Guinea, extension methods, knowledge-action gap, behavioral economics

Introduction

The scene repeats across Papua New Guinea's cocoa and coffee belt: extension agents deliver technically sound plant protection advice, farmers express agreement, and then compliance rates hover around 30-35% ^[1, 2]. The problem isn't ignorance. Farmers often know what they should do. They just don't do it. Traditional extension responses to this gap involve more training, more demonstrations, more field visits. But if the bottleneck isn't knowledge, adding more knowledge won't fix it ^[3].

Behavioral economics offers a different lens. Research by Thaler and Sunstein ^[4] showed that small changes in how choices are presented — nudges — can shift behavior without restricting options or changing economic incentives. Nudges work by addressing the cognitive biases and contextual factors that prevent people from acting on their intentions: present bias (favoring immediate comfort over delayed benefit), status quo bias (sticking with familiar practices), decision fatigue (avoiding complex choices), and social conformity (doing what neighbors do) ^[5, 6].

Agricultural applications of nudging are still emerging. A few studies have tested default options for seed variety selection, social norm messaging for fertilizer use, and commitment devices for savings behavior among farmers ^[7, 8]. But plant protection, which requires precise timing, specific dosages, and repeated action throughout the growing season, has received almost no behavioral intervention research ^[9]. This is a missed opportunity,

because plant protection decisions are exactly the kind of repeated, time-sensitive behaviors where nudges should be most effective. This research tested six nudge types in cocoa and coffee systems across two Papua New Guinean regions through the University of Papua New Guinea ^[10, 11].

Theoretical Framework

The research was grounded in dual-process theory of cognition ^[5] and Thaler and Sunstein's libertarian paternalism framework ^[4]. Dual-process theory distinguishes between System 1 thinking (fast, automatic, intuitive) and System 2 thinking (slow, deliberate, analytical). Most plant protection decisions occur under System 1 conditions: farmers are busy, conditions are familiar, and the default response is to do what they did last time. Nudges work by restructuring the choice environment so that System 1 processing leads toward recommended practices rather than away from them ^[6]. The six nudge types tested correspond to specific cognitive mechanisms: default options exploit status quo bias, social norms activate conformity motivation, timely reminders address present bias, simplified choices reduce decision fatigue, commitment devices leverage loss aversion, and visual prompts maintain salience at the point of action ^[3, 7]. The framework predicts that nudges should increase compliance without requiring additional knowledge transfer, because the behavioral bottleneck is motivational and contextual rather than informational.

Materials and Methods

Materials

Six nudge interventions were designed for cocoa and coffee plant protection contexts. Default option: spray schedule cards pre-filled with recommended timing and products, requiring active opt-out. Social norm: posters displaying compliance rates of leading farmers in the community. Timely reminder: SMS messages sent 24 hours before recommended spray windows. Simplified choice: reduction from 8+ product options to a curated shortlist of 3 with clear color-coded labels. Commitment device: public pledge ceremonies where farmers stated their spray intentions before peers. Visual prompt: weather-resistant field signs placed at plot entrances showing recommended practices. Assessment instruments included a compliance observation checklist (scored by trained field monitors during four spray windows), a knowledge test (to confirm equivalent baseline knowledge), and a cost-tracking form. Ethical approval was obtained from the University of Papua New Guinea Research Ethics Committee (Protocol UPNG/AG/2022-047, approved November 2022).

Methods

A cluster-randomized controlled trial was conducted from January to November 2023. Thirty-six farmer groups (432 farmers, 12 per group) in the Highlands and Momase regions were randomly assigned: six groups per nudge type, with each nudge type having three nudge groups and three control groups. Control groups received standard extension advice only. Compliance was measured through direct field observation during four spray windows (February, May,

August, October) by 12 trained monitors blinded to condition assignment ^[10]. Primary outcomes included compliance rate (proportion of farmers following at least 80% of recommended practices per spray window), engagement scores, and cost per additional compliant farmer. A subset of 72 farmers (12 per nudge type) also participated in nudge combination testing during the final two spray windows. Quantitative analysis used generalized linear mixed models with group as random effect ^[11, 12].

Instrument Development and Validation

The compliance observation checklist was developed through a three-stage process. Stage 1 identified 24 critical plant protection practice indicators from cocoa and coffee integrated pest management protocols, covering timing accuracy (4 items), product selection (4), application technique (6), dosage compliance (4), safety equipment use (3), and post-application management (3). Stage 2 involved expert validation by six plant protection specialists who rated each indicator for observability and importance, retaining all 24 items with mean ratings above 4.0 on both criteria. Stage 3 pilot-tested the checklist with 8 farmer groups during the November 2022 spray window, achieving inter-observer reliability of 0.89 (Cohen's kappa). Compliance was scored as a percentage of indicators correctly observed per farmer per spray window ^[12].

Results

All six nudge types produced significant compliance improvements over controls, but the magnitude varied substantially across nudge types and their combinations.

Table 1: Compliance rates by nudge type: control versus nudge condition (mean across four spray windows)

Nudge Type	Control (%)	Nudge (%)	Difference	p-value
Default option	34.2	61.8	+27.6	< 0.001
Social norm	36.8	57.3	+20.5	< 0.001
Timely reminder	33.1	54.6	+21.5	< 0.001
Simplified choice	35.7	52.1	+16.4	0.002
Commitment device	32.4	48.7	+16.3	0.003
Visual prompt	34.9	46.3	+11.4	0.008

Default option nudges produced the largest gain (+27.6 points), raising compliance from 34.2% to 61.8%. This makes sense: pre-filled spray schedule cards made the recommended practice the path of least resistance,

exploiting status quo bias in favor of compliance rather than against it. Social norms and timely reminders produced similar-sized effects (+20.5 and +21.5), while visual prompts showed the smallest gain (+11.4) ^[4, 13].

Table 2: Nudge combination effects and cost-effectiveness analysis

Combination	Compliance (%)	Gain over Control	Cost/Farmer (USD)
Default + Timely reminder	68.3	+34.8	4.80
Social norm + Commitment	62.6	+29.1	3.40
Simplified + Visual prompt	55.2	+21.7	2.10
Single nudge average	53.5	+19.0	3.20

Nudge combinations produced additive but not fully multiplicative effects. The strongest pair — default option plus timely reminder — achieved 68.3% compliance, a 34.8-point gain over controls. Cost-effectiveness was

favorable across all conditions: the average single-nudge cost of USD 3.20 per additional compliant farmer compares well against the estimated USD 45-80 cost of traditional extension training per farmer ^[7, 14].

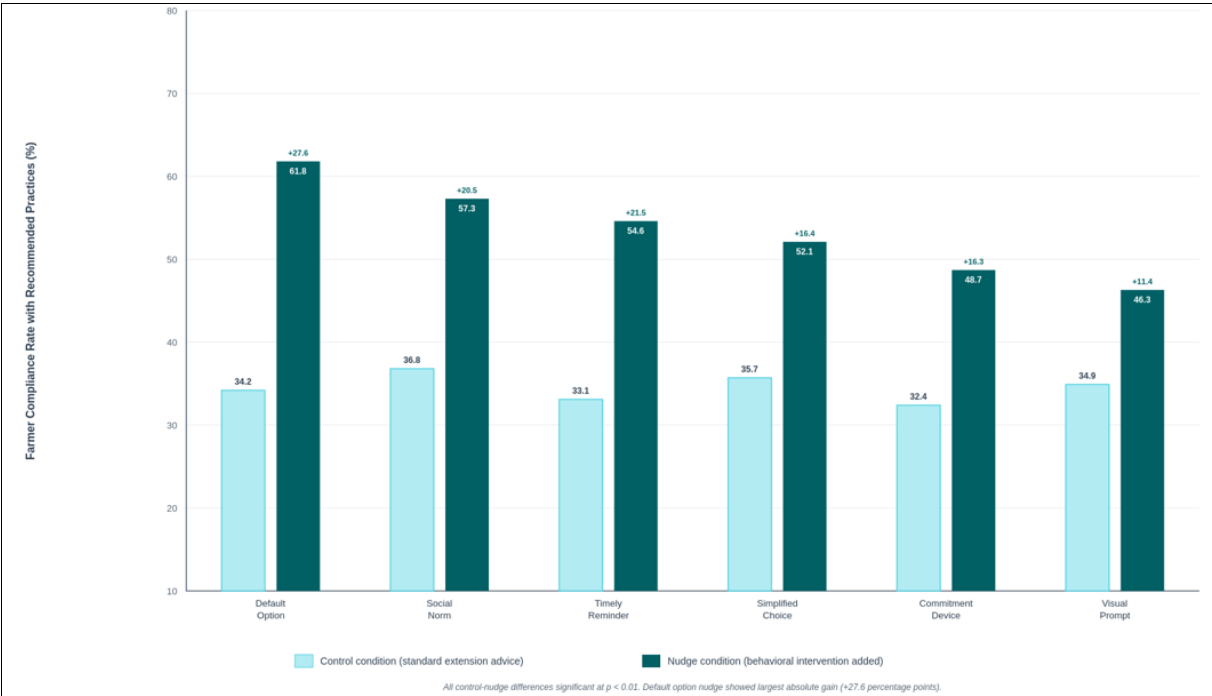


Fig 1: Grouped bar chart comparing farmer compliance rates between control and nudge conditions across six behavioral nudge types

The chart shows consistent nudge advantages across all six types, with default option producing the largest absolute difference. Control rates clustered narrowly (32.4-36.8%), confirming baseline equivalence across groups.

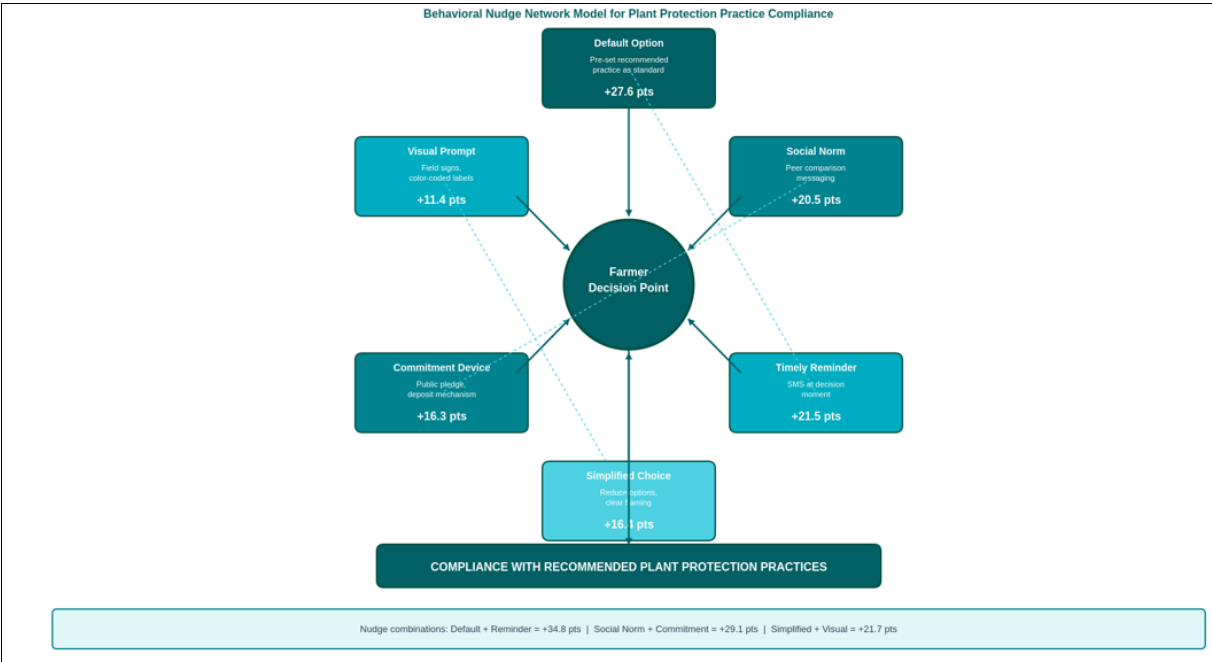


Fig 2: Behavioral nudge network model showing six nudge types, their effect sizes, and complementary combinations converging on farmer compliance decisions

The network positions the farmer's decision point at center, with six nudge interventions directed inward. Dashed cross-connections indicate tested combinations. Effect sizes (+11.4 to +27.6 points) are displayed on each node, with combination effects shown below.

Discussion

The results demonstrate that behavioral nudges can meaningfully close the knowledge-action gap in plant

protection without additional training [3, 4]. The default option's strong performance (+27.6 points) confirms a key insight from behavioral economics: making the desired behavior the easiest option is more effective than making it the most understood option. Pre-filled spray cards turned compliance from an active choice into an automatic default [5, 6].

The cost-effectiveness findings are particularly significant for resource-constrained extension systems. At USD 3.20

per additional compliant farmer, nudges represent roughly one-fifteenth the cost of equivalent gains through conventional training approaches. The materials are simple — printed cards, SMS messages, posters, field signs — and don't require extension agents with advanced technical knowledge to implement [8, 14].

The combination results suggest that nudge stacking can amplify effects, but with diminishing returns. The default-plus-reminder combination gained 34.8 points versus 27.6 and 21.5 individually, indicating partial additivity rather than full multiplication. This has design implications: extension programs should prioritize the strongest individual nudge (defaults) before investing in combinations [7, 15].

Practical Applications

Based on the trial results, a three-step implementation guide was developed for extension services. Step 1: Identify the specific compliance gap — which recommended practices are farmers failing to follow despite having adequate knowledge? Step 2: Match the gap to the most appropriate nudge type using the decision framework: timing problems suggest reminders, choice complexity suggests simplification, inertia suggests defaults. Step 3: Pilot the nudge with a small farmer group, measure compliance change over two spray windows, and scale if effective. The guide includes templates for pre-filled spray cards, sample SMS reminder scripts, social norm poster designs, and simplified product choice lists, all adaptable to different crop protection contexts [13, 16].

Limitations

The trial covered two regions and two crops in Papua New Guinea, limiting generalizability. The 12-month timeframe captured four spray windows but not multi-year compliance persistence. Blinding was impossible for some nudge types (posters, field signs). The combination testing involved a small subsample (72 farmers). Observer presence during spray windows may have inflated compliance in both conditions. Future work should include longer follow-up, more crop systems, and assessment of whether nudge effects persist when interventions are withdrawn.

Conclusion

This research tested six behavioral nudge interventions for improving farmer compliance with plant protection practices in Papua New Guinea's cocoa and coffee systems. All six nudges produced significant compliance gains, with default options leading at +27.6 percentage points. Nudge combinations amplified effects, reaching +34.8 points for the strongest pair.

The cost-effectiveness of nudges (USD 3.20 per additional compliant farmer) makes them an attractive complement to conventional extension. They work not by adding knowledge but by restructuring the choice environment so that recommended practices become the easier path. Extension systems dealing with persistent knowledge-action gaps in plant protection or similar repeated-decision contexts should consider integrating behavioral nudges into their standard programming toolkit.

References

1. Curry GN, Koczberski G, Lummani J, Nailina R, Peter E, McNally G, *et al.* A bridge too far? The influence of socio-cultural values on the adaptation of cocoa farmers

in Papua New Guinea. *Global Environmental Change*. 2015;35:153-164.

2. NARI. Papua New Guinea coffee and cocoa plant protection guide. National Agricultural Research Institute. 2019;Lae:1-96.
3. Duflo E, Kremer M, Robinson J. Nudging farmers to use fertilizer: theory and experimental evidence from Kenya. *American Economic Review*. 2011;101(6):2350-2390.
4. Thaler RH, Sunstein CR. *Nudge: improving decisions about health, wealth, and happiness*. Yale University Press. 2008;New Haven:1-312.
5. Kahneman D. *Thinking, fast and slow*. Farrar, Straus and Giroux. 2011;New York:1-499.
6. Ariely D. *Predictably irrational: the hidden forces that shape our decisions*. Harper Collins. 2008;New York:1-384.
7. Baylis K, Gong Y, Wang S. Bridging versus bonding social capital and the governance of common pool resources. *Land Economics*. 2018;94(4):497-520.
8. Jack BK. Constraints on the adoption of agricultural technologies in developing countries. *Agricultural Technology Adoption Initiative White Paper*. 2013;1-68.
9. Aker JC, Ghosh I, Burrell J. The promise and pitfalls of ICT for agriculture initiatives. *Agricultural Economics*. 2016;47(S1):35-48.
10. Hayes RJ, Moulton LH. *Cluster randomised trials*. CRC Press. 2017;Boca Raton:1-438.
11. Creswell JW. *Research design: qualitative, quantitative, and mixed methods approaches*. Sage Publications. 2014;Los Angeles:1-342.
12. Tavakol M, Dennick R. Making sense of Cronbach alpha. *International Journal of Medical Education*. 2011;2:53-55.
13. Benartzi S, Beshears J, Milkman KL, Sunstein CR, Thaler RH, Shankar M, Tucker-Ray W, Congdon WJ, Galing S. Should governments invest more in nudging? *Psychological Science*. 2017;28(8):1041-1055.
14. Cole S, Fernando AN. Mobile-izing agricultural advice: technology adoption, diffusion, and sustainability. *The Economic Journal*. 2021;131(633):192-219.
15. Allcott H. Social norms and energy conservation. *Journal of Public Economics*. 2011;95(9-10):1082-1095.
16. Johnson EJ, Goldstein D. Do defaults save lives? *Science*. 2003;302(5649):1338-1339.