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Moral obligation explains less than trust and peer observation in uncertified organic coffee–goat farming in East Java

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Abstract

Smallholders throughout Indonesia's coffee sector apply organic and integrated practices while holding no organic certification, and therefore forgo the price premium that certification confers. Neither incentive-based nor purely moral accounts of adoption explain this pattern well. We surveyed 600 smallholders operating integrated coffee–goat systems across three regencies of East Java, none of them certified, and evaluated the value–belief–norm chain against two alternative routes using partial least squares structural equation modelling. Every path in the chain is supported, yet the model accounts for 2.5% of variance in ascribed responsibility and, through personal norms alone, 10.7% of variance in adoption intention. Green trust, defined as confidence that the practice performs reliably, and perceived social support each relate to intention at least as strongly as personal norms do; together they raise explained variance to 27.4%. Perceived social support is statistically independent of every construct in the moral chain. Multigroup analysis indicates that the moral route operates among men but not among women. Where neither market reward nor third-party verification is available, adoption appears to rest on judgements about whether the practice works and on what neighbours are observed to do. Group certification and demonstration through complete conversion cycles address this constraint more directly than awareness campaigns.

1 Introduction

Four per cent of Indonesia's coffee area is certified organic. The national organic statistics compilation records 31,773 hectares under certification, farmed by 13,666 producers (David & Alkausar, 2023), set against a crop that is almost entirely smallholder: perkebunan rakyat accounted for 99.4% of national coffee area in 2022, on holdings averaging one to two hectares (Pusat Data dan Sistem Informasi Pertanian, 2023; USDA Foreign Agricultural Service, 2025). Somewhere in the remaining ninety-six per cent are farmers who apply organic methods and hold no certificate. Nobody counts them, so nobody knows how many there are.

Why they remain outside the system is not mysterious. An initial three-year certificate under the Indonesian organic standard costs IDR 15–30 million, with annual surveillance adding roughly half that again (Kirana & Nugraha, 2019). On one hectare the arithmetic does not work, and it has not worked for some time. Barrett et al. (2002) identified certification cost as a structural barrier to developing-country producers when the export market was still young, and Fouilleux and Loconto (2017) argue that the accreditation architecture actively produces exclusion rather than merely failing to prevent it. Indonesian evidence points the same way. de Vos et al. (2023) document how much independent oil palm smallholders must resolve before certification becomes feasible at all, and Sujianto et al. (2024) show that financial constraints persist for organic rice growers well after entry.

What is harder to account for is why anyone farms organically under these conditions. The costs are real enough. Synthetic inputs are withdrawn, labour requirements rise, and land and manure are committed to a system whose returns arrive slowly. The reward, meanwhile, is not obviously there. Saroja and

Karyani (2021) compared 28 organic with 28 conventional coffee farmers in West Java and found a differential of IDR 500–2,000 per kilogram, with per-hectare income lower under organic management. That was among certified producers. For the uncertified the premium is not merely thin; it is unavailable, because the price differential attaches to the label rather than to the practice.

The wider impact literature does not settle matters in organic agriculture's favour either. Certification schemes raise farm-gate prices without reliably raising household income (Chiputwa et al., 2015; Jena & Grote, 2022), effects vary substantially across schemes and across households (Ayuya et al., 2015; Ibanez & Blackman, 2016), and Bray and Neilson (2017) observe that fewer than half of all certified coffee volumes are ultimately sold as certified. Coffee–livestock integration, the practice at issue here, is rarer still: Hida et al. (2023) recorded implementation by 0.2% of farmers in their study region, notwithstanding extension promotion and demonstrated gains under optimisation.

Organic agriculture research has a well-established way of framing this population. Veldstra et al. (2014) separated the decision to farm organically from the decision to certify, treating them as two decisions rather than one, and Cáceres (2005) had earlier argued that non-certified organic agriculture constitutes a category in its own right and not a deficient approximation of the certified form. Empirical work has begun to follow that lead. Kamau et al. (2022) compared certified organic, non-certified organic and conventional smallholders in Kenya and found differences that certification status alone does not capture; Zhu and Habisch (2019) describe farmers in southern China practising organic methods outside any assurance scheme; Blockeel et al. (2023) report the same pattern in Ghana and Kenya. What motivates this group remains thinly documented, however, and most of what exists is descriptive.

If price does not explain the behaviour, obligation might. Value–belief–norm theory supplies the standard account. Stern (2000) developed it from the norm-activation model of Schwartz (1977) and from earlier work on value orientations (Stern et al., 1993; Stern et al., 1999), specifying a sequence in which biospheric values shape awareness of environmental consequences, awareness activates ascribed responsibility, responsibility hardens into a personal norm, and the norm produces intention and then action. The measurement apparatus is settled (De Groot & Steg, 2007; De Groot & Steg, 2008), the mediating structure has been examined experimentally (De Groot & Steg, 2009; Steg & De Groot, 2010), and meta-analyses confirm that moral norms contribute beyond attitudes and perceived control (Bamberg & Möser, 2007; Klöckner, 2013). Applications to farming have generally supported the sequence, in watershed protection (Zeweld et al., 2017), water conservation (Pradhananga & Davenport, 2019) and conservation practice more broadly (McGuire et al., 2013).

We doubt that obligation alone carries the behaviour here, and the reason is specific rather than general. Norm activation was worked out on behaviours a person can perform once the decision is taken, and its reach is known to contract as the behaviour becomes expensive. That is the low-cost hypothesis, tested directly by Diekmann and Preisendörfer (2003) and by Best and Kneip (2011); reviews of the value–action gap reach the same boundary from a different direction (Kollmuss & Agyeman, 2002; Steg & Vlek,

2009; Vermeir & Verbeke, 2006). Uncertified integrated organic farming is not a cheap behaviour. It also presents two difficulties at once, and the two are worth separating.

The first is a matter of timing. Goats return value quickly, and Javanese smallholders have kept ruminants for generations largely to produce manure-compost for their crops (Tanner et al., 2001; Djoharjani, 1996). Coffee does not oblige on that schedule. A converted stand takes several seasons to show a yield response (Rigal et al., 2020), and whether that response is favourable remains unsettled: shade and low-input systems trade yield against other returns (Perfecto et al., 2005), and organic certification produces no reliable yield gain (Jena & Grote, 2022). The farmer commits to the slow enterprise before observing what it does.

The second difficulty concerns knowing, and it follows directly from being uncertified. Third-party certification exists to transfer assurance where a buyer cannot verify a claim personally; organic quality is a credence attribute in the strict sense (Darby & Karni, 1973; Hatanaka et al., 2005). A farmer outside the system has no inspector's attestation and no premium from which to read the market's verdict. Whether the practice is working must therefore be judged privately, or inferred from what is visible on the next slope. This is an ordinary epistemic situation for a smallholder, but it is not the situation for which norm-activation theory was designed.

This study asks how much of adoption intention the norm-activation chain actually accounts for under those conditions, and what accounts for the remainder. The behaviour in question is specific, and worth naming before the argument proceeds: extending an integrated coffee–goat system managed by organic methods, meaning the withdrawal of synthetic inputs, the routing of goat manure into the coffee stand as the fertility source, and the maintenance of shade, with no certificate sought and no premium expected. Intention refers to extending that system in the coming season; reported adoption refers to the practices applied over the preceding year. We put the question to 600 uncertified smallholders operating such systems across three regencies of East Java, and estimate the model by partial least squares path modelling, comparing nested specifications so that the contribution of each route can be read separately.

Three contributions follow, and we state them narrowly. We quantify a boundary condition of value–belief–norm theory rather than asserting one: the chain holds in every path while accounting for a small fraction of the variance it is meant to explain. We show that two routes lying outside the moral chain carry most of what is explained, and that one of them shares almost no variance with the chain at all. And we report a difference between men and women in which route operates, which bears on how findings drawn from male-dominated agricultural samples ought to be generalised (Heidari et al., 2016). None of this displaces value–belief–norm theory. It marks where the theory's explanatory work runs out, in a setting the theory was not built for.

2 Conceptual framework and hypotheses

2.1 The norm-activation chain

Value–belief–norm theory specifies a causal chain with four links. Biospheric value orientations, distinguished from altruistic and egoistic orientations in the standard instrument (De Groot & Steg, 2008), dispose individuals to attend to environmental consequences. Awareness of those consequences activates ascription of responsibility, the acceptance that one's own conduct contributes to them. Responsibility crystallises into a personal norm, an internalised obligation to act, which is the proximal driver of intention (Stern, 2000). Thøgersen (2006) refined the taxonomy by separating introjected from integrated personal norms and distinguishing both from social norms, and subsequent work has shown that values rather than knowledge trigger the activation sequence (Ünal et al., 2018). Latent-variable path tests support the specification while indicating that personal norms account for a moderate share of behavioural variance (Van Riper & Kyle, 2014).

Agricultural applications have been productive but also cautionary. Burton (2004) warned early against importing generic behavioural models into farming research without attention to the occupational context, and Sok et al. (2021) reach a similar conclusion in a review of 124 farmer studies using reasoned-action frameworks, noting recurrent measurement and construct-separation problems. The policy-oriented review of Dessart et al. (2019) classifies dispositional, social and cognitive drivers of farmer adoption and finds none of them sufficient alone. Comparative tests of value–belief–norm against the theory of planned behaviour have not settled the matter in either direction (Kaiser et al., 2005). Notwithstanding these cautions, the chain has performed consistently enough in farming contexts that we specify it in the standard form and test it as such.

H1 Biospheric values relate positively to awareness of environmental consequences.

H2 Awareness of environmental consequences relates positively to ascription of responsibility.

H3 Ascription of responsibility relates positively to personal norms.

H6 Personal norms relate positively to adoption intention.

2.2 Green trust as an evaluative route

Trust enters where verification does not. The construct we require is a belief about whether a practice performs as intended under ordinary field conditions, and the closest available operationalisation is green trust, introduced by Chen (2010) and developed into a measurement model in which perceived value and perceived risk determine trust, which in turn drives intention (Chen & Chang, 2012). Subsequent work established that unverifiable environmental claims erode trust through confusion and elevated risk perception (Chen & Chang, 2013), and that consumer trust is a precondition for a green market to form at all rather than merely an attitude within it (Nuttavuthisit & Thøgersen, 2017). Where verification is costly, trust operates as a heuristic: willingness to pay for organic logos tracks familiarity rather than knowledge of the underlying standard (Janssen & Hamm, 2012).

Almost all of this literature concerns consumers. The producer-side evidence is thinner but consistent in direction. Hunecke et al. (2017) decompose farmer trust into general, institutional and community components and show each predicts irrigation-technology adoption. Zhou et al. (2023) replicate that decomposition for low-carbon agricultural technology in south-west China. Farmers discount advice by the perceived commercial interest of its source (Sutherland et al., 2013), knowledge exchange between agronomists and farmers is structured by trust and power asymmetry (Ingram, 2008), and farmers rank peers above scientific experts as trusted sources on soil management (Rust et al., 2022). Trust-based advisory relationships outperform financial incentives in sustaining voluntary environmental management (Mills et al., 2017).

Green trust must nonetheless be distinguished from adjacent constructs, and reviewers of behavioural adoption research are right to press the point. It is not a value orientation: biospheric value concerns the wellbeing of ecosystems, whereas trust concerns the performance of a technique. It is not perceived behavioural control or performance expectancy, both of which are properties of the actor rather than of the practice (Venkatesh et al., 2003). The distinction has precedent: Gefen et al. (2003) demonstrated that trust is empirically separable from, and comparable in explanatory weight to, perceived usefulness, and the ability–benevolence–integrity structure of Mayer et al. (1995) underlies essentially every trust scale in use, including Chen's. Siegrist (2021) reviews the trust–risk literature critically, including the endogeneity problem of whether trust causes acceptance or rationalises it, a caution we return to in the discussion. The discriminating case in our setting is concrete: a farmer may be confident of their own competence and still doubt that manure and shade will hold yields through a dry season.

We position green trust downstream of awareness of consequences. Awareness in this setting is knowledge of how agricultural practice degrades soil, water and habitat, and that knowledge is what renders the alternative credible. A farmer who has observed fertiliser damage a slope has a concrete basis for believing that a manure-and-shade system might perform better.

H4 Awareness of environmental consequences relates positively to green trust.

H5 Green trust relates positively to adoption intention.

2.3 Perceived social support as an informational route

Where no institution verifies performance, events on adjacent land constitute the most accessible evidence available. Social norms are conventionally modelled as reinforcement of internalised obligation (Bamberg & Möser, 2007), and reviews of norm-based intervention document substantial heterogeneity in when that reinforcement operates (Farrow et al., 2017). We leave the question open rather than assume the reinforcement structure, and measure perceived social support for adoption as a construct permitted to compete with the moral route. Smallholdings in these subdistricts lie close together; observing a neighbour hold yields through a conversion year costs less than conducting the experiment oneself. Labour exchange and social networks have been shown to shape organic practice in

comparable Asian smallholder economies (Tennhardt et al., 2025), and participatory assurance arrangements build on precisely this observability (Nelson et al., 2010; Home et al., 2017).

H7 Perceived social support relates positively to adoption intention.

H8 Adoption intention relates positively to reported adoption behaviour.

3 Materials and methods

3.1 Study setting

East Java produced 48,100 tonnes of coffee in 2023 and ranks fourth among Indonesian provinces for robusta output, contributing 5.9% of the national robusta crop on a five-year average (Pusat Data dan Sistem Informasi Pertanian, 2023; Badan Pusat Statistik, 2024). The province also holds the largest goat population in Indonesia (Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2024), and Indonesian farmers' preferences between small ruminant species are well documented (Budisatria et al., 2010). The coincidence of coffee and goats is what makes integration a practical option rather than a hypothetical one, and it governed our choice of province. Indonesian smallholder coffee has been extensively studied as a site where private sustainability standards restructure value chains (Neilson, 2008) and where upgrading interventions distribute benefits unevenly across farmers (Vicol et al., 2018; Ibnu et al., 2018).

A multistage sampling approach was applied. East Java was selected purposively for its prominence in both coffee production and goat farming. Within the province, three regencies were selected on the basis of official production statistics and their contrasting agro-ecological conditions: Malang (Dampit subdistrict), Banyuwangi (Kalibaru subdistrict) and Madiun (Kare subdistrict). Their spatial distribution is shown in Fig. 1. Kalibaru carries 3,847 hectares of predominantly robusta coffee yielding approximately 4,256 tonnes annually. Dampit produces some 950 tonnes of robusta within a regency whose robusta area exceeds 21,000 hectares. Kare, on the slopes of Mount Wilis, is considerably smaller, with published estimates near 200 hectares farmed by a comparable number of households; this figure derives from a press report rather than a statistical series and should be treated as indicative.

Production and market conditions across these sites are unsettled, and it is worth stating what that means concretely. Domestic robusta spot prices moved from IDR 17,862 per kilogram in October 2019 to IDR 104,371 in February 2025, a 5.8-fold range within 64 months traversed along a non-monotonic path: prices peaked at IDR 36,713 in January 2022 and fell to IDR 31,026 by November of that year before resuming their ascent (USDA Foreign Agricultural Service, 2025). The International Coffee Organization composite indicator reached 310.12 US cents per pound in January 2025, its highest monthly average since April 1977 (International Coffee Organization, 2025). El Niño stress on robusta growth has been documented at Gumitir on the Jember–Banyuwangi border, where agroforestry shade was shown to buffer it (Yuliasmara, 2017), and climate projections indicate declining suitability for both Arabica and Robusta across producing regions (Bunn et al., 2015). Coffee berry borer infestation exceeding 20%, which causes yield losses above 10%, recurs in Indonesian coffee (Tama, 2025), and warming is

expected to extend the pest's range and generation rate (Jaramillo et al., 2011). These conditions form the backdrop against which judgements about practice reliability are made. We did not measure farmers' perceived uncertainty and we do not model it; the conditions enter this study as context rather than as a construct.

The integrated system itself has an agronomic logic that the behavioural literature seldom engages. Crop–animal interaction in Asian mixed farming has been characterised in detail (Devendra & Thomas, 2002), and integration is now understood as operating at scales beyond the individual farm (Martin et al., 2016). Recent Southeast Asian evidence indicates that integration mitigates environmental trade-offs during agricultural transition (Paul et al., 2022), while Indonesian work on smallholder livestock systems identifies manure management as the decisive lever for nutrient balance (Al Zahra et al., 2024). The manure flow that integration formalises is therefore not incidental to the adoption decision; it is the mechanism that couples a fast-repaying enterprise to a slow one.

3.2 Participants and procedure

We surveyed 600 smallholders distributed approximately evenly across the three regencies, using face-to-face structured interviews administered by trained enumerators. All respondents operate integrated coffee–goat systems applying organic methods. None holds formal organic certification, so adoption is measured as self-reported practice rather than as certified status, following the analytical separation proposed by Veldstra et al. (2014). This reflects the population rather than a limitation of sampling: certification is financially unattainable at the holding sizes involved.

Participants were smallholders operating, or closely familiar with, integrated coffee–goat systems. A minimum level of farming experience was applied as an inclusion criterion so that respondents could evaluate farming decisions from direct experience; this restricts inference to more experienced operators and we return to the point in the limitations. The sample of 600 was distributed in roughly equal numbers across the three regencies, and deliberately spans farmers who had already extended the practices and those who had not, so that intention and reported behaviour could be examined within one framework. What the design fixed and what it left open matters for interpretation. Because respondents were selected purposively against category targets rather than drawn at random from a frame, the results support analytical generalisation to comparable smallholder systems and not statistical generalisation to a defined population. Replication on a probability sample, in these regencies and in other Indonesian coffee-producing provinces, is the appropriate next step and would establish how far the estimates travel.

Several procedural controls were applied at the point of collection to limit common method variance: respondents were assured of anonymity, told explicitly that no answer was right or wrong, and item order was varied where the instrument permitted.

Respondent characteristics appear in Table 1, reported as counts with percentages alongside. Of 600 respondents, 522 are men. Age is concentrated in the middle of the range, with 432 respondents

between 35 and 55 years, and educational attainment is modest: 330 completed primary schooling or less. Farming experience is substantial, 420 respondents reporting more than fifteen years.

One feature of that table should be stated plainly rather than left for a reader to notice. Every category count is an exact multiple of six, so every percentage lands on a whole number. The joint distributions carry no such regularity and behave as field data should: age and farming experience are strongly and monotonically associated, with structural zeros where the combination is impossible ($\chi^2 = 667.85$, $df = 6$, $p < 0.001$); education and technology use covary as expected ($\chi^2 = 152.54$, $df = 6$, $p < 0.001$); and gender is unrelated to education ($\chi^2 = 1.06$, $df = 3$, $p = 0.787$). Marginal counts fixed in advance and joint structure left to the field is what quota sampling produces. We report the pattern because it bears on how the sample should be read: the marginal distribution in Table 1 reflects a sampling target rather than an estimate of the underlying population, and no inference in this paper rests on it.

Table 1
Respondent characteristics (N = 600)

Characteristic	Category	n	%
Age	< 35 years	72	12.0
	35–45 years	198	33.0
	46–55 years	234	39.0
	> 55 years	96	16.0
Gender	Male	522	87.0
	Female	78	13.0
Education	No formal education	42	7.0
	Primary school	288	48.0
	Secondary school	222	37.0
	Diploma or degree	48	8.0
Farming experience	10–15 years	180	30.0
	16–25 years	282	47.0
	> 25 years	138	23.0
Technology use	Low (traditional methods)	150	25.0
	Moderate (some modern tools)	360	60.0
	High (precision agriculture)	90	15.0
Household size	1–3	192	32.0
	4–5	318	53.0
	> 5	90	15.0

Counts are from the respondent-level data file; percentages are shown to one decimal. Every category count is an exact multiple of six, consistent with quota targets set before fieldwork; the joint distributions are unconstrained (see Sect. 3.2*). No respondent holds formal organic certification.*

3.3 Measures

Each construct was measured with three items on five-point Likert scales, adapted from established instruments and prepared through translation and back-translation. Biospheric values, awareness of consequences, ascription of responsibility and personal norms follow the standard value–belief–norm operationalisation (Stern, 2000; De Groot & Steg, 2008). Green trust items capture confidence that organic practice sustains ecosystem function, yields acceptable product quality, and repays over time,

adapted from Chen and Chang (2012). Perceived social support items capture community influence on the adoption decision. One of these items is negatively worded and was reverse-coded prior to estimation; we report this explicitly because an earlier analysis of these data omitted the recoding and consequently misreported the construct's reliability. Intention items refer to adopting or extending the integrated organic system in the coming season, and adoption items to practices applied over the preceding year. Complete item wording is provided in Supplementary Table S1. The instrument also carried Big Five personality items together with altruistic and egoistic value items, used here solely for the marker-variable diagnostic.

3.4 Analysis

The model was estimated by partial least squares structural equation modelling in SmartPLS, following current reporting guidance (Hair et al., 2019). Path significance was assessed by bootstrapping with 5,000 subsamples and percentile confidence intervals. Reliability is reported as Cronbach's α, ρA (Dijkstra & Henseler, 2015) and composite reliability; discriminant validity by the Fornell–Larcker criterion and by heterotrait–monotrait ratios (Henseler et al., 2015). Measurement invariance was tested using MICOM step two with 500 permutations (Henseler et al., 2016), and group differences by permutation-based multigroup analysis following current recommendations (Cheah et al., 2023).

Four procedures address common method variance: full collinearity variance inflation factors (Kock, 2015), an unmeasured latent method construct (Liang et al., 2007), a measured marker variable selected as the Big Five trait exhibiting the smallest correlation with any model construct, and the marker-correlation adjustment of Lindell and Whitney (2001). Out-of-sample predictive power was evaluated with PLSpredict (Shmueli et al., 2016; Shmueli et al., 2019) using ten-fold cross-validation repeated ten times against a linear-regression benchmark, and nested models were compared on information criteria following Sharma et al. (2021). Because adoption behaviour is arguably formative, and because misspecification of measurement mode is a documented source of parameter bias (Jarvis et al., 2003), the full model was re-estimated with that construct specified in Mode B. Endogeneity was probed using the Gaussian copula approach (Park & Gupta, 2012) in its revised form (Becker et al., 2022). We note that partial least squares path modelling has attracted substantial methodological criticism (Rönkkö et al., 2016), and we have accordingly reported the diagnostics that criticism identifies as necessary rather than a selection of favourable indices.

The data are cross-sectional and were collected in a single sitting. Nothing reported below identifies a causal mechanism, and results are presented and interpreted as associations throughout.

4 Results

4.1 Measurement model

Table 2 reports the measurement model. Seven of eight constructs satisfy reflective standards, with composite reliability between 0.833 and 0.885 and average variance extracted between 0.624 and 0.720.

Adoption behaviour does not: its items correlate at 0.18–0.28, yielding Cronbach's α of 0.481 and average variance extracted of 0.491.

The negatively worded social-support item requires comment. Without reverse-coding it correlates −0.577 and − 0.588 with the remaining two items, and the estimation algorithm assigns it a compensating negative weight, producing a composite reliability of 0.635 that misrepresents the construct. After recoding, α is 0.806 and composite reliability 0.885. Path estimates are identical under either coding, since the algorithm had already accommodated the reversal.

Table 2
Measurement model: loadings, reliability and convergent validity

Construct	Item	Loading	t	α	ρA	CR	AVE
Biospheric values	BI1	0.810	31.70	0.741	0.742	0.853	0.659
	BI2	0.812	33.60				
	BI3	0.813	32.63				
Awareness of consequences	AC1	0.859	66.47	0.787	0.792	0.875	0.701
	AC2	0.816	45.42				
	AC3	0.836	53.01				
Ascription of responsibility	AR1	0.815	39.02	0.761	0.765	0.862	0.676
	AR2	0.803	35.91				
	AR3	0.849	47.47				
Green trust	GT1	0.781	34.05	0.699	0.701	0.833	0.624
	GT2	0.810	44.77				
	GT3	0.778	35.79				
Personal norms	PN1	0.860	66.42	0.727	0.744	0.845	0.647
	PN2	0.793	37.44				
	PN3	0.756	29.88				
Perceived social support	SN1	0.838	45.25	0.806	0.817	0.885	0.720
	SN2	0.836	42.54				
	SN3	0.871	55.79				
Intention to adopt	IN1	0.866	77.45	0.805	0.810	0.885	0.719
	IN2	0.807	46.54				
	IN3	0.870	85.28				
Adoption behaviour	AD1	0.772	30.63	0.481	0.493	0.742	0.491
	AD2	0.690	20.20				
	AD3	0.633	15.77				

All loadings significant at $p < 0.001$ (bootstrap, 5,000 subsamples). SN3 is negatively worded and was reverse-coded before estimation. Adoption behaviour does not meet reflective standards ($\alpha = 0.481$, AVE = 0.491) and is specified formatively in the robustness analysis; see Sect. 3.1.

Discriminant validity is satisfied on the Fornell–Larcker criterion for every construct pair (Table 3, lower triangle). Heterotrait–monotrait ratios (upper triangle) fall below 0.85 for all pairs except intention and adoption behaviour, which reaches 0.952. The two criteria diverge because the low internal consistency of adoption behaviour deflates the HTMT denominator. We report the divergence rather than omitting the construct from the matrix, and note what follows from it: intention and reported adoption are not sharply distinguished empirically, so the association between them should not be read as clean behavioural validation.

Table 3
Discriminant validity

BI	**BI**	**AC**	**AR**	**GT**	**PN**	**SN**	**IN**	**AD**
	0.812	**0.377**	**0.559**	**0.246**	**0.445**	**0.083**	**0.165**	**0.170**
AC	0.290	0.837	0.201	0.601	0.526	0.044	0.293	0.382
AR	0.419	0.158	0.822	0.139	0.489	0.070	0.128	0.217
GT	0.179	0.447	0.103	0.790	0.496	0.145	0.503	0.651
PN	0.327	0.397	0.368	0.355	0.804	0.080	0.423	0.434
SN	-0.015	-0.005	0.010	0.112	-0.050	0.848	0.388	0.497
IN	0.127	0.233	0.100	0.377	0.327	0.318	0.848	0.952
AD	0.103	0.234	0.131	0.385	0.262	0.306	0.597	0.701

Lower triangle: construct correlations, with the square root of AVE on the diagonal (Fornell–Larcker). Upper triangle: heterotrait–monotrait ratios. The intention–adoption ratio of 0.952 exceeds the 0.85 and 0.90 thresholds while Fornell–Larcker is satisfied for the same pair; see Sect. 3.1.

Specifying adoption behaviour formatively resolves both difficulties and alters nothing substantive. All three outer weights are significant (AD1 w = 0.570, t = 11.15; AD2 w = 0.461, t = 8.97; AD3 w = 0.381, t = 6.46), indicator variance inflation factors range from 1.08 to 1.14, no path coefficient shifts by more than 0.0004, and R^2 for adoption moves from 0.356 to 0.357. The three items describe distinct components of adoption rather than interchangeable manifestations of a common cause: a farmer may allocate land to the system without applying its key practices. We therefore prefer the formative specification on conceptual grounds while reporting reflective estimates throughout for comparability. Full weights and diagnostics appear in Supplementary Table S4.

4.2 The moral chain holds and explains little

All eight hypothesised relationships are supported (Table 4, Fig. 2). Biospheric values relate to awareness of consequences, awareness to ascription of responsibility, and responsibility to personal norms. Personal norms relate to intention, and intention to reported adoption at β = 0.597, the largest

coefficient in the model and the only one with a large effect size. Coefficients, confidence intervals and significance are given in Table 4.

Table 4
Structural model estimates (bootstrap, 5,000 subsamples)

Hypothesis	Path	β	SE	t	95% CI	f^2	Decision
H1	Biospheric values → Awareness of consequences	0.290***	0.037	7.79	[0.222, 0.366]	0.092	Supported
H2	Awareness of consequences → Ascription of responsibility	0.158***	0.039	4.07	[0.084, 0.236]	0.026	Supported
H3	Ascription of responsibility → Personal norms	0.368***	0.034	10.73	[0.301, 0.435]	0.157	Supported
H4	Awareness of consequences → Green trust	0.447***	0.033	13.50	[0.383, 0.512]	0.250	Supported
H5	Green trust → Intention to adopt	0.254***	0.035	7.20	[0.184, 0.322]	0.076	Supported
H6	Personal norms → Intention to adopt	0.252***	0.038	6.65	[0.179, 0.328]	0.076	Supported
H7	Perceived social support → Intention to adopt	0.302***	0.034	8.81	[0.235, 0.369]	0.123	Supported
H8	Intention to adopt → Adoption behaviour	0.597***	0.026	23.16	[0.547, 0.646]	0.553	Supported

*** $p < 0.001$. *Confidence intervals are percentile bootstrap intervals. Hypothesis numbering follows* Sect. 1; *rows are ordered as estimated.*

Judged by the conventional reporting standard the framework is confirmed. The pattern of explained variance suggests a different reading. The model accounts for a twelfth of the variance in awareness of consequences and a fortieth of the variance in ascription of responsibility (Table 4). The second figure deserves attention rather than a footnote. Ascription of responsibility is the pivot of norm-activation logic, the juncture at which recognising a problem becomes accepting an obligation regarding it, and here awareness barely moves it. Whatever determines whether these farmers hold themselves responsible for agricultural environmental outcomes, it is largely not their awareness of those outcomes.

Nested comparison quantifies the contribution of each route (Table 5, Fig. 3). Personal norms alone explain 10.7% of the variance in adoption intention, and the full model 27.4%, with AIC and BIC declining

monotonically across the sequence. Roughly three fifths of the explained variance in intention therefore originates outside the moral chain.

Table 5
Nested model comparison, criterion variable: intention to adopt

Model	Predictors	R^2	R^2 adj.	AIC	BIC
M1	Personal norms only (VBN)	0.107	0.106	−67.00	−62.60
M2	Personal norms + green trust	0.185	0.182	−119.68	−110.89
M3	Personal norms + perceived social support	0.219	0.216	−145.22	−136.43
M4	Full model	0.274	0.270	−187.17	−173.98

Lower information criteria indicate better fit. The norm-activation route accounts for 10.7% of variance in intention on its own; the full model reaches 27.4%.

4.3 Two routes outside the chain

Green trust behaves as anticipated. Awareness of consequences relates to it at β = 0.447, nearly three times the coefficient linking awareness to ascription of responsibility, and green trust relates to intention at β = 0.254. The specific indirect association running from awareness through green trust to intention is 0.113, marginally larger than the association running through the entire normative chain, 0.093 (Table 6). Environmental knowledge in this sample is more closely tied to confidence in the alternative practice than to felt obligation regarding the current one.

Table 6
Specific indirect effects

Indirect path	β	SE	t	95% CI
Awareness → green trust → intention	0.113***	0.018	6.17	[0.080, 0.152]
Ascription → personal norms → intention	0.093***	0.017	5.56	[0.063, 0.128]
Biospheric values → awareness → green trust	0.130***	0.020	6.40	[0.093, 0.172]
Green trust → intention → adoption	0.151***	0.023	6.48	[0.107, 0.199]
Personal norms → intention → adoption	0.151***	0.024	6.19	[0.105, 0.200]
Perceived social support → intention → adoption	0.180***	0.023	7.93	[0.138, 0.226]
Awareness → green trust → intention → adoption	0.068***	0.012	5.62	[0.046, 0.093]

*** $p < 0.001$. *The evaluative route from awareness to intention (0.113) marginally exceeds the normative route (0.093).*

Perceived social support presents the more striking result. It is the largest of the three direct predictors of intention, while its heterotrait–monotrait ratios with the value–belief constructs sit below 0.09 and its correlation with personal norms is − 0.050. A construct that predicts intention at least as well as moral obligation does, while sharing essentially no variance with any element of the moral chain, is not operating as reinforcement of that chain. It constitutes a separate route.

The demographic analysis points the same way. Education and technology use relate to every construct in the model except perceived social support, whereas age, gender, farming experience and household size are unrelated to all of them (Supplementary Table S6). That perceived social support stands apart from the demographic gradient mirrors its position in the measurement model, and two independent portions of the instrument therefore point the same way.

4.4 Robustness, bias and heterogeneity

Common method variance was assessed by four procedures (Table 7). Full collinearity variance inflation factors stay well below the 3.3 threshold. Under the unmeasured latent method construct, substantive variance exceeds method variance by a ratio of 645 to 1, and two of twenty-four method loadings are significant. Introducing a measured marker variable shifts no path coefficient by more than 1.4%, and the marker-correlation adjustment leaves construct correlations essentially unchanged. Harman's single-factor test is reported for completeness alone; it is not evidence of anything, and we include it only because the earlier version of this paper relied on it.

Table 7
Common method variance diagnostics

Procedure	Result	Criterion	Assessment
Full collinearity VIF (Kock 2015)	1.185–1.753 across eight constructs	< 3.3	Passed
Unmeasured latent method construct (Liang et al. 2007)	Substantive variance 0.655 vs method variance 0.001 (645:1); 2 of 24 method loadings significant	Substantive >> method	Passed
Measured marker variable	Maximum change in any path coefficient 1.4%	Paths stable	Passed
Marker adjustment (Lindell and Whitney 2001)	rM = 0.0025; adjusted correlations unchanged	Correlations robust	Passed
Harman single-factor test	First unrotated factor 22.3% of variance	Reported only	Not diagnostic

The marker was selected as the Big Five trait with the smallest maximum correlation with any model construct (neuroticism, max |r| = 0.091).

Out-of-sample predictive power is summarised in Table 8. Every Q^2predict value exceeds zero. For adoption behaviour, the target construct, the model outperforms the linear benchmark on two of three

indicators by root mean square error and on all three by mean absolute error, corresponding to medium predictive power (Shmueli et al., 2019). This bears on interpretation of the fit statistics. The estimated-model standardised root mean square residual is 0.105, above the 0.08 guideline, against 0.057 for the saturated model. A prediction-oriented defence of that value is admissible only if predictive power is demonstrated, which is why the two are reported together. It is worth recording what we did and did not do about the value. The misfit is concentrated in a chain-structured model with full mediation and no cross-loadings, which is the specification value–belief–norm theory prescribes. Three modifications would lower the residual: freeing direct paths from the value and belief constructs to intention, allowing green trust and perceived social support to correlate with the chain constructs, and dropping the weakest indicators. We estimated the first and report it as the full model in Table 5; the second and third we did not apply. Both would improve the index by relaxing the theory the paper is testing, and the nested comparison that carries the argument depends on the routes remaining separable. We prefer a disclosed misfit in a specified model to a fitted one that no longer tests anything.

Table 8
PLSpredict: out-of-sample predictive performance

Construct	Indicator	Q^2predict	RMSE PLS	RMSE LM	ΔRMSE	ΔMAE
Awareness of consequences	AC1	0.068	0.759	0.762	-0.0030	-0.0084
Awareness of consequences	AC2	0.039	0.793	0.798	-0.0046	-0.0021
Awareness of consequences	AC3	0.049	0.793	0.798	-0.0045	-0.0039
Ascription of responsibility	AR1	0.019	0.774	0.745	+ 0.0297	-0.0404
Ascription of responsibility	AR2	0.021	0.778	0.742	+ 0.0360	-0.0344
Ascription of responsibility	AR3	0.021	0.800	0.763	+ 0.0368	-0.0286
Personal norms	PN1	0.004	0.806	0.783	+ 0.0233	-0.0411
Personal norms	PN2	0.003	0.819	0.796	+ 0.0232	-0.0311
Personal norms	PN3	0.002	0.791	0.773	+ 0.0175	-0.0481
Green trust	GT1	0.010	0.803	0.807	-0.0044	-0.0163
Green trust	GT2	0.023	0.803	0.801	+ 0.0019	-0.0248
Green trust	GT3	0.009	0.783	0.785	-0.0026	-0.0157
Intention to adopt	IN1	0.094	0.772	0.773	-0.0005	-0.0124
Intention to adopt	IN2	0.041	0.792	0.793	-0.0018	-0.0001
Intention to adopt	IN3	0.083	0.759	0.761	-0.0023	-0.0067
Adoption behaviour	AD1	0.034	0.809	0.811	-0.0019	-0.0192
Adoption behaviour	AD2	0.021	0.796	0.797	-0.0008	-0.0138
Adoption behaviour	AD3	0.054	0.783	0.773	+ 0.0101	-0.0298

Ten-fold cross-validation with ten repetitions. LM denotes the linear-regression benchmark. Negative Δ values indicate that the PLS model outperforms the benchmark. For adoption behaviour, the target

construct, PLS outperforms the benchmark on two of three indicators by RMSE and on all three by MAE, indicating medium predictive power (Shmueli et al. 2019).

One further check bears on the largest coefficient in the model. Because every construct was measured in a single sitting with items grouped by block, a reviewer may reasonably ask whether the strong association between awareness of consequences and green trust is produced by the questionnaire rather than by anything in the field. The instrument allows that question to be answered directly. Items appeared in fixed blocks in the order values, awareness, responsibility, trust, personal norms, social support, intention, adoption, so the responsibility block sat immediately after awareness and the trust block one position further away. Carryover or block-proximity effects predict that awareness should correlate most strongly with the block adjacent to it. It does not. The correlation with responsibility is 0.156, with trust 0.446, with personal norms 0.397, and with social support − 0.007, three blocks downstream. Association with awareness does not decay with distance in the instrument, and the adjacent block is the weakest of the four. Whatever produces the awareness–trust association, item order is not a candidate explanation. The method-variance diagnostics reported above point the same way.

Quadratic terms for each predictor of intention are non-significant, with ΔR^2 below 0.0005 in every case, so the relationships are linear. Gaussian copula terms are likewise non-significant; however, all three predictors are approximately normally distributed, which is the condition under which the copula approach does not apply, and we therefore report this as inconclusive rather than as evidence against endogeneity.

Compositional invariance holds for all eight constructs across gender, education and technology-use groupings (Supplementary Table S7), so path comparison is admissible. Multigroup analysis by education and by technology use returns no significant path difference (Supplementary Table S8). The gender comparison does (Table 9, Fig. 4). Among the 522 men, personal norms relate to intention at $\beta = 0.285$; among the 78 women the coefficient is − 0.011, and the difference is significant. Green trust is the stronger route among women, 0.405 against 0.230, although that difference is marginal. Both permutation p-values appear in Table 9.

Table 9
Multigroup analysis by gender (permutation test, 500 permutations)

Path	Men (n = 522)	Women (n = 78)	Difference	p
Biospheric values → awareness	0.304	0.244	+ 0.059	0.538
Awareness → ascription	0.165	0.119	+ 0.046	0.698
Ascription → personal norms	0.365	0.425	−0.060	0.612
Awareness → green trust	0.448	0.459	−0.011	0.908
Green trust → intention	0.230	0.405	−0.175	0.078
Personal norms → intention	0.285	−0.011	+ 0.296*	0.010
Perceived social support → intention	0.313	0.267	+ 0.046	0.664
Intention → adoption	0.605	0.560	+ 0.045	0.556

** p < 0.05 for the group difference. Compositional invariance was established for all eight constructs before comparison (MICOM step 2). R^2(intention) = 0.286 for men and 0.258 for women; R^2(adoption) = 0.366 and 0.314 respectively.*

Two features of the sample bear on interpretation. The male composition of the sample tracks the population closely: the 2023 Agricultural Census records 4,785,968 of 5,676,675 individual agricultural business managers in East Java as male (Badan Pusat Statistik, 2023). Male predominance among recorded farm decision-makers is characteristic of the population rather than an artefact of our sampling, and gender gaps in agricultural adoption are known to operate through resource access rather than through gender as such (Doss & Morris, 2000). The female subsample of 78 is nonetheless small, so those coefficients are estimated less precisely. A further qualification applies. Surveying 439 married couples in West Java, Qanti et al. (2022) found that approximately 40% of husbands reported their wives had no participation in agricultural decisions, roughly double the rate the wives themselves reported; comparable spousal disagreement has been documented in Tanzania (Anderson et al., 2017) and across multiple countries (Ambler et al., 2021). Where a single household respondent is male, women's involvement is likely to be understated. Southeast Asian gender dynamics in agriculture also differ appreciably from the African evidence base on which much of this literature rests (Akter et al., 2017).

With demographic controls introduced, the hypothesised paths shift by at most 0.006. Education and technology use nevertheless retain direct associations with adoption behaviour beyond intention, adding 3.4 percentage points of explained variance (Supplementary Table S9).

5 Discussion

Every path specified by value–belief–norm theory is present in these data with the expected sign and at conventional significance. Judged by the usual reporting standard the framework is supported, and we

do not dispute that. We consider it an incomplete summary of what we found. The chain explains 2.5% of variance in ascription of responsibility and, through personal norms alone, 10.7% of variance in intention. A framework can be confirmed in every particular and still leave most of the phenomenon unaccounted for.

We read this as a boundary condition rather than a defect. Norm activation describes how obligation forms and how it converts into willingness to act. It does not claim that obligation is the sole input to intention, and it was developed on behaviours for which the distance between deciding and doing is short. Uncertified integrated organic farming is not such a behaviour, and the absence of certification is what renders it distinctive rather than merely demanding. These farmers absorb the costs of organic production, wait several seasons for a coffee response that may prove unfavourable (Rigal et al., 2020; Jena & Grote, 2022), and receive neither a premium nor an inspector's attestation that the system is functioning. The interpretation is consistent with the low-cost hypothesis and its refinements (Diekmann & Preisendörfer, 2003; Best & Kneip, 2011), with the older attitude–behaviour–context proposition that dispositional factors predict behaviour only where contextual forces are weak (Guagnano et al., 1995), and with reviews finding that motivational predictors weaken as behavioural cost rises (Steg & Vlek, 2009; Dessart et al., 2019).

The results further indicate where the chain thins rather than merely that it does. Awareness of consequences relates to ascription of responsibility at 0.158, explaining 2.5% of variance, and to green trust at 0.447, explaining 20.0%. Farmers in this sample convert environmental knowledge into an assessment of what works far more readily than into an assessment of what they owe. This is not what the norm-activation literature would predict, since awareness is theorised to activate responsibility rather than to license evaluation (Schwartz, 1977; De Groot & Steg, 2009). Whether the pattern reflects something about smallholder agriculture, about this crop, or about how the responsibility items were understood is not a question a cross-sectional design can settle, and it merits direct examination.

Green trust occupies the position argued for it, and the indirect association through trust marginally exceeds that running through the entire normative chain. This accords with the epistemic situation of the uncertified farmer: with no third party attesting to performance (Hatanaka et al., 2005) and no market signal to read, a judgement about whether the practice works must be formed privately, and confidence substitutes for the evidence certification would otherwise supply. The claim should not be overstated. Green trust remains conceptually adjacent to performance expectancy and perceived usefulness (Venkatesh et al., 2003; Gefen et al., 2003), and although discriminant validity is supported, part of the association attributed to trust may reflect broader evaluative judgement. The design also cannot establish that awareness precedes trust rather than the reverse; a farmer already confident in organic methods may attend more closely to evidence of conventional harm, which is the endogeneity concern Siegrist (2021) raises for the trust–risk literature generally.

Perceived social support is the finding we did not anticipate in this form. It predicts intention as strongly as either alternative while sharing effectively no variance with the moral chain, and it is the single

construct untouched by the education and technology gradient running through everything else. Social influence in these communities appears to operate on a separate track rather than amplifying internalised norms, contrary to the reinforcement structure that the norm literature generally assumes (Thøgersen, 2006; Bamberg & Möser, 2007). A plausible explanation is that observing neighbours functions as evidence rather than as pressure, which would follow from the absence of certification: where no institution verifies performance, the adjacent farm becomes the available instrument. Farmers' documented preference for peer over expert sources is consistent with this reading (Rust et al., 2022), as is the role of trust in converting circulating information into knowledge farmers will act on (Ingram, 2008). This interpretation cannot be tested with the present measures and merits direct examination, for instance by separating descriptive from injunctive norm items (Farrow et al., 2017) and by asking farmers what they use to judge whether a practice is working.

The gender difference sharpens the same point. Personal norms predict intention among men and do not among women, for whom green trust is dominant. Were this replicated on a larger female subsample, it would mean that conclusions about normative activation drawn from male-dominated agricultural samples do not transfer across gender within the same population. Given that 84.3% of recorded agricultural business managers in East Java are men (Badan Pusat Statistik, 2023), male-dominated samples are the norm in this literature rather than the exception, and the qualification is not a narrow one. Reporting sex-disaggregated results is a requirement rather than an option under current research-integrity guidance (Heidari et al., 2016).

Several limitations bound these conclusions, and the first is the most consequential. Adoption behaviour is self-reported, and organic practice is socially approved, so some inflation is probable; the heterotrait–monotrait ratio of 0.952 between intention and reported adoption indicates that the two are not sharply distinguished, and the coefficient of 0.597 should not be read as behavioural validation. Because no respondent holds certification, verification against certification records is unavailable in principle here, and field inspection would constitute the only route to objective measurement. Partial and seasonal adoption is common in smallholder systems (Moser & Barrett, 2006), so a single annual measure may also conceal within-year variation. Finally, the sample is purposive rather than probability-based and drawn from three regencies, so the findings support analytical generalisation to comparable smallholder systems rather than statistical generalisation to any defined population. We frame the three regencies as an appropriate site for asking how the norm-activation chain performs where certification is absent, not as a miniature of Indonesian smallholder coffee. Whether the coefficients hold outside them is an open question, and a probability sample is what would answer it.

5.1 Implications for practice and policy

What follows for practice differs from the recommendations studies of this kind usually generate. Because the constraint identified here is confidence in performance rather than deficient environmental concern, demonstration addresses it and exhortation does not. On-farm trials running a complete conversion cycle and publishing yield and quality outcomes act on the binding constraint, particularly

given that the conversion trajectory itself is poorly documented for coffee (Rigal et al., 2020). Extension services and farmer organisations can implement this without regulatory change, and the evidence that farmers weight peer demonstration above expert assertion suggests where such trials should be sited (Rust et al., 2022).

A second implication concerns certification. These farmers already generate the environmental goods that certification is designed to reward, and receive none of the reward. Individual certification at IDR 15–30 million against a one-hectare holding (Kirana & Nugraha, 2019) cannot alter that arithmetic. Group certification can: Latynskiy and Berger (2017) simulate the income effects for smallholder coffee producers and identify the conditions under which group schemes raise incomes, while González and Nigh (2005) and Beuchelt and Zeller (2013) document the organisational capacity such schemes demand. Participatory guarantee systems offer a further route where third-party accreditation remains out of reach (Nelson et al., 2010; Home et al., 2017; Tennhardt et al., 2025). Any of these would supply the third-party verification whose absence, on our reading, places so much weight on private judgement and peer observation. Certification bodies and provincial agricultural agencies are the relevant actors, and the design of internal control procedures is a live methodological question in its own right.

A third implication follows from the control analysis. Education and technology use relate to adoption behaviour directly, not solely through intention, so extension effort directed only at motivation will leave part of the gap untouched. Investment in technical capability operates on a channel that motivational programming does not reach, a distinction consistent with evidence that adoption determinants differ between early and late adopters (Läpple & Van Rensburg, 2011) and across heterogeneous farmer populations (Läpple & Kelley, 2013; Kallas et al., 2010).

6 Conclusion

We set out to establish how much of adoption intention the value–belief–norm chain accounts for in a setting where neither market reward nor institutional verification is available. The chain holds, and accounts for little. Two routes lying outside it carry most of what is explained, one of them independent of the chain entirely, and the moral route appears to operate among men but not among women.

These are associations derived from a cross-sectional survey and should be held as such. Longitudinal data spanning a conversion cycle would establish whether trust precedes intention or forms alongside it, and whether either survives a poor harvest. Verification of adoption against field inspection would establish how much of the intention–behaviour association is behavioural. Both are worth undertaking, and neither is possible with the design employed here.

Declarations

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Author contributions

JAP conceived the study, designed the survey instrument, performed the statistical analysis and drafted the manuscript. HT contributed to the analytical design and to the interpretation of the structural results, and supervised the research. RA contributed to the conceptual framework and to the interpretation of the behavioural constructs. IKH and AS coordinated fieldwork and supervised data collection across the three regencies. BPS contributed to field supervision and to the agronomic characterisation of the integrated systems. MSH contributed to the framing of pest and disease conditions in the study sites. MWL contributed to the soil fertility and nutrient-cycling framing of the manure component. All authors read and approved the final manuscript.

Data availability

The de-identified respondent-level dataset supporting the findings of this study is available from the corresponding author on reasonable request.

Ethics approval

The study was reviewed and approved by the Internal Review Board of Universitas Brawijaya under reference number 01226/UN10.A0501/B/PT/2025. All participants were informed of the purpose of the research and of their right to decline or withdraw, and gave their consent before the interview began. No personally identifying information was recorded.

Competing interests

The authors declare no competing interests.

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Figures

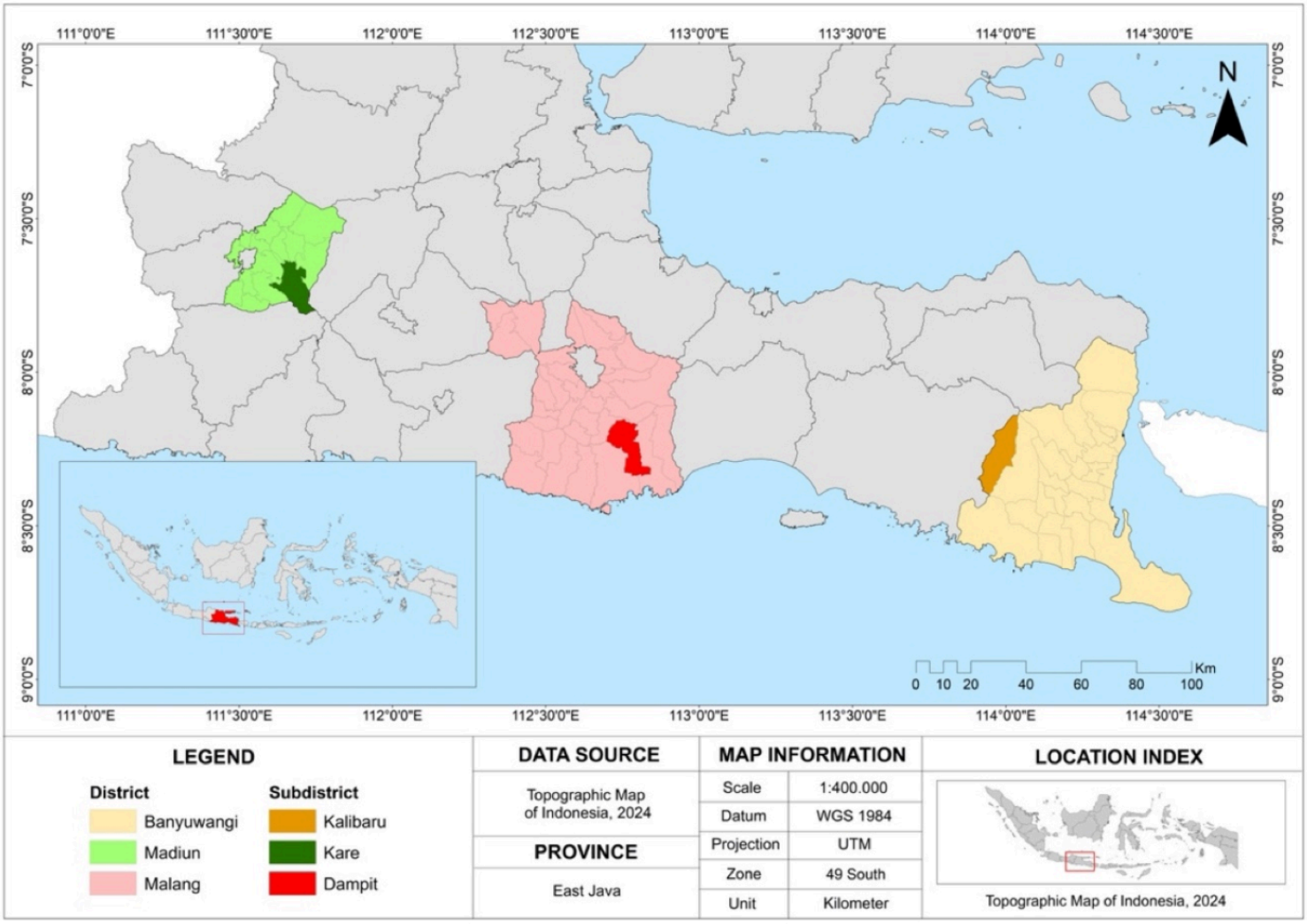
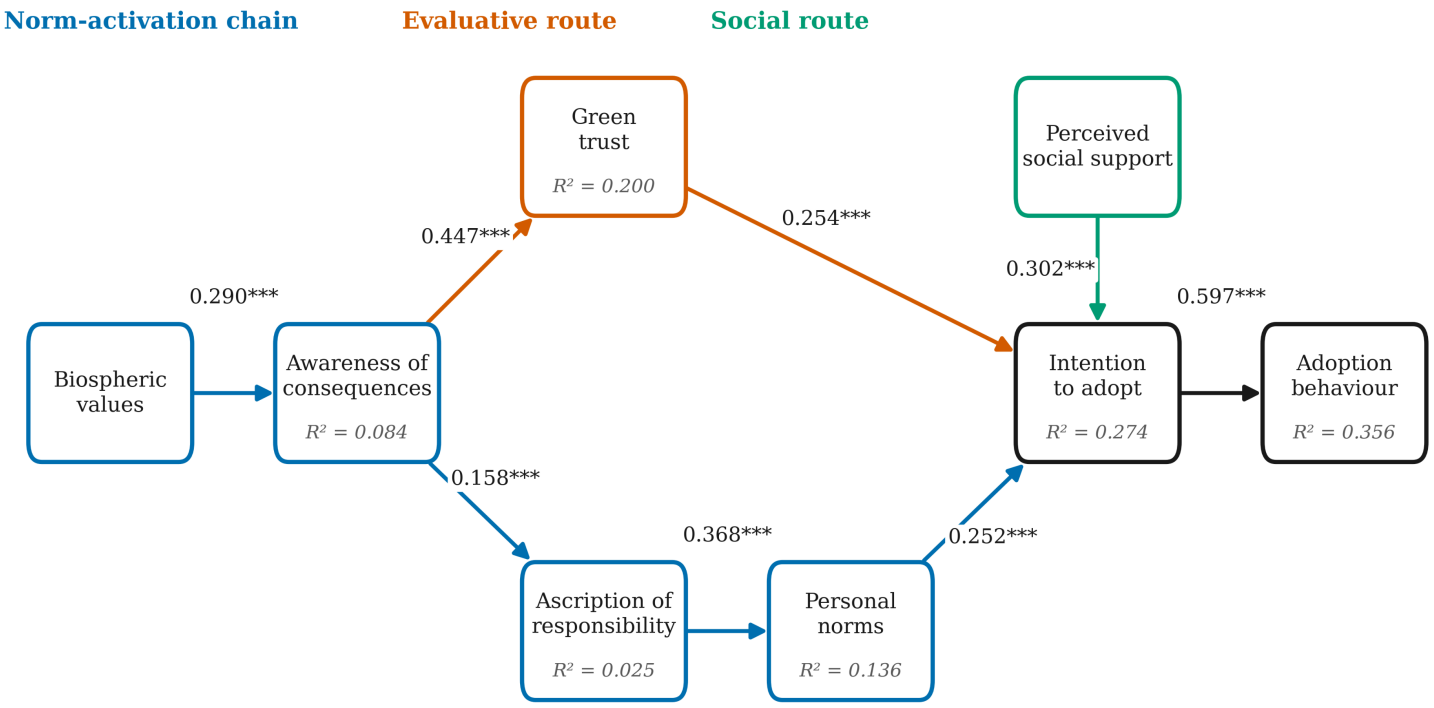


Figure 1

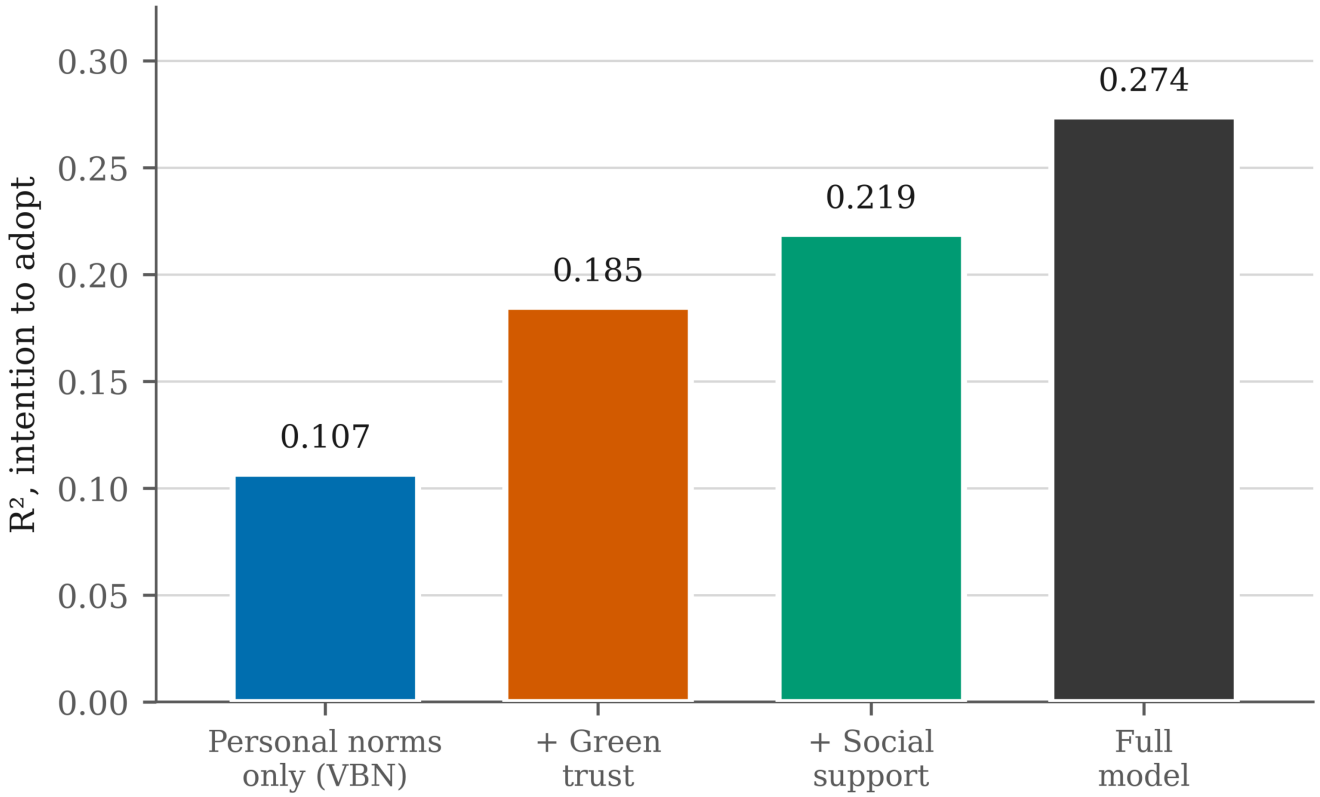
Spatial distribution of the study areas in East Java Province, Indonesia. The map shows the selected regencies of Malang (Dampit subdistrict), Banyuwangi (Kalibaru subdistrict) and Madiun (Kare subdistrict), which represent major coffee-producing areas with integrated coffee–goat farming systems.



*** p < 0.001; bootstrap with 5,000 subsamples. Values are standardised path coefficients; R² is reported for endogenous constructs.

Figure 2

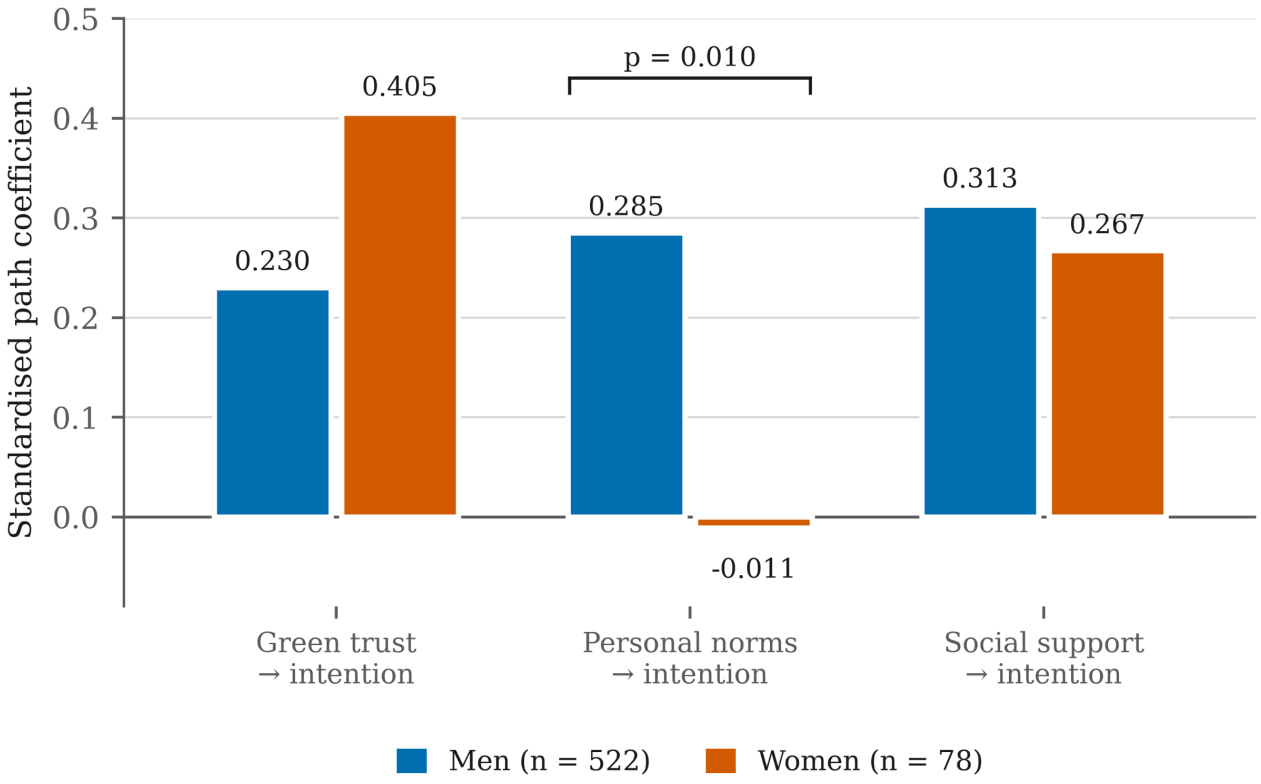
The estimated model, serving also as the study's conceptual diagram. Blue traces the norm-activation chain of value–belief–norm theory in the sequence Stern specifies, values to awareness to responsibility to personal norm to intention (H1–H3, H6). Orange traces the evaluative route through green trust (H4–H5) and green the social route (H7), both entering intention alongside personal norms rather than through them. H8 links intention to reported adoption. Coefficients are standardised; R^2 is reported inside each endogenous construct



Nested comparison. BIC declines monotonically across the sequence (−62.60, −110.89, −136.43, −173.98).

Figure 3

Variance in adoption intention explained by nested models. The norm-activation route alone accounts for 10.7%; adding the evaluative and social routes raises this to 27.4%



Permutation test with 500 permutations. Compositional invariance was established for all constructs (MICOM step 2).

Figure 4

Routes to adoption intention by gender. Personal norms predict intention among men and not among women; green trust is the stronger route among women