Received: 7 December 2023 | Revised: 24 April 2024 | Accepted: 26 April 2024

DOI: 10.1002/sd.3035

RESEARCH ARTICLE

Sustainable Development WILEY

Carrots rather than sticks: Governance of voluntary sustainability standards and farmer welfare in Peru

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Funding information
FWO PhD Fellowship Strategic Basic Research, Grant/Award Number: 1S40222N; KU Leuven Special Research Fund, Grant/Award Number: C24M/19/031; FWO International Coordination Action, Grant/Award Number: G0F4420N

Abstract

Aligned with the 2030 Sustainable Development Agenda, voluntary sustainability standards (VSS) have gained prominence as market-based tools for sustainability governance. However, whether VSS improve economic sustainability remains subject to vigorous debate. A major limitation of the evidence base is that it does not systematically examine which VSS design attributes affect their impact. In this study, we develop a conceptual framework disentangling three main governance mechanisms through which VSS may affect farmer welfare, which we operationalize using secondary data from a nationally representative farm household survey in Peru. Our results underscore the dominant role of market-based incentives, followed by capacity-building, while rule enforcement with good agricultural practices has no effect on farm revenue. Additionally, organizational membership is found to amplify the revenue effects of VSS through market-based incentives. Our findings advocate VSS organizations to strengthen market-based incentives and capacity-building, while improving standard setting and enforcement to effectively improve economic sustainability.

KEYWORDS
certification, fair trade, globalgap, mediation model, organic, private governance, private standards

1 | INTRODUCTION

The transition toward more sustainable food production and consumption, as outlined in SDG 12, is an essential step in achieving the 2030 Sustainable Development Agenda. While the views of policy, corporate and civil society stakeholders on how to realize this transition vary, thereby impeding the transition, the urgency of SDG12 is generally recognized (Allen et al., 2023; Colasante et al., 2024; Scheyvens et al., 2016). Various tools, such as voluntary sustainability standards (VSS), are used to accelerate this transition and bridge multiple sustainable development perspectives (Ayompe et al., 2024; Rubio-Jovel et al., 2023). VSS, also known as (eco-)certification schemes, private standards or eco-labels, have emerged in response to pressure from consumers, shareholders, and civil society organizations, who are urging international suppliers to offer products that align with elevated food safety, socioeconomic, and environmental requirements, and from agri-food companies seeking to build and maintain reputation and pursue product differentiation (Brandi, 2017; Vermeulen & Seuring, 2009). VSS are usually designed by corporate and/or civil society actors and delineate specific sustainability requirements that producers or processors voluntarily adhere to. VSS directly intersect with SDG 12 objectives, and given that most VSS encompass social, economic and environmental requirements, they are designed to contribute to other SDGs, notably SDG 1, 2, 6, and 8 (Konefal et al., 2023; Schleifer et al., 2022). Over the past three decades, VSS have proliferated and gradually moved from niche to mainstream markets (Dietz et al., 2021; Mann, 2018; Marx & Wouters, 2015). VSS certification is most widespread for agricultural commodity exports from low- and middle-income countries, where production is dominated by smallholder farmers who are often specifically targeted by VSS (Kemper et al., 2023).

Substantial gaps remain in our understanding of the sustainability impact of VSS, especially regarding farmer welfare. There is a wealth of case-studies focusing on specific VSS for specific crops in specific regions, and estimating impacts on various outcome indicators, such as poverty, farm or household income, yield of certified crops, producer prices, or production costs[i]—resulting in mixed evidence on the producer-level impact of VSS. Some case-studies focus on multiple outcome indicators to reveal the channels of effects, and investigate for example whether price or yield effects are more important to create positive effects on farm income (Boonaert & Maertens, 2023; Estrella et al., 2022; Vellema et al., 2015). Reviews of these case-studies highlight that VSS generate no or only small and context-specific economic benefits for producers, with effects on prices generally more positive than effects on yields (Meemken & Qaim, 2018; Oya et al., 2018; Traldi, 2021). Additionally, these studies show that effects vary by VSS, with for example smaller producer gains for Organic and higher gains for VSS focusing on good agricultural practices (e.g., GlobalGAP). A couple of case-studies include multiple VSS in the same setting and point to heterogenous impacts across VSS (Akoyi & Maertens, 2018; Chiputwa et al., 2015; Ruben & Zuniga, 2011). Other studies analyze synergies and trade-offs between farmer welfare and other dimensions of sustainability, uncovering divergent effects across VSS (Templer et al., 2018; Vanderhaegen et al., 2018). Overall, existing studies discuss to some extent the differences across VSS and reason about their varying impacts but do not further analyze this. Hence, a comprehensive understanding of which VSS design attributes contribute to creating impact at producer-level is currently lacking while such insights are important to optimize VSS design for a larger on-the-ground sustainability impact (UNFSS, 2020). In addition, gaining insights into these aspects is crucial for policy discussions, as VSS are increasingly acknowledged and integrated into public policy conditional upon certain design attributes.

We address this gap by using insights from the literature on VSS governance to understand through which design or so-called governance attributes and broader mechanisms VSS affect farmer welfare. VSS governance can be defined as "the structured arrangement of rules, procedures and other organizational elements that govern the development and enforcement of standards, and through which VSS aim to reach their sustainability objectives" (Depoorter & Marx, 2023, p. 3). Within the governance literature, different mechanisms have been explored concerning how VSS can generate sustainability outcomes, centering on the traditional "carrots-and-sticks" framework (Auld et al., 2015; Oya et al., 2018; Wijen & Flowers, 2023). The "sticks" represent the necessity of stringent rule enforcement to ensure compliance and uphold the integrity of VSS. In contrast, the "carrots" symbolize the need for capacity-building and market-based incentives that accommodate the diverse needs, capacities and motivations of producers to ensure compliance and generate sustainability outcomes.

In this article, we develop a comprehensive conceptual framework explaining how VSS affect farmer welfare through their governance. This results in the identification of three governance mechanisms, including rule enforcement, capacity-building and market-based incentives, and a set of VSS governance attributes pertaining to each mechanism. We then empirically investigate the hypothesized channels of effects using data from a nationally representative survey of family farms in Peru between 2016 and 2019. We derive farm-level indicators for the identified VSS attributes and employ multiple mediation models to estimate through which governance mechanisms and attributes VSS affect net farm revenue, as a proxy for farmer welfare and in line with SDG 1. We additionally investigate the role of farmer organizations in moderating the effect of VSS on farm revenue, as certification among small-scale farms commonly occurs through farmer organizations, especially agricultural cooperatives (Bennett, 2017; Ortiz-Miranda & Moragues-Faus, 2015; Sellare et al., 2020).

This study contributes to the current literature on VSS as market-based tools for sustainable development in three ways. First, it introduces an innovative conceptual framework that is not VSS- or commodity-specific explaining how VSS may influence farmer welfare through different governance mechanisms. We thereby create added value with respect to previous conceptualizations focused on, for example the coffee and palm oil sectors (Dietz et al., 2018; Kadarusman & Herabadi, 2018) or Organic and Fairtrade standards (Auld et al., 2015). Second, the study advances sustainability impact studies by examining *how* VSS affect sustainability outcomes through distinct governance mechanisms and their pertaining attributes. While prior impact studies rely on single-equation models to analyze different impact mechanisms (e.g., Dietz et al. (2021) and Grabs (2020)), our approach allows us to assess the relative importance of these mechanisms and explore potential counterbalancing effects. Third, the study uses nationally representative panel data from Peru covering multiple VSS and multiple years to enhance the internal and external validity of impact estimates. Current studies are largely case-specific, hindering comparative approaches, and general conclusions.

Overall, this article aims to identify *how* VSS affect farmer welfare through their governance. Consistent with the main hypothesis, the results reveal that "carrots" rather than "sticks" are the primary governance mechanism through which VSS affect the welfare of smallholders in Peru. However, these effects are limited, and do not lead to significant welfare gains. Among the "carrots", market-based incentives exhibit a stronger welfare-enhancing effect compared with capacity building. Conversely, the "sticks" do not significantly affect farmer welfare, despite the expectation of improved farming systems and increased yields. Furthermore, we find that membership in a farmer organization reinforces market-based incentives and plays a more important role toward capacity-building than VSS alone.

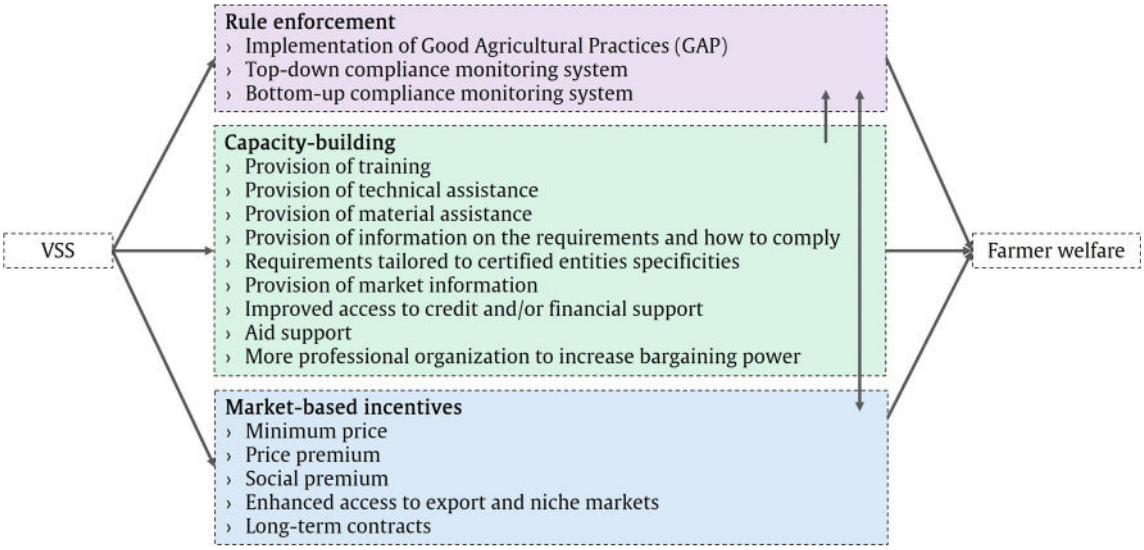

FIGURE 1 Conceptual framework on governance mechanisms and their pertaining attributes through which VSS affect farmer welfare.

The remainder of the article is structured as follows: Section 2 presents the conceptual framework elucidating *how* VSS governance may affect farmer welfare, along with a review of the empirical evidence on these conceptual links. Section 3 describes the dataset, empirical framework, and estimation strategy. Section 4 presents the results on the effects and relative importance of different VSS governance mechanisms and attributes in affecting farmer welfare. Section 5 discusses the results and policy recommendations, and Section 6 summarizes the findings and offers suggestions for future research.

2 | LITERATURE REVIEW

2.1 | Conceptual framework

The literature on VSS recognizes three dominant governance mechanisms for VSS to generate sustainability impacts: enforcement, capacity-building, and market-based incentives (Dietz et al., 2021; Grabs, 2020; Oya et al., 2018). The enforcement mechanism, regarded as a "stick" mechanism, focusses on precise, objective, and universally applicable rule setting and strict enforcement to prevent regulatory favoritism, shirking, free-riding, and to ensure that requirements related to sustainable production are complied with and can hence yield the promised sustainability benefits (Downs, 1997; Kadarusman & Herabadi, 2018; Locke, 2013). The capacity-building mechanism, regarded as a "carrot" mechanism, refers to enabling producers to implement sustainability practices by providing technical and financial support to prevent regulatory unreasonableness, drop-out of certification, exclusion, and suboptimal social outcomes (Auld et al., 2015; Riisgaard et al., 2020; Wijen & Flowers, 2023). Furthermore, the market-based incentives mechanism, also regarded as a "carrot" mechanism, focusses on the provision of market incentives to compensate producers for the costs of compliance, maintaining compliance over time, and directly generating economic sustainability benefits (Grabs, 2020; Oya et al., 2018; Yu & Bouamra-Mechemache, 2016).

We draw on the recent framework of Depoorter and Marx (2023), which operationalizes these three mechanisms into identifiable VSS governance attributes and expand their framework based on existing literature on VSS governance, impact studies on farmer welfare, international available databases, such as the International Trade Centre's Standards Map and leading VSS' theories of change on farmer welfare (Figure 1).

VSS can affect farmer welfare through stringent *rule enforcement* measures. Enforcement of certain good agricultural practices (GAP) prescribed by VSS can directly improve yields and farm-gate prices, be it at higher production costs, and may indirectly enhance market-based incentives, for example via improved product quality. VSS governance attributes related to top-down and bottom-up monitoring systems can improve rule enforcement and, in turn, farmer welfare. Top-down monitoring typically refers to independent, transparent, competent, and effective third-party auditing systems, whereas bottom-up monitoring involves available, accessible, transparent, and effective complaint systems, both increasing the likelihood that rules are effectively enforced. In addition, VSS can use a *capacity-building* mechanism to directly improve farmer welfare through enhanced knowledge and capacities to increase yields, receive higher prices and/or reduce costs, and indirectly by improving rule enforcement. Governance attributes of VSS materializing capacity-building include the provision of training, technical, and managerial assistance, information on VSS requirements and compliance mechanisms, tailoring requirements to certified entities specificities (such as localized standards, smallholder standards or continuous improvement standards), providing market information, improved access to credit, financial support, aid support, or organizational strengthening. The last mechanism involves providing *market-based incentives* for farmers, which can affect farmer welfare directly through generating higher income, and indirectly by reinforcing standard compliance. VSS governance attributes related to this mechanism include ensuring minimum prices and social premia[ii] (only in Fairtrade models), price premia subject to market forces, long-term contracts (only mentioned as best practice for Fairtrade USA), and enhanced access to export and niche markets through reputational benefits provided by certificates or product labels, and through traceability systems reducing transaction costs.

2.2 | Empirical evidence

Some studies analyze the rule enforcement, capacity-building and market-based incentives attributes associated with VSS adoption (the left set of arrows in Figure 1). Studies show that the main determinants of the effectiveness of rule enforcement to generate compliance with VSS requirements are economic factors, location, number of years of certification, and type of certification (Garbely & Steiner, 2022). In addition, evidence shows a positive capacity-building effect of VSS adoption on access to training (Meemken & Qaim, 2018), but the evidence for access to credit and organizational strength is mixed (Ruben & Fort, 2012; Ruben & Zuniga, 2011; Rueda & Lambin, 2013). Furthermore, studies on market-based incentives find that, on average, VSS adoption leads to a positive price effect (Boonaert & Maertens, 2023; Estrella et al., 2022; Mitiku et al., 2017) and improved access to export markets (Henson et al., 2011; Latouche & Chevassus-Lozza, 2015; Schuster & Maertens, 2015). Studies analyzing the effects of VSS governance attributes on farmer welfare (the right set of arrows in Figure 1) are limited. Grabs' (2020) empirical study finds that VSS with a clear price premium mechanism have a positive effect on farmer welfare, while training does not (operationalized using document analysis).

To date, most studies have focused on assessing the impact of a limited number of VSS governance attributes on farmer welfare rather than broader mechanisms into which attributes combine. Besides, no study has simultaneously analyzed how VSS affect farmer welfare through different mechanisms. In addition, no study has yet looked at the effects of capacity-building on rule enforcement (center arrow in Figure 1). Here, we aim to assess all sets of arrows simultaneously, focusing on a wider set of governance attributes put together into three distinct governance mechanisms.[iii] Based on the existing empirical evidence, we hypothesize that market-based incentives are the most important mechanism in affecting farmer welfare.

3 | MATERIALS AND METHODS

3.1 | Data and empirical framework

Rather than relying on information from VSS documents on their governance attributes, which might not always materialize at the producer-level and vary across VSS, we use non-VSS specific on-the-ground data to reflect the actual exposure of farms to the different governance mechanisms and attributes. We operationalize the conceptual framework (Figure 1) into an empirical framework (Figure 2) based on data availability described in this section.

To gather data on farmers' certification status, exposure to VSS governance attributes, and farmer welfare, we use secondary data from the *Encuesta Nacional Agropecuaria* (ENA), an annual agricultural survey in Peru for the period 2016–2019 (INEI & DNCE, 2023). In addition, we rely on qualitative data from 24 interviews conducted with different supply chain actors in Peru in April 2022 to interpret our findings. The ENA sample includes approximately 30,000 farms per year, sampled based on the 2012 agricultural census, including 28,500 family farms of which about 7500 farms are sampled over multiple years, enabling the use of panel data methods.[iv] The ENA data include detailed information on plot-specific crop and livestock production and farm characteristics, including farm-level certification and membership in farmer organizations. We use net farm revenue as a proxy for farmer welfare and account for inflation by converting to constant 2019 PEN using the consumer price index (The World Bank, 2024).

The ENA data contain farm-level certification data. On average, 1.7% of the family farms are certified. During the observed period, 70% of the certified farmers entered or exited certification. Organic is the most prevalent VSS among family farms (70%), followed by GlobalGAP (42%), Fairtrade (25%), and other VSS (4%) including Rainforest Alliance, SMETA and various health and safety certifications, such as HACCP, BASC, and BRC. Certification data are available only at the farm-level and to derive crop-level certification data, we rely on the assumptions that farm certification relates to crops that account for at least 50% of the farm's revenue or harvested area (following Ruben, 2017), or to crops for which at least 50% of the harvest is destined for export, Lima, or the agro-industry, where demand for certified products is high (Schuster & Maertens, 2013; UNFSS, 2022). These assumptions were verified using data on district-level certification programs from Fairtrade International, Fairtrade USA and Organic for 2016–2019 and crop-specific certification data from GlobalGAP for 2021. The main certified crops during the observed period are banana (32%), coffee (31%), and cacao (9%).

The ENA data allow to operationalize several governance attributes, summarized in Figure 2 and described in more detail in Table A1.[v] On the rule enforcement mechanism, this includes farm-level data on the following five GAP: good soil management (i.e., conducting soil analysis, crop rotation and/or erosion prevention through terracing), tillage, water monitoring (i.e., determining water availability, irrigation needs and/or water analysis), and use of fertilizers and pest control. No data are available on exposure to top-down monitoring through audits, nor on bottom-up monitoring through a complaint system. In addition, the ENA provides farm-level data on four capacity-building attributes: receiving training on 19 different topics in the last 3 years, receiving technical assistance on 11 different topics in the last 3 years, receiving market information in the last 12 months and credit obtained when demanded for in the last 12 months. No data are available on material assistance, receiving

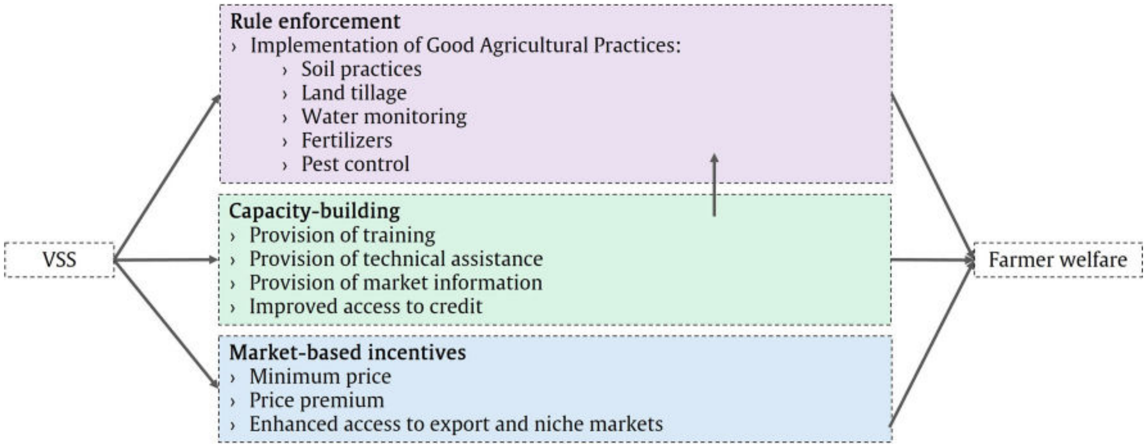

FIGURE 2 Empirical framework on governance mechanisms and their pertaining attributes through which VSS affect farmer welfare.

information about VSS requirements and how to comply, tailored standards, financial support, aid support, and organizational strength. Lastly, the market-based incentives mechanism can be captured through crop-level data on the following three attributes: minimum price (Fairtrade only), price premium, and access to export or niche markets. Data on social premiums (Fairtrade only) are not available. Yet, these social premiums go into a common fund and thus benefit both certified and non-certified farms. Minimum prices are calculated using official data from Fairtrade International, and price premiums are calculated using the average non-certified export-oriented market price from ENA data. We use mean aggregation with equal weights to create a score per governance attribute when multiple variables are available, and additionally, to create an index per governance mechanism.

3.2 | Econometric approach

We start with estimating a single-equation model of the effect of VSS on farmer welfare (Equation 1):

$$\text{Net revenue}_{i,t} = \alpha_0 + \beta_0 \text{VSS}_{i,t} + \theta_0 C_{i,t} + \mu_{0,i} + \tau_{o,t} + \varepsilon_{0,i,t}, \qquad (1)$$

where $\text{Net revenue}_{i,t}$ is the net revenue for farm *i* in year *t*, measured as the value of all farm output (i.e., crop and livestock produce, including home-consumed output) minus production costs (i.e., land rent, rental, maintenance, and depreciation of machinery and equipment, services, agricultural inputs, fuel, and hired labor). Data on certification costs are not available as in Peru these are commonly covered by cooperatives, buyers or NGOs and not by individual farmers. $\text{VSS}_{i,t}$ is the certification status (dummy) of farm *i* at year *t*. $C_{i,t}$ are time-variant observable farm-level control variables, comprising total area (level and squared), tropical livestock units,[v] proportion of irrigated fields, off-farm employment of the head of the household, the number of household laborers and crop dummies for the nine most important certified crops. μ_i are farm-level fixed effects, representing time-invariant unobserved confounders. τ_t are year dummies, capturing time trends and shocks, and $\varepsilon_{i,t}$ is the time-variant error term. We use crop-farm- and farm-level clustered standard errors to correct for arbitrary serial correlation and heteroskedasticity and for the treatment level (Abadie et al., 2023; Wooldridge, 2010). We apply the inverse hyperbolic sine transformation to the outcome variable and the total area to reduce skewness.

To analyze the relative importance of the three different governance mechanisms through which VSS may affect farmer welfare, we estimate the following mediation model (Equations 2 and 3):

$$\text{Net revenue}_{i,t} = \alpha_0 + \beta_0 \text{VSS}_{c,i,t} + \sum_{j=1}^{n} \gamma_{0,j} \text{Mediator}_{j,(c)i,t} + \theta_0 C_{i,t} + \mu_{0,c,i} + \tau_{o,t} + \varepsilon_{0,c,i,t}, \qquad (2)$$

$$\text{Mediator}_{j,(c)\,i,t} = \alpha_j + \beta_j \text{VSS}_{c,i,t} + \theta_j C_{i,t} + \mu_{j,c,\,i} + \tau_{j,t} + \varepsilon_{j,c,i,t} \forall j \in (1,3), \qquad (3)$$

where $\text{Mediator}_{j,(c)\,i,t}$ are the three governance mechanisms as described in Figure 2 and the other variables and specifications similar as for the model in Equation 1. The model is estimated at the crop-level, with two of the three mediators varying at the crop-level and the third mediator and outcome variable varying at the farm-level. In addition, to unravel which specific governance attributes are most important for each governance mechanism, we estimate the mediation model for each of the three governance mechanisms separately, with the governance attributes as mediators. Moreover, to disentangle the effect of certification from the effect of membership in a farmer organization, we reestimate Equations 2 and 3 with the addition of the main effect of membership and the interaction effect with VSS. We thereby distinguish between membership in any type of farmer organization (comprising cooperatives, associations, and committees), and membership in a cooperative specifically.

Based on these regression results, we calculate the effects of VSS on net farm revenue that operate through specific mediators (i.e., specific mediation effect) and through all mediators combined (i.e., total mediation effect) (Equations 4 and 5):

$$\text{Specific mediation effect} = \beta_j * \gamma_{0,j} \forall j \in (1,\mathrm{n}), \tag{4}$$

$$\text{Total mediation effect} = \sum_{j=1}^{3} \beta_j * \gamma_{0,j}. \tag{5}$$

We use the MPlus software to estimate the multiple mediation model using multilevel modeling.[vi] We use a Bayesian estimator[vii] with the Gibbs algorithm, 40,000 iterations and non-informative priors. For categorical outcome variables, the hierarchical Bayesian estimator uses a latent variable approach with a probit link.[viii] Convergence is evaluated by analyzing whether the potential scale reduction factor is less than 1.05, as recommended by Zyphur and Oswald (2015). Missing data are accounted for via a full-information approach. We allow for non-zero covariance between the mediators, to avoid confounding between the effects of the independent variables and the correlation of the residuals (Preacher & Hayes, 2008). We report the median point estimate of the posterior distribution, the posterior standard deviation, and the 95% credibility interval. We report both unstandardized and standardized coefficients. The latter allows to compare the relative magnitudes of the estimates.

We conduct three robustness checks. To account for reverse causality, we compare the mediation model estimates to a first difference model. To account for systematic measurement error, we control for sources of time-invariant systematic measurement error through unit and time fixed effects in our models. In addition, we perform a robustness check by reevaluating the single-equation model excluding outliers.[ix] To account for attrition, we recalculate the single-equation model estimates using a balanced panel for 2016–2019. Yet, we are unable to account for time-varying unobserved heterogeneity since no instruments are found that are relevant and valid for all governance attributes. In addition, we provide the results of the single mediation models since correlation among the mediators might attenuate their estimated coefficients.

4 | RESULTS

4.1 | Descriptive statistics

On average, certified farms differ from non-certified farms in having a higher net farm revenue, fewer livestock units, more land, and a higher likelihood to belong to a farmer organization (Table 1). Other differences concern household characteristics such as number of household laborers, experience, gender, language, ethnicity, and off-farm employment.

Moreover, on average, certified farms use fewer VSS recommended soil practices, less tillage and less pest control practices, but more fertilizers. In addition, they are more likely to receive training,

TABLE 1 Sociodemographic characteristics by certification status.

	Non-certified	Certified	
N farm	26,326	238	
Annual net farm revenue (2019 PEN)	6081 (545)	21,977 (3134)	***
Experience in independent agricultural activity (years)	26.47 (0.29)	25.89 (1.55)	*
Tropical livestock units	2.79 (0.18)	0.86 (0.28)	**
Use of advanced irrigation techniques (% of area)	0.38 (0.02)	0.64 (0.14)	
Total harvested area (ha)	1.80 (0.18)	2.74 (0.75)	***
Self-reported distance to the capital district (hours)	1.48 (0.09)	1.37 (0.50)	
Household size	3.56 (0.04)	4.00 (0.21)	
Number of household laborers on the farm	2.31 (0.02)	2.19 (0.13)	**
Age of the household head (years)	53.10 (0.31)	51.72 (1.47)	
Member in an association/cooperative/committee (0/1)	0.05	0.97	***
Member in a cooperative (0/1)	0.01	0.52	***
Female-headed household (0/1)	0.28	0.08	***
Secondary or tertiary education of the household head (0/1)	0.33	0.33	
Spanish as first language of the household head (0/1)	0.57	0.95	***
Indigenous ethnic group of the household head (0/1)	0.53	0.11	***
Off-farm employment by household head (0/1)	0.54	0.46	***

Note: Sampling weights used for all statistics. Standard errors for non-binary variables in parentheses. Comparison between the certified and non-certified subgroups is based on a Mann–Whitney or Chi^2 test. Significant differences of the mean of the subgroups are shown with *p < .1, **p < .05, ***p < .01.

TABLE 2 Exposure to governance attributes by certification status.

	Non-certified	Certified	
N farm	26,326	238	
Rule enforcement			
Soil practices	0.21	0.07	**
Land tillage	0.74	0.30	**
Water monitoring	0.09	0.15	
Fertilizers	0.74	0.96	***
Pest control	0.49	0.26	***
Capacity-building			
Training	0.01	0.09	***
Technical assistance	0.01	0.14	***
Market information	0.14	0.24	***
Credit obtained when demanded for	0.10	0.38	***
N crop	93,069	282	
Market-based incentives			
Minimum price	0.00	0.14	***
Price premium	0.00	0.82	***
Access to export and niche markets	0.04	0.81	***

Note: Sampling weights used for all statistics. Comparison between the certified and non-certified subgroups is based on a Mann–Whitney or Chi^2 test. Significant differences of the mean of the subgroups are shown with **p* < .1, ***p* < .05, ****p* < .01.

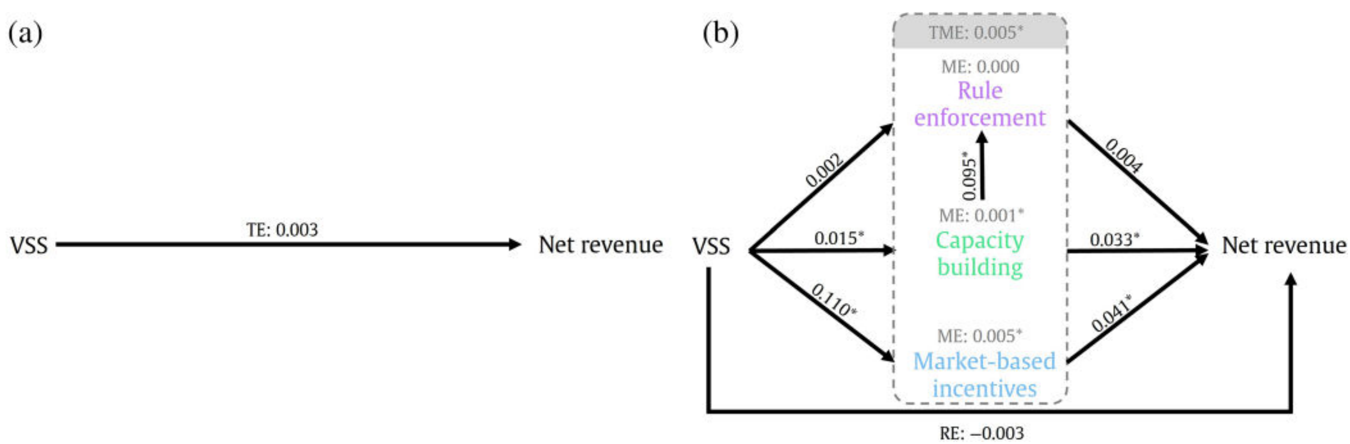

FIGURE 3 Summary of the estimated standardized coefficients for (a) the single-equation model and (b) the multiple mediation model for the three governance mechanisms. Full regression results are presented in Table 3. ME, mediation effect; RE, residual effect; TE, total effect; TME, total mediation effect.

technical assistance and market information, and to obtain credit when demanded for. Moreover, respectively 14% and 82% of certified farms report to receive a minimum price and a price premium. Certified farms also have more access to export and niche markets on average (Table 2).

4.2 | Results of multiple mediation analysis

Figure 3 visualizes the standardized estimates from (a) the single-equation model and (b) the mediation model on all three governance mechanisms, derived from the regression results in Table 3. We find that the total effect of VSS on net farm revenue is insignificant at a 95% level, indicating that VSS adoption does not improve net farm revenue (Figure 3a). The mediation models decompose this total effect into a significantly positive total mediation effect and a non-significant residual effect (Figure 3b). These mediation model results additionally show that market-based incentives are the main governance mechanism mediating the positive effect of VSS on farm revenue, followed by capacity-building that is significant but five time less important, while rule enforcement does not contribute. VSS adoption increases the likelihood to receive capacity-building by 5 percentage

TABLE 3 Results of the single-equation model estimating the total effect of VSS on net farm revenue and the mediation model for the effect of VSS on net farm revenue through the three governance mechanisms together.

	Single-equation model		Mediation model for all governance mechanisms	
(Un)standardized effects	Unstandardized	Standardized	Unstandardized	Standardized
DV: Net farm revenue				
VSS (β_0)	0.373 (0.677)	0.003 (0.006)	−0.628 (0.589)	−0.003 (0.003)
	[−0.966, 1.681]	[−0.008, 0.014]	[−1.778, 0.534]	[−0.010, 0.003]
Rule enforcement ($\gamma_{0,1}$)			0.097 (0.119)	0.004 (0.005)
			[−0.138, 0.335]	[−0.006, 0.013]
Capacity-building ($\gamma_{0,2}$)			**1.892** (0.257)	**0.033** (0.004)
			[1.382, 2.388]	[0.024, 0.042]
Market-based incentives ($\gamma_{0,3}$)			**1.033** (0.096)	**0.041** (0.004)
			[0.843, 1.218]	[0.034, 0.049]
DV: Rule enforcement				
VSS (β_1)			0.016 (0.025)	0.002 (0.003)
			[−0.032, 0.066]	[−0.004, 0.009]
Capacity-building ($\gamma_{1,1}$)			**0.220** (0.008)	**0.095** (0.003)
			[0.205, 0.235]	[0.089, 0.102]
DV: Capacity-building				
VSS (β_2)			**0.050** (0.011)	**0.015** (0.003)
			[0.029, 0.071]	[0.009, 0.022]
DV: Market-based incentives				
VSS (β_3)			**0.835** (0.025)	**0.110** (0.003)
			[0.787, 0.884]	[0.104, 0.116]
ME				
Rule enforcement ($\beta_1 * \gamma_{0,1}$)			0.001 (0.004)	0.000 (0.000)
			[−0.007, 0.011]	[0.000, 0.000]
Capacity-building ($\beta_2 * \gamma_{0,2}$)			**0.093** (0.024)	**0.001** (0.000)
			[0.048, 0.142]	[0.000, 0.001]
Market-based incentives ($\beta_3 * \gamma_{0,3}$)			**0.862** (0.084)	**0.005** (0.000)
			[0.697, 1.027]	[0.004, 0.006]
TME $\left(\sum_{j=1}^{3} \beta_j * \gamma_{0,j}\right)$			**0.958** (0.088)	**0.005** (0.000)
			[0.797, 1.142]	[0.004, 0.006]
N total	25,642	25,642	93,349	93,349
N clusters crop-farm			49,717	49,717
N clusters farm	6886	6886	6886	6886

Note: Median point estimate, standard deviations (round brackets), and highest posterior density credibility intervals [square brackets] are reported. Significant (at 5%) parameters indicated in bold. Control variables, crop-, farm-, and year-fixed effects are included but not reported.
Abbreviations: DV, dependent variable; ME, mediation effect; TME, total mediation effect.

points (pp) and market-based incentives by 28 pp, which result indirectly in average farm revenue increases of 10% and 138% respectively. In addition, we find that capacity-building positively affects the likelihood of implementation of GAP requirements by 19%, but this implementation does not affect farm revenue. Robustness checks for the mediation model provide similar results (Tables A2 and A3).

Figure 4 visualizes the standardized estimates for separate mediation models for the three governance mechanisms, derived from the regression results in Table 4. We find no significant mediation through rule enforcement, although we find that some GAP (land tillage, water monitoring, and pest control) significantly affect net farm revenue (Figure 4a). The positive mediation through capacity-building can be attributed to training, technical assistance, and market information (Figure 4b), with the effect through technical assistance being two and five times as important as that of training and market information respectively. VSS increase the likelihood to receive training by 65 pp, technical assistance by 61 pp, and market information by 40 pp, which result indirectly in average farm

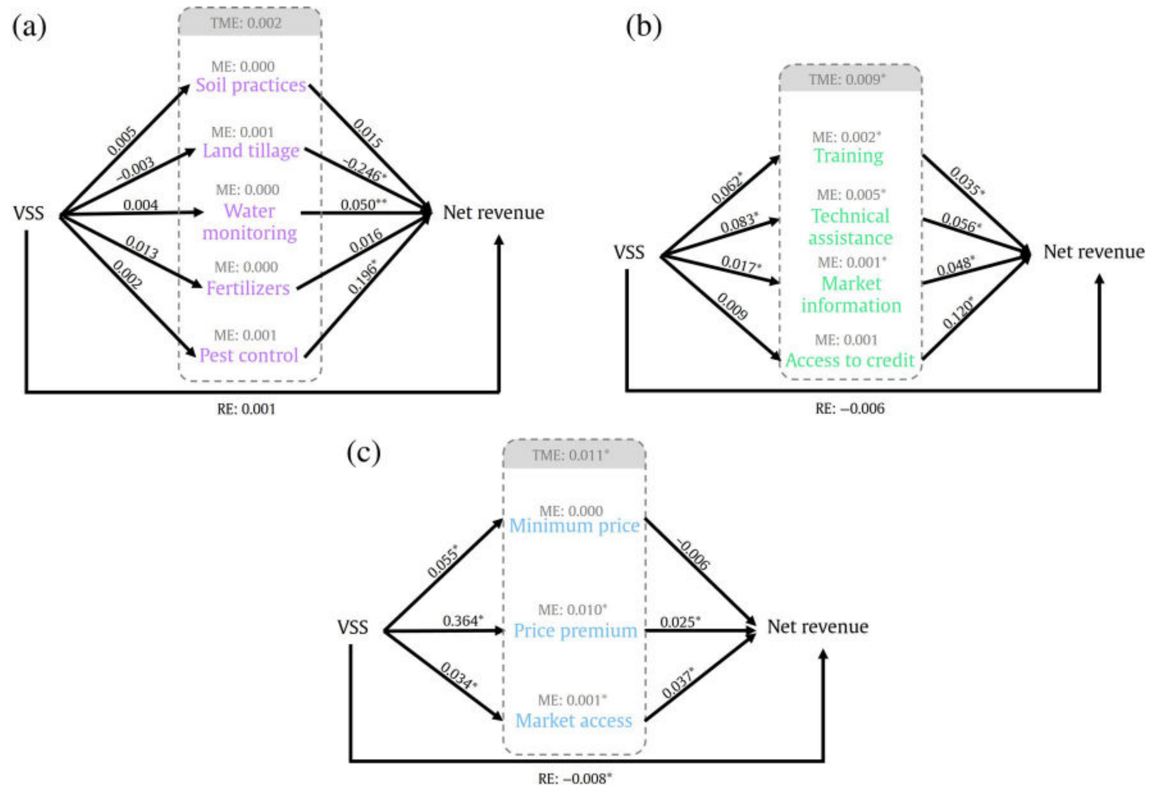

FIGURE 4 Summary of the estimated standardized coefficients for (a) the rule enforcement mechanism, (b) the capacity building mechanism, and (c) the market-based incentives mechanism and their respective attributes. Regression results are presented in Table 4. ME, mediation effect; RE, residual effect; TE, total effect; TME, total mediation effect.

revenue increases of 29%, 72%, and 10%, respectively. VSS do not significantly affect the provision of credit, although it has the strongest standardized effect on net revenue among the capacity-building attributes. The positive mediation through market-based incentives can be attributed to price premiums and market access: VSS increase the likelihood to receive a price premium with 56 pp and to access higher-value markets with 24 pp, which result indirectly in average farm revenue increases of 270% and 27%, respectively (Figure 4c). While VSS increase the receipt of a minimum price by 4 pp, this does not translate into revenue effects.

Figure 5 visualizes the moderating effect of membership in a farmer organization or cooperative, based on the regression results in Table 5. We do not find significant main or moderation effects of membership in an organization or cooperative for rule enforcement (Figure 5a). We find a positive main effect of organization or cooperative membership on capacity-building that is larger than the main effect of VSS, but we do not find evidence of a reinforcing moderation effect of this membership on how VSS affects capacity-building—and even a negative moderation effect for cooperative membership (Figure 5b). Further, we find a positive main effect of organization membership on market-based incentives that is smaller than the main effect of VSS, and a positive mediation effect of organization and cooperative membership on the relation between VSS and market-based incentives (Figure 5c).

5 | DISCUSSION

In line with the hypothesis, the results document that VSS adoption among family farms in Peru primarily improves farmer welfare through market-based incentives, followed by capacity-building, while showing no significant effect through rule enforcement. Notably, price premiums emerge as the most important market-based incentive attribute, and technical assistance as the most important capacity-building attribute through which VSS affect farmer welfare. Yet, the positive effects through these mechanisms are limited and do not create significant overall welfare gains, which casts doubt on the potential of VSS to improve economic sustainability.

Findings indicate that incentives ("carrots") are more effectively operated on the ground than strict rule enforcement ("sticks"). These findings differ somewhat from theoretical expectations based on VSS document analysis, as only Fairtrade International is strongly designed with regard to "carrots" (Depoorter & Marx, 2023). However, caution is warranted, as highlighted by Grabs (2020), as an overemphasis on incentives may lead to oversupply and standard proliferation, ultimately resulting in price premium erosion. Indeed, a previous study confirmed that while certified farms in Peru receive price premia, these are not high enough to cover increased production costs (Boonaert & Maertens, 2023). This shortfall could hinder the implementation of behavioral changes associated with GAP, particularly those that increase investment or opportunity costs. This implies that

TABLE 4 Results of separate mediation models for the three governance mechanisms and their respective attributes.

Rule enforcement			Capacity-building			Market-based incentives		
(Un)standardized effects	Unstandardized	Standardized		Unstandardized	Standardized		Unstandardized	Standardized
DV: Net farm revenue			DV: Net farm revenue			DV: Net farm revenue		
VSS (β_0)	0.179 (0.692)	0.001 (0.006)	VSS (β_0)	−0.656 (0.693)	−0.006 (0.006)	VSS (β_0)	**−1.579** (0.671)	**−0.008** (0.004)
	[−1.171, 1.537]	[−0.010, 0.013]		[−1.988, 0.726]	[−0.017, 0.006]		[−2.874, −0.241]	[−0.015, −0.001]
Soil practices ($\gamma_{0,1}$)	0.101 (0.077)	0.015 (0.012)	Training ($\gamma_{0,1}$)	**0.400** (0.087)	**0.035** (0.008)	Minimum price ($\gamma_{0,1}$)	−1.814 (1.097)	−0.006 (0.004)
	[−0.054, 0.249]	[−0.008, 0.038]		[0.228, 0.570]	[0.020, 0.051]		[−3.969, 0.305]	[−0.014, 0.001]
Land tillage ($\gamma_{0,2}$)	**−1.605** (0.120)	**−0.246** (0.018)	Technical assistance ($\gamma_{0,2}$)	**0.898** (0.124)	**0.056** (0.008)	Price premium ($\gamma_{0,2}$)	**3.091** (0.613)	**0.025** (0.005)
	[−1.841, −1.369]	[−0.281, −0.209]		[0.657, 1.141]	[0.041, 0.071]		[1.918, 4.318]	[0.016, 0.035]
Water monitoring ($\gamma_{0,3}$)	**0.321** (0.063)	**0.050** (0.010)	Market information ($\gamma_{0,3}$)	**0.237** (0.036)	**0.048** (0.007)	Market access ($\gamma_{0,3}$)	**1.003** (0.100)	**0.037** (0.004)
	[0.199, 0.445]	[0.030, 0.068]		[0.166, 0.308]	[0.034, 0.062]		[0.809, 1.203]	[0.030, 0.044]
Fertilizers ($\gamma_{0,4}$)	0.103 (0.149)	0.016 (0.023)	Access to credit ($\gamma_{0,4}$)	**0.765** (0.078)	**0.120** (0.012)			
	[−0.186, 0.392]	[−0.029, 0.060]		[0.611, 0.921]	[0.095, 0.143]			
Pest control ($\gamma_{0,5}$)	**1.275** (0.111)	**0.196** (0.017)						
	[1.060, 1.494]	[0.163, 0.229]						
DV: Soil practices			DV: Training			DV: Minimum price		
VSS (β_1)	0.099 (0.136)	0.005 (0.007)	VSS (β_1)	**0.646** (0.065)	**0.062** (0.006)	VSS (β_1)	**0.036** (0.002)	**0.055** (0.003)
	[−0.171, 0.362]	[−0.009, 0.020]		[0.517; 0.771]	[0.050, 0.074]		[0.032, 0.040]	[0.048, 0.061]
DV: Land tillage			DV: Technical assistance			DV: Price premium		
VSS (β_2)	−0.054 (0.129)	−0.003 (0.007)	VSS (β_2)	**0.612** (0.046)	**0.083** (0.006)	VSS (β_2)	**0.560** (0.005)	**0.364** (0.003)
	[−0.303, 0.202]	[−0.017, 0.011]		[0.521, 0.700]	[0.071, 0.095]		[0551, 0.569]	[0.358, 0.369]
DV: Water monitoring			DV: Market information			DV: Market access		
VSS (β_3)	0.067 (0.145)	0.004 (0.008)	VSS (β_3)	**0.400** (0.139)	**0.017** (0.006)	VSS (β_3)	**0.239** (0.023)	**0.034** (0.003)
	[−0.219, 0.348]	[−0.012, 0.019]		[0.125, 0.669]	[0.005, 0.028]		[0.194, 0.284]	[0.027, 0.040]
DV: Fertilizers			DV: Access to credit					
VSS (β_4)	0.236 (0.140)	0.013 (0.008)	VSS (β_4)	0.165 (0.150)	0.009 (0.008)			
	[−0.034, 0.516]	[−0.002, 0.028]		[−0.128, 0.458]	[−0.007, 0.025]			
DV: Pest control								
VSS (β_5)	0.043 (0.140)	0.002 (0.008)						
	[−0.230, 0.318]	[−0.013, 0.017]						

TABLE 4 (Continued)

Rule enforcement			Capacity-building			Market-based incentives		
(Un)standardized effects	Unstandardized	Standardized		Unstandardized	Standardized		Unstandardized	Standardized
ME			ME			ME		
Soil practices ($\beta_1 * \gamma_{0,1}$)	0.006 (0.019)	0.000 (0.000)	Training ($\beta_1 * \gamma_{0,1}$)	**0.256** (0.062)	**0.002** (0.001)	Minimum price ($\beta_1 * \gamma_{0,1}$)	−0.065 (0.040)	0.000 (0.000)
	[−0.023, 0.055]	[0.000, 0.001]		[0.139, 0.383]	[0.001, 0.004]		[−0.144, 0.012]	[−0.001, 0.000]
Land tillage ($\beta_2 * \gamma_{0,2}$)	0.087 (0.208)	0.001 (0.002)	Technical assistance ($\beta_2 * \gamma_{0,2}$)	**0.547** (0.086)	**0.005** (0.001)	Price premium ($\beta_2 * \gamma_{0,2}$)	**1.731** (0.344)	**0.010** (002)
	[−0.318, 0.500]	[−0.003, 0.005]		[0.380, 0.719]	[0.003, 0.007]		[1.043, 2.391]	[0.006, 0.014]
Water monitoring ($\beta_3 * \gamma_{0,3}$)	0.021 (0.048)	0.000 (0.000)	Market information ($\beta_3 * \gamma_{0,3}$)	**0.093** (0.037)	**0.001** (0.000)	Market access ($\beta_3 * \gamma_{0,3}$)	**0.238** (0.033)	**0.001** (0.000)
	[−0.071, 0.118]	[−0.001, 0.001]		[0.027, 0.170]	[0.000, 0.002]		[0.176, 0.305]	[0.0001, 0.002]
Fertilizers ($\beta_4 * \gamma_{0,4}$)	0.017 (0.043)	0.000 (0.000)	Access to credit ($\beta_4 * \gamma_{0,4}$)	0.125 (0.116)	0.001 (0.001)			
	[−0.071, 0.118]	[−0.001, 0.001]		[−0.102, 0.353]	[−0.001, 0.003]			
Pest control ($\beta_5 * \gamma_{0,5}$)	0.054 (0.179)	0.001 (0.002)						
	[−0.297, 0.407]	[−0.003, 0.004]						
TME $\left(\sum_{j=1}^{5} \beta_j * \gamma_{0j}\right)$	0.198 (0.246)	0.002 (0.002)	TME $\left(\sum_{j=1}^{4} \beta_j * \gamma_{0j}\right)$	**1.029** (0.164)	**0.009** (0.002)	TME $\left(\sum_{j=1}^{3} \beta_j * \gamma_{0j}\right)$	**1.905** (0.334)	**0.011** (0.002)
	[−0.294, 0.671]	[−0.003, 0.006]		[0.704, 1.347]	[0.006, 0.012]		[1.253, 2.561]	[0.007, 0.014]
N total	25,642	25,642		25,642	25,642		93,349	93,349
N clusters crop-farm							49,717	49,717
N clusters farm	6886	6886		6886	6886		6886	6886

Note: Median point estimate, standard deviations (round brackets), and highest posterior density credibility intervals [square brackets] are reported. Significant (at 5%) parameters indicated in bold. Control variables, crop-, farm-, and year-fixed effects included (except for crop-fixed effects in the rule enforcement and capacity-building models) but not reported.

Abbreviations: DV, dependent variable; ME, mediation effect; TME, total mediation effect.

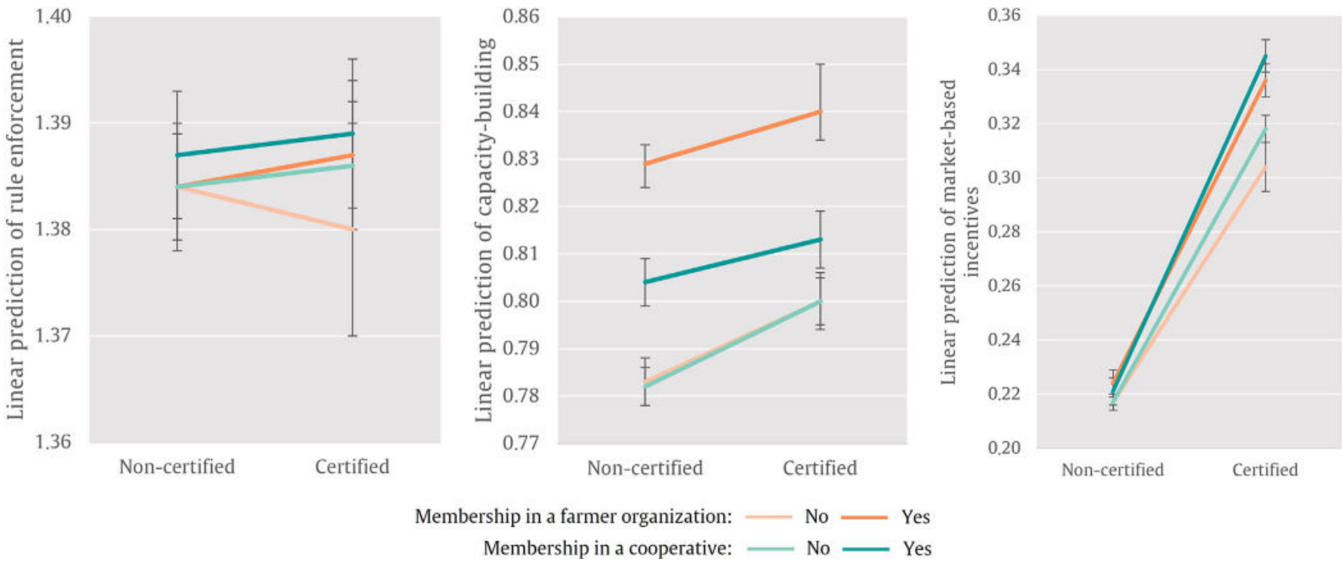

FIGURE 5 Visualization of the standardized moderation effects of cooperative membership for (a) the rule enforcement mechanism, (b) the capacity building mechanism, and (c) the market-based incentives mechanism. Regression results are presented in Table 5.

standard setters must carefully balance "carrots" and "sticks" mechanisms in VSS design.

The identification of market-based incentives as the primary governance mechanism through which VSS affect farm revenue holds important implications, as previous studies have highlighted that price premiums and market access are key drivers of VSS adoption and compliance (Carter & Siddiki, 2021; Galati et al., 2017). However, stakeholder interviews reported issues of oversupply of certified products and elite capture of price premiums, which could undermine the effectiveness of market-based incentives. To limit oversupply, VSS could either focus on strengthening the demand side as willingness to pay for certified products is not guaranteed in a global market with substitute goods and price competition, or rely on formal limits to entry while at the same time balancing equity to reach producers that are most in need of sustainability improvements (de Janvry et al., 2015). We do not find an effect of VSS through minimum prices, an important attribute in Fairtrade certification, which might relate to a low share of Fairtrade certification in the sample, to market conditions not warranting the use of a minimum price during the study period (only 14% of certified farmers reported receiving a minimum price), or to the ineffectiveness of this mechanism.

The insignificance of the rule enforcement mechanism is particularly notable, given that VSS are expected to improve farming systems, resulting primarily in better yields. We test the latter, and do not find evidence for a yield effect, but identify a potential effect through land tillage, water monitoring, and pest control (Table A4). This may imply that GAP requirements are not more advanced than the current farming practices, that effects might be long-term, or that GAP requirements are not complied with. One major instance of noncompliance we identify is the use of inorganic pesticides by 27% of Organic certified farms. Non-compliance might be the result of requirements being impractical, unachievable, poorly translated and enforced in the field, or farmers not being aware of their certification status, as mentioned during the stakeholder interviews. The challenge of non-compliance, particularly among smallholders, has been highlighted in previous studies (Albersmeier et al., 2009; Meemken, 2021), and should be taken into account in future impact studies, for example by consulting audit data (Garbely & Steiner, 2022). Addressing the non-compliance issue is crucial for certification bodies to prevent greenwashing, maintain consumer trust, and uphold the role of VSS in stimulating responsible consumption behavior and environmental stewardship (Albersmeier et al., 2009). Widely discussed potential technological solutions to improve compliance and long-term sustainability performance are big data analytics, blockchain, sensors, satellite imagery, and social media, but their synergistic effects with VSS are still subject to debate (Awan et al., 2023; Castka et al., 2020; Köhler et al., 2022). Additional avenues for improvement include enhancing stakeholder engagement in the VSS management and certification process and reevaluating the formulation of credible theories of change, favoring gradual improvement schemes over linear approaches (Jia, 2023).

Additionally, our finding that capacity-building positively affects rule enforcement of GAP is important, because capacity-building might accommodate capacities of less well-off farms to adopt VSS, where adoption is lowest (Tayleur et al., 2018), and ameliorate noncompliance with GAP requirements stemming from knowledge and capacity limitations (Meemken et al., 2017). Moreover, we find that while technical assistance is the most important capacity-building attribute through which VSS affect farmer welfare, the provision of credit emerges as the capacity-building attribute with the greatest potential to improve farmer welfare.

We find that membership in a farmer organization or cooperative reinforces the positive effect of VSS adoption on market-based incentives to some extent. Yet, cooperative membership slightly diminishes

TABLE 5 Results of the mediation model of the effect of VSS on net farm revenue through the three governance mechanisms together with the moderation effect of membership in a farmer organization or cooperative.

Moderator	Membership in a farmer organization		Membership in a cooperative	
(Un)standardized effects	Unstandardized	Standardized	Unstandardized	Standardized
DV: Net farm revenue				
VSS (β_0)	−0.634 (0.588)	−0.003 (0.003)	−0.634 (0.588)	−0.003 (0.003)
	[−1.778, 0.518]	[−0.009, 0.003]	[−1.778, 0.518]	[−0.009, 0.003]
Rule enforcement ($\gamma_{0,1}$)	0.092 (0.120)	0.004 (0.005)	0.092 (0.120)	0.004 (0.005)
	[−0.147, 0.324]	[−0.006, 0.013]	[−0.147, 0.324]	[−0.006, 0.013]
Capacity-building ($\gamma_{0,2}$)	**1.891** (0.259)	**0.033** (0.005)	**1.891** (0.259)	**0.033** (0.005)
	[1.372, 2.384]	[0.024, 0.042]	[1.372, 2.384]	[0.024, 0.042]
Market-based incentives ($\gamma_{0,3}$)	**1.034** (0.097)	**0.041** (0.004)	**1.034** (0.097)	**0.041** (0.004)
	[0.843, 1.220]	[0.034, 0.049]	[0.843, 1.220]	[0.034, 0.049]
DV: Rule enforcement				
VSS (β_1)	−0.034 (0.067)	−0.004 (0.009)	0.012 (0.027)	0.002 (0.004)
	[−0.166, 0.097]	[−0.022, 0.013]	[−0.042, 0.065]	[−0.005, 0.009]
Capacity-building ($\gamma_{1,1}$)	**0.220** (0.008)	**0.095** (0.003)	**0.220** (0.008)	**0.095** (0.003)
	[0.206, 0.235]	[0.089, 0.102]	[0.206, 0.235]	[0.089, 0.102]
Moderator	0.000 (0.005)	0.000 (0.003)	0.009 (0.012)	0.002 (0.003)
	[−0.010, 0.011]	[−0.006, 0.007]	[−0.015, 0.033]	[−0.004, 0.009]
VSS*Moderator	0.057 (0.071)	0.007 (0.009)	0.010 (0.043)	0.001 (0.004)
	[−0.080, 0.197]	[−0.010, 0.024]	[−0.071, 0.097]	[−0.006, 0.008]
DV: Capacity-building				
VSS (β_2)	**0.057** (0.029)	**0.017** (0.009)	**0.057** (0.012)	**0.017** (0.004)
	[0.001, 0.114]	[0.000, 0.034]	[0.035, 0.081]	[0.010, 0.024]
Moderator	**0.032** (0.002)	**0.046** (0.003)	**0.034** (0.005)	**0.021** (0.003)
	[0.028, 0.037]	[0.039, 0.052]	[0.023, 0.044]	[0.015, 0.028]
VSS*Moderator	−0.022 (0.030)	−0.006 (0.009)	−**0.040** (0.018)	−**0.008** (0.004)
	[−0.082, 0.037]	[−0.023, 0.011]	[−0.076, −0.004]	[−0.015, −0.001]
DV: Market-based incentives				
VSS (β_3)	**0.660** (0.067)	**0.087** (0.009)	**0.766** (0.027)	**0.101** (0.004)
	[0.529, 0.790]	[0.070, 0.104]	[0. 712, 0.819]	[0.094, 0.108]
Moderator	**0.013** (0.005)	**0.008** (0.003)	0.017 (0.012)	0.005 (0.003)
	[0.003, 0.023]	[0.002, 0.014]	[−0.006, 0.042]	[−0.002, 0.011]
VSS*Moderator	**0.193** (0.070)	**0.024** (0.009)	**0.248** (0.042)	**0.021** (0.004)
	[0.056, 0.330]	[0.007, 0.041]	[0.166, 0.331]	[0.014, 0.029]
ME				
Rule enforcement ($\beta_1 * \gamma_{0,1}$)	−0.001 (0.011)	0.000 (0.000)	0.000 (0.004)	0.000 (0.000)
	[−0.029, 0.017]	[0.000, 0.000]	[−0.007, 0.011]	[0.000, 0.000]
Capacity-building ($\beta_2 * \gamma_{0,2}$)	**0.105** (0.057)	**0.001** (0.000)	**0.106** (0.027)	**0.001** (0.000)
	[0.002, 0.222]	[0.000, 0.001]	[0.057, 0.161]	[0.000, 0.001]
Market-based incentives ($\beta_3 * \gamma_{0,3}$)	**0.679** (0.094)	**0.004** (0.001)	**0.791** (0.079)	**0.004** (0.000)
	[0.499, 0.867]	[0.003, 0.005]	[0.642, 0.951]	[0.004, 0.005]
TME $\left(\sum_{j=1}^{3} \beta_j * \gamma_{0,j}\right)$	**0.784** (0.115)	**0.004** (0.001)	**0.900** (0.084)	**0.005** (0.000)
	[0.565, 1.015]	[0.003, 0.006]	[0.734, 1.064]	[0.004, 0.006]

(Continues)

TABLE 5 (Continued)

Moderator (Un)standardized effects	Membership in a farmer organization		Membership in a cooperative	
	Unstandardized	Standardized	Unstandardized	Standardized
N total	93,349	93,349	93,349	93,349
N clusters crop-farm	49,717	49,717	49,717	49,717
N clusters farm	6886	6886	6886	6886

Note: Median point estimate, standard deviations (round brackets), and highest posterior density credibility intervals [square brackets] are reported. Significant (at 5%) parameters indicated in bold. Control variables, crop-, farm-, and year-fixed effects are included but not reported.
Abbreviations: DV, dependent variable; ME, mediation effect; TME, total mediation effect.

the positive effect of VSS adoption on capacity-building, possibly due to diverging interests or goals, and in contradiction to earlier research that stresses the complementary role of organizational strength for VSS welfare impacts (Oya et al., 2018). However, when a farm is both a cooperative member and certified, it experiences greater capacity-building compared with either condition alone. Moreover, when comparing their relative importance, we find that organizational and cooperative membership plays a more significant role than VSS adoption alone in receiving capacity-building, underscoring the importance of accounting for institutional heterogeneity in impact studies (Oya et al., 2018; Sellare et al., 2020).

Our study shows that simultaneously analyzing the effect of multiple VSS governance mechanisms on farmer welfare using mediation analysis can be very useful to unravel the channels of effects of VSS. The study has several limitations that could be addressed in future research. A first limitation is the lack of strong external instruments to fully control for time-varying unobserved heterogeneity for VSS certification and cooperative membership. Other limitations relate to data availability. First, the dataset does not include sufficient information to measure all governance attributes in the conceptual framework. Particularly, we lack data on top-down or bottom-up monitoring, which are more stringent rule enforcement attributes than GAP, on the provision of social premia, and on some capacity-building interventions, such as material assistance or financial support. Second, our analysis primarily concentrates on net farm revenue as outcome indicator, and includes a control variable for participation in off-farm employment. While farm revenue remains a central metric for evaluating the immediate economic performance of smallholder farms, we also acknowledge the significance of off-farm employment as income source for farm-households and of other non-income areas of household welfare (Schaafsma et al., 2023). Third, crop-specific certification data were derived based on assumptions verified with data from certification programs and stakeholder interviews, assuming that farms certify their entire acreage or harvest of a specific crop. We lack information on whether the certified products were fully sold as certified. Such information is usually not available from farm-level data collection as farmers often do not know whether their certified products are actually marketed as certified throughout the supply chain. Fourth, the number of certified smallholders is relatively small, but comparable to sample sizes typically seen in surveys specifically designed to analyze the impact of VSS (Meemken, 2020). However, this limits the extent to which we can disentangle the effect by VSS given small subsample sizes. Given that most of the certified farms in the sample are Organic certified, the results are largely driven by this VSS.

Our findings have important implications for VSS organizations and sustainability interventions more broadly. In particular, we recommend VSS organizations to strengthen market-based incentives and capacity-building of certified farms while improving standard setting and enforcement. This is most effectively done through providing price premiums rather than minimum prices, through improving the provision of credit next to technical assistance and training, and through improving standard setting and enforcement related to land tillage, water monitoring, and pest control. In addition, we recommend VSS organizations to better balance “carrots” and “sticks” mechanisms in VSS design, as previous research and stakeholder interviews indicate that an overemphasis on “carrots” might lead to standard proliferation and oversupply of certified products, ultimately resulting in price premium erosion. Moreover, VSS organizations should consider the varying effect of producer organizations on standard compliance, necessitating a more tailored approach in standard implementation strategies and enhanced engagement with relevant stakeholders in the field.

6 | CONCLUSION

Our study illustrates that aiming for farmer welfare, as promoted in the 2030 Agenda on Sustainable Development, via smallholder certification might be challenging. We demonstrate the importance of VSS governance in understanding sustainability impacts of VSS, an aspect that has often been overlooked in previous research. We find that “carrots”, in the form of market-based incentives and capacity-building, rather than “sticks”, in the form of rule enforcement, are the primary governance mechanisms through which VSS affect the welfare of smallholders in Peru. However, these effects are limited and do not lead to significant overall welfare gains. Price premiums, followed by market access, are the most important market-based incentives, while the minimum price in Fairtrade supply chains does not significantly influence farmer welfare. Capacity-building in the form of technical assistance, followed by training and market information, creates the largest effects of VSS on farmer welfare while access to credit has no effect but has the largest potential effect. We find that "sticks", in the form of rule implementation related to GAP, do not significantly affect farmer welfare and yields, despite expectations. Specifically, we identify a major instance of non-compliance with the use of inorganic pesticides by Organic certified farms. However, we identify potential welfare-enhancing effects through land tillage, water monitoring, and pest control and find that an increase in capacity building positively affects the enforcement of GAP rules. Furthermore, we find that membership in a farmer organization reinforces market-based incentives and plays a more important role towards capacity building than VSS alone.

The focus of this article is on understanding how VSS governance affects farmer welfare. We do not focus on heterogeneity across VSS, crops, nor farm types. Understanding how and why welfare effects vary across VSS, crops, and farm types opens interesting avenues for future research. In addition, replicating our analysis to other countries, commodities, VSS, and sustainability indicators might result in more comprehensive insights into how the design and governance of VSS can be improved to maximize sustainability outcomes. Furthermore, future research could delve into the reasons behind non-compliance with VSS to provide strategies aimed at improving enforcement mechanisms, and ultimately improving sustainability in the agri-food sector.

ACKNOWLEDGMENTS

This work was supported by a PhD Fellowship Strategic Basic Research granted by the Flemish Fund for Scientific Research (FWO) [grant number 1S40222N], the VSS4f/wOOD project granted by the KU Leuven Special Research Fund [grant number C24M/19/031], and the FWO International Coordination Action [grant number G0F4420N]. The funding institutions were not involved in the design, analysis, and writing of the study. The authors would like to thank Prof. Michael Zyphur for the advice in model selection and Diana Llacsahuanga Carrasco for support in facilitating the primary data collection in Peru.

FUNDING INFORMATION

Open access publishing facilitated by Griffith University, as part of the Wiley - Griffith University agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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ENDNOTES

[i] An exhaustive list of these studies would be unwieldy. This includes for example: Tran and Goto (2019) investigating the effect of UTZ certification on prices, yields, costs, and net income among tea producers in northeastern Vietnam, Jena and Grote (2017) analyzing the effect of Fairtrade certification on coffee income, household income, and poverty among coffee producers in southern India, and Meemken and Qaim (2018) exploring the effect of dual Fairtrade-UTZ certification on cash revenues among coffee producers in central Uganda.

[ii] The minimum price is the floor price to be paid to certified producers for their products if market prices are below this minimum price. If market prices rise above this minimum, producers still receive the higher market price. Social premiums are an additional amount of money on top of the selling price and can be used to invest in economic, social, and environmental development after democratic decision-making within the certified cooperative.

[iii] We do not assess the relationship between the rule enforcement mechanism and the market-based incentives mechanism as causality can theoretically go in both directions (hence the bidirectional arrow).

[iv] We discard livestock farms as they differ importantly from crop or mixed farms.

[v] We used ILRI's (2011) conversion factors.

[vi] Panel data mediation models can be estimated via multilevel modeling or structural equation modeling (Hamaker & Muthén, 2020). We use the former because of computational speed.

[vii] We use Bayesian estimation because it has several advantages over frequentist methods: (1) it provides credibility intervals for the parameters of interest, enabling both support *for* or *against* a null hypothesis (Zyphur & Oswald, 2015), and eliminating the need for multiple hypothesis correction (Gelman et al., 2012); (2) it can be more robust when dealing with complex models and small sample sizes (Asparouhov & Muthén, 2018); and (3) it does not assume normally distributed model parameters, which is advantageous for estimating indirect effects which are known to be skewed (Preacher & Hayes, 2008).

[viii] By definition, the construction of the minimum price and price premium variables will lead to quasi-complete separation. To solve this, we use a linear probability model for the variable market-based incentives, as proposed by Chatla and Shmueli (2016).

[ix] An outlier is defined here as having a *z*-score larger than 3.

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How to cite this article: Boonaert, E., Depoorter, C., Marx, A., & Maertens, M. (2024). Carrots rather than sticks: Governance of voluntary sustainability standards and farmer welfare in Peru. *Sustainable Development*, 1–22. https://doi.org/10.1002/sd.3035

APPENDIX A: "Carrots rather than sticks: Governance of voluntary sustainability standards and farmer welfare in Peru"

TABLE A1 Operationalization of VSS governance attributes pertaining to the governance mechanisms.

	Operationalization	Weight in governance attribute	Weight in governance mechanism
Rule enforcement mechanism			
Soil practices	Soil analysis (0/1)	1/3	1/5
	Use of crop rotation (0/1)	1/3	
	Use of terraces (0/1)	1/3	
Land tillage	Plowing (0/1)	1/2	1/5
	Crumbling (0/1)	1/2	
Water monitoring	Water determination (0/1)	1/5	1/5
	Irrigation frequency (0/1)	1/5	
	Water infiltration (0/1)	1/5	
	Maintenance of irrigation system (0/1)	1/5	
	Water analysis (0/1)	1/5	
Fertilizers	Use of inorganic or organic fertilizers (0/1)	1	1/5
Pest control	Use of inorganic or organic (i.e., biological control, integrated pest management) pesticides (0/1)	1	1/5
Capacity-building mechanism			
Receiving training	Training on soil analysis (0/1)	1/19	1/4
	Training on soil tillage techniques (0/1)	1/19	
	Training on crop rotation (0/1)	1/19	
	Training on seed management techniques (disinfection, selection and proper storage) (0/1)	1/19	
	Training on operation and maintenance of irrigation systems (0/1)	1/19	
	Training on technical irrigation systems (0/1)	1/19	
	Training on proper irrigation practices (0/1)	1/19	
	Training on the use of organic and inorganic fertilizers (0/1)	1/19	
	Training on the use of pesticides (insecticides, fungicides, herbicides, acaricides, bactericides, nematicides, rodenticides, molluscicides, etc.) (0/1)	1/19	
	Training on the use of biological control (0/1)	1/19	
	Training on integrated pest management (0/1)	1/19	
	Training on irrigation water quality standards (0/1)	1/19	
	Training on good agricultural practices (0/1)	1/19	
	Training on Organic production (0/1)	1/19	
	Training on handling and hygiene of food of plant or animal origin (0/1)	1/19	
	Training on storage of food of plant or animal origin (0/1)	1/19	
	Training on contamination of food of plant or animal origin (0/1)	1/19	
	Training on other self-specified topics (0/1)	1/19	
Receiving technical assistance	Technical assistance on the implementation of soil analysis (0/1)	1/11	1/4
	Technical assistance on the operation and maintenance of irrigation systems (0/1)	1/11	
	Technical assistance on technical irrigation systems (0/1)	1/11	

TABLE A1 (Continued)

	Operationalization	Weight in governance attribute	Weight in governance mechanism
	Technical assistance on the use of organic and inorganic fertilizers (0/1)	1/11	
	Technical assistance on the use of pesticides (insecticides, fungicides, herbicides, acaricides, bactericides, nematicides, rodenticides, molluscicides, etc.) (0/1)	1/11	
	Technical assistance on the use of biological control (0/1)	1/11	
	Technical assistance on integrated pest management (0/1)	1/11	
	Technical assistance on good agricultural practices (0/1)	1/11	
	Technical assistance on organic production (0/1)	1/11	
	Technical assistance on other self-specified topics (0/1)	1/11	
Receiving market information	Information on selling price (farm, wholesale, retail) (0/1)	1/8	1/4
	Information on quantity produced (0/1)	1/8	
	Information on demand for agricultural products (0/1)	1/8	
	Information on quantity traded (0/1)	1/8	
	Agroclimatic information (0/1)	1/8	
	Information on prices of agricultural inputs (0/1)	1/8	
	Information on new crop management and breeding techniques (0/1)	1/8	
	Information on other self-specified topics (0/1)	1/8	
Access to credit	Credit received when applied for (0/1)	1	1/4
Market-based incentive mechanism			
Minimum price	Average market price above the average minimum price per crop and per year (0/1). Minimum price data were obtained from online documents of Fairtrade International. Of the available Free on Board and Ex Works price levels, we chose the most conservative (i.e., lowest) price value. When different product types exist for one crop, we weighted the different product types based on the share of exported volume from FAOSTAT data	1	1/3
Price premium	Average market price above the average export-oriented market price in Peru per crop and per year (0/1)	1	1/3
Enhanced access to export and niche markets	Access to export market, Lima market or agro-industry (0/1)	1	1/3

TABLE A2 Robustness checks of the mediation model of the effect of VSS on net farm revenue through the three governance mechanisms together: (1) first difference model, (2) model excluding outliers, and (3) balanced panel for 2016–2019.

Model	(1)		(2)		(3)	
(Un)standardized effects	Unstandardized	Standardized	Unstandardized	Standardized	Unstandardized	Standardized
DV: Net farm revenue						
VSS (β_0)	0.367 (0.329)	0.003 (0.003)	−0.513 (0.587)	−0.003 (0.003)	−0.601 (0.591)	−0.003 (0.003)
	[−0.279, 1.012]	[−0.002, 0.008]	[−1.676, 0.617]	[−0.009, 0.003]	[−1.786, 0.516]	[−0.010, 0.003]
Rule enforcement ($\gamma_{0,1}$)	−0.254 (0.230)	−0.005 (0.005)	−0.017 (0.118)	−0.001 (0.005)	0.076 (0.121)	0.003 (0.005)
	[−0.705, 0.197]	[−0.014, 0.004]	[−0.246, 0.217]	[−0.010, 0.009]	[−0.164, 0.311]	[−0.007, 0.013]
Capacity-building ($\gamma_{0,2}$)	**2.244** (0.250)	**0.030** (0.003)	**1.627** (0.258)	**0.029** (0.005)	**1.851** (0.258)	**0.032** (0.005)
	[1.745, 2.733]	[0.023, 0.036]	[1.112, 2.124]	[0.020, 0.038]	[1.354, 2.367]	[0.024, 0.041]
Market-based incentives ($\gamma_{0,3}$)	**0.733** (0.374)	**0.008** (0.004)	**0.931** (0.098)	**0.037** (0.004)	**1.028** (0.098)	**0.041** (0.004)
	[0.039, 1.506]	[0.000, 0.016]	[0.742, 1.125]	[0.030, 0.045]	[0.837, 1.222]	[0.033, 0.049]
DV: Rule enforcement						
VSS (β_1)	0.020 (0.014)	0.008 (0.006)	0.020 (0.025)	0.003 (0.003)	0.016 (0.025)	0.002 (0.003)
	[−0.007, 0.048]	[−0.003, 0.019]	[−0.029, 0.070]	[−0.004, 0.009]	[−0.033, 0.065]	[−0.004, 0.009]
Capacity-building ($\gamma_{1,1}$)	**0.120** (0.007)	**0.081** (0.005)	**0.209** (0.008)	**0.090** (0.003)	**0.213** (0.008)	**0.092** (0.003)
	[0.106, 0.135]	[0.071, 0.090]	[0.194, 0.225]	[0.084, 0.097]	[0.197, 0.228]	[0.086, 0.099]
DV: Capacity-building						
VSS (β_2)	**0.036** (0.012)	**0.021** (0.007)	**0.047** (0.011)	**0.014** (0.003)	**0.050** (0.011)	**0.015** (0.003)
	[0.012, 0.059]	[0.007, 0.035]	[0.025, 0.068]	[0.008, 0.020]	[0.030, 0.072]	[0.009, 0.022]
DV: Market-based incentives						
VSS (β_3)	**0.285** (0.027)	**0.210** (0.021)	**0.832** (0.025)	**0.111** (0.003)	**0.834** (0.025)	**0.111** (0.003)
	[0.233, 0.338]	[0.168, 0.251]	[0.784, 0.881]	[0.104, 0.117]	[0.786, 0.882]	[0.105, 0.118]
ME						
Rule enforcement ($\beta_1 * \gamma_{0,1}$)	−0.005 (0.006)	0.000 (0.000)	0.000 (0.004)	0.000 (0.000)	0.000 (0.004)	0.000 (0.000)
	[−0.017, 0.006]	[0.000, 0.000]	[−0.009, 0.007]	[0.000, 0.000]	[−0.006, 0.011]	[0.000, 0.000]
Capacity-building ($\beta_2 * \gamma_{0,2}$)	**0.080** (0.029)	**0.001** (0.000)	**0.075** (0.022)	**0.000** (0.000)	**0.092** (0.024)	**0.001** (0.000)
	[0.024, 0.136]	[0.000, 0.001]	[0.035, 0.119]	[0.000, 0.001]	[0.047, 0.141]	[0.000, 0.001]
Market-based incentives ($\beta_3 * \gamma_{0,3}$)	**0.220** (0.109)	**0.002** (0.001)	**0.774** (0.085)	**0.004** (0.000)	**0.857** (0.086)	**0.005** (0.000)
	[0.007, 0.434]	[0.000, 0.003]	[0.606, 0.938]	[0.003, 0.005]	[0.691, 1.027]	[0.004, 0.006]
TME $\left(\sum_{j=1}^{3} \beta_j * \gamma_{0,j}\right)$	**0.295** (0.112)	**0.002** (0.001)	**0.850** (0.087)	**0.005** (0.000)	**0.952** (0.089)	**0.005** (0.001)
	[0.075, 0.515]	[0.001, 0.004]	[0.679, 1.022]	[0.004, 0.006]	[0.778, 1.129]	[0.004, 0.006]
N total	37,143	37,143	91,531	91,531	90,525	90,525
N clusters crop-farm	20,023	20,023	49,148	49,148	47,817	47,817
N clusters farm	6429	6429	6867	6867	6547	6547

Note: Model 1 is estimated using a maximum likelihood estimator to account for clustering. Estimate, standard errors (round brackets), and confidence intervals [square brackets] are reported. Models 2 and 3 are estimated using Bayes. Median point estimate, standard deviations (round brackets) and highest posterior density credibility intervals [square brackets] are reported. Significant (at 5%) parameters indicated in bold. Control variables, crop-, farm-, and year-fixed effects are included but not reported.
Abbreviations: DV, dependent variable; ME, mediation effect; TME, total mediation effect.

TABLE A3 Results of the single mediation models of the effect of VSS on net farm revenue through the three governance mechanisms.

	Rule enforcement		Capacity-building		Market-based incentives	
(Un)standardized effects	Unstandardized	Standardized	Unstandardized	Standardized	Unstandardized	Standardized
DV: Net farm revenue						
VSS (β_0)	0.378 (0.685)	0.003 (0.006)	0.026 (0.688)	0.000 (0.006)	−0.577 (0.589)	−0.003 (0.003)
	[−0.989, 1.700]	[−0.009, 0.014]	[−1.349, 1.349]	[−0.011, 0.012]	[−1.732, 0.568]	[−0.009, 0.003)
Rule enforcement ($\gamma_{0,1}$)	0.290 (0.201)	0.011 (0.008)				
	[−0.113, 0.680]	[−0.004, 0.026]				
Capacity-building ($\gamma_{0,2}$)			**7.245** (0.455)	**0.112** (0.007)		
			[6.361, 8.143]	[0.098, 0.125]		
Market-based incentives ($\gamma_{0,3}$)					**1.066** (0.096)	**0.043** (0.004)
					[0.878, 1.253]	[0.035, 0.050]
DV: Rule enforcement						
VSS (β_1)	0.025 (0.028)	0.006 (0.006)				
	[−0.029, 0.080]	[−0.007, 0.018]				
Capacity-building ($\gamma_{1,1}$)						
DV: Capacity-building						
VSS (β_2)			**0.050** (0.011)	**0.027** (0.006)		
			[0.028, 0.072]	[0.015, 0.039]		
DV: Market-based incentives						
VSS (β_3)					**0.853** (0.025)	**0.110** (0.003)
					[0.788, 0.886]	[0.104, 0.116]
ME						
Rule enforcement ($\beta_1 * \gamma_{0,1}$)	0.005 (0.011)	0.000 (0.000)				
	[−0.011, 0.033]	[0.000, 0.000]				
Capacity-building ($\beta_2 * \gamma_{0,2}$)			**0.358** (0.085)	**0.003** (0.001)		
			[0.197, 0.529]	[0.002, 0.005]		
Market-based incentives ($\beta_3 * \gamma_{0,3}$)					**0.890** (0.085)	**0.005** (0.000)
					[0.724, 1.055]	[0.004, 0.006]
TME $\left(\sum_{j=1}^{3} \beta_j * \gamma_{0,j}\right)$						
N total	25,642	25,642	25,642	25,642	93,349	93,349
N clusters crop-farm					49,717	49,717
N clusters farm	6886	6886	6886	6886	6886	6886

Note: Median point estimate, standard deviations (round brackets) and highest posterior density credibility intervals [square brackets] are reported. Significant (at 5%) parameters indicated in bold. Control variables, crop-, farm-, and year-fixed effects are included but not reported.
Abbreviations: DV, dependent variable; ME, mediation effect; TME, total mediation effect.

TABLE A4 Results of the mediation model of the effect of VSS on yield instead of net farm revenue through rule enforcement.

Rule enforcement		
(Un)standardized effects	**Unstandardized**	**Standardized**
DV: Yield		
VSS (β_0)	0.109 (0.076)	0.009 (0.006)
	[−0.042, 0.254]	[−0.003, 0.021]
Soil practices ($\gamma_{0,1}$)	−0.003 (0.010)	−0.004 (0.014)
	[−0.021, 0.016]	[−0.031, 0.025]
Land tillage ($\gamma_{0,2}$)	**0.029** (0.015)	**0.042** (0.022)
	[0.001, 0.058]	[0.003, 0.087]
Water monitoring ($\gamma_{0,3}$)	**0.036** (0.008)	**0.053** (0.012)
	[0.020, 0.052]	[0.030, 0.076]
Fertilizers ($\gamma_{0,4}$)	−0.018 (0.017)	−0.026 (0.026)
	[−0.051, 0.017]	[−0.074, 0.025]
Pest control ($\gamma_{0,5}$)	**0.139** (0.014)	**0.205** (0.021)
	[0.112, 0.165]	[0.166, 0.247]
DV: Soil practices		
VSS (β_1)	0.097 (0.137)	0.005 (0.007)
	[−0.169, 0.367]	[−0.008, 0.020]
DV: Land tillage		
VSS (β_2)	−0.052 (0.129)	−0.003 (0.007)
	[−0.305, 0.199]	[−0.017, 0.011]
DV: Water monitoring		
VSS (β_3)	0.071 (0.146)	0.004 (0.008)
	[−0.214, 0.359]	[−0.010, 0.021]
DV: Fertilizers		
VSS (β_4)	0.239 (0.140)	0.013 (0.008)
	[−0.035, 0.512]	[−0.001, 0.029]
DV: Pest control		
VSS (β_5)	0.053 (0.140)	0.003 (0.008)
	[−0.213, 0.337]	[−0.012, 0.017]
ME		
Soil practices ($\beta_1 * \gamma_{0,1}$)	0.000 (0.002)	0.000 (0.000)
	[−0.004, 0.003]	[0.000, 0.000]
Land tillage ($\beta_2 * \gamma_{0,2}$)	−0.001 (0.004)	0.000 (0.000)
	[−0.011, 0.007]	[−0.001, 0.001]
Water monitoring ($\beta_3 * \gamma_{0,3}$)	0.002 (0.005)	0.000 (0.000)
	[−0.008, 0.014]	[−0.001, 0.001]
Fertilizers ($\beta_4 * \gamma_{0,4}$)	−0.003 (0.005)	0.000 (0.000)
	[−0.016, 0.005]	[−0.001, 0.000]
Pest control ($\beta_5 * \gamma_{0,5}$)	0.007 (0.019)	0.001 (0.002)
	[−0.031, 0.046]	[−0.003, 0.004]
TME $\left(\sum_{j=1}^{5} \beta_j * \gamma_{0,j}\right)$	0.004 (0.022)	0.000 (0.002)
	[−0.038, 0.047]	[−0.003, 0.004]
N total	25,642	25,642
N clusters farm	6997	6997

Note: We transformed the outcome indicator yield (kg/ha) using the inverse hyperbolic sine transformation. For the posterior distribution of each model parameter, we report the median point estimate, standard deviations (in round brackets), and highest posterior density credibility intervals (in square brackets). We consider model parameters to be significantly different from zero (in bold) when their 95% credibility intervals do not intersect zero. DV stands for dependent variable, ME for mediation effect, and TME for total mediation effect. Control variables, farm- and year-fixed effects are included but estimated coefficients not shown for brevity.