



Beyond inputs: How market linkages and quality infrastructure can address crop disease in Rwanda's horticulture sector

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- Crop disease is one of the most significant and under-addressed constraints on horticulture productivity in Rwanda, with many smallholders losing half or more of their potential yields annually.
- Conventional policy responses—such as input subsidies and public extension—are necessary but insufficient on their own; they fail to resolve the underlying incentive failures that drive poor disease management.
- The structure of markets matters: farmers who are integrated into demanding value chains adopt better practices, not primarily because they receive more inputs, but because commercial relationships create enforceable incentives and reliable information flows.
- Certification schemes, when well-designed, can align private incentives with public productivity goals at scale.
- A coordinated package of reforms—spanning certification, buyer–supplier linkage facilitation, and value chain coordination—offers the highest return on public investment.

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The policy problem

Rwanda's horticulture sector has received sustained public investment over the past two decades, spanning irrigation infrastructure, input subsidies, and an ambitious export promotion agenda. The sector is strategically important: horticulture accounts for a growing share of non-traditional agricultural exports and contributes to rural income diversification.

Yet aggregate productivity remains well below potential. A striking feature of the sector is that many producers—including those selling into export markets—report low or negative profit margins, even as revenues have risen. The proximate cause is not difficult to identify: crop disease is pervasive, costly, and poorly managed across the smallholder base.

Survey evidence from Rwanda's key horticulture zones reveals that a majority of producers report disease as a significant constraint in any given season. Yield losses of 40% to 60% are common; losses exceeding this are not unusual during high-disease episodes. The aggregate cost, in foregone output, wasted inputs, and farmer welfare, is substantial.

What makes this a policy problem, rather than simply an agronomic one, is the pattern of who manages disease well and why. Disease management is not purely a knowledge or input access problem. Extension outreach and subsidised agrochemicals exist and reach many farmers. Yet uptake of improved practices is uneven, and adoption is weakly correlated with access to public services (J-PAL, 2023). This points to something deeper: a structural failure in the incentive environment facing smallholders.

Economic mechanisms: Why markets shape agricultural practices

Understanding why market structures drive practice adoption and why conventional supply-side policy falls short requires engaging with several well-established economic mechanisms.

1. Learning through demanding buyers

A foundational insight from the trade and development literature is that firms and farmers improve their practices when integrated into supply relationships with demanding buyers (Atkin et al., 2017; Alfaro-Ureña et al., 2022). The mechanism operates through multiple channels simultaneously:

- **Information transfer:** Buyers with quality requirements have an incentive to share technical knowledge with suppliers, because supplier

failure imposes costs on them. This creates a private-sector analogue to extension that is often more targeted and timelier than public services.

- **Incentive alignment:** Price premiums for quality, and discounts or rejection for poor quality, give farmers a direct financial stake in meeting standards. Unlike public extension advice, which carries no financial consequence for non-compliance, buyer-linked standards have real enforcement power.
- **Repeated interaction:** Long-term buyer–supplier relationships create reputational stakes that reinforce compliance over time, even when formal contracts are incomplete.

The implication for Rwanda is significant: the effectiveness of any productivity intervention is partly conditioned on the commercial environment in which farmers operate. A farmer selling into a spot market with no quality differentiation has weak incentives to invest in disease management, regardless of the technical advice available. A farmer with a committed buyer who pays a premium for clean produce has strong incentives and typically receives better support to meet them.

2. Standards as commitment devices

Product standards, whether public, private, or third-party certified, play a distinct economic role beyond signalling quality. They function as commitment devices that resolve coordination failures (Verhoogen, 2008; Jaffee & Henson, 2005).

In horticulture, a key coordination failure is this: individual farmers have limited incentive to invest in disease control if their neighbours do not, because disease pressure is partially determined at the landscape or community level. No individual farmer can internalise the full benefit of their investment in clean production. This is a classic externality problem, and one that spot markets do not resolve.

Certification addresses this by creating a collective standard that all participating farmers must meet. The certifying body, whether a government agency, an NGO, or a third-party auditor, monitors compliance across the group, making the standard credible and enforceable. Critically, certification also unlocks access to buyers and markets that are unavailable to uncertified producers, raising the return to compliance for each individual farmer.

Evidence from Rwanda supports this: certified producers systematically report higher revenues, higher profits, and relationships with higher-value buyers, even after controlling for firm size and location (Bergquist et al., 2026). The revenue premium is not simply a reward for being more productive—it reflects the market access that certification enables.

3. Value chain coordination and the hold-up problem

Even where buyer–supplier relationships exist, their productivity benefits depend heavily on the structure of the value chain. Thin or fragmented markets, where farmers sell to many different intermediaries with no ongoing relationship, do not generate the information flows or incentive alignment described above (Macchiavello & Morjaria, 2015; Antràs & Foley, 2015).

Constraints in Rwanda's horticulture sector point to what economists call the hold-up problem: a case in which both farmers and buyers are reluctant to invest in the relationship, such as in crop-specific inputs, storage, or logistics, because they cannot credibly commit to transacting with each other in the future. Without commitment, neither side invests optimally, and the productivity benefits of the relationship are never realised.

Outgrower schemes, forward contracts, and other relational contracting arrangements are institutional solutions to this problem. By creating mutual commitment between buyers and sellers, they unlock relationship-specific investments on both sides. Input provision on credit, technical assistance, and guaranteed offtake, and other hallmarks of a well-functioning outgrower scheme, emerge from the commercial logic of a committed supply relationship.

The available evidence from Rwanda establishes that weak buyer–supplier linkages are associated with poor information flows and limited market access (Bergquist et al., 2024). Whether stronger relational ties specifically improve disease management practices, independently of other factors such as input access or farm characteristics, is not yet established by the existing evidence base.

Evidence from Rwanda

Three recent IGC-funded projects provide an unusually rich empirical foundation for understanding Rwanda's horticulture sector: a producer survey documenting profitability and disease constraints (Aggarwal et al., 2025); a matched difference-in-differences analysis of the effects of quality certification on firm outcomes (Bergquist et al., 2026); and a survey-based diagnostic of buyer–supplier linkage barriers across Rwandan firms (Bergquist et al., 2024). Together, they paint a coherent picture that motivates the policy case for linkage and coordination interventions.

1. The revenue-profit disconnect

The most striking finding from recent producer survey data is the sharp divergence between revenues and profits across market segments (Robinson et al., 2025). Exporters earn the highest revenues (around USD 3,000 per year on average), followed by those selling into domestic value chains (USD 910),

with local market sellers earning the least (USD 380). Yet this revenue ranking does not translate into a corresponding profit ranking.

Input costs rise sharply alongside revenues. For exporters, average input costs of around USD 2,400 nearly cancel out revenues, leaving contemporaneous profits of only around USD 570 per year. For producers selling into domestic value chains, profits are deeply negative at approximately -USD 1,000. Even local market sellers report average losses of around -USD 200. Across the full sample, average profit is close to zero, and roughly half to two-thirds of all producers—regardless of market segment—report negative profits. These figures do not account for the substantial start-up costs of establishing orchards and perennial crops, most of which were heavily subsidised through government sapling distribution programs; accounting for those costs would make the picture considerably bleaker.

The main takeaway from this survey is that profitability is currently very modest across the sector. The policy implication is not that export market integration is counterproductive — revenues are distinctly higher, and a minority of exporters do earn meaningful profits. Rather, the data show that the cost burden of meeting export quality standards is consuming most of the revenue premium. Disease is the proximate mechanism through which input expenditure fails to translate into output value.

2. Disease prevalence and its drivers

Disease is the single most commonly cited production constraint in the Robinson et al. (2025) survey, and measured prevalence is extremely high across all producer groups. 90% of exporters identify it as a major challenge—a higher share than among domestic value chain producers (69%) or local market sellers (61%). This is likely due to exporters facing stricter quality standards, making disease a more consequential and visible problem for them rather than a more frequent one per se.

Quantitative disease prevalence confirms the picture. Nearly all producers selling into export or domestic value chains report experiencing disease in the prior year (94% and 100% respectively), as do 75% of local market sellers. Yield losses are severe: among exporters, 76% report that disease reduced yields to half or less of what they would otherwise have been. Fruit rot is the most pervasive problem, affecting 86% of exporters and 77% of domestic value chain producers, with leaf spot, root rot, woodiness, blight, and fruit flies also reported widely.

Despite the near-universality of disease, active mitigation remains limited. Pesticide application is nearly universal across all groups, but other practices are adopted by only small minorities. Exporters are roughly twice as likely to uproot infected plants (39% vs. 19% among other producers)—a pattern

consistent with the incentive argument in Section 2: where quality standards are higher and rejection by buyers is a real risk, farmers take more active steps. But even among exporters, prevention practices such as using certified planting materials, maintaining adequate plant spacing, and crop rotation are uncommon. The overall level of disease management remains well below what effective control would require.

3. The certification premium

Bergquist et al. (2026) find suggestive evidence that quality certification is associated with substantially better firm outcomes — revenues and gross profits around 35% higher, and employment 30% higher two years after certification — with gains concentrated in agribusiness and driven by product rather than system certifications. What is equally interesting, though, is the mechanism: certification appears to deepen existing buyer relationships (with sales per buyer around 50% higher post-certification) and facilitate access to more demanding customers, including multinationals. This is precisely the kind of market signal that, if embedded in horticulture value chains, could create enforceable incentives for quality and disease management practices at the farm level.

The barrier is uptake. Only around one in ten SME suppliers in Rwanda holds any internationally recognised certification, while almost all large buyers require it—a mismatch that keeps domestic producers locked out of higher-value supply relationships and, by extension, insulated from the quality demands that would motivate better disease management.

4. Weak buyer–supplier linkages

The Bergquist et al. (2024) buyer–supplier survey—covering 189 formal firms in Kigali—reveals that matching frictions are severe and that the market currently lacks the infrastructure to resolve them. Large buyers cite low and hard-to-verify quality as a top-three barrier to sourcing locally, with three-quarters agreeing that quality is easier to verify from international suppliers. On the supplier side, the dominant barriers are not quality or certification per se, but visibility: around 60% of SME suppliers cite lack of information on relevant buyers among their top three challenges, and 40% cite a lack of reputation or recognition.

The relevance for disease management is indirect but real. Where buyer–supplier relationships are absent or thin, farmers face no commercial pressure to meet quality standards, and therefore no market-based incentive to invest in the disease management practices that underpin quality. The survey underscores just how structurally thin these relationships currently are: 94% of respondents are unaware of any B2B platform in Rwanda, and no dedicated business-to-business matching service exists. Over 95% of firms express a

strong interest in participating in a structured information-sharing program to facilitate linkages, suggesting latent demand that policy could unlock.

Policy recommendations

The following recommendations are presented in order of priority and reflect a coherent package rather than isolated interventions. Their combined logic is to align private incentives with public productivity goals, reduce coordination failures, and make the benefits of improved practice adoption financially tangible to farmers.

1. Integrate disease management into certification frameworks

The Government should revise existing horticulture certification standards to make disease management practices explicit and auditable requirements. This could mean:

- Establishing specific, measurable criteria for integrated pest and disease management (IPDM) within domestic and export certification schemes.
- Training and expanding the cadre of certification auditors, with a focus on agronomic competence in disease identification and management.
- Introducing tiered certification tracks—with lower compliance costs for entry-level standards—to widen smallholder participation while maintaining a credible premium tier for export markets.
- Linking certification to access to government-supported market channels (e.g., public procurement, export facilitation) to raise the return to compliance.

The rationale is straightforward: certification is currently the strongest observable predictor of good disease management. Rather than treating this as a correlation, policy should actively use certification as a delivery mechanism for disease management standards.

2. Facilitate structured buyer–supplier linkages via a B2B platform

The Government should invest in a digital and institutional platform that facilitates long-term commercial relationships between horticulture buyers (exporters, processors, supermarkets) and smallholder suppliers or their aggregators. Key design features could include:

- A curated matching function that prioritises relationship depth over transaction volume, with the goal of fostering durable bilateral linkages, not spot-market liquidity.
- Transparency on buyer requirements (quality, volume, timing, disease management protocols) so farmers can invest with confidence in meeting them.
- Dispute resolution mechanisms to reduce hold-up risk and support the mutual commitment that relational contracts require.
- Integration with the certification framework, so that certified farmers are more visible to premium buyers.

3. Scale coordinated value chain models

The Government should support outgrower schemes and contract farming arrangements that bundle input provision, technical assistance, and quality-linked offtake. The rationale is that these arrangements address the hold-up problem, by creating mutual commitment between buyers and farmers, they unlock the relationship-specific investments that spot markets cannot sustain.

However, scheme design is critical. The evidence base is mixed: Konja et al. (2024) find positive effects on technology adoption and yields among outgrower participants in Ghana, but Ragasa et al. (2018) find that average profitability remained negative because yield gains were insufficient to offset higher input costs—a dynamic that maps closely onto Robinson et al.'s (2025) findings in Rwanda. Schemes that provided only offtake guarantees without embedded technical support failed to generate sufficient returns. Public support should therefore be conditional on schemes meeting minimum design standards, and existing arrangements in Rwanda's horticulture sector should be evaluated before any model is scaled.

Conclusion

Rwanda's horticulture sector plays a key role in the export sector, and the public investment made to date has built real foundations. But realising that potential requires confronting a set of market failures that conventional input-and-extension policy cannot resolve on its own.

Crop disease is not primarily a knowledge gap. It is an incentive problem—one rooted in the structure of markets, the fragmentation of buyer–supplier relationships, and the absence of credible quality infrastructure. Addressing it requires policy instruments that are calibrated to these structural realities: certification frameworks that create enforceable standards, linkage mechanisms

that generate relational commitment between buyers and farmers, and value chain models that align private investment with productivity goals.

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