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Information Framing and Willingness to Pay for Wrap-and-Plant Technology among Smallholder Potato Farmers in Nyandarua, Kenya

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Abstract

Purpose: This study examines whether alternative information framing affects the economic valuation of Wrap-and-Plant (WAP) technology among smallholder potato farmers in Nyandarua County, Kenya, distinguishing the extensive margin of stated adoption from the intensive margin of willingness to pay (WTP).

Methodology: Data from 431 farmers were analysed following exposure to positive yield-gain or negative loss-avoidance framing. WTP was elicited using a double-bounded contingent valuation design and estimated using interval regression. A framing-only specification was followed by a multivariate specification incorporating behavioural, socioeconomic, demographic, farm and market characteristics.

Findings: Stated willingness to adopt was high under both negative framing (94.15%) and positive framing (94.24%). The baseline model showed a KES 266.48 association for negative relative to positive framing (p=0.091). The model-based predicted mean WTP was KES 1,989.26 under negative framing and KES 2,216.04 under positive framing, a difference of KES 226.78 (p=0.040). Attitude was positively associated with WTP (p=0.093), while log per-capita expenditure was positively associated with WTP (p=0.034).

Unique Contribution to Theory, Practice and Policy: The study contributes to agricultural economics by demonstrating that information framing may operate differently across the extensive and intensive margins of technology demand. While framing produced little difference in stated adoption, monetary valuation varied across information conditions. The findings suggest that technology communication, pricing and affordability should be considered jointly when assessing agricultural technology demand.

Keywords: *Information Framing, Willingness to Pay, Wrap-and-Plant, Potato Cyst Nematodes, Agricultural Technology Adoption*

JEL Classification: *D83, Q12, Q16*

INTRODUCTION

Potato (Solanum tuberosum L.) is an important staple and cash crop in Kenya, supporting food security and the livelihoods of smallholder farmers. The importance of improving potato productivity is reflected in national agricultural policy, including the Kenya Agriculture Act and the Agricultural Sector Transformation and Growth Strategy, which seek to promote sustainable agricultural production, improve market infrastructure, and support farmers' access to modern production methods and financing (RoK, 2012; NPCK, 2020). The National Potato Strategy 2021–2025 similarly seeks to increase potato productivity through improved access to quality seed, markets and improved production practices.

Within this production system, Nyandarua County is particularly important. The county is Kenya's leading potato-producing county, with more than 70,000 smallholder potato farmers and potato production valued at approximately USD 80 million, representing about 16% of the national value of potato production (NPCK, 2024). The economic importance of potato production in the county is nevertheless accompanied by significant biological production constraints, among which potato cyst nematodes (PCNs) are particularly important. PCNs reduce potato yields and threaten the sustainability of production, while their persistence in soil and ability to survive within protective cysts complicate their management (Mburu et al., 2020; Orlando & Boa, 2023; Lima et al., 2018). The thesis reports PCN-related yield losses in Nyandarua ranging from 4.2 to 21.8 tonnes per hectare.

The PCN constraint is not distributed uniformly across Nyandarua. Mean soil infectivity is highest in Kinangop at 158 viable eggs per gram of soil, followed by Kipipiri at 90.7 and Ol'Jororok at 42.3, compared with 37.3 in Ndaragwa and 30.6 in Ol'Kalou. Reported PCN-related losses similarly range from 21.8 tonnes per hectare in Kinangop to 4.2 tonnes per hectare in Ol'Kalou, with losses of 12.5 tonnes per hectare in Kipipiri and 5.8 tonnes per hectare in Ol'Jororok. These differences formed the basis for the purposive selection of Kinangop, Kipipiri and Ol'Jororok for the study, allowing the analysis to account for variation in PCN infestation and associated production losses.

The persistence and economic consequences of PCNs create a need for technologies capable of managing the constraint within potato production systems. Wrap-and-Plant (WAP) represents such a technological response. The technology uses a biodegradable banana-fibre-based lignocellulosic matrix containing nematicide to envelop potato seedlings before planting, with the intention of suppressing PCN multiplication and inoculum production while supporting potato production. Evidence cited in the thesis indicates that WAP can reduce nematode populations and improve tuber production potential (Silvestri et al., 2019). The economic relevance of WAP therefore derives from its potential to address a production constraint that directly affects potato yields and, consequently, the returns available to smallholder farmers.

The introduction of such a technology, however, requires more than evidence of agronomic effectiveness. Agricultural technology adoption is also an economic decision. Farmers must assess the expected benefits of an innovation against the resources required to obtain and use it, while making decisions within conditions of uncertainty, limited resources and competing household demands. The thesis recognises that farmers' willingness to invest in WAP can be constrained by access to resources and awareness of its benefits, and identifies financial resources, income and

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credit access as relevant dimensions of the socioeconomic environment within which technology decisions are made.

For a technology requiring financial commitment, the economic dimension of adoption can be examined through willingness to pay (WTP). Whereas a stated adoption response indicates whether a farmer is willing to consider using a technology, WTP provides information on the monetary value attached to that decision. This distinction is important because farmers who express similar willingness to adopt may nevertheless place different monetary values on the technology according to their expected benefits, production circumstances, perceived risks and economic capacity. The thesis consequently treats WTP as an economic valuation of the technology rather than simply another measure of adoption intention.

Information through which the technology is presented forms part of this decision environment. Farmers may not respond only to the characteristics of a technology itself, but also to how its expected benefits and potential consequences are communicated. In this study, two alternative information framings are considered: positive framing, which emphasises the potential yield gains associated with adoption, and negative framing, which emphasises the potential production losses associated with non-adoption. The two messages concern the same underlying technology and production problem but make different consequences salient. A yield-gain message draws attention to the expected benefits of adoption, whereas a loss-avoidance message draws attention to the potential costs of leaving the problem unmanaged.

The framing question is particularly relevant in the WAP context because the technology addresses a production risk whose consequences can be understood both in terms of gains from successful management and losses associated with continued infestation. How these consequences are communicated may therefore shape how farmers perceive the value and relevance of the technology, particularly where production outcomes are uncertain and resources are constrained. Existing research suggests that farmers' responses to agricultural technologies can depend on how expected benefits, risks and consequences are communicated (Rogers, 2003; Ward et al., 2014; Aditya et al., 2020). However, whether such framing affects only farmers' willingness to consider adopting a technology or also the monetary value they attach to it remains an important empirical question.

This question is particularly important because technology demand has more than one dimension. The first is the extensive margin, reflected in whether a farmer states willingness to adopt WAP. The second is the intensive economic margin, reflected in the amount a farmer is willing to pay for the technology. These dimensions need not respond in the same way to information. Farmers may express a high willingness to adopt because the technology addresses a salient production constraint, while still differing substantially in the monetary value they attach to it. Consequently, a framing intervention may have limited observable influence on the decision to adopt where baseline acceptance is already high, yet still influence the intensity of economic demand expressed through willingness to pay.

This creates an empirical gap in understanding the economic implications of information framing for agricultural technology decisions. Evidence that farmers are willing to adopt a technology does not necessarily indicate the strength of their economic demand for it, while WTP provides information about the monetary value attached to the technology that an adoption response alone cannot capture. In the context of WAP and PCN management, there is therefore a need to establish whether alternative ways of communicating the same technological solution produce different levels of stated adoption and economic valuation among smallholder farmers.

Against this background, the study examines whether information framing influences smallholder potato farmers' stated adoption response and willingness to pay for Wrap-and-Plant technology for potato cyst nematode management in Nyandarua County, Kenya. It specifically considers whether framing produces different responses across the extensive margin of stated adoption and the intensive economic margin represented by willingness to pay, and whether the relationship between framing and WTP persists after accounting for differences in farmers' behavioural and socioeconomic characteristics.

Problem Statement

WAP has potential to address an important biological constraint to potato production, but technology diffusion depends on more than agronomic effectiveness. Farmers must receive and interpret information about the technology, form expectations about its benefits, and determine whether those benefits justify the cost of acquisition. Communication can influence these judgements, yet evidence on how alternative framing affects the economic valuation of agricultural technologies remains context dependent. The behavioural relevance of framing is particularly important where the same technology can be presented in terms of gains from adoption or losses associated with non-adoption. Prospect Theory suggests that individuals evaluate outcomes relative to reference points and that losses may carry greater psychological weight than equivalent gains. This provides a theoretical basis for expecting gain- and loss-framed information to influence economic valuation differently, even when the underlying technology is unchanged. In the WAP context, a yield-gain frame makes adoption benefits salient, whereas a loss-avoidance frame makes the potential costs of leaving PCN-related risks unmanaged salient. This distinction is important because technology demand has both extensive and intensive margins. The extensive margin concerns whether a farmer states willingness to adopt, while the intensive margin concerns the monetary value placed on the technology. Where baseline willingness to adopt is already very high, the extensive margin may exhibit a ceiling effect, leaving limited scope for framing to produce a measurable difference in a binary response. However, farmers may still differ substantially in how much they are willing to pay. The behavioural anomaly tested in this study is therefore whether framing can have little observable effect on stated adoption while simultaneously producing differences in monetary valuation. The empirical gap is consequently not simply whether farmers are willing to adopt WAP, but whether alternative information framing changes the economic value assigned to the technology when stated adoption is already high, and whether any such relationship persists after accounting for differences in farmers' behavioural perceptions and socioeconomic circumstances.Establishing this requires an econometric treatment of the double-bounded WTP data rather than a descriptive comparison of bid responses alone.

Objective and Research Question

The objective of the study is to determine whether information framing influences smallholder potato farmers' valuation and stated adoption response to Wrap-and-Plant technology for potato cyst nematode management in Nyandarua County, Kenya.

The research question is: Does the framing of information about WAP's potential gains and losses influence farmers' stated adoption response and their willingness to pay for the technology, and how does the framing effect change after accounting for behavioural and socioeconomic characteristics?

Contribution of the Study

The research makes an agricultural-economic contribution in three respects. First, it distinguishes the extensive behavioural margin of stated adoption from the intensive economic margin represented by WTP. Second, it estimates framing effects using the appropriate interval-regression treatment of double-bounded contingent valuation data, rather than treating reported bids as exact WTP. Third, it moves from an unadjusted framing specification to a fully specified economic valuation model, allowing the monetary treatment effect to be interpreted alongside behavioural perceptions and household economic capacity. The findings also provide practical implications for technology commercialisation and agricultural policy. For agro-dealers and other market actors, the difference in predicted WTP across framing conditions suggests that pricing and market-entry strategies should consider how technology benefits are communicated, rather than relying on stated adoption interest alone. For policymakers, WTP and economic-capacity differences can inform targeted affordability measures, including subsidies or financing mechanisms, where farmers' interest may not translate into purchasing capacity. For public agricultural extension, the findings support communicating credible and comprehensible productivity benefits alongside technology information. The study demonstrates that agricultural technology communication should be assessed not only by farmers' willingness to adopt, but also by the economic intensity of demand. If framing does not materially change stated adoption because baseline receptiveness is already high, but changes WTP, communication becomes relevant not only to extension and awareness but also to the economic intensity of demand. This distinction can inform pricing, financing and market-entry decisions for agricultural technologies.

LITERATURE REVIEW

Prospect Theory and Information Framing

Prospect Theory provides the principal behavioural foundation for understanding why alternative presentations of the same agricultural technology may produce different valuations. The theory proposes that individuals evaluate outcomes relative to a reference point and that the psychological value of losses may exceed that of equivalent gains (Kahneman & Tversky, 1979). A simplified value function can be represented as:

$$v(x) = \begin{cases} x^{\propto}, & x \geq 0 \\ -\lambda(-x)^{\beta}, & x < 0 \end{cases}$$

Where x represents a gain or loss relative to a reference point, α and β capture diminishing sensitivity, and λ > 1 represents greater sensitivity to losses than to equivalent gains.

This framework provides a behavioural rationale for the framing treatment used in the study. Positive framing presents WAP in terms of potential yield gains from adoption, while negative framing presents the potential production losses associated with non-adoption. Although the underlying technology and production problem remain unchanged, the two frames make different

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consequences salient. The relevant theoretical proposition is therefore that framing can alter the subjective value attached to the consequences of adoption and non-adoption.

Prospect Theory does not imply that loss framing must necessarily generate higher willingness to pay in every context. Rather, it establishes why gain- and loss-framed information may produce different valuations. In the WAP context, the empirical question is whether this difference in psychological salience is reflected in the monetary intensity of technology demand, particularly when stated willingness to adopt is already high. The theory therefore provides the behavioural mechanism through which information framing may affect the intensive margin of demand.

Random Utility Theory

Random Utility Theory (RUT) provides the principal economic foundation for the WTP analysis. Under the utility framework as defined by McFadden (1974), a farmer evaluates WAP relative to available alternatives according to the utility associated with each option. Utility can be represented as:

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

Where U_{ij} is the total utility that farmer i obtains from option j, V_{ij} is the observable component of utility, and ε_{ij} captures unobserved influences.

A farmer accepts a price for WAP when the utility obtained from the technology at that price is at least as high as the utility associated with the relevant alternative. The maximum willingness to pay can therefore be represented as a latent monetary threshold:

$$WTP_i = \max P_i \ such\ that\ U_{i,WAP}(P_i) \geq U_{i,A}$$

Where A denotes the relevant alternative.

This formulation establishes the economic link between information, perceived value and monetary valuation. Information does not necessarily alter the physical characteristics of WAP, but it may change the expected benefits or losses associated with adoption and non-adoption. If framing changes the expected utility associated with WAP, the farmer's latent maximum WTP may also change. The empirical implication is that farmers exposed to different information conditions may exhibit different locations of the latent WTP distribution.

RUT also accommodates heterogeneity across farmers. Farmers differ in PCN risk, production systems, expected yields, resource constraints and opportunity costs. Consequently, even when the same information and bids are presented, their latent valuations need not be identical. This provides the economic basis for interpreting WTP as an intensive margin of technology demand rather than simply another measure of adoption intention.

Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) provides a complementary behavioural perspective on farmers' responses to WAP. TPB proposes that behavioural intention is shaped by attitude, subjective norms and perceived behavioural control (Ajzen, 1991). The structural relationship can be represented as:

$$BI_i = f(A_i, SN_i, PBC_i)$$

Where BI_i represents behavioural intention, A_i represents attitude, SN_i represents subjective norms, and PBC_i represents perceived behavioural control.

In the present study, these constructs capture observable dimensions of how farmers evaluate and perceive WAP. Attitude may reflect the perceived desirability of the technology and therefore relate to the expected benefits entering economic valuation. Perceived behavioural control captures whether farmers believe they possess the ability or resources required to use WAP successfully, while subjective norms capture the influence of relevant social expectations and information. These constructs therefore provide a complementary explanation for differences in farmers' responses beyond the information treatment itself.

TPB is not treated as a substitute for the economic valuation mechanism provided by RUT or the framing mechanism provided by Prospect Theory. Rather, it helps explain why farmers exposed to the same information condition may nevertheless differ in their behavioural responses and monetary valuations. In the empirical model, the behavioural constructs therefore provide dimensions of heterogeneity through which attitudes, perceived capability and social influence can be considered alongside information framing and socioeconomic characteristics.

Diffusion of Innovations Theory

Diffusion of Innovations Theory (DIT) provides a further perspective on the adoption context of WAP. Rogers identifies relative advantage, compatibility, complexity, trialability and observability as important perceived characteristics of innovations influencing their diffusion (Rogers, 1962). The adoption relevance of an innovation can therefore be understood conceptually as a function of these perceived attributes:

$$Adoption\ Response_i = f(RA, Compatibility, Complexity, T, O)$$

WAP can be assessed in terms of its perceived relative advantage (RA) over existing PCN-management practices, compatibility with potato production systems, the complexities of the farming season and conditions, its practical trialability (T) and the observability (O) of expected productivity benefits. A technology that addresses a salient production constraint and is perceived as advantageous may generate strong initial interest among potential users.

This perspective is important for interpreting the high stated adoption response observed in the study. Where an innovation is already perceived as relevant and advantageous, the proportion of farmers expressing willingness to adopt may approach a ceiling. Under such conditions, an information treatment may have limited capacity to produce a measurable difference in the extensive margin of adoption. However, substantial variation may remain in the monetary value farmers attach to the technology. DIT therefore complements Prospect Theory and RUT by providing a theoretical explanation for why the extensive margin may be relatively insensitive to framing while the intensive economic margin remains responsive.

Information Framing and Agricultural Technology Decisions

Taken together, the four theoretical perspectives provide a complementary framework for examining information framing and WAP demand. Prospect Theory explains why gain- and loss-framed information may make different consequences salient and consequently influence valuation. RUT provides the economic mechanism through which changes in perceived value can be expressed as differences in latent willingness to pay. TPB accounts for behavioural heterogeneity through attitude, subjective norms and perceived behavioural control, while DIT explains how strong perceived relevance and relative advantage may contribute to high baseline willingness to adopt.

Framing concerns the presentation of substantively equivalent information in different ways (Hanemann et. al., 1991). In agricultural decisions, gain-oriented information may make expected productivity improvements salient, while loss-oriented information may make the consequences of non-adoption salient. The economic relevance of framing follows from the possibility that farmers do not evaluate uncertain production outcomes solely through their objective probabilities; the presentation of those outcomes may influence their perceptions of risk and expected benefit. The relevance of framing is particularly strong where technologies address losses that are difficult to observe ex ante. PCN management is an example. A farmer may value WAP because it can protect yields that would otherwise be lost, or because it can produce higher yields relative to current practice. These are related economic benefits but may have different psychological salience when communicated to farmers.

The present study does not attempt to identify a universal behavioural law about loss or gain framing. Instead, it tests a specific empirical treatment: positive framing communicated potential yield gains, while negative framing communicated potential production losses in the absence of adoption. The effect is evaluated within the WAP and Nyandarua context.

Empirical Evidence and Research Gap

Recent empirical evidence confirms that information and framing can influence farmers' valuation and technology-related decisions, although effects vary across contexts and outcomes. In Kenya, Mwangi et al. (2022) used a double-bounded contingent valuation approach to estimate farmers' willingness to pay for clean sweet potato seed and found that WTP varied across geographical locations and according to prior use of clean seed. By comparing estimated WTP with the costs of seed multiplication, the study also demonstrated the relevance of WTP for assessing agricultural technology commercialisation and pricing.

More directly, Channa et al. (2021) used an experimental auction in Western Kenya to examine WTP for farm moisture-detection technologies and found that farmers were sensitive to bid framing. In Ghana, Hidrobo et al. (2022) randomly varied marketing-message framing for a digital agricultural and nutrition information service and found differences in WTP across information conditions. More recently, Obebo et al. (2025) examined gain- and loss-framed messages in a Kenyan WTP and choice experiment for biofortified iron beans, finding heterogeneous framing responses across respondent groups. These studies demonstrate that information presentation can influence monetary valuation in African agricultural and food contexts.

Evidence on the extensive margin is less consistent. Alif et al. (2025), using randomized field experiments with farmers, found no general effect of gain- or loss-framed information on eco-scheme enrolment, although effects emerged among particular farmer groups. This suggests that framing may not uniformly alter participation decisions and that its effects may depend on the margin and context examined.

Despite these advances, limited evidence examines whether gain- and loss-framed information produces divergent effects across the extensive and intensive margins of demand for the same agricultural technology, particularly where baseline willingness to adopt is already high. The present study addresses this gap by comparing positive yield-gain and negative loss-avoidance framing for WAP and examining both stated adoption and monetary valuation using a double-bounded contingent valuation design.

METHODOLOGY

Study Area and Study Design

The study was undertaken among smallholder potato farmers in Kinangop, Kipipiri and Ol'Jororok sub-counties of Nyandarua County, Kenya. These areas were selected because of their importance to potato production and variation in PCN infestation and associated production losses. The study used a cross-sectional household survey and incorporated an information-framing treatment followed by stated adoption and WTP elicitation.

The full survey sample consisted of 431 farmers. The framing treatment was allocated as follows: 243 farmers (56.38 percent) received positive framing and 188 farmers (43.62 percent) received negative framing. The study describes the allocation as random, providing the basis for comparing responses across the two information conditions.

Positive framing emphasised potential yield gains expected from adopting WAP, while negative framing emphasised potential production losses that might occur in the absence of adoption. The treatment was introduced before the stated adoption response and before the contingent valuation bids. This ordering allows the paper to distinguish the initial behavioural response from the subsequent monetary valuation.

Adoption Response by Framing

Stated adoption was measured as a binary response following exposure to the framing information. Although the broader thesis also modelled baseline adoption intention using an ordered probit specification, the present framing analysis does not introduce a new multivariate adoption model beyond the reported evidence. The treatment comparison is used to establish whether the communication manipulation shifted the extensive margin of stated adoption before examining its effect on monetary valuation.

Table 1: Information Framing Adoption Response

Framing	No	Yes	Total	% Yes
Negative / loss avoidance	11 (5.85%)	177 (94.15%)	188	94.15
Positive / yield gain	14 (5.76%)	229 (94.24%)	243	94.24
Total	**25 (5.80%)**	**406 (94.20%)**	**431**	**94.20**

The treatment-specific adoption responses are nearly identical. This result provides the empirical benchmark for the WTP analysis: if framing has little observable scope to change whether farmers say they would adopt, the economically relevant question becomes whether it changes the value farmers attach to the technology.

Double-Bounded Contingent Valuation

WTP was elicited using a double-bounded dichotomous-choice contingent valuation design. Each respondent received an initial bid and, conditional on the first response, a higher or lower follow-up bid. The design generates information about an unobserved maximum WTP without requiring respondents to state an exact monetary amount. The observed response sequence determines whether WTP is below a lower bid, lies between two bids, or exceeds an upper bid.

The bid schedule used initial bids of KES 2,400, KES 2,800 and KES 3,500. For initial NO responses, lower follow-up bids were KES 2,000, KES 2,400 and KES 3,000, respectively. For initial YES responses, higher follow-up bids were KES 2,800, KES 3,200 and KES 4,000, respectively. These sequential responses create the interval-censored structure required for the econometric analysis.

Table 2: Double-Bounded Contingent Response

Initial response	Follow-up response	Information about latent WTP	Observation type
YES	YES	WTP is at or above higher follow-up bid	Right-censored
YES	NO	WTP lies between initial and higher bid	Interval-censored
NO	YES	WTP lies between lower and initial bid	Interval-censored
NO	NO	WTP lies below lower follow-up bid	Left-censored

Econometric Model Specification

Latent WTP Model

Let the farmer's latent maximum WTP be represented by:

$$WTP_i^* = \beta_0 + \beta_1 F_i + \beta_2 A_i + \beta_3 PBC_i + \beta_4 SN_i + X_i'\gamma + \varepsilon_i \qquad (1)$$

where WTP_i^* is the unobserved maximum willingness to pay of farmer i; F_i is the information-framing treatment; A_i is the attitude index; PBC_i is perceived behavioural control; SN_i is subjective norms; X_i is a vector of demographic, socioeconomic, farm and market-access variables; γ is the corresponding parameter vector; and ε_i is the stochastic error term.

The baseline specification estimates the treatment effect before introducing the observed determinants:

$$WTP_i^* = \beta_0 + \beta_1 F_i + \varepsilon_i \qquad (2)$$

The specification then introduces the behavioural and socioeconomic variables. The progression is important because the baseline model provides an unadjusted reference for the framing association, while the full model assesses valuation after accounting for observed heterogeneity across farmers.

Interval Regression

Because WTP is observed through bounds rather than exact values, interval regression is used. For interval-censored observations, the likelihood contribution is the probability that latent WTP lies between the lower and upper bounds:

$$Pr(L_i < WTP_i^* < U_i) = \Phi[(U_i - X_i'\beta)/\sigma] - \Phi[(L_i - X_i'\beta)/\sigma] \qquad (3)$$

Where L_i and U_i denote the relevant lower and upper WTP bounds and Φ denotes the standard normal cumulative distribution function. Right-censored observations contribute the probability that latent WTP exceeds the upper bound, while left-censored observations contribute the probability that WTP falls below the lower bound.

The fitted model therefore uses the information contained in the double-bounded responses rather than treating the initial or follow-up bid as the respondent's exact WTP. Robust standard errors are used for inference. The final WTP analysis uses eligible respondents, comprising 128 right-censored observations and 303 interval-censored observations in the fitted specification.

Predicted Mean WTP

After estimating the full interval regression, predicted mean WTP is obtained for the framing groups using the fitted model. The treatment contrast is expressed as:

$$\Delta WTP = E(WTP \mid Positive\ framing) - E(WTP \mid Negative\ framing) \qquad (4)$$

This transformation expresses the framing effect in Kenyan shillings and provides an economically interpretable comparison between the two information treatments.

Variables and Covariates

The principal explanatory variable is information framing, with positive yield-gain framing and negative loss-avoidance framing as the two treatment conditions. The model includes Min–Max-normalised attitude, perceived behavioural control and subjective norms. Additional variables include household size, child composition, age, gender, education, marital status, number of parcels, total land size, potato farming experience, land under potato, distance and travel time to roads and markets, log per-capita income, log per-capita expenditure, credit access and occupation categories. Wealth quintile is excluded from the final specification because the diagnostic procedure reported in the underlying analysis identified high multicollinearity, with a variance inflation factor exceeding 10. Its exclusion prevents unstable coefficient estimates and inflated standard errors.

Estimation Strategy

The econometric analysis proceeds in two stages. First, a framing-only interval regression estimates the unadjusted association between treatment and latent WTP. Second, the full interval regression introduces behavioural, demographic, socioeconomic, farm and market variables. Predicted mean WTP is then calculated from the final specification to provide the treatment contrast in monetary terms. This sequence permits the paper to distinguish the raw treatment association from the adjusted economic valuation result.

The framing treatment is interpreted as the experimentally assigned information condition. The WTP outcome remains a stated-preference measure, while the coefficients on the observed control

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variables are interpreted as conditional associations. The analysis therefore distinguishes the treatment comparison from the correlational interpretation of the other covariates.

RESULTS

Distribution of the Framing Treatment

Positive framing was assigned to 243 farmers (56.38 percent), while 188 farmers (43.62 percent) received negative framing. The source analysis describes the allocation as random, providing the experimental basis for comparing responses across the two information conditions.

Table 3: Distribution of Stated Adoption Response

Outcome	Negative framing	Positive framing	Difference
No	11 (5.85%)	14 (5.76%)	−0.09 percentage points
Yes	177 (94.15%)	229 (94.24%)	+0.09 percentage points

Willingness to adopt was 94.15 percent among farmers exposed to negative framing and 94.24 percent among those exposed to positive framing. The difference is only 0.09 percentage points. Thus, the communication treatment did not materially differentiate the extensive margin of stated adoption in this sample. The high adoption response also suggests that WAP had strong baseline relevance among farmers before monetary valuation was considered.

This result should not be interpreted as evidence that communication is irrelevant to adoption in general. Rather, the treatment appears to have had limited scope to shift a response that was already overwhelmingly positive. The economically more informative test is therefore whether the same treatment changes the monetary value assigned to WAP.

Table 4: Double-Bounded WTP Response Structure

Response pattern	N	Percent	Censoring interpretation
YES–YES	128	25.37	Right-censored
YES–NO	31	7.64	Interval-censored
NO–YES	7	1.72	Interval-censored
NO–NO	265	65.27	Left-censored
Total	431	100.00	

The WTP data show considerably more heterogeneity than the adoption response. One quarter of respondents accepted both bids, while nearly two thirds rejected both bids. The double-bounded design therefore identifies substantial variation in latent monetary valuation even though the binary adoption response was highly concentrated at Yes.

For the final interval-regression estimation, the source analysis reports 128 right-censored and 303 interval-censored observations, with the left-censored observations excluded from the fitted specification. This preserves the information used in the final model and distinguishes the econometric sample from the full 431-person framing sample.

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Econometric Effect of Information Framing

Table 5: Baseline Interval Regression of WTP

Predictor	Coefficient (KES)	SE	z	p-value	95% CI
Negative framing vs positive framing	266.48	157.53	1.69	0.091	−42.28 to 575.24
Constant / positive-framing baseline	2,158.48	118.72	18.18	<0.001	1,925.81 to 2,391.16

The baseline interval regression provides the unadjusted economic reference point. Relative to positive framing, negative framing is associated with a KES 266.48 higher latent WTP, with a standard error of KES 157.53 and $p=0.091$. The estimate is therefore marginally significant at the 10 percent level. The baseline positive-framing intercept is KES 2,158.48 and is highly statistically significant.

This specification establishes the treatment association before introducing the socioeconomic, behavioural and farm-level determinants of WTP. Its role is comparative: it establishes the initial framing relationship against which the richer model is evaluated. The baseline result is not treated as the final economic treatment magnitude.

Table 6: Full Interval Regression of WTP

Variable	Coefficient (KES)	SE	z	p-value
Negative framing (loss avoidance)	327.04	205.17	1.59	0.111
Attitude index	1,303.05	775.75	1.68	0.093
Perceived behavioural control	−516.23	448.64	−1.15	0.250
Subjective norms	244.10	360.24	0.68	0.498
Household size	56.59	37.65	1.50	0.133
Male household head	753.90	388.47	1.94	0.052
Primary education	821.75	465.40	1.77	0.077
Secondary education	531.94	430.44	1.24	0.217
Tertiary education	601.12	554.53	1.08	0.278
University	−163.21	551.63	−0.30	0.767
Number of parcels	−47.74	63.15	−0.76	0.450
Total land size	47.38	54.30	0.87	0.383
Potato farming experience	6.80	7.93	0.86	0.391
Land under potato	−119.29	91.46	−1.30	0.192
Time to tarmac road	21.85	11.69	1.87	0.062
Log per-capita income	−33.70	119.78	−0.28	0.778
Log per-capita expenditure	171.40	80.93	2.12	0.034
Credit access	16.57	189.97	0.09	0.930
Unemployed household head	−823.33	446.58	−1.84	0.065

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The model provides a richer explanation of latent WTP. The framing coefficient remains positive but is not statistically significant at conventional levels in the coefficient table (β=327.04; p=0.111). Attitude is positively associated with WTP at the 10 percent level (β=1,303.05; p=0.093), while log per-capita expenditure is positively associated at the 5 percent level (β=171.40; p=0.034). Male household headship, primary education, time to the nearest tarmac road and unemployment are marginally associated with WTP at the 10 percent level. The remaining variables do not exhibit statistically significant associations in the reported specification.

The movement from the baseline framing coefficient of KES 266.48 to KES 327.04 after introduction of the covariates illustrates that the framing coefficient is sensitive to the composition of the valuation model. The appropriate headline treatment comparison is therefore the final model-based predicted WTP contrast.

Table 7: Predicted Mean WTP by Information Framing

Information framing	Predicted mean WTP (KES)	SE	95% CI	Difference vs negative	p-value	WTP variation σ
Negative / loss avoidance	1,989.26	86.32	1,820–2,158	—	—	953.87
Positive / yield gain	2,216.04	73.61	2,072–2,360	+226.78	0.040	953.87

The final model-based predictions provide the principal economic treatment result. Predicted mean WTP is KES 1,989.26 under negative framing and KES 2,216.04 under positive framing. The positive-framing estimate is therefore KES 226.78 higher than the negative-framing estimate, and the difference is statistically significant at the 5 percent level (p=0.040). The difference represents approximately an 11.4 percent increase relative to predicted WTP under negative framing.

The result should be distinguished from the baseline coefficient. The baseline specification estimates an unadjusted framing association, whereas the predicted means are derived from the final interval-regression model and provide the economically interpretable comparison after accounting for the covariate structure. The two estimates consequently serve different purposes within the empirical strategy.

Behavioural and Economic Correlates of WTP

Attitude towards WAP is positively associated with latent WTP at the 10 percent level. This indicates that farmers with more favourable evaluations of WAP tend to assign higher monetary values to the technology, conditional on the other variables. The result is consistent with the economic proposition that perceptions of expected benefits contribute to utility and hence valuation.

Perceived behavioural control and subjective norms are not statistically significant in the final WTP model. Their lack of significance does not imply that capability or social influence are irrelevant to technology diffusion. It indicates that, conditional on the full set of controls, these measured behavioural indices do not systematically explain variation in latent monetary valuation in the WTP sample.

The significant coefficient on log per-capita expenditure provides evidence that economic capacity is relevant to the monetary expression of valuation. Farmers with greater expenditure capacity exhibit higher latent WTP, holding other characteristics constant. By contrast, log per-capita income and credit access are not statistically significant in the final model.

The results therefore identify two important dimensions of WTP: perceived value, represented by attitude, and effective purchasing capacity, represented by expenditure. The framing treatment operates within this heterogeneous economic environment rather than independently of it.

DISCUSSIONS AND CONCLUSION

Framing and the Extensive Margin of Adoption

The near-identical adoption responses across the two framing groups are substantively important. Negative framing generated a 94.15 percent adoption response and positive framing generated 94.24 percent. The difference is negligible. The most defensible interpretation is not that communication has no role in adoption, but that the particular framing manipulation had little room to move the extensive margin because WAP already commanded very high stated acceptance.

This is consistent with an innovation that addresses a salient production constraint. Farmers in the study areas were exposed to a technology designed to manage PCNs, and the underlying study identifies awareness of PCN severity and perceived efficacy of WAP as relevant to the high adoption response. In diffusion terms, an innovation perceived to have strong relative advantage may already attract substantial early interest. Once that interest is close to saturation, changing the presentation of benefits may not materially change the binary adoption response.

The result has an important methodological implication. A binary adoption measure alone could lead to the conclusion that the communication treatment had little economic importance. The WTP analysis demonstrates why that conclusion would be incomplete.

Framing and the Intensive Economic Margin

The WTP results reveal a different response. The baseline framing-only interval regression identifies an economically positive association between negative and positive framing, although only at the 10 percent level. After introducing the broader determinant structure, model-based predicted mean WTP is significantly higher under positive framing by KES 226.78.

The difference between the baseline coefficient and the final predicted treatment contrast is not a contradiction. The baseline model and the final model answer different questions. The first asks how WTP differs between the framing groups before accounting for observed heterogeneity. The second asks what predicted WTP looks like for the two treatment conditions under the fitted multivariate economic valuation model. The latter is the appropriate basis for the headline adjusted valuation comparison.

Economically, the result indicates that communication can influence the intensity of stated demand even where it does not alter the broad willingness to adopt. Positive framing that makes potential yield gains salient produces a higher predicted monetary valuation than negative framing that emphasises production losses. The result therefore places communication within the economic demand side of agricultural technology diffusion rather than treating it solely as an extension or awareness intervention.

Why the Framing Result is Economically Plausible

The WAP technology addresses a production risk with two related ways of communicating its value. One can describe the gain from successful management in terms of higher productivity, or describe the loss associated with leaving the PCN problem unmanaged. The two descriptions concern the same technology and production problem but make different outcomes salient.

The positive-framing result suggests that, in this setting, the productivity-gain narrative is associated with greater monetary valuation. Farmers may respond more strongly to a concrete expected gain in potato production than to a description of losses avoided. The finding is context specific and should not be generalised into a universal proposition that gain framing is always superior to loss framing in agricultural technology communication.

The estimated WTP variation parameter of KES 953.87 for the predicted framing groups also indicates that the treatment contrast exists within substantial heterogeneity in valuation. Communication therefore operates in a population where farmers differ in economic resources, perceptions and production circumstances.

The Role of Attitude

The positive attitude coefficient in the full WTP model provides an important behavioural channel through which information and valuation can be interpreted. Farmers who evaluate WAP more favourably assign higher monetary value to it. This is consistent with TPB's emphasis on attitude as a determinant of behavioural intention and with RUT's emphasis on expected utility in choice and valuation.

The coefficient should not be interpreted as a causal mediator of the framing treatment. The data do not establish that framing changed attitude and that attitude subsequently changed WTP. What the model establishes is a positive conditional association between measured attitude and latent WTP. The result therefore supports a cautious interpretation: communication can matter in an environment where farmers' underlying evaluations of the technology also matter for economic valuation.

Economic Capacity and the Translation of Perceived Value into WTP

The significance of log per-capita expenditure is central to the agricultural-economic interpretation. WTP is not a pure measure of desirability. It is a monetary measure constrained by the resources a household can mobilise. Two farmers can assign similar expected benefits to WAP but differ in the amount they are able to express through a monetary bid. The expenditure result therefore complements the attitude result. Attitude captures perceived value, while expenditure captures an aspect of economic capacity. A farmer can be favourably disposed towards WAP without having sufficient resources to support a high WTP. The economic valuation model consequently provides information that a simple adoption-intention measure cannot provide. This also explains why communication strategy and economic policy should not be considered substitutes. A message may increase perceived value, but affordability mechanisms may still be necessary for farmers to translate that valuation into a purchase.

Implications of the Study

The findings have implications for theory, practice and policy. Theoretically, the study extends the understanding of agricultural technology demand by showing that information framing may operate differently across the extensive and intensive margins. Where stated adoption is already highly concentrated, monetary valuation can reveal differences in the strength of demand that a binary adoption measure may obscure. This supports the complementary application of Prospect Theory and Random Utility Theory in interpreting how information salience may translate into economic valuation.

For practice, the findings suggest that agricultural technology developers and market actors should consider communication as part of technology commercialisation rather than solely as an awareness function. The higher predicted WTP associated with positive yield-gain framing indicates that the way benefits are communicated may influence price acceptance and market positioning. Agro-dealers can therefore consider pairing pricing and product information with credible, evidence-based explanations of expected productivity benefits.

For policy, the positive association between household economic capacity and WTP indicates that communication alone may not translate interest into effective demand. Extension strategies may therefore need to be complemented by appropriately targeted subsidies, credit or cooperative purchasing mechanisms where affordability constrains uptake. The findings consequently support integrated approaches linking communication, market access and affordability in agricultural technology scale-up.

Implications for Agricultural Technology Strategy

The findings have implications for the design of WAP dissemination strategies. First, communication should be designed around credible and comprehensible technology benefits. The positive-framing result indicates that messages emphasising potential yield gains can be associated with higher monetary valuation. Extension communication should therefore make productivity implications explicit, supported by credible evidence rather than promotional claims.

Second, technology developers and market actors should distinguish high stated adoption interest from effective economic demand. The fact that more than 94 percent of farmers in both framing groups expressed willingness to adopt does not imply that all farmers are willing to pay the same amount. Pricing decisions should therefore consider the heterogeneous WTP distribution rather than the adoption-intention rate alone.

Third, financing and affordability mechanisms may be relevant to commercialisation. Because expenditure capacity is positively associated with WTP, farmers who value WAP may nevertheless face constraints in translating that valuation into a purchase. Cooperative purchasing, appropriate credit mechanisms or targeted support could therefore complement communication interventions where affordability is a binding constraint.

Fourth, extension systems should avoid treating framing as a universal behavioural lever. In this study, framing did not materially shift the extensive adoption response. Its stronger relevance was observed in monetary valuation. The strategic role of communication may therefore be to influence the strength and economic salience of demand rather than simply to increase the number of farmers who express interest.

Implications for Agricultural Economics

The study illustrates why agricultural technology adoption can be analysed on more than one margin. The extensive margin concerns whether a farmer states willingness to adopt. The intensive margin concerns the economic value attached to adoption. In a setting where the extensive margin is already highly concentrated at Yes, WTP provides additional information about market potential and heterogeneity in demand.

The econometric sequence used here also illustrates the value of moving from a simple treatment specification to a richer description of observed heterogeneity. The baseline framing regression establishes the unadjusted association. The full interval regression places that association alongside behavioural, socioeconomic and farm characteristics. Predicted WTP then translates the fitted model into a treatment contrast that can be interpreted in monetary terms. This is more informative for economic decision-making than reporting the treatment coefficient alone.

The result also demonstrates the value of stated-preference methods where an agricultural technology has no established market price or where the technology is at a stage of introduction. Double-bounded contingent valuation does not observe actual purchases, but it can provide economically structured evidence about how farmers value an innovation and how that valuation responds to information conditions.

Conclusion

This study examined whether information framing affects smallholder potato farmers' responses to WAP technology for PCN management in Nyandarua County, Kenya. The analysis distinguished between stated adoption and economic valuation and used a double-bounded contingent valuation framework with interval regression to estimate latent WTP.

The first result is that stated adoption willingness was very high and essentially unchanged by the framing treatment: 94.15 percent under negative loss-avoidance framing and 94.24 percent under positive yield-gain framing. Communication therefore had little observable effect on the extensive margin of stated adoption in this sample.

The second result is that the economic valuation response was more sensitive. The baseline framing-only interval regression showed a KES 266.48 positive association for negative framing relative to positive framing at the 10 percent level. After introducing the broader determinant structure, the model-based predicted mean WTP was KES 1,989.26 under negative framing and KES 2,216.04 under positive framing. The KES 226.78 difference was statistically significant at p=0.040.

The full model further shows that attitude towards WAP is positively associated with WTP at the 10 percent level, while log per-capita expenditure is positively associated at the 5 percent level. These findings indicate that monetary valuation reflects both perceived benefits and economic capacity. Communication therefore operates within a heterogeneous economic environment rather than as an isolated determinant of demand.

The principal conclusion is that information framing can matter differently across adoption margins. Where a technology already has high behavioural relevance, framing may have little scope to change whether farmers say they would adopt it. Yet the same communication treatment can affect the monetary intensity of demand, as reflected in WTP. For agricultural technology policy, this means that communication should be considered alongside pricing, affordability and financing when assessing the economic prospects for scale-up.

The results should nevertheless be interpreted within the limits of stated-preference analysis. WTP is a contingent monetary valuation rather than an observed transaction price, and the study is not a longitudinal test of actual adoption. Future research should examine whether the framing effect persists when farmers face real purchase decisions and whether predicted WTP translates into acquisition and sustained use of WAP.

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