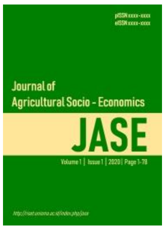

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A Social Neuroscience Perspective on Maize Input-Use Decisions: A Grounded Theory Study from Bengkayang, West Kalimantan, Indonesia

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Abstract. Maize plays a strategic role in Indonesia's food security; however, productivity disparities persist despite the availability of production inputs, indicating that farmers' decisions are shaped not only by technical factors but also by behavioral processes. Existing studies predominantly emphasize physical and economic determinants while overlooking the sociocognitive and affective dimensions underlying farmers' behavior. Unlike previous studies that rely on linear behavioral frameworks such as the Theory of Planned Behavior, this study adopts a social neuroscience perspective, integrated with an inductive grounded theory approach, to examine the interaction among cognitive, affective, and social processes in farmers' input-use decisions. This study employed a qualitative grounded theory design using in-depth, semi-structured interviews with 10 maize farmers in Bengkayang Regency, West Kalimantan, Indonesia, selected through iterative snowball sampling until theoretical saturation (at Participant 3) and conceptual saturation (at Participant 10) were achieved. Data were analyzed using the constant comparative methods, including open, axial, and selective coding. The findings reveal that farmers' input-use decision-making is shaped by a "relational-collective survival-oriented rationality," in which decisions are guided not only by individual profit maximization but also by the need to maintain social relationships, relational trust, collective security, and livelihood continuity in the face of uncertainty. These behavioral patterns reflect the interaction of cognitive evaluation, affective regulation, and socially embedded experiences associated with the prefrontal cortex, limbic system, and social brain functions, implying the need for more relational and participatory development approaches.

Keywords: Cognitive Appraisal; Agricultural Behavior; Decision-Making Process; Relational Rationality; Smallholder Farming.

INTRODUCTION

Since 1981, following the consensus of more than 150 member countries of the Food and Agriculture Organization (FAO), including Indonesia, October 16 has been commemorated annually as World Food Day. For an agrarian country endowed with rich biodiversity and extensive agricultural resources, Indonesia regards World Food Day as a strategic moment to reaffirm its national commitment to food sovereignty, rural welfare, and equitable access to food. Accordingly, the 2024 commemoration was translated into concrete agricultural policy directions prioritizing self-sufficiency and food sovereignty as key instruments to reduce vulnerability to food insecurity. In practical terms, the realization of these policy directions largely depends on the productive capacity of local agricultural systems to ensure stable food availability and accessibility, as food sovereignty is fundamentally rooted in the ability of communities and nations to produce food independently and sustainably. Therefore, improving the productivity of strategic food commodities constitutes a concrete manifestation of these principles at the local level (Sudirman et al.,2025; Bayuaji & Sugiarto., 2026). Within this framework, maize (Zea mays L.) plays a strategic dual role as both a staple food commodity and a primary input for the livestock feed industry, thereby contributing significantly to food diversification and national food resilience (Hasanah & Isfianadewi., 2019; Widayatsih et al.; 2022; Mukhlishah et al., 2023; Aldila et al., 2024).

To understand how these national food sovereignty mandates translate into grassroots realities, it is essential to examine regional production centers where strategic crop policies are actively implemented. Since 2017, Bengkayang Regency, located in West Kalimantan Province, has been designated as one of Indonesia's strategic maize production zones (Food Crops and Horticulture Office of West Kalimantan Province, 2021). By 2021, this regency contributed nearly 60% of the province's total maize output, positioning it as a key regional supplier. Consequently, maximizing maize yields in Bengkayang serves as a critical, localized manifestation of securing the 'Right to Food' and operationalizing national food sovereignty. Nevertheless, compared to other provinces on the island of Kalimantan, West Kalimantan's maize productivity remains relatively low (Aini, 2019). This condition indicates that the availability of agricultural resources and strategic policy support does not automatically translate into optimal productivity. Instead, it suggests that farming outcomes are influenced not only by the availability of production inputs, but also by farmers' capacity to select, combine, and manage inputs effectively and efficiently (Wangi & Adriansyah, 2023; Putra et al., 2024; Joko et al., 2022; Rachmawati et al., 2022; Susanti et al., 2025). In this regard, managerial capacity, including decision-making, judgment, and control over farming practices, positions farmers as active agents in shaping production outcomes (Toldbod & Dumay, 2023; Svenson et al., 2024; Qian et al., 2024; Ke et al., 2025). However, while the practical gap of low regional productivity is clear, a significant theoretical gap persists: existing agricultural literature predominantly overlooks how underlying sociocognitive, affective, and relational processes shape these behavioral responses to risk. Most current approaches continue to rely on rigid technical, economic, or rational-linear explanations of agricultural decision-making under uncertainty.

The Theory of Planned Behavior (TPB) provides a relevant framework for conceptualizing these phenomena by shaping behavioral intentions through attitudes, subjective norms, and perceived behavioral control (Westaby, 2005; Xu et al., 2022). It has been widely used to explain and predict human behavior in various contexts, including farmers' decisions regarding production and technology adoption (Sok et al., 2020; Mahdavi, 2021; Lee et al., 2023; Pirmoghani et al., 2024). Even so, when perceived behavioral control is limited, several studies have shown that normative pressures and social expectations may play a more dominant role in shaping intentions (Mulyani et al., 2020; Malabayabas & Mishra, 2022, Tigre & Heshmati, 2022). In response to these limitations, Behavioral Reasoning Theory (BRT) was introduced to better account for the cognitive and contextual processes underlying intention formation (Westaby, 2005). However, accumulating evidence suggests that BRT remains primarily grounded in articulated and conscious cognitive reasoning, thereby underrepresenting the roles of affective dynamics, habitual responses, and embodied experiences, and socially embedded interactions in decision-making process that frequently operate below conscious awareness (Sahu et al., 2020; Biesheuvel et al., 2021).

These limitations indicate the need for a broader behavioral perspective capable of capturing the interaction between cognitive evaluation, emotional regulation, and social relational processes in farmers' decision-making. This complex interplay can be effectively addressed through a social neuroscience perspective. Crucially, rather than employing biological markers, functional neuroimaging, or direct neural activity measurements, which fall outside the scope of traditional field research. This study utilizes a Grounded Theory approach to capture the behavioral manifestations and experiential proxies of these underlying neural processes. Through this qualitative lens, the study inductively explores how sociocognitive and affective dynamics shape farmers' input-use decisions (Cacioppo & Berntson, 1992; Cacioppo, Berntson, & Decety, 2010) under conditions of uncertainty, production risk, and social circumstances (Dwiyanti & Wirama, 2024). Accordingly, this study aims to identify the socio-neuroscientific and affective mechanisms that drive maize farmers' input-use decisions in Bengkayang Regency and to develop an inductively grounded conceptual model explaining how these mechanisms mediate farmers' behavioral responses to production uncertainty.

METHODS

Locus and Period

The study was conducted from April to October 2025 in two major maize-producing subdistricts of Bengkayang Regency, West Kalimantan Province, Indonesia: (1). Sanggau Ledo and (2). Tujuh Belas. These locations were purposively selected to capture contrasting socio-agroecological contexts within the regency. Sanggau Ledo is characterized by more intensive and market-oriented maize production, supported by relatively better access to agricultural inputs, infrastructure, and extension services. In contrast, Tujuh Belas represents a semi-traditional smallholder farming system in which cultivation practices rely predominantly on family labor, indigenous knowledge, and community-based resource sharing (Primary Data, 2025).

Data Collection and Analysis Methods

This study employed a qualitative Grounded Theory Approach, which is particularly suitable for addressing the study objectives (Glaser & Strauss, 1967). Primary data were collected through semi-structured, in-depth interviews lasting between 60 and 120 minutes with purposively selected respondents. Interviews were conducted in participants' homes to ensure a natural and reflective setting that facilitated rich narrative accounts (Kvale & Brinkmann, 2015). Thirteen guiding questions (Table 1) were developed using sensitizing concepts derived from social neuroscience perspectives, including cognitive appraisal, emotion regulation, social influence, and risk perception (Cacioppo & Berntson, 1992; Lieberman, 2007). These concepts did not function as predefined variables, but rather as flexible analytical lenses to guide inquiry while allowing meanings, categories, and relationships to emerge inductively from the data.

All interviews were audio-recorded using a smartphone recorder and transcribed verbatim into Word documents using Clipto.AI. Data were analyzed manually using the constant comparative method, in which data collection and initial open coding were conducted iteratively until theoretical and conceptual saturation was achieved (Figure 1). Open coding was first performed to identify preliminary concepts, followed by axial and selective coding based on the analytical framework proposed by Strauss and Corbin (1998). Although no additional Focus Group Discussions (FGDs) were conducted due to time and resource constraints, the trustworthiness of the study was strengthened through triangulation methodology, iterative engagement with the data, systematic coding procedures, and memo-writing, consistent with established qualitative research criteria (Lincoln & Guba, 1985; Patton, 2015).

Table 1. Sensitizing Concepts and Analytical Focus Underpinning the Interview Guide

Sensitizing Concept	Analytical Focus	Examples of Interview Probing Areas
Economic Resources	Cognitive appraisal of financial adequacy, emotional responses to financial risk, and trust-based decision-making.	Sources of capital, trust in lenders, confidence in using personal funds.
Land Use Decisions	Risk evaluation, future-oriented reasoning, and adaptive responses to environmental and economic uncertainty.	Crop rotation, land ownership, willingness to expand or relocate.
Labour Management	Social cognition, relational trust, and affective considerations in labor coordination.	Family vs non-family labour, wage decisions, trust in workers.
Input Selection	Interpretive judgment, experiential learning, and perceived reliability of agricultural inputs.	Information sources, certification, perceived effectiveness.
Technology Adoption	Cognitive flexibility, emotional resistance or acceptance, and responses to novelty and uncertainty.	Past experiences, perceived benefits, resistance or acceptance.
Social Influence	Social relational processing and behavioral adaptation shaped by social norms and interpersonal influence.	Advice from peers, extension agents, traders.
Risk and Uncertainty	Emotional regulation, anticipatory reasoning, and coping strategies under production uncertainty.	Responses to crop failure, uncertainty, and future planning.

Source: Primary Data, 2025

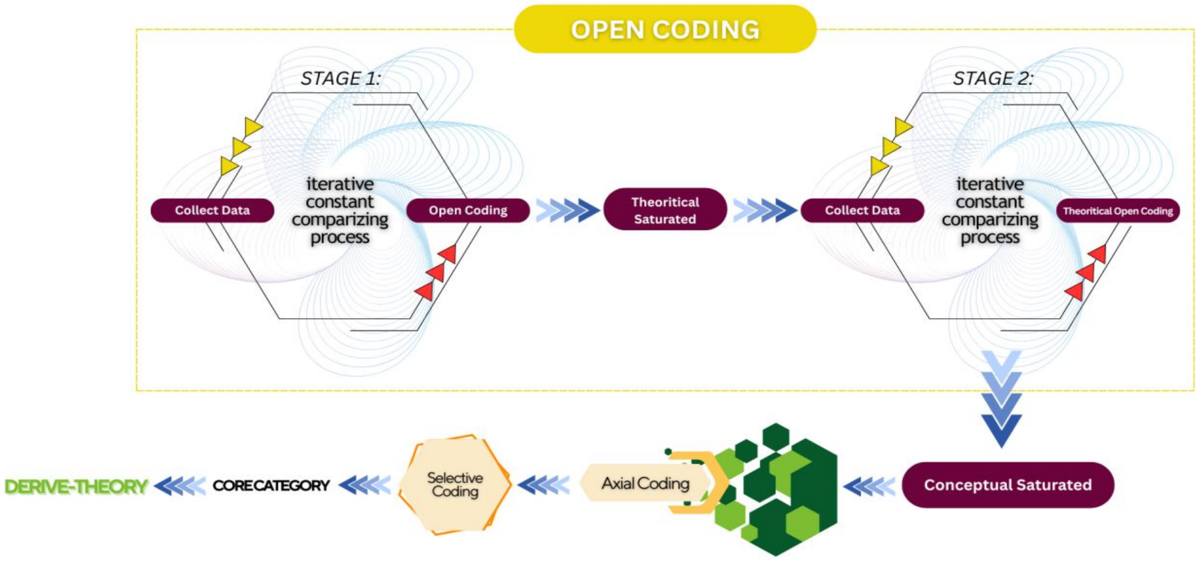

Figure 1. Stages of the Grounded Theory Data Analysis Procedure Conducted in This Study.

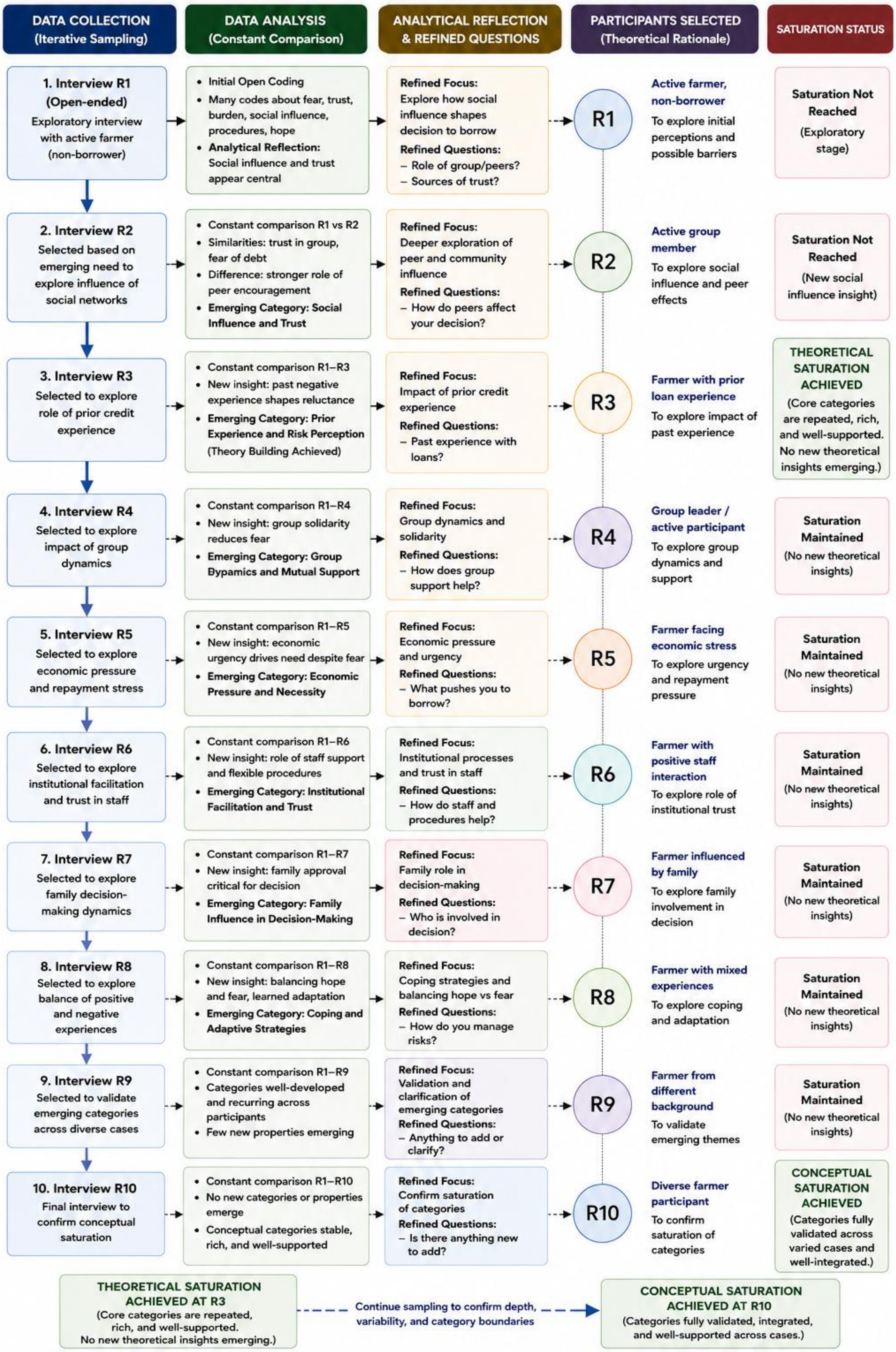

Figure 2. Iterative Constant Comparative Analysis and Theoretical Sampling Procedure (R = respondent)

Participants and Sampling Strategy

A total of ten maize farmers participated in this study. Participants were recruited using a snowball sampling strategy embedded within a grounded theory approach, in which sampling decisions were guided by ongoing data analysis rather than a predefined sampling frame (Charmaz, 2014). Unlike conventional snowball sampling, which aims to maximize sample size, sampling in grounded theory is conducted iteratively through constant comparison alongside the open coding process, with the objective of achieving theoretical and conceptual saturation (Figure 2).

In line with the "Constant Comparative Method", each interview was analyzed immediately after data collection to identify emerging categories, relational patterns, and conceptual gaps. These preliminary analyses informed both the selection of subsequent participants and the refinement of probing questions, enabling iterative development of the emerging grounded theory.

As data collection and open coding progressed in tandem, theoretical saturation emerged by the third respondent, after which no substantively new themes or categories were identified (Saunders et al., 2018). However, to ensure conceptual robustness and analytical refinement (Bryant, 2017), seven additional respondents were interviewed to confirm, elaborate on, and stabilize the emerging categories and their properties, resulting in a total of 10 participants.

RESULT AND DISCUSSION

Emergence of Farmers' Socio-Relational Behavioral Pattern

Grounded theory analysis conducted in this study reveals that maize farmers' behavioral patterns in Bengkayang Regency cannot be adequately understood as purely individual economic decision-making processes. Instead, farmers' actions emerged as socio-relational behavioral patterns shaped by continuous interaction among cognitive evaluation, emotional regulation, and socially embedded experiences (Figure 3). From a social neuroscience perspective, these behavioral dynamics reflect adaptive neurocognitive processes associated with executive functioning, affective regulation, social cognition, and risk interpretation operating within relational farming environments (Gangopadhyay et al., 2020). This is reflected in farmers' own accounts, such as: *"We cannot survive alone; if other farmers cannot continue, we also cannot continue"* (R2) and *"Without relationships with traders and fellow farmers, we cannot sustain this farming business for long"* (R8), highlighting the inherently collective and interdependent nature of their decision-making.

Limited access to capital, price and production uncertainty, livelihood demands, and biographical experiences of economic hardship serve as causal conditions that orient farmers toward a Relational-Collective Survival-Oriented Farming rationality. As illustrated in the model, this rationality operates within broader contextual conditions, including local economic systems, socio-cultural structures, and relational farming practices that shape how farmers cognitively interpret and emotionally respond to uncertainty and production risks. Farmers' narratives further demonstrate how decisions are socially negotiated, as reflected in statements such as: *"Before deciding to plant or borrow capital, we always discuss with family and fellow farmers to avoid making the wrong decision"* (R9). From a social neuroscience perspective, these interactional processes may reflect forms of social cognition and collective risk appraisal behaviorally associated with adaptive regulation of uncertainty and social threat avoidance (Morawetz et al., 2019).

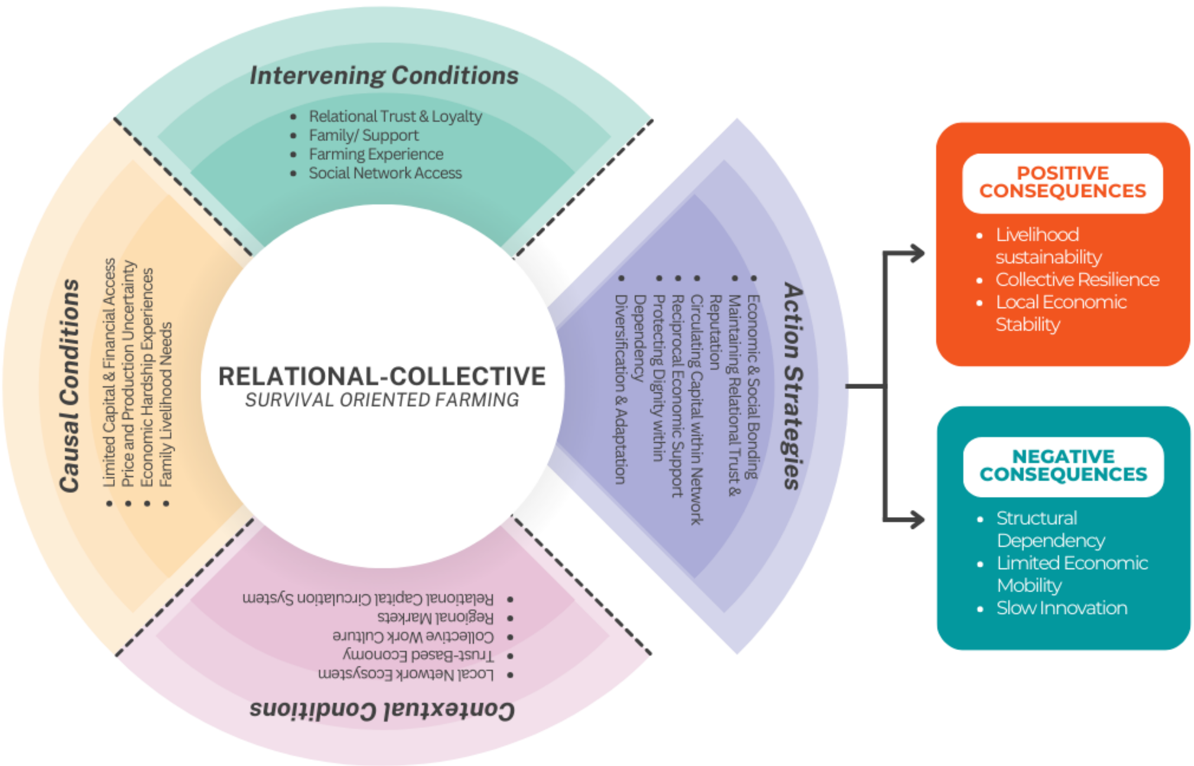

Figure 3. A Grounded Theoretical Model of Farming Behavior on Input-Use Decisions among Maize Farmers in Bengkayang Regency.

This rationality is further strengthened by intervening conditions such as relational trust and loyalty, family and close social support, accumulated farming experience, and access to social networks, all of which help farmers regulate emotional stress and maintain behavioral stability under uncertain conditions. Within this integrated system, farmers develop adaptive action-interaction strategies such as: circulating capital within social network, reciprocally supporting the local community economy, preserving relational dignity under conditions of economic dependency, maintaining long-term socioeconomic ties, relational trust, and social reputation; and continuously diversifying farming activities as a form of adaptation. In social neuroscience perspective, these strategies behaviorally reflect executive functioning processes associated with planning, inhibitory control, emotional regulation, and adaptive decision-making under risk conditions (Morawetz et al., 2019; Gangopadhyay et al., 2020).

Emotional resilience also plays a crucial role, as illustrated by the statement: *"If we fail, we are prepared. The most important thing is to stay calm and find a way to plant again"* (R1). This response suggests the importance of affective regulation mechanisms that enable farmers to suppress panic reactions and sustain future-oriented decision-making despite repeated uncertainty (Morawetz et al., 2019). At the same time, the collective circulation of resources becomes a key survival mechanism, as expressed in *"Capital must circulate among us; if only one person progresses, the others cannot move forward"* (R3). From a social neuroscience perspective, this pattern reflects efforts to avoid social exclusion, in which conformity to collective norms serves as an adaptive strategy to maintain relational security and reduce socio-emotional uncertainty (Chen et al., 2015).

Socio-Cognitive and Neural Mechanisms Underlying Maize Farmers' Behavior

Taken together, these processes reveal a layered neurobiological architecture underlying farmers' behavior: (1) Executive evaluation by prefrontal regions, (2) Emotional signaling through limbic circuits, (3) Social interpretation via the social brain network, and (4). Behavioral reinforcement through dopaminergic reward pathways, including the mesolimbic system (Lieberman, 2019; Crone & Fuligni, 2020; Lockwood & Klein-Flügge, 2021). The functional integration of these neural systems produces adaptive behavioral strategies such as gradual modification of inputs, selective adoption of innovations, maintenance of trust-based financial ties, and continued cultivation under tenancy to sustain livelihoods under structural uncertainty. Collectively, this Relational-Collective Survival-Oriented Farming Rationality represents the behavioral output of the functional integration between executive evaluation systems, affective-regulatory mechanisms, and social-relational neurocognitive processes. This behavioral configuration reflects the coordinated operation of neural systems that shape perception, evaluation, emotional regulation, and the interpretation of social consequences through interactions among the prefrontal cortex, limbic system, and social brain structures (Figure 4).

Evaluation processes related to the use of production inputs such as fertilizer, seeds, and labour are primarily initiated in the dorsolateral and ventromedial prefrontal cortex, which serve as central sites for planning, valuation, and trade-off reasoning. These regions support future-oriented cognition and cost-benefit analysis, enabling individuals to simulate potential outcomes before acting (Hiser & Koenigs, 2018; Ester & Kullmann, 2021). However, rational evaluation does not operate independently. It is continuously modulated by affective processing through the amygdala and broader limbic circuitry, which signal uncertainty, financial risk, and potential loss. Under conditions of debt pressure, price instability, or crop failure, increased amygdala activation heightens emotional salience, encouraging cautious and incremental adjustments in input use rather than abrupt experimentation (Rilling, et.al, 2011; Phelps, Lempert, & Sokol-Hessner, 2014, Tovote, Fadok, & Lüthi, 2015).

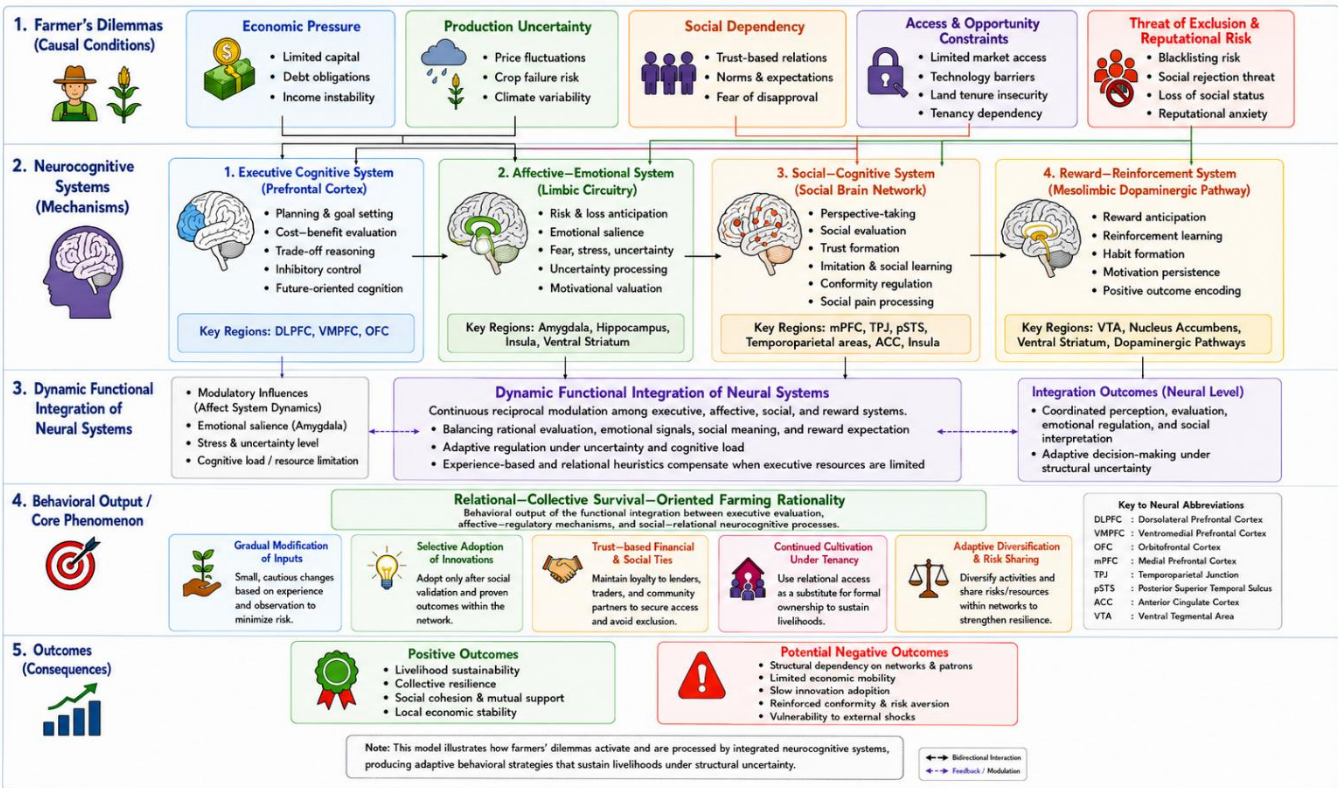

Figure 4. Neurobiological Mechanism Underlying Maize Farmers' Behavior in Bengkayang Regency

The adoption of new farming methods illustrates a neurobiological learning process shaped by social observation. Farmers rarely change practices independently; instead, they observe peers, compare outcomes, and seek validation within networks. This reflects activity within the social brain network-particularly the medial prefrontal cortex, temporoparietal junction, and posterior superior temporal sulcus, which supports perspective-taking, imitation, and trust formation (Frith & Frith, 2007; Van Overwalle, 2009; Weaverdyck & Parkinson, 2015). These neural systems enable social learning, allowing individuals to reduce uncertainty by relying on collective experience. Consequently, technological adoption in agriculture often occurs through relational validation rather than purely technical evaluation.

Land tenancy and sharecropping arrangements also trigger complex neural responses. When farmers cultivate on non-owned land, the prefrontal cortex regulates the behavioral aspects of input-use decisions driven by a fear of displacement. At the same time, the social brain network mediates negotiations with landowners and community members, balancing livelihood continuity with relational expectations. This interaction produces adaptive decision-making in which relational access substitutes for formal ownership, shaped by both cognitive appraisal and social dependence.

The threat of financial exclusion, or “blacklisting,” deeply affects farmers' cognitive processing and subsequent input-use decisions. Anticipation of social rejection activates neural regions associated with social pain and self-evaluation, particularly the anterior cingulate cortex and anterior insula. These structures respond not only to physical threat but also to reputational risk and social exclusion, reinforcing behavioral conformity and responsibility within networks (Eisenberger, 2015; Koban & Pourtois, 2014; Rotge et al., 2015). Consequently, repayment discipline, cautious borrowing, and loyalty to the observed input-use behaviors are not merely economic strategies, but rather neurobiologically mediated responses to environmental stressors.

Financial stress and production uncertainty further shape neural decision pathways. Chronic uncertainty shifts processing from deliberative executive control toward experience-based and relational heuristics, as emotional and social brain systems compensate for cognitive overload (Schwabe & Wolf, 2013; Hermans et al., 2014; Arnsten, 2015). Farmers, therefore, rely on intuition, community advice, and prior experiences when making decisions about inputs and land use, reflecting adaptive neural rebalancing rather than irrationality.

Theoretical Contributions and Practical Implications

This study advances agricultural decision-making theory by demonstrating that farmers’ behavior cannot be adequately explained by individualistic, efficiency-oriented frameworks alone. Instead, it introduces a relational–collective survival-oriented rationality, in which decision-making is embedded within dynamic social relationships, shared experiences, trust-based interactions, and collective survival considerations under structural uncertainty.

By employing a Grounded Theory approach, this study conceptualizes farmers’ behavioral patterns as action–interaction strategies arising from limited capital access, market volatility, ecological uncertainty, and livelihood pressures. These strategies, including maintaining long-term socioeconomic ties, sharing risks, and sustaining an informal communication network, function not only as adaptive responses, but also as socio-neurobehavioral stabilization mechanisms integrating cognitive evaluation, emotional regulation, and socially embedded experiences. While these relational networks provide an important social safety net that enables farmers to survive under uncertainty, they may simultaneously operate as a cognitive-adaptive trap that reinforces conformity to established practices and discourages experimentation with unfamiliar innovations. From a social neuroscience perspective, the anticipation of social disapproval, relational disruption, or exclusion may strengthen conformity-based decision-making and inhibit risk-taking behavior associated with modernization. Therefore, agricultural transformation should not attempt to dismantle these relational systems, but rather strategically utilize trusted peer networks, collective demonstrations, and socially validated innovation models to gradually introduce behavioral change without undermining existing social cohesion.

The findings extend and reconceptualize the explanatory scope of the Theory of Planned Behavior (TPB). Rather than understanding subjective norms merely as external social pressures influencing behavioral intentions, this study suggests that normative influence may operate through socio-neurocognitive mechanisms associated with social pain avoidance, relational security, and affective regulation. In this context, farmers' compliance with collective expectations is not merely a rational response to social norms but also reflects adaptive behavioral regulation in anticipation of relational rejection, reputational risk, and socio-emotional uncertainty. Consequently, behavioral intentions emerge not only from attitudes, perceived behavioral control, and normative beliefs, but also from the functional integration of executive cognitive systems, affective-emotional processing, and social brain mechanisms that continuously mediate decision-making within relational environments.

Furthermore, this study advances the agricultural behavioral literature by positioning relational systems not merely as contextual variables but as constitutive neuro-social structures that shape how farmers perceive risks, evaluate alternatives, regulate emotions, and construct adaptive behavioral responses under uncertainty. This perspective reconceptualizes agricultural decision-making as an emergent socio-neurobehavioral process produced through the interaction between micro-level cognitive-affective regulation and meso-level relational systems, thereby providing a more integrative explanation of farming behavior under structural vulnerability.

An important implication of these findings is that the effectiveness of agricultural development programs depends largely on their alignment with the relational systems that underpin farmers' everyday practices. Programs designed through technical-productive and administrative approaches often assume that farmers are individual actors ready to adopt innovations when available. However, empirical evidence shows that farmers' decisions are shaped not only by efficiency considerations but also by relational stability, collective experience, and trust developed through long-term interactions and social capital dynamics. Consequently, interventions that fail to account for these relational structures often struggle to integrate into farmers' daily decision-making environments (Adokou, 2025; Erekalo et al., 2025).

Within this context, farmers' adaptive strategies, such as maintaining long-term economic relationships, sharing risks, and sustaining informal communication, should be recognized as essential mechanisms that sustain farming systems under structural constraints. These strategies generate positive outcomes, including livelihood continuity, collective resilience, and the reproduction of social networks that support agricultural production (Park et al., 2025). However, they may also contribute to structural dependency, limited economic mobility, and slower innovation diffusion.

From an agribusiness perspective, this relational rationality has direct implications for farm productivity and technical efficiency. Although trust-based networks and collective risk-sharing mechanisms enable production continuity under resource constraints, they may also delay the adoption of productivity-enhancing technologies. Thus, technical efficiency is not solely determined by input availability, but also by how farmers cognitively and affectively interpret risks within their relational systems. Therefore, agricultural interventions should move beyond a narrow input-oriented approach and instead strengthen farmers' relational and socio-cognitive capacities. Extension systems should strategically leverage mechanisms associated with the social brain network, including peer endorsement, relational validation, observational learning, and social proofing. Rather than relying exclusively on top-down technical instruction, innovation dissemination should prioritize trusted community actors, farmer-to-farmer demonstration networks, collective field learning, and socially endorsed experimentation platforms. Such approaches are more likely to reduce perceived socio-emotional risks associated with innovation adoption while preserving relational trust and community cohesion. Programs such as cooperative-based financing, peer-network extension systems, and participatory innovation platforms may therefore improve both allocative efficiency and innovation adoption while strengthening local resilience and rural economic performance (Lai, Beethem, & Marquart-Pyatt, 2025; Zhou & Ning, 2025).

Directions for Future Research

Building on these findings, future research should further examine the dynamics of socio-neuroscience mechanisms across different agricultural and sociocultural contexts to assess the transferability and boundary conditions of the relational–collective survival rationality identified in this study. Comparative studies across regions, commodities, and farming systems would be particularly valuable for identifying how variations in institutional arrangements, market structures, and cultural norms shape the interaction among cognitive, affective, and relational processes in shaping farmers' behavior.

In addition, future research could adopt mixed-method or longitudinal designs to capture the temporal evolution of farmers' decision-making processes, especially in response to shocks such as price volatility, climate change, or policy interventions. Such approaches would allow for a more dynamic understanding of how behavioral patterns, emotional regulation, and social networks co-evolve over time, rather than being observed as static configurations. Future studies may also benefit from incorporating neurophysiological measurements, such as Eye Tracking, Heart Rate Variability (HRV), galvanic skin response, or other psychophysiological indicators, to provide complementary biological evidence regarding attention allocation, emotional arousal, stress regulation, and risk perception associated with agricultural decision-making. The integration of these approaches would strengthen the empirical grounding of socio-neuroscience interpretations by connecting behavioral narratives with measurable physiological responses under conditions of uncertainty and social pressure.

Further theoretical development is also needed to refine the integration between social neuroscience perspectives and established behavioral frameworks such as the Theory of Planned Behavior. In particular, future studies could explore how relational and affective mechanisms interact with constructs such as attitudes, subjective norms, and perceived behavioral control in influencing behavioral intentions and actual decision-making outcomes. Such investigations may contribute to the development of more integrative behavioral models capable of explaining how socio-emotional regulation, social pain avoidance, and collective validation processes shape adaptive decision-making in agricultural systems.

Another important direction for future inquiry concerns the growing influence of digital social networks and digital communication environments on farmers' relational–collective behavior. As agricultural information increasingly circulates through social media platforms, online farmer communities, digital extension systems, and mobile communication networks, future studies should investigate how digital relational interactions transform trust formation, social validation, conformity processes, and innovation diffusion among farmers. In particular, research is needed to examine whether digital social environments strengthen traditional relational dependencies or alternatively create new forms of behavioral flexibility, social learning, and technology adoption within farming communities.

Quantitative operationalization of the proposed conceptual model also needs to represent an important avenue for future inquiry. Developing measurable indicators of socio-cognitive-affective processes and relational dynamics would enable empirical testing using econometric or experimental methods, thereby strengthening the model's generalizability and predictive capacity.

CONCLUSION

The findings demonstrate that maize farmers' decision-making is governed by a set of interconnected socio-neuroscience mechanisms integrating cognitive appraisal, affective regulation, and social interpretation. These mechanisms involve executive evaluation processes associated with the prefrontal cortex, emotional signaling under uncertainty through limbic structures, and socially mediated interpretation within the social brain network. Together, they shape how farmers interpret information, perceive risks, regulate emotions, and make production-related decisions under conditions of uncertainty and resource constraints.

This study also develops an inductively grounded conceptual model showing that these social neuroscience mechanisms interact dynamically within relational farming systems to produce distinct behavioral patterns. More fundamentally, the findings shift the dominant paradigm of agricultural decision-making away from the assumption that farmers primarily behave as individual profit maximizers. Instead, this study demonstrates that farmers operate as relational survival seekers whose decisions are continuously shaped by the interaction between cognitive evaluation, affective regulation, and socially embedded relational obligations within networks of trust, reciprocity, and shared experience. In this relational–collective survival-oriented rationality, behavioral decisions are directed not solely toward economic optimization, but toward maintaining relational security, collective continuity, and livelihood resilience under structural uncertainty. This interaction generates adaptive action–interaction strategies, including maintaining long-term socio-economic relationships, sharing risks, and regulating emotions, which enable farmers to sustain production while optimizing the use of available resources.

Author Contribution

Pepi Rospina Pertiwi and Heny Kurniawati contributed to the study design, concept formulation, and final approval of the manuscript. Bayu Eka Wicaksana was involved in the study design, concept formulation, and data collection. Anita Suharyani and Sawitania Situmorang actively participated in data collection and curation, with Sawitania Situmorang also contributing significantly to the writing and revision of the manuscript. Ismail Hasvi and Ludivica Endang Setijorini performed the data analysis and interpretation. Erika Pradana Putri provided final approval and assumed overall accountability for the study. All authors have read and agreed to the published version of the manuscript.

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