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Article

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The Role of Neuroscience in Shaping Marketing Narratives for Rural Agricultural Producers: A Systematic Review

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Abstract: Rural agricultural markets face unique challenges, yet neuromarketing applications in this sector are understudied. This systematic review investigates how neuroscience has been applied to shape marketing narratives for rural agricultural producers. The objectives were to catalog relevant studies, identify key themes using inductive thematic synthesis, and derive practical implications for rural marketing strategy and future research. We systematically searched English-language, peer-reviewed studies published between 2016 and 2024 across multiple academic databases, following PRISMA guidelines. Two independent reviewers screened the records, resulting in the inclusion of 20 studies. Key data from each study were extracted and synthesized using an inductive thematic analysis approach. The synthesis revealed several recurrent findings. First, in terms of social and community context, farmers showed greater trust and engagement with familiar local buyers than with distant corporations, indicating that local relationships strongly influence producer behavior. Second, regarding product and narrative attributes, marketing narratives that emphasized local provenance, organic or sustainable production, and ethical values such as animal welfare and environmental sustainability resonated strongly with rural consumers. Third, sensory and emotional cues particularly visual elements and storytelling techniques including color, imagery, and packaging design consistently enhanced consumer attention and engagement. Overall, these neuroscience-informed themes suggest that marketing narratives emphasizing authenticity, trust-building, and community values can effectively strengthen rural agricultural marketing. This review provides neuroscience-informed interpretations of key rural marketing challenges, drawing on dual-process theory and consumer decision models for applying neuromarketing insights in this context. Practically, rural producers can leverage these findings by designing marketing messages and packaging that highlight local identity and ethical values, thereby building consumer trust and loyalty. The review also highlights gaps such as the need for more field-based neuromarketing studies and suggests directions for future research, offering guidance for both scholars and practitioners working at the intersection of neuroscience and rural consumer behavior.

Keywords: neuroscience; neuromarketing; rural agriculture; rural producers; systematic review



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1. Introduction

Marketing in rural agricultural markets faces unique challenges due to the physical and socio-economic characteristics of these regions. Key obstacles such as limited market access, low population density, and weak infrastructure can significantly hinder the effective delivery of marketing messages (Ahmed & Sur, 2024). For rural agricultural producers,

that is, smallholder farmers and agri-based enterprises operating in rural or peri-urban areas, these challenges complicate efforts to communicate value, build trust, and compete in broader markets. Additionally, rural consumers often exhibit distinct cultural values, shopping habits, and product preferences compared to urban consumers, implying that conventional, urban-centric marketing strategies might overlook important nuances. In this context, marketing narratives defined as strategically crafted messages that use storytelling, emotion, and sensory cues to influence consumer perception offer a promising means for rural producers to differentiate their products and build local relevance. Therefore, these differences necessitate innovative, context-specific marketing approaches tailored explicitly for rural audiences (Qorri & Felföldi, 2024).

One promising avenue for developing tailored strategies is the application of insights from neuroscience, particularly the emerging fields of neuromarketing and neuroeconomics to better understand and influence consumer behavior. Neuromarketing integrates neuroscience, psychology, and marketing to analyze how consumers' brains respond to marketing stimuli (Singh et al., 2023). Utilizing neuroscientific tools such as electroencephalography (EEG), functional magnetic resonance imaging (fMRI), eye tracking, and biometric sensors to measure attention, emotion, and memory responses, neuromarketing reveals subconscious reactions consumers themselves may not articulate (Khondakar et al., 2024; Byrne et al., 2022). For instance, Barbierato and Alvino (2025) review how neuroscience tools reveal consumers' subconscious responses to product cues (e.g., taste or scent). Similarly, Bortolotti et al. (2023) emphasizes the impact of color preferences in marketing, highlighting how visual cues affect emotion and choice.

Neuroeconomics, closely related to neuromarketing, combines neuroscience, economics, and psychology to investigate the neural underpinnings of economic decision-making processes. It is explicitly defined as "the application of neuroscientific methods to analyze and understand economically relevant behaviors" (Bayramoğlu & Öztürk, 2024). Neuroeconomics aims to construct realistic models capturing how people evaluate choices, integrating rational calculations with psychological and emotional influences. Within this field, consumer neuroscience specifically focuses on consumer decision processes such as shopping preferences and brand choices, thereby providing the scientific foundation for neuromarketing practices (Mallio et al., 2024). While consumer neuroscience emphasizes academic understanding of decision-making mechanisms, neuromarketing applies these neuroscientific insights practically for instance, optimizing advertisements or product placements based on neural responses (Singh et al., 2023). These disciplines collectively enrich marketing theory, underscoring that consumer choices result from both deliberative reasoning and automatic, emotion-driven impulses (Bayramoğlu & Öztürk, 2024). Classic consumer decision theories in marketing traditionally assumed a high degree of rationality, yet contemporary neuroscience consistently illustrates consumers often rely on intuitive and emotional reactions rather than purely rational deliberations. This aligns well with dual-process theories, distinguishing between analytical, slower cognition ("System 2") and fast, intuitive responses ("System 1") (Conway-Smith & West, 2023). Neuroscience-informed marketing explicitly addresses these dual processes by examining emotional and intuitive brain responses shaping consumer behavior alongside conscious deliberation (Khondakar et al., 2024).

While both neuromarketing and neuroeconomics apply neuroscience to study decision-making, they differ in scope and application. Neuroeconomics focuses on how the brain makes economic choices, often integrating game theory, reward processing, and utility-based models in highly controlled settings (Koundouri et al., 2023). In contrast, neuromarketing applies similar neuroscientific techniques such as EEG, eye-tracking, and fMRI to real-world marketing stimuli to understand consumer attention, emotional response, and decision-making at the point of purchase (Devendran et al., 2025). The distinction is particularly relevant when translating laboratory-based insights into actionable marketing strategies for rural and agricultural contexts.

However, despite its potential, neuromarketing has been notably underutilized within rural and agricultural marketing contexts. Recent literature highlights that although neuromarketing has found considerable application across sectors such as retail and digital commerce, its integration into rural agriculture marketing remains rare and underdeveloped (Kirylyuk-Dryjska & Rani, 2023). This research gap is especially significant given the distinct decision factors influencing rural market behaviors such as vendor trust, risk perception regarding innovative farming technologies, and emotional attachments to traditional products (Ahmed & Sur, 2024). For instance, rural consumers frequently base purchase decisions on long-term trust relationships and may respond differently to marketing stimuli compared to their urban counterparts, suggesting significant value in applying neuroscientific insights to these contexts. Recent evidence indicates neuro-inspired strategies enhance customer understanding and brand loyalty, even in traditional sectors (Qorri & Felföldi, 2024). Leveraging subconscious drivers of trust and emotional connection through targeted neuromarketing approaches could empower rural marketers to craft more resonant branding narratives, thus fostering deeper consumer engagement.

Given the limited literature in this area, the present systematic review synthesizes recent findings at the intersection of neuroscience and rural agricultural marketing. By integrating contemporary research and foundational works from neuromarketing and neuroeconomics, this review contributes to ongoing efforts to align neuroscience concepts with rural marketing theory by examining how cognitive and emotional processes shape consumer and producer behavior. Ultimately, this review aims to systematically examine how neuroscience methods have been applied in marketing research, particularly in ways that inform strategies for rural agricultural producers. It seeks to identify recurring themes, evaluate methodological trends, and highlight practical implications for improving marketing effectiveness in rural contexts.

2. Problem Statement and Rationale of the Study

Neuroscience applications in marketing, particularly neuroeconomics and neuromarketing, have significantly advanced how companies understand consumer engagement and decision-making through tools like brain imaging, physiological tracking, and cognitive analysis (Singh et al., 2023; Khondakar et al., 2024). However, the agricultural sector, especially in rural contexts, has not yet fully leveraged these developments. This review focuses on rural agricultural producers, defined here as smallholder and subsistence farmers, family-operated farms, and informal producer cooperatives that are predominantly found in low- and middle-income regions. Examples include maize farmers in Kenya and Uganda, coffee cooperatives in Colombia and Peru, and rice-farming communities in rural Vietnam and the Philippines (FAO, 2021; Hammond et al., 2022). These producers often operate in contexts marked by weak infrastructure, limited digital connectivity, and fragmented market systems, which constrain their ability to access and respond to conventional marketing channels.

Despite accounting for up to 70% of food production in Sub-Saharan Africa and Asia, smallholders remain marginalized in formal market systems (IFAD, 2021). A World Bank (2021) report notes that only 15–20% of small-scale producers in developing countries are integrated into formal agricultural value chains, limiting their ability to benefit from commercial marketing strategies. Furthermore, the cognitive and emotional dimensions of rural producer–consumer behavior such as trust in intermediaries, loyalty to tradition, and aversion to perceived marketing manipulation are underexplored in neuroscience research despite their centrality to rural decision-making (Kiryłuk-Dryjska & Rani, 2023).

To address this, our study poses the following specific research questions:

1. What neuroscience methods have been applied in studies of agricultural or rural consumer behavior?
2. What consumer behavior insights do these studies reveal?
3. How do these insights differ from those obtained by traditional marketing approaches in agriculture?
4. What practical strategies for rural producers emerge from neuroscience findings?

By addressing these research questions, this systematic review aims to provide evidence-based insights that can empower rural agricultural producers with neuroscience-informed marketing strategies, ultimately improving their market access, consumer engagement, and overall economic sustainability.

3. Methodology for the Study

This systematic review collected relevant data from previous literature regarding the use of neuroscience in marketing, neuroeconomics, and agriculture.

3.1. Literature Search Strategy

A comprehensive search was performed across multiple academic databases to identify relevant studies. The primary sources included Google Scholar, ScienceDirect, PubMed, APA PsycINFO, JSTOR, and AGRIS (Agricultural Science and Technology). We used a combination of keywords and Boolean operators to cast a wide net over the literature.

The exact search string utilized was (neuroscience OR neuromarketing OR neuroeconomics OR “consumer neuroscience”) AND (agriculture* OR farm* or rural) AND (marketing OR “consumer behavior”).

Additionally, variations of terms were used to ensure inclusivity, such as rural marketing, agricultural marketing, EEG, fMRI, eye-tracking, etc., in conjunction with the above. The initial search was limited to publications from January 2016 up to August 2024 to capture the most recent decade of research, during which consumer neuroscience methods have rapidly evolved and become more accessible. We restricted the search to English-language publications and peer-reviewed sources (journal articles, conference proceedings, book chapters) to maintain a high level of scholarly reliability.

The search process involved scanning titles and abstracts for relevance to our topic. We specifically looked for studies that applied neuroscience techniques or perspectives to marketing, consumer decision-making, or economics in contexts that could relate to agriculture or rural populations. When a title or abstract suggested potential relevance, the full text was retrieved for detailed examination. Throughout this stage, we also checked the reference lists of pertinent articles to uncover any additional studies that our database queries might have missed.

3.2. Study Selection and Data Extraction

We established clear inclusion and exclusion criteria before screening to ensure consistency and objectivity.

Inclusion Criteria: Studies had to be peer-reviewed and published in English between 2016 and 2024. They need to explicitly focus on the application of neuroscience (e.g., brain imaging, physiological measurement, or cognitive experiments) to marketing, consumer behavior, or economic decision-making. We included studies dealing with consumer neuroscience, neuromarketing, or neuroeconomic approaches, and we were particularly interested in those that either dealt directly with agricultural products and rural consumers/producers or provided insights transferable to the rural/agricultural context (such as research on food marketing, trust in food supply chains, etc.).

Exclusion Criteria: We excluded non-peer-reviewed literature (such as magazine articles, opinions), studies unrelated to neuroscience applications in consumer/marketing domains, and any articles without a clear link to either marketing or agriculture (for example, purely medical neuroscience studies). We also excluded publications prior to 2016, duplicates of the same study appearing in different venues, and studies in languages other than English due to translation feasibility. If a study used neuroscience methods but did not address consumer or economic behavior (e.g., purely clinical neuroscience) or if it focused on marketing but without any neuroscientific component, it was excluded.

The study selection process was carried out in multiple stages. Initially, 282 records were identified through the database searches. After removing duplicate entries, 184 unique articles remained. These 184 articles were subjected to title and abstract screening by two independent reviewers (the authors of this paper). Each reviewer applied the inclusion/exclusion criteria to the abstracts, and any discrepancies in judgments were resolved through discussion and consensus. This screening narrowed the pool to 33 articles that appeared to meet the criteria and were retrieved for full-text review. During the full-text assessment, we examined each article in detail to confirm its relevance and quality. We paid special attention to whether the study's context or findings could inform marketing for rural agricultural producers. Upon full-text evaluation, a total of 20 articles were selected for final inclusion in the review. Data from the final set of 20 included studies were extracted using a structured extraction form that captured key information such as study title, authors, publication year, objectives, neuroscience/marketing methods used (e.g., EEG, fMRI, eye tracking), context (agriculture, rural marketing, etc.), and major findings. An inductive thematic analysis approach was then employed. Two reviewers independently reviewed and coded the extracted data, identifying patterns, recurring concepts, and emergent insights related to neuroscience applications in rural and agricultural marketing. These initial codes were then compared and refined collaboratively to develop overarching themes. The coding and synthesis process was iterative, with themes being validated across multiple studies to ensure consistency and representativeness. Discrepancies in interpretation were discussed and resolved through consensus, ensuring a rigorous and transparent analytical process.

Our selection process is summarized in Figure 1, which provides a PRISMA flow diagram of the study identification, screening, eligibility, and inclusion stages. This visual representation ensures transparency by illustrating how we moved from the initial broad search to the final set of studies and why certain papers were excluded along the way (Table S1: PRISMA 2020 Checklist).

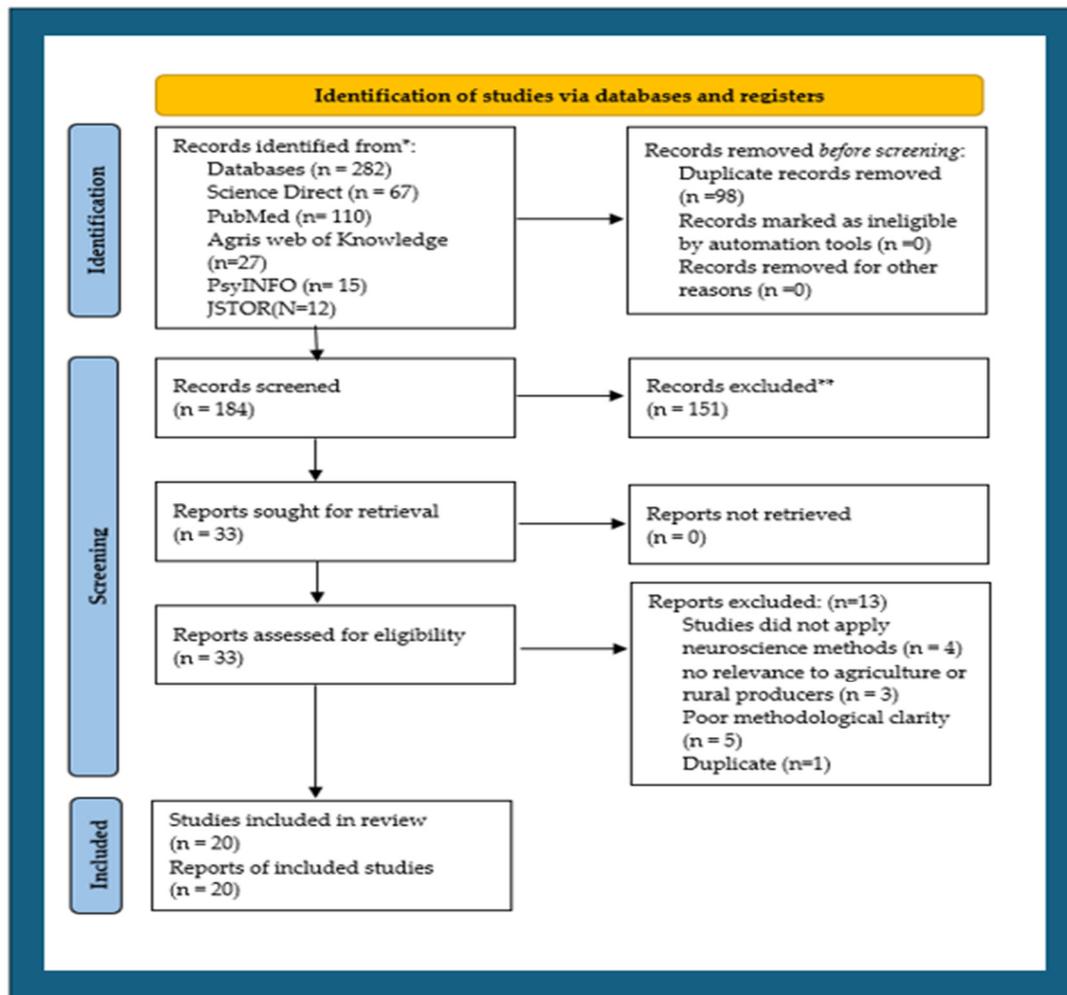


Figure 1. PRISMA flow diagram illustrates the identification, screening, eligibility, and inclusion of studies for the systematic review. * These are the records identified from several scientific databases
** These are excluded studies that did not relate to marketing or consumer neuroscience.

3.3. Quality Assessment and Data Synthesis

To enhance the rigor of this review, we conducted a qualitative quality appraisal of the included studies. Although the studies were diverse in design (ranging from laboratory experiments to field studies and literature reviews), we assessed each against common criteria such as clarity of objectives, appropriateness of methodology, sample size and representativeness, and the transparency of reporting results and limitations. Most studies were exploratory in nature and did not always fit traditional risk-of-bias checklists (since many were not clinical trials but consumer experiments or observational studies). Nonetheless, we noted potential sources of bias where applicable for example, over-reliance on student samples, lack of blinding in stimulus presentation, or selective reporting of outcomes. Overall, the articles included were of moderate quality. Specifically, they provided valuable insights but often with caveats such as small sample sizes or context-specific constraints (as we discuss in the Discussion of Findings section). We use these quality observations to temper our interpretations, especially when drawing implications for real-world rural settings.

For data synthesis, we adopted a narrative thematic approach. Given the heterogeneity of the studies (different objectives, methods, and outcome measures), a meta-analysis was not feasible. Instead, we carefully read and re-read the extracted data to identify patterns or recurring topics. Two reviewers independently coded the findings of each study for key

themes, then compared and consolidated these codes through discussion. This inductive process yielded a set of overarching themes that capture how neuroscience has been applied to marketing and what insights have emerged, particularly those relevant to rural producers. We ensured that themes were grounded in the data from multiple studies, not just a single source, to increase the robustness of our synthesis. The thematic analysis was iterative. Specifically, we refined the theme definitions and groupings as we integrated more studies, and we revisited original articles to verify that our thematic interpretations accurately reflected the authors' findings.

To facilitate comprehension, we organized the results by these thematic categories. In the section that follows, we first provide an overview of the literature search results and the characteristics of included studies (with a summary in Table 1). We then present the findings according to the identified themes, interweaving evidence from different studies and highlighting how each theme contributes to understanding the role of neuroscience in shaping marketing narratives for rural agricultural producers.

Results of the Literature Search: In total, 20 studies were rigorously reviewed and included for analysis. Table 1 offers a summary of these articles, including authors, year of publication, sector focus, study objectives, the neuroscience/marketing methods used, and key findings. As shown in the PRISMA diagram and summarized here, this body of literature spans research on consumer neuroscience in food and agriculture, neuromarketing techniques in various contexts, and neuroeconomic studies on decision-making. Notably, the application of neuroscience in an explicit agricultural context is still emerging. Consequently, many of the included studies focus on general consumer science, neuroeconomics, and neuromarketing in food or retail settings, with relatively fewer directly addressing rural or farm marketing scenarios. Nonetheless, we include these studies because their insights (for instance, on how consumers respond to organic labels or how farmers react to different buyer relationships) can be applicable to the rural agricultural settings.

Table 1. Summary of articles included in the systematic review (2016–2024), with their sector focus, objectives, methods, and key findings.

Authors and Year of Publication	Sector Focus	Objectives	Method	Outcomes
(Rihn et al., 2016)	General Consumer Behavior	The study explored the impact of organic production methods, origin designations, and visual attention to in-store promotions on consumers' purchase likelihood (PL) for indoor foliage and fruit-producing plants.	Eye Tracker	Consumers prefer organic plants over conventional ones as well as plants grown in-state or domestically over imported ones, and visual attention to organic production methods positively influences fruit-producing plants' purchase likelihood, but not indoor foliage plants.
(Aprilianty et al., 2018)	Agriculture	The study used neuroscience to analyze the influence of different types of agricultural buyers on farmers' perceived value, trust, performance, and commitment.	EEG	Farmers demonstrate varying emotional responses toward different types of buyers. The majority of farmers showed a high interest in perceived value and expressed trust in the farmers' group while exhibiting the lowest interest and engagement responses to cooperatives.

Table 1. Cont.

Authors and Year of Publication	Sector Focus	Objectives	Method	Outcomes
(Alvino, 2018)	General Consumer Behavior	How can consumer neuroscience research improve the study of consumer behavior and decision-making processes by establishing the benefits and limitations of this field and clarifying how neuroimaging techniques like EEG can help study individual preferences and the influence of extrinsic cues?	EEG	Consumer neuroscience research can improve marketing research by providing unbiased measures of consumer responses and individual preferences and studying the decision-making process and buying behavior at different levels. However, consumer neuroscience research also has several limitations, including the lack of a unified definition, unclear goals, difficulties reproducing natural environments, and issues with reverse and forward inference.
(Garczarek-Bak, 2018)	General Consumer Behavior	The study sought to understand several key problems related to consumer behavior and decision-making in the context of private-label (PL) products.	EEG and Eye Tracker	The probability of purchasing private-label products tends to increase with age and income. This suggests that as consumers gain financial resources and shopping experience, they may develop a greater willingness to consider PL products.
(Meyerding & Merz, 2018)	Food/Organic Products	The study looked to improve understanding of how visual attention influences decision-making in purchasing organic products.	Eye Tracker	The study reveals that consumers' visual attention is influenced by their preferences and choices regarding organic food labelling. Eye-tracking technology and choice-based conjoint analysis help overcome the limitations of traditional methods like social desirability and memory constraints. Consumers who value specific product attributes tend to pay more attention to them.
(Panfilov & Mann, 2018)	Agriculture	The study sought to understand how real-time visual information can enhance the supervision of autonomous agricultural machines.	Eye Tracker	The supervisor prefers graphical indicators for information, while live video serves as a secondary source. However, live videos can decrease problem detection performance compared to graphical indicators. Despite this, most participants feel more secure and understand machine functions better when live video is available.

Table 1. Cont.

Authors and Year of Publication	Sector Focus	Objectives	Method	Outcomes
(Van Loo et al., 2018)	Food Labeling	How does visual attention to information on food products, such as labels and packaging, relate to consumer preferences, choices, and valuation?	Eye Tracker	Eye tracking can reveal consumer attention to food labelling information, influenced by stimuli like label design and location and goal-driven factors like motivation and knowledge. This attention is related to consumer preferences, valuation, and choice, highlighting the importance of visual attention in food labelling.
(Lahm, 2019)	General Consumer Behavior	The study explores eye movements' role in decision-making, visual ecology in consumer research, and perceptual grouping of nutritional labels to guide attention without compromising brand-related elements.	Eye Tracker	Internal and external factors influence visual attention in decision-making, while product packaging structure can hinder nutritional information. Perceptually grouping labels can increase attention, but this effect diminishes under time pressure.
(Georgakarakou et al., 2020)	Agriculture	This study sought investigate how various packaging features (eco-labels, image, shape, color) of organic agricultural products (feta cheese and olive oil) affect consumers' eye reactions and influence their perception, attitude, and buying behavior.	Eye Tracker	Consumers prioritize brand name, text, and place of origin on product packaging over color, shape, and images. Eco-labels are appealing but require information about eco-friendly features. Angled packaging shapes are preferred over rounded ones due to habitual associations with the product type.
(Rödiger & Hamm, 2020)	Food Pricing	The study explores visual information search for organic food prices during shopping, focusing on the differences among conventional food consumers, regular organic food consumers, and occasional organic food consumers.	Eye Tracker	Consumers, regardless of their preference for organic or conventional food, often notice and compare prices of both types of products. Although regular organic consumers pay less attention to price information, they still examine prices of both types. The duration of visual attention on organic product packaging strongly influences the choice to purchase organic products, while conventional product prices decrease this likelihood.

Table 1. Cont.

Authors and Year of Publication	Sector Focus	Objectives	Method	Outcomes
(Castagna et al., 2021)	Food Aesthetics	The study explores how consumers' aesthetic biases toward food products influence their risk perceptions and purchase intentions and how construal level theory can be used to mitigate these biases.	Eye Tracker	Consumers have higher risk perceptions and lower purchase intentions for imperfect food products, with the influence of food aesthetics moderated by the construct level. Concrete mindset consumers have higher risk perceptions and lower purchase intentions.
(Schukat et al., 2021)	Agriculture	The study explores how neuroeconomic methods can provide insights into consumer decision-making processes. It investigates the potential of these methods to explain and predict consumer behavior, especially in agricultural contexts where traditional economic models may fall short.	fMRI/fNIRS/ Eye Tracker	Visual stimuli, such as food labeling systems (e.g., traffic light labeling), can significantly influence consumer buying behavior. Eye-tracking studies indicated that the design and arrangement of nutritional information on labels effectively attract consumer attention, thereby impacting their purchasing choices.
(Bojić et al., 2022)	General Consumer Behavior	The study explores how neuromarketing can provide insights into consumer behavior. By utilizing neuroscience techniques, the research aims to analyze how consumers make purchasing decisions and what factors influence their preferences.	fMRI	The study suggests that neuromarketing has the potential to be a sophisticated approach for understanding and satisfying consumer needs. This indicates that, when used responsibly, neuromarketing can provide valuable insights into consumer preferences and behaviors.
(Kumar et al., 2022)	Animal Welfare	The negative impact of pre-slaughter stress on animal welfare, consumer acceptance, carcass, and meat quality due to various pre-slaughter stressors.	EEG	EEG is a sensitive, efficient, and cutting-edge technique for measuring stress and pain perception in animals during the slaughtering process. EEG can also be used to assess the state of consciousness and insensibility during slaughter, which is crucial for animal welfare.

Table 1. Cont.

Authors and Year of Publication	Sector Focus	Objectives	Method	Outcomes
(Liang, 2022)	Agricultural Education	The study aimed to identify brain regions activated during IQ tasks, identify participants' thought patterns during experimental tasks, and distinguish between HC and LC groups, crucial for creativity in agriculture students.	EEG	Numeric problem solving in agricultural extension students activates the frontoparietal network and promotes self-generated thought. The high-creativity group inhibits creativity evaluation and engages in divergent semantic processing. The transition from visual perception to semantic processing is significantly different between the HC and LC groups (HC > LC).
(Markova, 2022)	Sustainability	The study explores how sustainable businesses can strengthen their position in the market and reach more customers.	fMRI/EEG/Eye Tracker	Neuromarketing techniques can be an effective solution for sustainable businesses to improve their competitiveness and reach more customers.
(Kumar et al., 2023)	Animal Welfare	The study assesses the effect of exposure to the slaughter environment on the emotional state and physiological responses of goats.	EEG	Exposure of goats to the slaughter of conspecifics alters their emotional state, as evidenced by significant changes in their neurobiological activity as recorded by the EEG spectrum, including increased beta and theta waves. Emotional stress in goats during exposure to the slaughter environment significantly increased their blood glucose levels, indicating a physiological stress response.
(Kirylyuk-Dryjska & Rani, 2023)	Agriculture	The study seeks to understand the current state of research on the application of neuroeconomic tools such as an eye tracker (ET) and electroencephalogram (EEG) in the field of agriculture and food economics.	EEG and Eye Tracker	Neuroeconomic tools like eye trackers and electroencephalograms are being used in agriculture and food economics to study consumer behavior and visual attention, as well as neural correlates of decision-making, problem-solving, and emotional responses. However, their application is relatively rare, and their use is still limited.

Table 1. Cont.

Authors and Year of Publication	Sector Focus	Objectives	Method	Outcomes
(Lalani et al., 2023)	Climate-Smart and Sustainable Agriculture	The study seeks to understand the complexities surrounding environmental decision-making in the context of climate change and sustainable agriculture	fNIRS	The study highlights that higher degrees of systems thinking are associated with more effective adaptation strategies to climate change and improved environmental decision-making. This is particularly relevant in low-income countries (LICs) where agricultural productivity is threatened by climate change.
(Min et al., 2024)	Nutrition/Menu Labeling	The study explores how consumers interact with nutritional information and the characteristics of visual attention during the menu scanning process to inform menu development and nutrition policies.	Eye Tracker	Consumers focused the most on the menu name, price, and image when selecting a menu item, while they paid less attention to the country of origin, calories, and special indications. Gender differences were observed in menu selection, with men preferring menus with meat or cheese patties and women preferring menus with shrimp patties. Consumers who had previous dieting experience were more likely to select menus based on factors such as favorite ingredients and images rather than calorie information.

After compiling the above table, we observed some noteworthy trends in the methods and contexts of these studies. The 20 included studies used a variety of neuroscience methods in agricultural/consumer settings. Most prominently, eye tracking was employed in 12 studies, while EEG was used in seven studies. A smaller number utilized fMRI (three studies) or fNIRS (two studies), often in combination with other tools; these methods provide deeper insights into brain activation patterns but are less common, likely due to cost and practical constraints. The dominance of eye tracking and EEG suggests that research in consumer neuroscience often prioritizes techniques that are relatively portable and applicable to realistic settings, which should be a crucial consideration for future work involving rural populations, where laboratory infrastructure may be limited. In terms of substantive focus, most studies centered on consumer behavior in food and retail contexts, such as responses to organic labelling, packaging aesthetics, and price information. Only a subset directly examined rural actors (e.g., farmers' trust or decision processes). This points to a gap in literature, while general findings about consumer neuroscience can be applied to rural marketing, there is a need for more studies set in explicitly rural environments or involving agricultural producers as participants. Nonetheless, the collected findings offer valuable clues. For example, factors like trust and social relationships, cognitive load, visual cues (labels, eco-certifications), and emotional engagement emerge as important across multiple studies. In the next section, we delve into these themes to discuss how neuroscience has illuminated each area and what it means for rural agricultural marketing. We also explicitly connect the findings back to the rural context, illustrating how rural

producers can apply these insights or how the unique rural environment might modulate these effects.

4. Discussion of Findings

Neuroscience-based research in marketing and consumer economics offers valuable insights into the cognitive and emotional processes that influence decision-making and behavior in agricultural and food contexts. This review identified eight thematic areas through which neuroscience can inform rural marketing strategies ranging from social trust and cognitive load to consumer preferences for organic products and the effectiveness of packaging and neuromarketing techniques. Ethical and environmental factors, such as animal welfare and climate-smart practices, were also highlighted as influential in shaping consumer perceptions and marketing narratives.

The discussion underscores how neuroscience enhances our understanding of why certain marketing strategies succeed by revealing underlying brain mechanisms such as emotional activation or visual attention. This perspective is particularly relevant for rural producers, who must use limited resources efficiently. By focusing on high-impact areas like trust-building and sensory design, producers can better align their marketing with subconscious consumer responses. The themes are presented with attention to their interconnections, reflecting the real-world complexity of rural marketing and the need for integrated, neuroscience-informed approaches.

4.1. Thematic Analysis of Findings

- Influence of Social and Economic Relationships on Cognitive and Emotional Engagement
- Impact of Cognitive Load and Confidence on Task Performance
- Cognitive Processes in Problem-Solving and Creativity
- Consumer Preferences and Behavior
- Impact of Visual Information
- Role of Neuromarketing
- Packaging and Labelling
- Animal Welfare and Environmental Decision-Making

4.1.1. Theme 1: Influence of Social and Economic Relationships on Cognitive and Emotional Engagement

Social relationships and economic context can significantly shape the cognitive and emotional engagement of rural producers in marketing situations. [Aprilianty et al. \(2018\)](#) demonstrated this using an EEG study examining how different buyer types affect farmers' responses. In their research on Indonesian farmers, the type of customer or buyer had a pronounced effect on the farmers' brain responses and reported attitudes. Farmers exhibited greater interest, trust, and commitment when dealing with familiar peer groups (such as farmer cooperatives or farmer-to-farmer groups) compared to more formal or distant entities like large cooperatives or corporate buyers. This finding suggests that the social context such as who the producer is selling to can influence how much mental and emotional energy they invest in the transaction.

The strong association observed between perceived value and trust indicates that emotional and cognitive processes (like trust-building, perceived fairness, and sense of community) are not just side effects of transactions but central to improving farmers' performance and dedication in business relationships. [Larasati et al. \(2019\)](#) similarly highlighted that when farmers perceive high value in a relationship and trust their counterpart, they are more committed and engaged. For rural marketing, this implies that producers might

benefit from narratives that emphasize trust and shared values. For example, marketing strategies that frame transactions as partnerships or community-building (rather than one-off sales) could neurologically and psychologically encourage producers (and possibly consumers) to be more invested. From the perspective of rural agricultural producers, understanding the role of these social-emotional factors is crucial. A rural producer often operates in tight-knit communities where reputation and long-term relationships are paramount. Neuroscience-backed evidence suggests that fostering trust can literally engage the producer's brain in ways that promote better decision-making and resilience. Practically, a farmer may feel more motivated and confident selling at a local farmers' market (where they know their customers and get direct feedback) than through an impersonal supply chain. The implication is that marketing narratives or programs that strengthen social bonds like customer testimonials, community events at the farm, or loyalty programs that make customers feel like "partners", could enhance the producer's own cognitive engagement and, in turn, their marketing effectiveness. Social and relationship factors set the stage for how much attention and mental effort producers and consumers are willing to invest. Building on that, it is also important to consider the limits of their cognitive capacities in processing information. Even with strong trust, an overload of information or poorly presented data can undermine decision quality. Theme 2 delves into how cognitive load and confidence impact task performance in contexts relevant to rural producers, such as using new technology or handling complex information.

4.1.2. Theme 2: Impact of Cognitive Load and Confidence on Task Performance

Cognitive load is the amount of mental effort being used in the working memory that can heavily influence decision accuracy and confidence, especially when individuals must process complex or abundant information. In the agricultural context, [Panfilov and Mann \(2018\)](#) provide a telling example. They studied operators (akin to farmers or agricultural technicians) supervising autonomous farming machinery and compared two support systems: a high-detail live video feed versus simplified graphical indicators. Intuitively, one might expect that more information (video) leads to better oversight. However, their findings showed the opposite: participants experienced information overload with the video feed, leading to a 9.1% drop in problem-detection performance. Moreover, this decline in task performance was accompanied by a reduction in the operators' confidence levels. Essentially, the live video imposed a heavier cognitive load, overwhelming the decision-making process and causing operators to miss critical issues.

This phenomenon is not unique to agriculture; studies in other domains (railways, military, etc.) similarly report that too much information can reduce decision accuracy. [Gamble et al. \(2018\)](#), for instance, found that flooding decision-makers with a high volume of data (even if accurate) can impair their ability to discern important signals from noise, confirming that human brains have limited bandwidth for processing at any given time. [Moncur et al. \(2023\)](#) also noted that cognitive overload in operational decisions (like those made under time pressure or heavy information flow) can be mitigated by tools that simplify information presentation, such as augmented reality interfaces that filter and highlight key data.

For rural producers, the lesson is twofold. First, when adopting new technologies or analytics (e.g., farm management software, market data dashboards), simplicity and clarity in information display are paramount. An overly complicated system might provide more data but could paradoxically lead to worse outcomes if the user's brain cannot effectively process it all. For example, a tool that tracks soil moisture, weather forecasts, commodity prices, and social media trends in one screen might sound useful for marketing decisions; however, if it is not intuitively visualized, a farmer might ignore critical alerts (like a market

price drop) amidst the clutter. On the other hand, a well-designed dashboard that uses clear visuals or even neuroscience-informed interfaces (perhaps highlighting data in a way that aligns with human attention patterns) can improve both performance and confidence.

Secondly, this theme underscores the importance of confidence in decision-making. When cognitive load is managed and information is digestible, producers feel more confident, which in turn can lead to more decisive and effective action. Marketing narratives can leverage this insight by avoiding overwhelming consumers with information. For instance, a rural cooperative marketing organic produce might be tempted to present every single detail about their products (nutritional info, farming practices, community impact, etc.). However, neuroscience suggests there is an optimal amount of information that persuades without overloading. A cleaner message focusing on a few powerful, trust-building facts (like “certified organic, pesticide-free, supporting 50 local families”) could have more impact on consumers’ decisions than an exhaustive list of stats. This aligns with the “less is more” principle in advertising, now supported by neuro-cognitive evidence.

Having considered how too much information can hinder performance, we turn to Theme 3, which looks at the flip side: the cognitive processes underlying problem-solving and creativity. In dynamic agricultural markets, producers often face novel problems that require creative solutions. How does the brain handle such tasks, and what distinguishes highly creative decision-makers? Theme 3 will explore these questions, shedding light on cognitive diversity among individuals which can be critical for innovation in rural marketing.

4.1.3. Theme 3: Cognitive Processes in Problem-Solving and Creativity

Creative problem-solving is essential for rural producers operating in resource-constrained and rapidly evolving markets. Neuroscience offers valuable insights into how creativity functions in the brain, highlighting distinct neural networks involved in analytical versus creative thinking. For instance, [Liang \(2022\)](#) used EEG to study agricultural extension students and found that quantitative tasks activated the frontoparietal network (linked to logic and attention), while spatial tasks engaged regions associated with visual reasoning. Notably, highly creative individuals showed brainwave patterns suggesting divergent thinking suppressing initial, obvious answers to explore novel solutions. These findings align with broader neuroscience research, such as [Beatty et al. \(2019\)](#), who found that creative cognition involves alternating engagement of the brain’s default mode network (idea generation) and executive control network (evaluation). This explains why separating brainstorming from critique often enhances innovation.

For rural marketers, these insights suggest creativity is both trainable and strategically valuable. Highly creative individuals may naturally develop inventive marketing narratives or unconventional strategies, while others can benefit from training that fosters divergent thinking. Neuromarketing tools, such as EEG, can help measure consumer engagement with creative storytelling versus standard advertising. For example, instead of promoting honey with simple features, a rural beekeeper might craft a narrative about “the journey of a bee” to emotionally engage the audience. Understanding individual cognitive strengths can also help rural teams delegate tasks effectively, some may focus on strategic analysis while others lead in creative ideation. Overall, neuroscience shows that both analytical and creative thinking are critical and complementary in crafting compelling, effective marketing strategies for rural producers.

While Themes 1–3 have focused on the producer side (social dynamics, information processing, and problem-solving), the next set of themes shifts focus toward the consumer side of the equation, specifically, how consumers make choices about agricultural products and how certain product attributes and marketing cues influence those choices. Theme 4

begins this by examining consumer preferences and behaviors related to organic and local products, which are particularly relevant for many rural producers who compete on these attributes.

4.1.4. Theme 4: Consumer Preferences and Behavior of Organic and Local Products

Consumer neuroscience research shows that organic, local, and sustainably produced food strongly appeals to values like health, quality, and community. Eye-tracking studies (e.g., [Rihn et al., 2016](#)) reveal that consumers often prefer organic products, especially when visual cues like logos or sustainable imagery are prominent. These cues work synergistically, reinforcing each other and increasing purchase likelihood. Attention plays a critical role: the more time a consumer spends visually engaging with packaging (e.g., reading certifications or logos), the more likely they are to choose that product. [Rödiger and Hamm \(2020\)](#) found that habitual organic consumers even suppress price sensitivity in the presence of organic labels. [Meyerding and Merz \(2018\)](#) further demonstrated that consumers naturally direct attention toward product attributes they personally value, suggesting that effective marketing can either reinforce existing preferences or strategically attract new interest.

For rural producers, especially those operating in organic or local food systems, these findings underscore the importance of label design and strategic packaging placement. Simply being organic or locally grown is not enough, consumers must instantly recognize these traits through high-visibility labels, earthy color palettes, trusted certifications, and storytelling that appeals to their values. Neuroscience shows that positioning (e.g., labels in the top-left corner) can guide attention, and emotional narratives (e.g., about supporting the environment or local community) can trigger brain responses that make consumers more willing to pay premium prices. Thus, rural producers can optimize both impact and profitability by designing packaging that captures attention, communicates values, and builds emotional reward around their product.

One of the key reasons organic and local cues work is because they are visual and informational triggers that influence perception. Theme 5 will broaden the discussion to visual information in general, examining how various visual stimuli and neuroeconomic insights (like the use of eye tracking to gauge reactions) show the impact of visuals on consumer behavior. This is closely related to Theme 4 but extends beyond organic/local to any form of visual cue or design element that can sway a decision.

4.1.5. Theme 5: Impact of Visual Information Through Neuroeconomic Insights

Visual presentation plays a critical role in shaping consumer perceptions and behavior, often influencing purchasing decisions more than the product information itself. Neuroeconomic studies show that packaging elements such as color, label layout, font size, and imagery can trigger cognitive and emotional responses that guide attention and decision-making. Studies by [Van Loo et al. \(2018\)](#) and [Georgakarakou et al. \(2020\)](#) highlight how even minor design elements determine what consumers notice first, shaping their impressions of quality and value. Imperfections in product appearance, as shown in studies by [Castagna et al. \(2021\)](#) and [Ntobela and Mbukanma \(2024\)](#), can unconsciously signal risk or inferiority, even when actual quality remains high. However, this bias can be mitigated through strategic messaging that reframes visual flaws, such as campaigns promoting “ugly” produce as sustainable and equally nutritious.

For rural producers, the implication is clear, visual design must be intentional, not incidental. From product labels to signage at market stalls, how information is displayed can impact whether a consumer engages with the product at all. Neuroeconomic methods like eye tracking and EEG have shown that repositioning overlooked elements (e.g., sustainability logos) or enhancing visual salience (e.g., using icons or strategic placement) can

meaningfully shift consumer attention and purchase intent. Even with limited resources, rural producers can test and improve visuals by observing shopper responses or trying simple A/B experiments. A brighter label, a bolder claim, or a farm photo may significantly boost visibility and trust, making visual design a powerful, cost-effective marketing lever in competitive markets.

Having discussed the impact of visual design and information, we now turn to the broader domain of neuromarketing techniques themselves, like EEG and fMRI, which can decode subconscious consumer responses. Theme 6 will explore how these technologies provide insights into consumer behavior that traditional marketing might miss, and how such insights can be used to refine marketing strategies.

4.1.6. Theme 6: Role of Neuromarketing on Consumer Behavior

Neuromarketing tools like EEG and fMRI provide valuable insights into consumers' subconscious reactions to marketing stimuli, uncovering preferences and emotions that traditional surveys may miss. EEG captures real-time electrical brain activity, helping marketers identify precise moments of attention or confusion during an ad, while fMRI maps active brain regions, revealing whether marketing triggers emotional, memory-related, or decision-making areas. These techniques offer marketers the ability to craft narratives that resonate with both the intuitive "System 1" and the rational "System 2" parts of the brain. Studies by [Alvino \(2018\)](#), [Bojić et al. \(2022\)](#), and [Schukat et al. \(2021\)](#) have demonstrated how EEG can track emotional spikes or cognitive overload, enabling marketers to fine-tune content by removing or reworking confusing elements.

Similarly, fMRI studies (e.g., [Alsharif et al., 2021](#)) show that recognizable branding or emotionally charged messaging can activate reward centers in the brain, creating deep consumer connections. This has meaningful implications for rural producers, who can use storytelling and consistent branding to build trust and emotional loyalty. For instance, a local dairy or winery might leverage neuromarketing insights to identify which narrative elements resonate most, such as themes of heritage, sustainability, or family. By doing so, even small-scale producers can cultivate strong emotional bonds with their audience, encouraging brand loyalty and increasing perceived value.

One practical application of neuromarketing for rural producers is advertising optimization. By testing different video or label designs using EEG or eye tracking, producers can determine which visuals evoke trust, attention, or excitement. For example, consumers may engage more when shown authentic farm imagery rather than generic product shots. While these techniques offer powerful tools, ethical concerns must be considered. Neuro-marketing should aim to enhance genuine consumer satisfaction rather than manipulate emotions for profit. As [Bojić et al. \(2022\)](#) noted, when applied ethically, these tools help align products with consumer needs by supporting more authentic, emotionally resonant marketing strategies that benefit both producers and buyers.

Since visuals and neuromarketing techniques have been covered, we proceed to a more specific aspect of visual marketing: packaging and labelling. Theme 7 focuses on how packaging itself functions as a critical marketing narrative for products, which is a particularly salient point for rural producers selling value-added goods (jams, cheeses, wines, etc.). The discussion will encompass both the design elements and information aspects of packaging, linking back to how they influence consumer brains and behavior.

4.1.7. Theme 7: Significance of Packaging and Labelling

Packaging and labelling are powerful marketing tools, often serving as the first impression a product makes on potential buyers. For rural producers competing alongside mass-market goods, packaging becomes a key medium for communicating brand values

such as authenticity, quality, and sustainability. Studies like [Georgakarakou et al. \(2020\)](#) show that visual elements such as brand name, origin, and eco-labels strongly influence consumer attitudes. A familiar farm name or region can trigger trust and positive associations, while eco-labels may boost appeal but require supporting information to avoid skepticism. Simply labelling a product “eco-friendly” is no longer enough because today’s informed consumers want to know what that claim is based on.

Beyond content, the structure and presentation of packaging information significantly impact how consumers process details. [Lahm \(2019\)](#) found that well-grouped data, such as nutritional facts, improves decision-making; however, under time pressure, even clear packaging may be overlooked. [Evans \(2021\)](#) emphasizes that hurried consumers rely on visual shortcuts by choosing products based on familiarity or standout visuals rather than careful analysis. For rural producers, this means key messages (e.g., “Local. Organic. Hand-crafted.”) must be prominent and digestible immediately. In contrast, longer descriptions may only reach more deliberate shoppers. Aesthetic appeal also matters, this implies that packaging that is clean, modern, or intentionally rustic can communicate quality, while messy or outdated designs can undermine product value.

From a neuroscientific standpoint, well-designed packaging engages the brain’s visual and emotional systems, influencing subconscious motivation and decision-making. Eye-tracking and EEG research show that good design draws attention and can stimulate desire, making the product more likely to be chosen. Colors, fonts, and imagery all play roles such that green can signal freshness, blue cleanliness, and red excitement. For rural producers, investing in thoughtful packaging is not cosmetic but strategic. It helps tell the product’s story and reinforces brand identity. Whether it is jam evoking homemade care or gourmet cheese marketed as exclusive, every design element should support the emotional message that will resonate with the consumer’s brain.

Our final theme broadens the lens to considering ethical and environmental factors, specifically looking at how neuroscience has contributed to understanding issues like animal welfare and sustainability decisions (climate-smart practices), which are increasingly entangled with marketing narratives. Rural producers today often need to address these concerns in their storytelling because consumers want to know about animal treatment and environmental impact. Theme 8 will discuss research on monitoring stress in animals and cognitive aspects of environmental decision-making and how these insights might shape marketing and business practices.

4.1.8. Theme 8: Animal Welfare and Environmental Decision-Making: Monitoring Stress and Welfare as Well as Systems Thinking and Adaptation

Modern consumers increasingly value not just the end product but also the ethical and environmental practices behind it. Neuroscience contributes to this space by offering tools to measure animal welfare such as EEG used by [Kumar et al. \(2022\)](#) to detect livestock stress and by shedding light on how consumers and producers process sustainability-related decisions. High animal stress levels affect both ethics and product quality, allowing producers to credibly market claims like “humane handling” or “better taste through low-stress practices” ([Kumar et al., 2023](#)). These are not just emotional appeals as they can be backed by physiological evidence, reinforcing trust and offering a competitive advantage. Similarly, FNIRS study by [Lalani et al. \(2023\)](#) links systems thinking such as understanding the interconnected nature of agriculture to better adoption of climate-smart practices, emphasizing the cognitive skills needed for sustainable farming.

From a marketing perspective, producers who implement and can prove science-based sustainable practices stand to benefit from growing consumer interest in ethical and eco-friendly products. Narratives that highlight “climate-smart” methods or low-stress animal handling can resonate deeply, especially when backed by research rather than vague claims.

Neuroscience offers a foundation for credibility, helping confirm whether practices truly improve outcomes. Additionally, understanding producer psychology like risk aversion or decision fatigue can guide better policy and marketing approaches. Tailored messaging that acknowledges these cognitive realities can support adoption of sustainable practices while also appealing to emotionally driven consumers. In this way, neuroscience bridges scientific validation with marketing integrity, ensuring that ethical storytelling aligns with real-world behavior.

In summary, neuroscience shows that ethical and sustainable practices in agriculture are measurable and improvable, not just idealistic concepts. Rural producers can stand out by adopting these practices and clearly communicating them such as highlighting animal welfare or climate-smart farming as part of their product story. When backed by evidence, these narratives can enhance consumer trust, delivering both moral satisfaction and potential financial gain.

Having explored all eight themes, it is evident that the application of neuroscience to marketing in the context of agriculture spans a wide range: from the micro-level of brainwaves and eye movements to the macro-level of community trust and global sustainability. In the next sections, we will synthesize these insights further, address the limitations of our review, suggest directions for future research, and draw practical conclusions, especially oriented toward helping rural agricultural producers implement these findings.

5. Limitations of Findings

While this systematic review has brought together insights from neuroscience and marketing relevant to rural agricultural producers, it is important to recognize its limitations. These limitations arise both from the scope and quality of the available studies and from the methodological choices we made in conducting the review. A clear understanding of these caveats can guide readers in interpreting the findings appropriately and can also point to areas where further work is needed.

- **Generalizability and Sample Representativeness:** Several studies reviewed (e.g., [Meyering & Merz, 2018](#); [Markova, 2022](#); [Garczarek-Bąk, 2018](#)) utilized convenience samples such as university students or urban consumers, limiting representativeness. These samples differ notably from rural agricultural producers and typical rural consumers, who often vary in age, educational background, and cultural practices, potentially altering response patterns (e.g., visual attention) observed in lab-based studies. Additionally, geographic specificity such as the US-focused research by [Rihn et al. \(2016\)](#) and Greek-based studies by [Georgakarakou et al. \(2020\)](#) reduces generalizability, given diverse cultural and infrastructural contexts across rural markets globally. Small sample sizes (e.g., [Panfilov & Mann, 2018](#)), $n = 17$; [Liang, 2022](#)), $n = 36$) further constrain statistical power, risking overstated or idiosyncratic results, particularly given inherent variability in neural responses. Thus, rural producers should interpret these findings cautiously, considering local validation or adaptation. Lastly, [Aprilianty et al.'s \(2018\)](#) study, focused narrowly on strategic supplier relationships, necessitates broader research to ensure applicability across diverse agricultural buyer–supplier contexts.
- **Methodological Constraints and Ecological Validity:** Several studies encountered methodological constraints limiting ecological validity. Laboratory conditions (e.g., [Kumar et al., 2022](#); [Panfilov & Mann, 2018](#)) often oversimplified complex realities of rural agricultural settings, such as unpredictable weather, animal behaviors, or farmers multitasking. Consumer studies employing static or virtual tasks (e.g., [Castagna et al., 2021](#); [Georgakarakou et al., 2020](#)) might omit critical contextual factors like social interactions, sensory stimuli, or market dynamics present in real settings. Technology-

related limitations further challenge accuracy. Liang (2022) noted that EEG data quality diminishes with subject movement or complexity of tasks. Task framing also influenced outcomes, with priming effects (Liang, 2022) potentially biasing results.

- **Depth of Cognitive and Behavioral Insights:** Despite employing advanced neuroscientific methods, existing marketing studies often provide limited insight into underlying cognitive mechanisms. As noted by Alvino (2018) and Van Loo et al. (2018), current tools effectively measure attention and emotional arousal but struggle to clarify the precise reasons behind these responses, such as visual appeal, memory triggers, or confusion. Particularly in rural contexts, consumer decisions frequently involve deeper socio-cultural factors like community norms or traditions that neuroscience methods can detect (e.g., emotional reactions linked to local imagery) but do not fully explain. Moreover, most studies examine immediate or short-term effects, overlooking long-term impacts such as whether initial responses to neuromarketing-informed packaging persist beyond novelty (e.g., sustained brand loyalty through repeated exposure). This gap is significant for rural producers, whose marketing success often depends on relationship-building over extended periods.
- **Resource and Ethical Constraints:** Implementing neuroscientific methods can be resource intensive. As (Kirylyuk-Dryjska & Rani, 2023) and Kumar et al. (2023) noted, advanced research instruments like fMRI or even high-end EEG rigs are expensive and require technical expertise. Rural areas might lack access to such facilities, and producers or local marketers rarely have the budget for neuroscience experiments. This reality means that there is a gap between what research can suggest and what is immediately actionable on the ground. Ethical considerations also loom large. For example, in studies involving animals, Kumar et al. (2022, 2023) had to be very careful in design to avoid unnecessary harm. Similarly, on the consumer side, neuromarketing raises questions about privacy and manipulation. None of the studies in our review aimed to deceive or coerce consumers; however, as a limitation, we acknowledge that our review did not deeply delve into the ethics of applying these techniques in practice (we touch more on this in the Future Directions and Conclusion). If, hypothetically, a rural producer had the means to use neuromarketing, there would be ethical imperatives to use it to better serve customers, not to exploit them (for instance, avoiding practices that intentionally trigger excessive cravings for unhealthy foods, etc.).
- **Review Scope and Process Limitations:** Regarding our systematic review's scope, restricting inclusion to post-2016 studies, while capturing recent technological advances, may exclude foundational older literature, partially mitigated by referencing key theoretical frameworks. Focusing solely on studies explicitly incorporating neuroscience methods may also omit relevant behavioral insights without such explicit methods. Our narrative synthesis inherently involved subjective thematic identification, which, despite internal cross-checking for consistency, another team might have conducted differently. Lastly, the absence of a formal quantitative meta-analysis or standardized bias assessment due to data heterogeneity represents a methodological limitation, suggesting potential areas for enhancement in future reviews.

6. Future Research Directions

Building on the gaps and opportunities identified in this review, we propose several directions for future research at the intersection of neuroscience, marketing, and rural agriculture. Addressing these areas can deepen our understanding and provide more actionable insights for both academics and practitioners:

- **Bridging Neuroscience and Traditional Consumer Behavior Theories in Agriculture:** Future research should integrate neuroscientific methods with established consumer decision models, examining neural correlates of biases such as loss aversion or overconfidence in rural producers. Specifically, investigating neural responses to potential losses versus gains could clarify cognitive biases influencing farmers' pricing and sales decisions. Understanding neural underpinnings of emotional drivers such as pride in product quality or fear of market rejection could inform targeted interventions to enhance producers' marketing confidence. Thus, combining neuroeconomics with rural consumer behavior can yield valuable insights into effective marketing strategies within rural contexts.
- **Neuroscience-Informed Negotiation and Communication Training:** Future research should investigate neural mechanisms underlying negotiation and communication processes between rural producers and market stakeholders. Studies employing techniques such as EEG, cortisol measurement, eye tracking, or fMRI during simulated negotiations could identify cognitive and emotional patterns associated with successful outcomes. For instance, examining whether specific framing of price offers mitigates neural indicators of stress or anxiety could inform targeted negotiation training programs. Additionally, neuroscience can elucidate how producers effectively communicate product value propositions by identifying elements (e.g., sustainability, tradition, quality) that maximally engage consumer interest at a subconscious level. Insights from these studies can support practical interventions to enhance producers' communication strategies, aligning marketing efforts with consumer neural responses.
- **Personalization and Profiling in Rural Marketing:** With the rise of accessible tech, future research could explore using portable EEG or other biosensors in real-world rural settings to tailor marketing strategies. For instance, a study could equip farm shop visitors with wearable devices to unobtrusively gauge emotional responses as they browse (respecting privacy and ethics). The data might reveal micro-preferences. Local teenagers might respond strongly (in terms of brain excitement) to social media testimonials from peers about a farm product, whereas older customers respond more to in-person interactions. These insights could inform segmented marketing strategies. Research should examine the feasibility and effectiveness of such personalization: Do neuroscience-informed tailored messages (like adjusting a market's signage based on general crowd reactions) significantly improve engagement or sales in rural markets? This would push neuromarketing beyond the lab into the field, testing its practical utility.
- **Integration of Neuroscience with Traditional Market Research Methods:** A promising direction is combining qualitative insights (from interviews, focus groups) with neural data for a holistic understanding. Future studies should use mixed methods, for example, conducting focus group discussions with rural consumers about a product while also recording physiological responses (heart rate, skin conductance) to gauge emotional arousal during different topics. This can validate whether what people say aligns with what their subconscious signals show. Such triangulation in a rural context might reveal for instance that consumers verbally insist price is most important, but physiologically light up more when discussing trust in the producer. Marketers can then align strategies accordingly. Research on how to cost-effectively implement this (maybe using smartphone sensors or low-cost EEG headbands) would be highly useful for rural contexts.
- **Chronic Stress and Cognitive Load Management for Producers:** Rural producers frequently operate under chronic stress due to market volatility and climate-related challenges, potentially impairing marketing decision-making. Future neuroscience

research should examine the cognitive and neural effects of stress in high- versus low-stress conditions using biomarkers or neuroimaging to assess impacts on decision quality. Such insights could inform the development of interventions like mindfulness or biofeedback programs that are aimed at enhancing stress resilience. Additionally, cognitive training targeting functions like flexibility, problem-solving, and strategic planning (e.g., via prefrontal cortex stimulation) may support producers' adaptability to evolving marketing demands. Evaluating these interventions' effects on both neural activity and business outcomes would provide practical value.

- **Social Neuroscience in Community Marketing:** Given the importance of social networks and word-of-mouth in rural marketing, future research should apply social neuroscience methods such as hyperscanning to examine neural mechanisms underlying peer influence and community information flow. Investigating how attitudes and behaviors are transferred between individuals during interactions can reveal how marketing ideas disseminate through rural networks. Such insights could inform the design of campaigns that strategically engage community leaders or early adopters. Moreover, exploring how rural audiences neurologically respond to messages from trusted local sources versus outsiders can guide culturally attuned, trust-based communication strategies.
- **Enhancing Representativeness and Contextual Relevance in Rural Neuroscience Marketing Studies:** Given the overreliance on convenience samples (e.g., university students, urban consumers) in existing studies, future research should prioritize the inclusion of larger, demographically and culturally diverse samples, particularly from rural agricultural communities. Studies should aim to capture variability in age, education, cultural norms, and technology access to ensure findings are contextually relevant and generalizable to rural settings. Additionally, cross-cultural research comparing neural responses in different geographic regions (e.g., Sub-Saharan Africa, Southeast Asia, Latin America) could uncover important differences in decision-making dynamics shaped by local agricultural practices and socio-economic environments. Such efforts would improve the ecological validity of neuromarketing strategies aimed at rural producers and consumers.
- **Ethical Neuromarketing and Cultural Nuances:** Future research should engage more deeply with the ethical and cultural dimensions of neuromarketing in rural and low-literacy settings. This includes examining stakeholders' perceptions of neuroscience tools (such as EEG and eye tracking) and evaluating how local cultural values such as communalism, oral traditions, and spiritual beliefs influence acceptance or resistance. To ensure ethical integrity, neuromarketing practices in these contexts must emphasize informed consent using accessible, non-technical language that may be supported by visual or verbal explanations. Transparency regarding how data are collected, interpreted, and used is essential, particularly to build trust in communities unfamiliar with neuroscientific research. It is equally important to avoid manipulative tactics, especially in populations where cognitive vulnerability may be heightened due to limited literacy or formal education. Researchers should prioritize community engagement and participatory design, allowing local actors to play an active role in shaping or interpreting neuromarketing applications. Where resistance to advanced methods exists, simplified neuroscience tools and community-led approaches may provide more culturally appropriate and ethically sound alternatives. These measures help ensure that neuromarketing efforts uphold local norms, protect participant autonomy, and contribute responsibly to rural development.

In conclusion, advancing research in rural marketing will benefit from a multidisciplinary and inclusive approach that combines neuroscience with practical agricultural

knowledge while acknowledging the human dimension of decision-making. The proposed future research directions aim not only to address existing gaps in the literature but also to offer practical strategies for supporting and empowering rural producers in an evolving marketplace.

7. Conclusions

In conclusion, this review offers a neuroscience-informed perspective on rural marketing by examining how cognitive and emotional processes influence consumer and producer behavior. While not applying formal theoretical models, the study is informed by key concepts from dual-process theory and the consumer decision-making literature, particularly in framing the relevance of subconscious influences, trust, and attention in rural marketing contexts. These insights provide a foundation for future research to build more explicitly on psychological theory and contribute to more effective and ethically grounded marketing strategies for rural agricultural producers.

Drawing from studies published between 2016 and 2024, the review highlights a significant gap in applying brain-based insights to rural marketing, despite growing interest in the field. Findings were synthesized into eight thematic areas, including social trust, information processing, visual design, ethical marketing, and packaging. Together, these themes offer a roadmap for how rural producers can improve branding, storytelling, and consumer engagement using neuroscientific tools and principles.

In addition, the review provides practical recommendations for producers, such as simplifying messaging, enhancing product visuals, emphasizing trust and sustainability, and using feedback from customer behavior to refine strategies. It also calls on agronomists, neuroscientists, extension services, and policymakers to support rural marketers with training in consumer psychology and collaborative branding. Ethical considerations remain central; producers must prioritize transparency and avoid manipulative tactics, especially when adopting neuromarketing techniques. Ultimately, the review argues that neuroscience offers a valuable lens to understand and influence consumer behavior and that rural producers who embrace these insights stand to improve both their marketing effectiveness and customer relationships in a competitive, value-driven market.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/businesses5020025/s1>, Table S1: PRISMA 2020 Checklist.

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