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Article

Communicating Cleaner Production Among Value-Chain Actors Through Actionable Guidelines for Climate-Smart Agriculture Implementation in South Africa: A Content Analysis

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Abstract: In light of cleaner production methods and the framing and stylization of communication via the lens of agroecological principles, this study content examined practical recommendations for the implementation of climate-smart agriculture in South Africa. This study used content analysis, a conceptual analysis technique that identifies the presence and frequency of concepts in a text. Social values, co-creation of knowledge, and inputs are practices with the highest frequency on response, while synergy, fairness, governance, animal health, and recycling are vulnerable cleaner production practices follow the frequency of codes in decreasing order. In contrast to efficacy-induced communications on cleaner production methods, which were coded 54 times, threat-induced messages on cleaner production were coded 28 times. The actionable instructions on climate-smart agriculture coded the present incidence of cleaner production techniques 44 times and the future incidence 65 times. Practice action was tagged 76 times and non-practice action was coded 25 times in the actionable guidelines on climate-smart agriculture, which outlined practical measures to be followed for the adoption of cleaner production. The findings have implications for future and existing incidence, practice actuation and non-practice actuation, and treatment-induced and efficacy-induced communication connected to cleaner manufacturing practices.

Keywords: cleaner production; climate smart-agriculture; communication framing; climate messages

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1. Introduction

Cleaner production has been defined in a variety of ways as a collection of environmental practices used to minimize waste, prevent pollution, change products, handle chemicals safely, and reduce operating, waste, and raw material costs. It also reduces pollution of the air and water, ozone depletion, global warming, and resource depletion. "The continuous application of a preventive and integrated environmental strategy applied to processes, products, and services in order to increase efficiency and reduce risks to humans and the environment" is how the United Nations Environment Programme (UNEP) defined cleaner production (Shi et al 2021). Shin et al. (2008) state that cleaner production is a "strategic approach that transforms unsustainable development into environmentally friendly that can balance the socioeconomic and environmental needs of countries."

Globally, about half of all emissions generated by food systems occur at the farm level, emanating from synthetic fertilizers use and the reduction of organic soil matter; exploring the need for nature-based solutions through regenerative agriculture and agroecology principles, such as recycling, greening, and soil carbon sequestration among others. In agriculture, cleaner production practices are methods that reduce the use of natural resources and waste generated during production, by using cleaner technologies, modifying operating parameters, and using greener materials. The prominent cleaner agricultural production measures cover major areas on reduction and substitution of fertilizer use, reduction and efficiency enhancement of pesticides, straw utilization, water-saving and solar-powered irrigation, and agricultural recycling. The cleaner production practices are hinged on the enhancement of biodiversity through agroforestry, use of species that support ecosystem services, crop rotation, intercropping, enhancement of intraspecific diversity, nutrient cycling, natural pest management, and polyculture, diversifying animal population.

The global pursuit of sustainable development has highlighted the need for cleaner production practices in which agricultural extension services have been providing different models and strategies for communication with practitioners along the value chain. The agricultural extension can be defined as the entire set of organizations that support people engaged in agricultural production and facilitate their efforts to solve problems, link to markets and other players in the agricultural value chain, and obtain information, skills, and technologies to improve their livelihoods (Davis et al., 2020). According to Yanfika et al. (2024), Agricultural extension services are channels for knowledge dissemination, training provision, and innovation facilitation in the agricultural sector, bridging the gap between research, policy, and implementation, enhancing farmers transitioning to cleaner production practices. Branca and Perelli (2020) noted that the diffusion and adoption of climate-smart technologies are critical for African smallholder farmers to achieve a sustainable transition towards cleaner, circular, and more productive food systems. Saifan et al. (2021) found that extension services and climate change are vital factors that can affect the farm level outcomes like income and output and that increased access to education and experience of farmers were related to the extension services received by the farmers.

Wulandari (2022) reported that the strategies for improving cleaner production practices include developing knowledge transfer, enhancing farmer skills, and processing infrastructure and technology provision through extension services. Mburu et al. (2024) reported that it is imperative to strengthen the pluralistic extension system, increase extension contacts with farmers, and train farmers on climate change for intensified promotion and intensified uptake of the least adopted dairy climate-smart practices. According to Hilmi et al. (2024), farmers' knowledge, skills, comprehension, training, and extension services are crucial for climate change adaptation and mitigation tactics. According to Kalogiannidis and Syndoukas (2024), agricultural extension services enhance farmers' organizations and last-mile agricultural input providers, bridge the knowledge gap between research and actual farming, and facilitate access to better inputs, appropriate production methods, and knowledge. This is necessary to boost farm productivity and sustainability on a large scale.

Cleaner production methods are part of Climate Smart Agriculture (CSA), and as a result, the practical recommendations for CSA practice implementation in South Africa list many methods to facilitate the shift to a green economy that benefits everybody. A number of agroecological concepts were also mentioned as workable methods for agriculture to accomplish adaptation and mitigation goals (England et al., 2018; High Level Panel of Experts on Food Security and Nutrition [HLPE], 2019). The specifics of the unusual communication patterns have an impact on South Africa's acceptance and execution of climate change policies, according to Poortvliet et al. (2020).

Communicating Climate Change and Cleaner Production

Communicating climate change is about educating and mobilizing audiences to take action to confront the climate crisis as shaped by different experiences, cultural contexts, and underlying values. Donlon (2023) reported that "mis- and disinformation are widespread on the issue of climate change and across digital platforms, as bad-faithed actors are sowing doubt and confusion, with the aim of delaying or obstructing action on the climate crisis." The Intergovernmental Panel on Climate Change (IPCC, 2021) reported that "rhetoric and misinformation on climate change and the deliberate undermining of science have contributed to misperceptions of the scientific consensus, uncertainty, disregarded risk and urgency, and dissent." Doyle (2022) noted that communication on climate change should enhance more diverse narratives that go beyond catastrophic imageries but more clearly center on climate justice within popular cultural complexities. Yusuf and St John (2021) noted that communicating climate change explores access, relevance, and understandability as key elements to provide an overview of how these aspects allow multiple groups of stakeholders to act on climate-related information to build resilience. Lee et al. (2024) stated that utilizing systems approaches to understand and anticipate how information may be distributed and received can lead to more proactive climate communication.

According to Evans et al. (2018), there are a number of different paradigms from which climate change communication has been theorized. These paradigms include risk communication, development journalism, environmental communication, advocacy journalism, and communication for social change and development. Conflicting values and social dilemmas result from the misalignment of values between the climate message and its audience, according to Boakye et al. (2023). This is why climate change messages are rejected and psychological denial is caused by a lack of goal specifications, fear, blaming, and negative criticism. According to Sippel et al. (2022), people determine their opinions about climate communication by evaluating expert knowledge, looking at cost-benefit analysis, and evaluating the relationships between emotions and values.

According to Maibach et al. (2023), society's response to climate change is improved by evidence-based heuristic attempts to disseminate science-based knowledge about the phenomenon. Communication tactics that focus climate messages on iconic locations may encourage action, and communications that highlight collective efficacy can increase message effects and impact the adoption of a wider variety of behaviors, according to Waters et al. (2024). In the analysis of the ways in which climate scientists, climate doubters, and climate activists communicate their (un)certainty, Penz (2022) came to the conclusion that communication alone cannot account for the failure to advance climate action. According to Peters et al. (2022), ideas and practices for communicating about climate change should be grounded in theory and backed by data.

The Extended Parallel Process Model (EPPM), which explains how people react to frightening messages and is based on perceived danger, self-efficacy, response efficacy, and response, is one of the communication theories examined in this study. Individuals must feel threatened by the consequences of specific behavior, feel capable of taking the necessary action to avoid that threat, and believe that the action will be effective in preventing the incidence of the perceived threat in order to take protective action, according to the EPPM's climate messaging. The Constructal Level Theory (CLT) explains the connection between the widely recognized definitions of events and objects and the degree to which people's thoughts are categorized about them. When an object is closer to a person, it is perceived more concretely, and when it is farther away, it is thought of more abstractly. A concrete conceptual level may make climate change seem more psychologically approachable, which could lead to a greater acceptance of the issue and a greater willingness to address it, while an abstract conceptual level may make climate change seem more psychologically distant, which could lead to a lower acceptance of the issue and a decreased willingness to address it, according to Wang et al. (2019).

In addition, the use of risk communication in climate change has focused on the idea of a deficit model; in order to rectify factual errors, additional information is needed for comprehension and behavior modification. Perceptions of climate change risks and the ability to take action against those risks are crucial for encouraging adaptation and mitigation behaviors, according to a number of authors (Poortvliet et al., 2020; Branca & Perelli, 2020; Mujeyi et al., 2021). However, the content of communications and the existence, meanings, and connections of specific words, themes, and concepts could encourage the use of cleaner production methods.

How is communication about cleaner manufacturing framed? This is one of the research topics that emerges from this study. Which forms of communication are linked to more environmentally friendly production? Which aspects of communication are relevant to cleaner production methods? This paper's primary goal is to analyze the substance of the reports on climate-smart agriculture in South Africa, namely the cleaner production principles that were covered and the way that cleaner production communication was presented.

2. Materials and Methods

In order to investigate the existence, definitions, and connections of terms, themes, and concepts related to cleaner production methods, this article content-analyzed the practical recommendations for climate-smart agriculture implemented in South Africa. In order to ascertain whether or not concepts are included in a text, this study used the conceptual content analysis technique. Both overtly and covertly, the actionable guidelines' use of cleaner production, agroecology concepts, and communication framing were analyzed. Dictionary or contextual translation rules, or both, were used to code the explicit and implicit terms. The results were then analyzed by making generalizations and deductions.

This analysis approach is based on the observation that, in spite of the substantial amount of CSA knowledge that is available in South Africa, there aren't many useful recommendations for putting cleaner production methods into reality. According to Mnkeni et al. (2019), CSA approaches have been established as stand-ins for cleaner production practices. The actionable guidelines are based on the goals of guiding actions at all levels on improving resilience to climatic shocks, helping to reduce national emission intensity, and ensuring that climate-smart agriculture is implemented effectively at all levels.

Only two volumes of actionable guidelines were examined in this study: "Actionable Guidelines for the Implementation of Climate-Smart Agriculture in South Africa." Volume 1, titled "Situation Analysis and Useful Advice for South Africa's Climate-Smart Agriculture Implementation," contains 106 pages with 46,091 words. Volume 2, titled "Climate Smart Agriculture Practices," consists of 201 pages with 98,721 words. The country's move to cleaner production is made possible by the two volumes' comprehensive explanations of the advantages of adopting techniques identified and illustrated as CSA by value chain operators. The two books included sections on managing soil and water, cropping systems based on cereals, sugar cane production, fruit production and viticulture, climatic information services, weather insurance based on the index, urban agriculture, management of pasturelands and rangelands, agroprocessing, marketing, sharing of information, social inclusion and gender, and policy concerns. The two volumes underwent content analysis by employing the concepts from cleaner production processes to code the reports' text. This allowed for the execution of distinct content analysis for each of the concepts. In accordance with the HLPE principles of agroecology, the following codes were used in the content analysis: recycling, inputs, soil health, animal health, biodiversity, synergy, economic diversification, knowledge co-creation, social values, fairness, connectivity, land and natural resources governance, and participation. Codes were applied to sentences or text passages that were determined to address an idea from one of the cleaning procedures.

As a result, each of the cleaner production concepts was used separately as a code, and the frequency of occurrences of each code was counted to determine the total frequency for each concept. This made the analysis quantitative and deductive (Hennink et al., 2019), and it concentrated on the frequency and timing of concepts in the report. The codes are used to determine the meanings and connections between specific phrases, topics, and concepts throughout the two volumes' many parts pertaining to cleaner production.

In order to consider the communication theories and models used in the actionable recommendations on climate-smart agriculture in South Africa, the study also conducted a content analysis of the guidelines using the extended parallel model, construal level theory, and deficiency model. To investigate the communication theories' dimensions on the deficit model, Constructal Level Theory (CLT), and Extended Parallel Process Model (EPPM), a general coding was used that cut across the risk communication theories as susceptibility, which includes fear and threat, and response, which covers the efficacy dimensions. The purpose of this general coding was to ascertain how well the practical recommendations for implementing climate-smart agriculture in South Africa used and articulated notions of susceptibility and responsiveness in connection to cleaner output. CLT stood for current incidence and future incidence, EPPM for threat-induced and efficacy-induced, and deficit model for practice-actuation and non-practice actuation. The codes' frequency counts and percentages were displayed using graphs.

3. Results

The findings include definitions of each code, as well as the frequency and percentages of cleaner practices coded in the examination of the coverage of actionable guidelines on climate-smart agriculture in South Africa. In the actionable guidelines on climate-smart agriculture reporting in South Africa, this article examined what cleaner production principles are included and how they have been used for communication. The underlying agroecological principles and theoretical frameworks of the extended parallel process model (EPPM), constructal level theory (CLT), and deficit model serve as the basis for this. These frameworks were coded as practice actuation and non-practice actuation, threat-induced and efficacy-induced, current incidence and future incidence, and so on.

The results and discussion part are divided into three sections: concepts related to risk communication theories, cleaner production practices, and indications of the extended parallel model, deficit model, and constructive level theory in practical guidelines. In the actionable guidelines on climate-smart agriculture, Figure 1 shows how often cleaner production strategies are used.

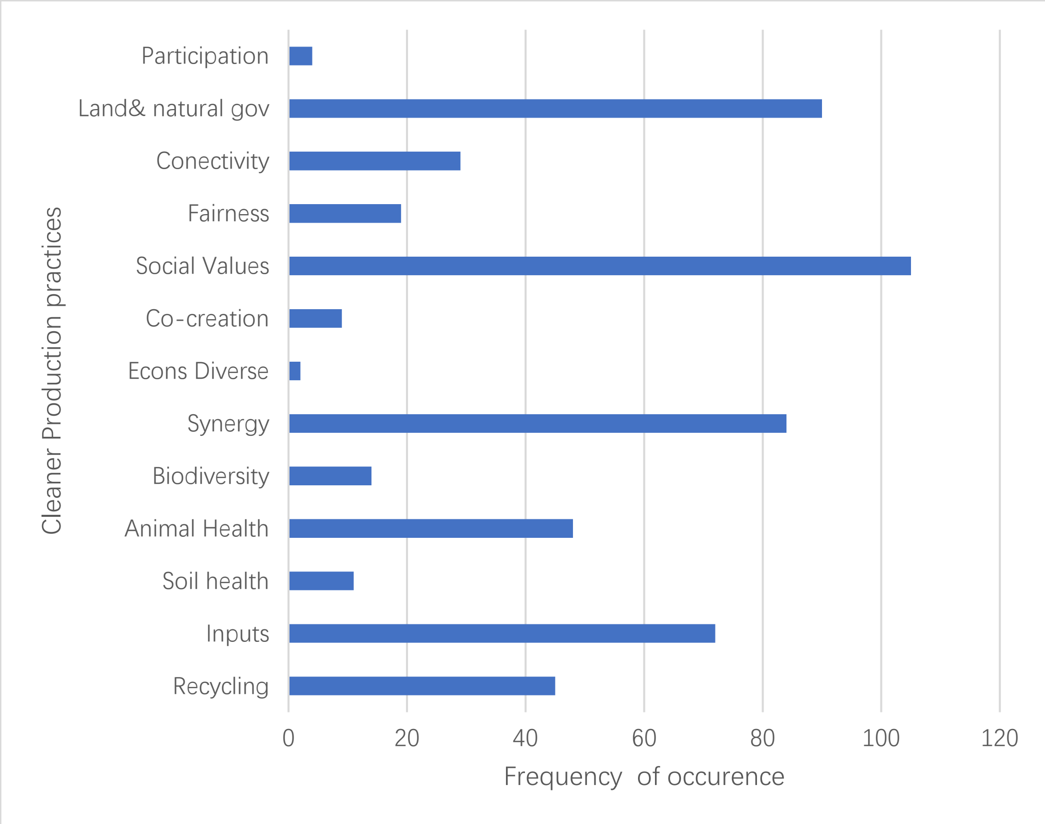

Figure 1. Frequencies of cleaner production practices.

4. Discussions

4.1. Figure 1 Results: Cleaner Production Practice Frequencies

As detailed in the following sections, the findings from Figure 1 addressed the cleaner production techniques that are communicated through actionable instructions on climate-smart agriculture.

4.1.1. Reusing and Recycling

The preferential use of local renewable resources and the closest possible resource cycles of biomass and nutrients are how HLPE (2019) operationalizes this. One of the most important cleaner production concepts identified in the text analysis of actionable guidelines on climate-smart agriculture is recycling. Recycling, which includes closed-loop, on-site, re-use, off-site, and reclamation including composting, animal manure, wastewater, grey water, and food wastes, saves money on waste handling, insurance premiums, and environmental damage costs.

4.1.2. Input Reduction

In order to assure cleaner production, the process of decreasing and removing reliance on purchased inputs and increasing self-sufficiency makes sure that inputs are processed, recycled, and reused while outputs reduce waste and emissions (Fet et al., 2023). As a cleaner production method, eco-efficiency in agriculture tackles all green, circular, and bioeconomy processes because agriculture produces a large amount of biomass (Tsangas et al., 2020; Jimenez-Lopez et al., 2020).

4.1.3. Soil Health

HLPE (2019) states that the actionable guidelines on climate-smart agriculture include zero and minimum tillage, integrated soil fertility management, conservation agriculture, compost, and biofertilizers. These practices are all part of the security and improvement of soil health and functioning for improved plant growth, especially by managing organic matter and enhancing soil biological activity. Similarly, vermicompost's humic compounds and improved microbiology activities reduce harmful environmental repercussions, ensuring a cleaner and greener process that involves bio-oxidation and stabilization (Bhattacharyya et al., 2021; Gupta et al., 2021).

4.1.4. Animal Health

As stated in the actionable guidelines on climate-smart agriculture, animal health is operationalized by HLPE (2019) as guaranteeing animal health and welfare through practices like crop-livestock integration, reduced enteric fermentation, recoupling of nutrient cycles, rangeland management, nutrition, welfare, and Holistic Regenerative Land Management (HLMR).

4.1.5. Biodiversity

At the field, farm, and landscape sizes, this is shown as the process of preserving and improving species variety, functional diversity, and genetic resources for the total biodiversity of agroecosystems over time and place (HLPE, 2019). According to Dawson et al. (2020) and the World Wide Fund for Nature (2021), species diversity increases productivity by providing essential ecosystem services, protects against the effects of drought and high temperatures, increases resilience to drought, floods, and other calamities, and lowers exposure to harmful synthetic agrochemicals.

4.1.6. Synergy

Synergy improves beneficial ecological interaction, synergy, integration, and complementarity among the components of agroecosystems (crops, trees, soil, water, and animals), claims HLPE (2019). According to research on Land Equivalent Ratios (LER), mixing two or more components in a production system enhances output compared to monocultures through an integrated system of biotic and abiotic diversity and alignment in time and space. This is related to recycling, using co-existing microbiomes to improve nutrient uptake and resilience (Singh et al., 2020).

4.1.7. Economic Diversification

Increasing small-scale farmers' financial independence and providing them with options for value addition will help them diversify their on-farm revenue streams and meet consumer demand (HLPE, 2019). This includes integrating waste and by-products from one activity to another, crop diversification, sustainable farming methods, and non-farm activities that reduce the risk of losses and improve resilience to environmental changes, as well as non-farm income-generating activities (Kurdyś-Kujawska et al., 2021).

4.1.8. Co-creation of Knowledge

The improvement of co-creation and horizontal information sharing, including local and scientific innovation, particularly through farmer-to-farmer exchange, is what HLPE (2019) defines as this. FAO (2021) and Glassman et al. (2018) state that in order to achieve sustainable development, agroecology necessitates a thorough understanding of the environment, culture, and social relevance. Co-creation and co-production of knowledge make it easier to connect different kinds of knowledge, improve sustainable results, encourage multi-stakeholder viewpoints, and encourage value-chain actors to learn and grow together.

4.1.9. Social Values

In order to create food systems that offer wholesome, varied, seasonally, and culturally appropriate meals, social values and diets are founded on the culture, identity, tradition, social equality, and gender of local communities (HLPE, 2019). The practical recommendations for climate-smart agriculture illustrated the social virtues of climate-smart adaptation and the advantages of diversity, including the intake of culturally significant foods and dietary diversity. According to Santoso et al. (2021), farmers benefit from more nutritional diversity when there is agrobiodiversity.

4.1.10. Fairness

All participants in food systems, particularly small-scale food producers, should have respectable and stable livelihoods based on fair trade, fair employment, and fair handling of intellectual property rights, according to HLPE (2019). "Cleaner production practices should improve codes of conduct, accountability, risk assessment, collaboration, control of their agricultural production, decision-making process, resource use, and livelihoods," the recommendations stressed (Principles for Responsible Investment, 2020).

4.1.11. Connectivity

By encouraging equitable and efficient distribution networks and reintegrating food systems into local economies, producers and consumers can maintain closeness and trust (HLPE, 2019). This promotes a circular and solidarity economy, whereby production and consumption minimise waste and optimize sustainability by extending the lifespan of materials and goods. Reusing and repurposing, recycling, cutting waste, and regenerating natural systems are all ideas that connectivity examines (Villalba-Eguiluz et al., 2023).

4.1.12. Land and Natural Resource Governance

HLPE (2019) operationalizes this as bolstering institutional frameworks to enhance, such as acknowledging and assisting smallholders, family farmers, and peasant food producers as sustainable managers of genetic and natural resources and as responsible governing bodies. Focusing on the benefits and opportunities for development, connecting climate policy to poverty reduction goals, providing clean energy to communities, and encouraging the growth of new low-carbon industries, helps to maximize opportunities to strengthen climate governance. Leveraging buy-in and effective engagement across levels of governance, both horizontally and vertically, is crucial (Averchenkova et al., 2019).

4.1.13. Participation

In order to enhance decentralized governance and local adaptive management of agricultural and food systems, HLPE (2019) advocates for social organization and increased involvement in decision-making by food producers and consumers. This entails farmer-to-farmer communication, empowering procedures, and the development of research agendas in participatory research (Dong et al., 2023).

4.2 Findings from Figure 2: Climate Smart Agriculture Actionable Guidelines' Susceptibility and Response Concepts for Cleaner Production

In the actionable suggestions on climate smart agriculture, the findings in Figure 2—which addressed susceptibility and response ideas in relation to cleaner production—are discussed in the following sections. In order to evaluate how well the practical suggestions for implementing climate-smart agriculture in South Africa implemented and conveyed notions of susceptibility and response in relation to cleaner production, the general coding across the three communication theories is described in this part. The content analysis of actionable instructions on climate-smart agriculture shows that the sustainable cleaner production practices of recycling, animal health, governance, synergy, and fairness have the highest frequency of codes in decreasing order. On the other hand, processes that receive a lot of responses include inputs, co-creation of knowledge, and social values. Value chain members' inclination to embrace cleaner production methods and the communication style's potential response is highlighted in the presentation of the actionable instructions. According to Duan et al. (2022), perceptions may change as a result of other role players' activities, but mitigation behavioral intentions are increased when production outlooks are perceived to be cleaner. Managers' and politicians' understanding of the threat posed by climate change affects their adoption of carbon offset programs and carbon neutrality (Wang et al., 2023).

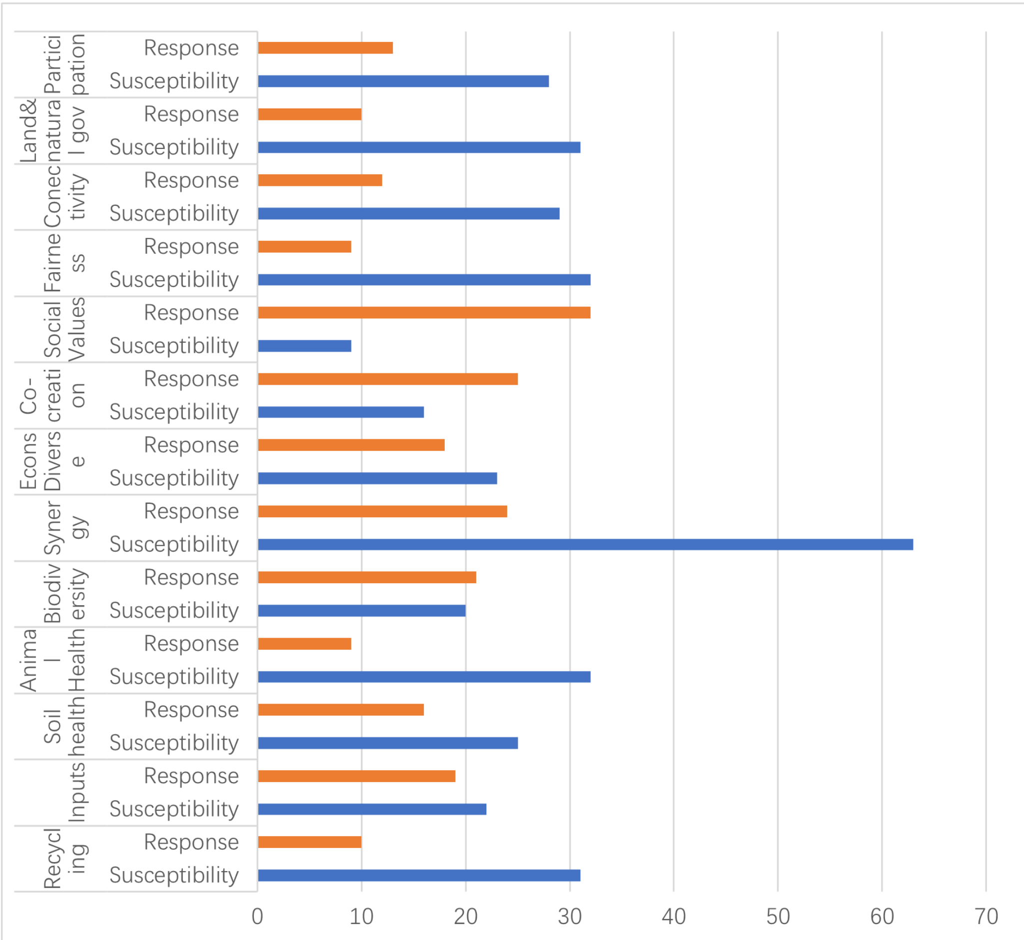

Figure 2. Frequency of concepts associated with risk communication theories in the actionable guidelines for climate smart agriculture.

4.3 Results from Figure 3: Indicators of the Deficit Model, Conceptual Level Theory, and Extended Parallel Model Frequencies in Practical Recommendations.

The indicators of the extended parallel model, construal level theory, and deficit model in relation to cleaner production practices in the actionable guidelines on climate-smart agriculture are presented in Figure 3 and are covered in the parts that follow.

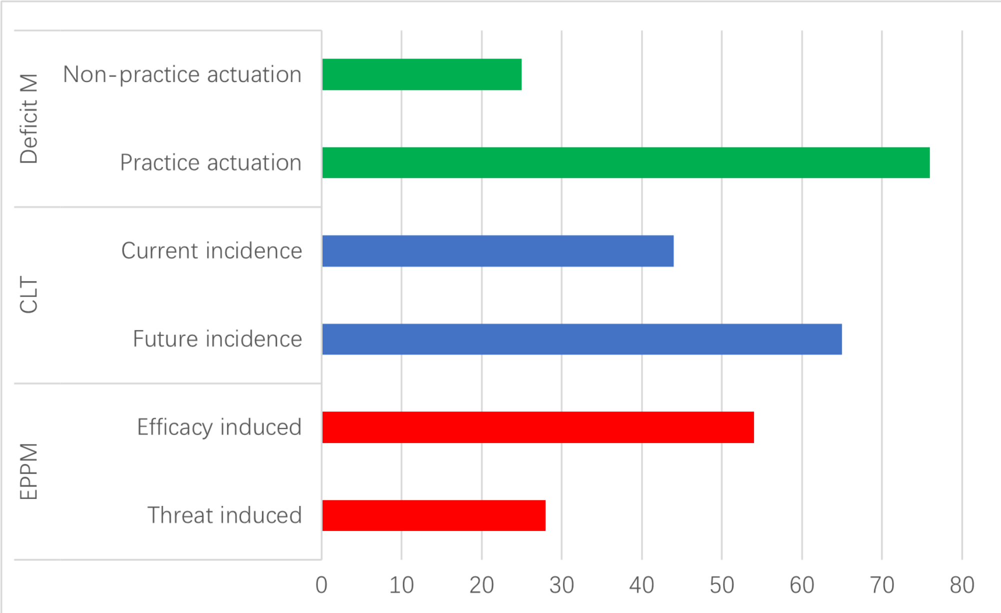

Figure 3. Frequencies of extended parallel model, construal level theory, and deficit model in actionable guidelines.

4.3.1. Threat-induced and Efficacy-induced

Threat-induced messages on cleaner production were coded 28 times, according to the content analysis of practical guidance on climate-smart agriculture. The recommendations created a threat by requiring clean production methods, which are necessary to prevent the spread of climate change's effects, including droughts, low productivity, and poor resilience. 54 different codes were used to encode efficiency-induced messages about cleaner production methods, which promoted recycling, reducing inputs, improving soil and animal health, and biodiversity, fostering collaboration, diversifying the economy, co-creating knowledge, social values, and fairness as ways to mitigate the effects of climate change. Improvements in soil structure, biomass conversion, soil carbon sequestration, and soil fertility would result from the effective response brought about by cleaner production methods. Environmental concerns and the impression of climate change encourage pro-environmental behavior (Chen et al., 2020).

4.3.2. Current Incidence as Well as Future Incidence

The actionable instructions on climate-smart agriculture coded the present incidence of cleaner production techniques 44 times and the future incidence 65 times. This suggests that the practical recommendations encourage more environmentally friendly production methods in both the present and the future. As a result, practices that do not support sustainable practices, integrated soil fertility management, local involvement, natural resource management, and livestock management techniques must be stopped. Numerous portrayals of climate change as an existential threat highlight the necessity of encouraging environmentally friendly behavior in order to boost cleaner output. Perception of climate change as a personal threat influences the intention to take action to reduce its impacts (Ma et al., 2023).

4.3.3. Actuation in Practice and Non-practice

The practical methods to embrace cleaner production are outlined in the climate-smart agricultural actionable guidelines. Practice actuation and non-practice actuation were tagged 76 and 25 times, respectively, from the actionable recommendations. The many phases for implementing cleaner production were discussed, but other cleaner practices were enumerated without any concrete measures to illustrate them. Cleaner production methods can be implemented using the practice and non-practice actions that are suggested in the actionable guidelines. According to Abunyewah et al. (2020), information about climate mitigation must be useful, accessible, inclusive, comprehensive, and integrate indigenous and scientific knowledge that examines cultural, social, and value systems.

5. Conclusions

This study's content examined practical recommendations for implementing climate-smart agriculture in South Africa in relation to cleaner production methods, as well as how to frame and style communication within agroecological principles. The practical guidelines address the key cleaner production methods of inputs, synergy, social values, and land and national government. Synergy, fairness, governance, animal health, and recycling are among the cleaner production practices that have the highest frequency of codes, in decreasing order, according to the content analysis of actionable guidelines on climate-smart agriculture. In contrast, social values, knowledge co-creation, and inputs are among the practices that have the highest frequency of responses.

Droughts, low productivity, and poor resilience are some of the repercussions of climate change that would worsen if clean production techniques were not mandated by the rules. The actionable guidelines are supposed to encourage cleaner production methods in both the present and the future. This means that practices that do not align with sustainable practices, integrated soil fertility management, local participation, natural resource management, and livestock management practices must be suspended. The practical methods to embrace cleaner production are outlined in the climate-smart agriculture actionable guidelines. While several cleaner practices were given without any concrete procedures for proof, the various stages of implementing cleaner production were presented. These findings have implications for future and existing incidence, practice actuation and non-practice actuation, and treatment-induced and efficacy-induced communication connected to cleaner manufacturing practices.

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