Dimensions of rural web as factors influencing farmer’s adoption of sustainable agricultural practices: A review

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Abstract. Agriculture is one of the main driving forces of rural development. Ensuring its sustainability in practice will provide economic, social and environmental benefits to the rural area. This will then contribute to sustainable rural development in general. Similarly, the processes of rural development are also the external influences that can facilitate the condition for sustainable practices to be carried out in ease of manner. The purpose of this paper is to analyse the importance of rural development processes as facilitating factors in farmer’s decision-making on the adoption of Sustainable Agricultural Practices (SAP). Using the method of Protocol, Search, Appraisal, Synthesis, Analysis and Reporting (PSALSAR), this study has adapted six steps towards conducting a systematic literature review. A total of 50 empirical studies obtained from Scopus database were reviewed to determine the significant factors influencing the adoption of SAP. These factors were then coded into six dimensions of rural development processes which are endogeneity, novelty, market governance, institutional, social capital and sustainability. The finding of this paper has discovered that the institutional dimension contains the most factors influencing SAP adoption, followed up by social capital. The rural development dimension with the least significant factors from the empirical studies reviewed is the novelty dimension. This finding has highlighted the gap in the literature regarding factors influencing adoption. Future research should consider exploring the relationship between farmers’ novelty practices with their decisions in adopting SAP.

1. Introduction
In many different countries, agriculture is the powerhouse of its economy. Natural resources have a significant role in accommodating agricultural production, and the unsustainable use of these resources will only create future negative impacts. Conventional agriculture has been linked to many environmental concerns and this creates the need for agriculture to be practised sustainably. Besides providing benefits to the conservation of the environment, sustainable agricultural practices (SAP) also significantly reduce household poverty [1]. Sustainably practising agriculture contributes to the well-being of the rural community, it’s a means towards obtaining sustainable rural development. SAP is not a new concept, yet the rate of adoption all over the world has not been significantly satisfying.
The studies of farmers’ behaviour on adoption have evolved since its initial findings in the 1980s [2]-[3]-[4] and the robust literature has provided a countless amount of framework in understanding farmer’s adoption. The need to understand these influencing factors is crucial to encourage more adoption of sustainable measures. The novelty of this review paper lies in the integration of an idea that rural development processes also play an important role in providing the external conditions that influence farmer’s adoption. The purpose of this paper is to analyze the importance of rural development processes as facilitating factors in farmer’s decision-making on the adoption of SAP.

2. Adoption of sustainable agriculture in the context of rural development
Addressing the environmental problems of intensive agriculture is an important feature of rural development. It is essential to link agriculture production with conservation to plan for the rural areas. Sustainable rural development can be defined as the economic, social and cultural improvement that protects the environment while contributing to the well-being of the rural community [5]. The modernization of agriculture which has resulted in environmental degradation has created an increase of awareness on the importance of conserving natural resources [6]. This has provided the need for sustainable agriculture to be one of the main agendas for rural development.

According to the concept of rural web, sustainable rural development consists of six dimensions of processes. The dimensions are endogeneity, novelty, market governance, institutional, social capital and sustainability [7]. Rural web is a conceptual model that represents the idea that for sustainable rural development to occur, it has to be supported by these six dimensions as its supporting resources. From the perspective of SAP adoption, these six dimensions have the potential of acting as influencing factors. Agricultural practices that are considered sustainable are mostly tailored towards the condition of its farmland. Most SAPs that are commonly practised and easily executed by farmers are conservational practices such as conservation tillage, crop rotation, composting, crop diversification, and intercropping. The different types of SAPs covered in this review are listed out in Table 1 below.

3. Materials and methods
Using the PSALSAR method, this study has adapted six steps towards conducting a systematic literature review [8]. The six steps are protocol (define the research scope), search (define searching string and types of databases), appraisal (pre-defined literature inclusion and exclusion, and quality assessment criteria), synthesis (extract and categorized the data), and analysis (narrate the result and finally reach into conclusion), and reporting results (stating the procedure followed and communicating the result). The Scopus database was used to obtain the empirical studies for this review due to its large database of peer-reviewed literature. The screening process for the abstracts was performed using a tool called Abstrakr. Abstrakr is a system to facilitate screening for systematic reviews [9]. Once the papers were screened to fit the inclusion criteria, Google Scholar was then used as a secondary database to perform citation tracking.

| Author(s)          | Study Area     | Sample Size | Type of SAP                                         | Statistical Model Used         |
|--------------------|----------------|-------------|----------------------------------------------------|--------------------------------|
| Abdulai et al. [10] | Zambia         | 408         | Crop rotation, cover crops                         | Factor analytic model          |
| Adnan et al. [11]  | Malaysia       | 74          | Green Fertilizer Technology                        | Structural equation model      |
| Adusumilli and Wang [12] | United States | 500       | Best Management Practices                          | Probit model                   |
| Agholor and Nkosi [13] | South Africa | 100         | Water Conservation Practices                        | Logit model                    |
| Amare and Simane [14] | Ethiopia      | 442         | Water and Soil Conservation Measures                | Logit model                    |
| Arunrat et al. [15] | Thailand       | 661         | Irrigation system, crop rotation                   | Logit model                    |
| Aryal et al. [16]  | India          | 1267        | Climate Smart Agriculture                          | Probit model                   |
| Authors | Country | Year | Practice/Technology                                                                 | Model/Method                          |
|--------|---------|------|-------------------------------------------------------------------------------------|---------------------------------------|
| Badu-Gyan et al. [17] | Ghana | 295 | Organic farming                                                                      | Logit model                           |
| Bavorová et al. [18] | Russia | 110 | Reduced tillage practices                                                            | Logit model                           |
| Branca and Perelli [19] | Ethiopia | 2218 | Climate Smart Agriculture                                                           | Fractional regression                 |
| Canales et al. [20] | United States | 290 | Soil Conservation Practices                                                           | Logit model                           |
| Debie [21] | Ethiopia | 155 | Compost and crop rotation                                                            | Logit model                           |
| Dhehibi et al. [22] | Tunisia | 250 | Water and Soil Conservation Measures                                                 | Logit model                           |
| Etsay et al. [23] | Ethiopia | 230 | Sustainable Land Management                                                          | Logit and probit model                |
| Faridi et al. [24] | Iran | 538 | Water and Soil Conservation Measures                                                 | Structural equation model             |
| Han et al. [25] | China | 385 | Conservation tillage                                                                | Logit model                           |
| Hou and Hou [26] | China | 442 | Low-carbon agriculture                                                               | Structural equation model             |
| Jabbar et al. [27] | Pakistan | 612 | Sustainable Intensification Practices                                                | Probit model                          |
| Jha et al. [28] | Tanzania | 701 | Water Conservation Practices                                                         | Logit model                           |
| Ji et al. [29] | China | 266 | Conservation tillage                                                                | Probit model                          |
| Kanyenji et al. [30] | Kenya | 334 | Soil Carbon Enhancing Practices                                                      | Probit model                          |
| Karidjo et al. [31] | Niger | 149 | Soil and Water Control Technology                                                    | Logit model                           |
| Kotu et al. [32] | Ghana | 1284 | Sustainable Intensification Practices                                                | Probit model                          |
| Kpadonou et al. [33] | Burkina Faso | 440 | Water and Soil Conservation Measures                                                 | Probit model                          |
| Kurgat et al. [34] | Kenya | 685 | Sustainable Intensification Practices                                                | Probit model                          |
| Lawin and Tamini [35] | Benin | 2800 | Agri-environmental practices                                                        | Endogenous treatment effects model    |
| Makate et al. [36] | Zimbabwe and Malawi | 1173 | Climate Smart Agriculture                                                           | Regression with inverse probability weighting |
| Mekuriaw et al. [37] | Ethiopia | 269 | Water and Soil Conservation Measures                                                 | Logit model                           |
| Mihiretu and Yimer [38] | Ethiopia | 176 | Sustainable Land Management                                                          | Logit model                           |
| Muchai et al. [39] | Kenya | 291 | Zai pit technology                                                                  | Logit model                           |
| Mujeyi et al. [40] | Zimbabwe | 386 | Climate Smart Agriculture                                                           | Logit model                           |
| Muriiu-Ng'ang'a et al. [41] | Kenya | 351 | Rain water harvesting                                                               | Logit model                           |
| Mutua-Mutuku et al. [42] | Kenya | 248 | Soil Fertility And Water Management                                                  | Tobit model                           |
| Ndagijimana et al. [43] | Burundi | 160 | Sustainable Land Management                                                          | Logit model                           |
| Ng'ang'a et al. [44] | Kenya | 45  | Sustainable Land Management                                                          | Probit model                          |
| Nguyen and Nguyen [45] | Vietnam | 318 | Organic farming                                                                    | Exploratory factor analysis           |
| Nigussie et al. [46] | Ethiopia | 300 | Sustainable Land Management                                                          | Probit model                          |
| Nshangase et al. [47] | South Africa | 185 | Conservation Agriculture                                                            | Logit model                           |
| Olawuyi [48] | Nigeria | 350 | Conservation Agriculture                                                            | Heterogeneous treatment effects model |
| Paul et al. [49] | Guadeloupe | 520 | Compost                                                                            | Logit model                           |
| Sileshi et al. [50] | Ethiopia | 408 | Water and Soil Conservation Measures                                                 | Probit model                          |
| Suwanmaneepong et al. [51] | Thailand | 108 | Organic farming                                                                    | Logit model                           |
| Tinh et al. [52] | Vietnam | 294 | Good Agricultural Practices                                                         | Structural equation model             |
| Tran et al. [53] | Vietnam | 579 | Climate Smart Agriculture                                                           | regression model                      |
| Tsige et al. [54] | Ethiopia | 344 | Conservation Agriculture                                                            | Logit model                           |
| Tu et al. [55] | Vietnam | 202 | Eco-friendly practices                                                              | Logit model                           |
| Zakaria et al. [56] | Ghana | 300 | Climate Smart Agriculture                                                           | regression model                      |
| Zeng et al. [57] | China | 550 | Sustainable Agricultural Technologies                                                | Probit model                          |
| Zeweld et al. [58] | Ethiopia | 350 | Sustainable Land Management                                                          | Probit model                          |
| Zhang et al. [59] | China | 924  | Eco-friendly practices                                                              | Logit model                           |
A total of 50 empirical studies from the year 2017 to 2021 carried out in different countries were included as research materials for this review. The inclusion and exclusion criteria for article screening is explained in detail in Figure 1 below. These studies were reviewed to determine the significant factors influencing SAP adoption. These factors were then coded into six dimensions of rural development processes by using NVivo 12 software. The dimensions of rural development are endogeneity, novelty, market governance, institutional, social capital and sustainability [7].

Figure 1. Inclusion and exclusion criteria for the article screening process.

4. Factors influencing adoption of SAP

4.1. Institutional and social capital
According to the empirical studies reviewed in this paper, the institutional dimension contains the most factors that influence the adoption of SAP as portrayed in Figure 2 below. The institutional dimension refers to the constellations that solve coordination problems and support cooperation among rural dwellers. Factors in this dimension that influences the adoption of SAP are access to public programs, access to credit and subsidies, frequent extension delivery system, training provided by local institutions, and membership within an agricultural cooperative. Institutional networks play a big role in directly and indirectly spreading the information regarding SAP to farmers. It can be described well through frequent visits from the extension agents, active participation of farmers in organizations, training and workshops, and group membership [10]-[13]-[14]-[18]-[19]-[21]-[22]-[25]-[26]-[37]-[56]. These are highly influential towards technology diffusion as it supports the dissemination of information regarding SAP. As for the dimension of social capital, it refers to the norms and networks which enables people to act collectively for a common purpose. Factors such as active involvement in social networking, involvement in collective action, relationship and communication with other farmers were found to be influential towards the adoption of SAP. This is because connections between farmers in social spheres act as sources of information for farmers to get introduced to practices that are sustainable [14]-[15]-[27]-[28]-[45]-[48]. This is especially useful towards introducing information on sustainable practices that were not familiar to the farmers.
4.2. Sustainability, market governance, endogeneity and novelty

According to the rural web conceptual model, the sustainability dimension refers to the multifunctionality of agriculture. This can be explained through the act of diversifying the income of farmers through practices that go alongside the agricultural produce. Factors such as off-farm income and diversification of activities were found to be influential in farmers’ adoption of SAP [31]-[37]-[44]. As for market governance, this dimension refers to the capacity to control and strengthen existing markets. Factors such as market access and market integration were found to be influential towards the adoption of SAP [16]-[32]-[34]. With regards to the endogeneity dimension, it refers to the element of local context that affects rural economic activities. Factors such as the distance of farmland from home and the environmental condition of the farm were found to be influential towards the adoption of SAP among farmers. The environmental condition of the plot of farming land significantly affects adoption as arid or semi-arid agro-ecological zones adopt more climate-smart intense technology packages [19]. As for the novelty dimension, it refers to the re-patterning of resource use and the capacity to make new territorial connections that strengthen the local setting [60]. This dimension seeks to highlight new practices and insights that are carried out on the farm. However, findings from the review of literature have not been exploring the connection between novelty practices with the adoption of SAP.

Table 2 below shows the SAP adoption factors found from the empirical studies that can be categorized under dimensions of sustainable rural development.

| Dimensions       | Related SAP adoption factors                                           |
|------------------|------------------------------------------------------------------------|
| Institutional    | Access to public programs, credit and subsidies, frequent extension delivery system, training provided by local institutions, membership within an agricultural cooperative |
| Social Capital   | Active involvement in social networking, involvement in collective action, relationship and communication with other farmers |
| Sustainability   | Off-farm income, diversification of activities                          |
| Market Governance| Market access, market integration                                      |
| Endogeneity      | Farm distance from home, environmental condition of farm location      |

5. Conclusions

Based on the finding of this paper, the adoption of sustainable agricultural practices conducted in most literature has proven that the factors mostly can be categorized into the dimensions of sustainable rural development. However, the sustainability, market governance, endogeneity dimensions were least associated with influential factors. Factors related to the novelty dimension were not recorded in any
findings from the reviewed studies. Therefore, the analysis done has highlighted the gap in the literature regarding factors influencing adoption. There is a need to address the connection between these dimensions with farmers’ decision to adopt sustainable practices to acquire a comprehensive representation of the whole situation. Future research should consider exploring the relationship of novelty practices and agricultural multifunctionality with the adoption of sustainable agricultural practices.

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