The Effect of Tailored Digital Content, Ability to Access and Create It, on Leveraging on Developmental Benefits of Digital Services in Agriculture by Smallholder Farmers and Underserved Communities

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Abstract: This paper's purpose was to investigate the effect of tailored digital content (TDC), the ability to access (ACC) and create or add digital content (ADC), and leveraging on developmental benefits (LDB) of digital services in agriculture (DSA) by smallholder farmers and underserved communities. The study achieved this goal by pursuing three objectives: analysing tailored digital content, the ability to access the content, and the capacity to create or add digital content to leverage the developmental benefits of DSA. A representative random sample of 1510 smallholder farmers from Laikipia County in Kenya were the respondents, with data collected using an assisted structured questionnaire. The paper established a positive and statistically significant relationship between the independent and dependent variables. The resulting linear regression model is Leveraging Developmental Benefits of DSA=1.688 + 0.103×Tailored Digital Content+0.292×Access to DSA+0.151×Ability to Add to Content. Further research using multi-county variables is recommended.

Keywords: *Digital, Agriculture, Content, Farmers, Developmental benefits*

1. Introduction

1.1 Leveraging on Developmental Benefits of Digital Services in Agriculture

The challenge of leveraging developmental benefits for smallholder farmers in digital services in agriculture presents several gaps in practice, theory, and methods. The digital divide in agriculture has been highlighted, indicating limited access to information and digital technologies for smallholder farmers [1]. This inequality in access hinders the potential for developmental gains. Additionally, the effectiveness of digital agricultural extension services in improving agricultural performance among smallholder farmers is not fully understood, emphasising the need for empirical evidence to support their impact [2]. Furthermore, smallholder farmers' adaptation to climate change is influenced by access to relevant, credible, and up-to-date agricultural information, indicating the importance of information access for agricultural adaptation [3]. These gaps in practice, theory, and methods underscore the need for further research to address issues of equitable access, the effectiveness of extension services, and the role of information access in agricultural adaptation. Addressing these gaps is crucial for leveraging the developmental benefits of digital services in agriculture for smallholder farmers.

This paper defines leveraging the developmental benefits of digital services in agriculture as harnessing the advantages and opportunities provided by digital technologies and platforms to promote and enhance agricultural practices and processes, including utilising digital tools for activities such as precision agriculture, data-driven decision-making, and the dissemination of agricultural advice and information through digital channels [4] [5]. The use of digital technology in agriculture has been shown to significantly contribute to sustainable agriculture, with the ultimate goal of realising sustainable development [6] [7]. Digital technologies are rapidly permeating agriculture, from laboratory to field, and are being developed and adopted across the agri-food system, from farm to fork [8]. Furthermore, developing and adopting digital technologies in agriculture has created new learning opportunities and fostered new demands, relations, and tensions in agricultural decision-making [9]. The evolution of technological patterns in agriculture also reveals the role of digitalisation in developing the modern technological production of agricultural products [9]. Nonetheless, smallholder farmers and underserved communities will not reap developmental benefits from leveraging the developmental benefits of digital services in agriculture unless digital equity is achieved. For this reason, this paper proposes three interventions: the provision of tailored digital content, access to digital content, and the capacity to create digital content.

1.2 Tailored Digital Content

Tailored digital content may be defined as digital information or material that is customised or personalised to meet the specific needs, preferences, or characteristics of a particular user or audience, designed to be more relevant and engaging to the target audience, leading to increased user engagement and satisfaction [10] [11] [12]. Tailored digital content in agriculture has been a subject of interest due to its potential impact on smallholder farmers and the developmental benefits of digital services in agriculture.

Prior studies, for instance, have utilised participatory video to disseminate targeted agricultural information to small and marginal farmers in India [13]. However, although this approach has shown promise in providing tailored digital content to farmers, it is essential to consider criticisms from movements advocating for structural transformations in agriculture, such as agroecology or community-based organic farming, as they highlight patterns of inequalities in digital agriculture [14]. These criticisms emphasise the need to ensure that tailored digital content initiatives address the concerns of all stakeholders, including smallholder farmers and movements for food sovereignty. Furthermore, the role of agricultural advisers as trusted sources of information and mediators of sustainable agricultural practices has been historically recognised [15]. This highlights the importance of ensuring that tailored digital content initiatives integrate the expertise and knowledge of agricultural advisers to leverage developmental benefits for smallholder farmers effectively.

1.3 Access to Digital Content

The ability to access digital content encompasses the capability and opportunity for individuals to obtain and retrieve digital information from various sources, such as the internet, databases, or digital libraries and platforms, including physical access to digital content, the availability of the appropriate software, and the degree to which the structural information of the content is accessible for processing by other applications [10] [11] [12]. Previous studies have established that women cannot leverage digitalisation, as the COVID-19 pandemic exposed significant existing gender digital divides. Digital solutions should include all farmers, especially with regard to access to digital content and adopting climate-smart farming practices if such divides are to be reduced [16].

1.4 Ability to Create and Add Digital Content in Agriculture

The ability to create or add to digital content refers to the capacity and skill of individuals to generate, produce, or contribute new digital information, material, or media, including the creation of digital content in various forms, such as text, images, videos, and multimedia, and the incorporation of this content into digital platforms or systems [7] [17] [18]. There is empirical evidence [19] [20], that emphasises the critical elements for establishing and embedding digital tools and services in everyday agriculture in Africa, including access to digital tools, enabling digital infrastructure, digital literacy among farmers and extension officers, and aligning digital tools with local customs and norms. Additionally, it highlights the development of digital services to improve smallholder farmers' access to agricultural information, indicating the potential for leveraging developmental benefits through digital content. Furthermore, research [21] suggests that digitally delivered advice to farmers increases yields and the probability of adopting recommended inputs, which may be critical to reducing poverty, food insecurity, and environmental risks. This aligns with the hypothesis that access to digital content can positively influence developmental benefits in agriculture.

2. Objectives

The specific objectives of this paper were:

1. To investigate the influence of tailored digital content (TDC) on leveraging the developmental benefits (LDB) of digital services in agriculture by smallholder farmers and underserved communities,
2. To analyse the influence of the ability to access digital content (AAD) on leveraging the developmental benefits (LDB) of agricultural digital services by smallholder farmers and underserved communities, and
3. To study the capacity to create or add digital content (CCA) influence on leveraging the developmental benefits (LDB) of agricultural digital services by smallholder farmers and underserved communities.

3. Methodology

3.1 Research Design

This study was part of a more considerable cross-sectional research on digital services for enhanced agricultural productivity, improved livelihoods, and social inclusion of farmers in three sub-counties in Laikipia County in Kenya (DSA III). This paper adopted a descriptive survey design and used an assisted questionnaire to obtain data from a representative sample..

3.2. Population, Sample Design and Sample Size

The DSA Project I -2020/2021 and DSA Project II -2021/2022 delivered several interventions to 38,026 farmers. These interventions included DSA benefits awareness creation, digital skills literacy training, locally relevant digital content, reliable and affordable intent access, DSA platforms, DSA bundled services, and access to champion farmers. In 2023, DSA Project III used stratified random sampling to obtain a sample of 1,510 farmers selected to represent the population of 38,026 farmers. Each stratum was assigned a proportional sample size relative to the entire population, as shown in Table 1. Since the more significant the sample, the better, in this paper, the sample size was deliberately made to be four times that calculated by the formula provided [23].

Table 1: The Stratum and Respective Sample Proportions

Target Population			Sample	
Sub-county Name	**Strata count**	**Percentage of target population**	**Sample count**	**Percentage of sample respondents**
Laikipia East	15,150	40%	638	42.25%
Laikipia North	5,840	15%	253	16.75%
Laikipia West	17,036	45%	619	40.99%
Total	**38,026**	**100%**	**1,510**	100.00%

3.3. Instruments and Data Collection

This paper defines digital services for agricultural (DSA) smallholder farmers as individuals engaged in activities along agricultural value chains with access to computing devices and the internet or basic data connectivity. In constructing the survey instrument, the researchers used a 5-point Likert scale where '1' was used for strongly disagreed and '5' for strongly agreed. The design drew insights from literature synthesis and the researchers' experience in the application of digital technologies in digital services for agriculture. However, validated construct items were unavailable from the literature for adaptation, so the researchers innovated almost all of the survey items. The researchers further used the feedback from the pilot test and inputs from agriculture and digital services experts, including county agricultural officers, to refine the instrument. The instrument was then deployed on the Kobolt online platform, where some of the resulting refinements included simplifications for online quality and presentation adapted from prior research, including those on digital skills training [24].

3.4 Research Procedure

The farmers who participated in the study had their roles clarified and gave informed consent. The field research assistants were trained to assist the farmers and aid them in responding to the survey. A pilot test of the survey questionnaire was done on ten farmers not included in the final survey. Participatory workshops and meetings in each sub-county involving local farmers and stakeholders were conducted. Additionally, meetings with all stakeholder engagement and support were done to educate them on their roles and delivery time in the project.

3.4.1 Reliability & Validity

The study utilised three approaches to test reliability: internal reliability, achieved when the Cronbach's alpha value is 0.6 or higher [25]; composite or construct reliability, achieved when a composite reliability value of $CR \geq 0.6$ [25]; and the average variance extracted (AVE); which is the average percentage of variation explained by the items in a construct and requires that $AVE \geq 0.5$ [25].

The study measured the validity of the constructs' measurements using three approaches: convergent validity, achieved when all items in a measured model are statistically significant and also measured using AVE; construct validity, realised when the fitness indices achieve the level of acceptance; and discriminant validity realised when the measurement model is free from redundant items, the correlation between each pair of the latent exogenous construct

is less than 0.85, and the square root of AVE for the construct is higher than the correlation between the respective constructs [26].

3.4.2 Diagnostics Tests

The study used diagnostic tests to measure whether the assumptions on regression analysis, that is, sample adequacy and multicollinearity, hold [27], [28].

3.5 Data Analysis Methods and Tools

The collected data was coded, cleaned, and analysed using the SPSS version 27. The study applied an existential abduction approach using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) to determine the underlying factor structure. Multivariate linear regression was used to test the findings of the study objectives. Descriptive and inferential statistics were used to analyse data for the study.

4. Technology Description

In the context of this paper, this study states that tailored digital content, access to digital content, and the ability to create and add to the content have a positive and significant influence on leveraging developmental benefits in digital agriculture services. Collaborative, participatory action research was adopted to measure the said influence, guided by the theory of change as illustrated in Figure 1. A survey was then taken as an intermediate activity over two years after the farmers received the interventions.

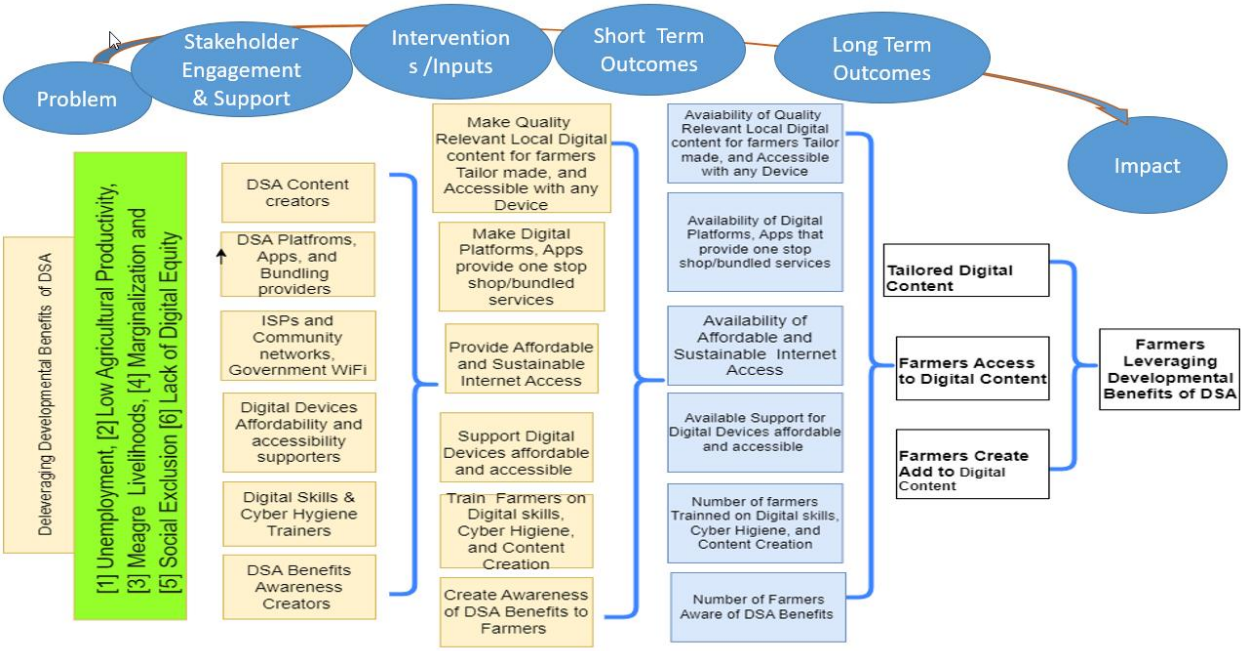

Figure 1: Theory of change for farmers leveraging developmental benefits of DSA

Tailored digital content was created and provided by content providers, platforms and providers as agents. The content was accessed through the internet and supported by local community networks. In contrast, the ability to create and add content was imparted through training by basic digital skills trainers.

5. Research Conceptual Framework

The conceptual framework for this study was modelled using the independent versus dependent variables concept. The independent variables were tailored digital content, access to digital content, and the ability to create and add to content.

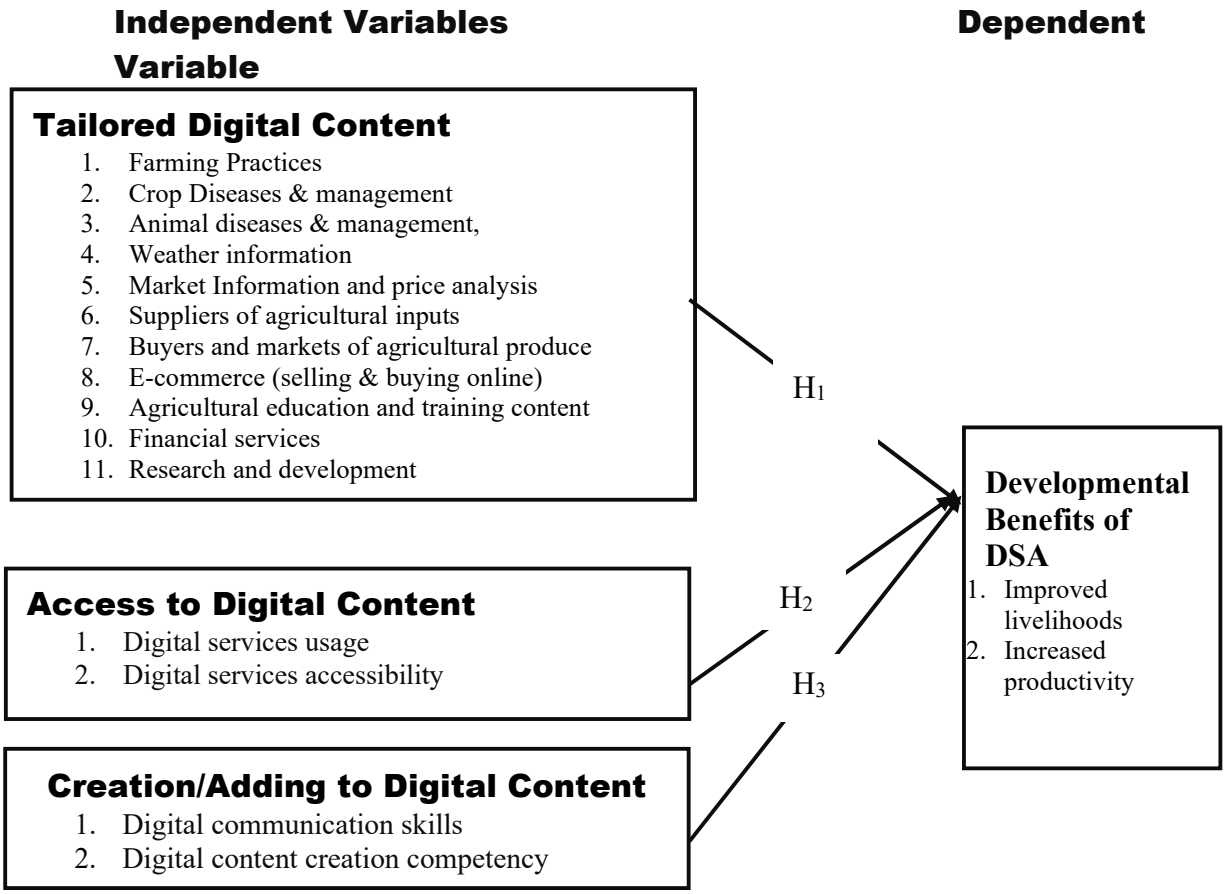

Figure 2: Research Conceptual Framework

The tailored digital content variable was measured by assessing eleven key dimensions, including farming practices, crop diseases and management, animal diseases and management, weather information, market information and price analysis, suppliers of agricultural inputs, buyers and markets of agricultural produce, e-commerce (selling & buying online), agricultural education and training, financial services, and research and development. These eleven dimensions were assessed for each of the thirteen (13) content delivery digital platforms used in the larger study during the interventions. These thirteen platforms were: Laikipia Agricultural Observatory platform, Laikipia Good Agricultural Practices, Laikipia GAPs app, Laikipia Wakulla Market, ACWICT digital skills training platform (ACWICTS4E), ACWICT S4E app, Plan tix app, Kenya Agricultural Observatory platform, KALRO Selector, KALRO Good Agricultural Practices app, Centre for Agriculture and Biosciences International (CABI), and ACRE Africa, Digi Farm. For this paper's objective, the assessments of the last three platforms (CABI, ACRE Africa, and Digi Farm) were combined and averaged to give the measurement value of 'tailored digital content'.

Similarly, the developmental benefits of DSA were assessed by examining fourteen key dimensions: improved livelihoods, increased productivity, improved nutrition, resource efficiency, reduced cost and labour, improved crop management, increased internet access, networking and collaboration, resilient from climate change, mitigation to climate change,

access to markets, data-driven decision, empowerment of women, and usage of DSA. For this paper's objective, the assessments, using a five-point Likert scale of the first two dimensions, namely improved livelihoods and increased productivity, were averaged to give the measurement value of 'developmental benefits of DSA'.

Finally, access to digital content was measured by averaging the measurements of its two dimensions: digital services usage and accessibility. Creation or adding to digital content was measured by averaging the measurements of its two dimensions: digital communication skills and digital content creation competency.

6. Results of Regression Analysis

The overall model performance as established by the regression analysis model summary, suggested that combining the three independent variables explains a substantial portion of the variance in the developmental benefits of DSA. The R-squared value of 0.372 indicates that the model can account for approximately 37.2% of the variability in the dependent variable. Table 2 shows the regression results.

Table 2: Regression Results

	Unstandardised Coefficients		Standardised Coefficients			Collinearity Statistics	
Model 1	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	1.688	.059		28.753	.000		
Tailored digital content	.103	.013	.168	8.014	.000	.951	1.051
Access to content	.292	.015	.418	19.297	.000	.891	1.123
Creation of digital content	.151	.013	.260	11.775	.000	.852	1.174

Moving to the individual predictor variables, the regression coefficients provide insights into the strength and direction of their impact on the dependent variable. Thus, the regression analysis suggests that access to DSA, the ability to add to content, and tailored digital content are all significant predictors of the leveraging developmental benefits of DSA. These findings provide valuable insights for program developers and administrators, emphasising the importance of these factors in enhancing the perceived benefits of DSA for participants. Incorporating the unstandardised coefficients for each independent variable, the regression equation is thus written as follows:

$$\textit{Leveraging developmental benefits of DSA} = 1.688 + 0.103 \times \textit{Tailored digital content} + 0.292 \times \textit{Access to DSA} + 0.151 \times \textit{Ability to add to content}$$

7. Business Benefits

Our study on the impact of tailored digital content, accessibility, and creation capabilities on leveraging developmental benefits within agriculture has unveiled many business advantages for smallholder farmers and underserved communities. Two key ones include enhanced market access and financial inclusion, whereby digital content tailored to the needs of underserved communities has dismantled traditional barriers to market access. Smallholder

farmers now enjoy improved connectivity to buyers and financial institutions, fostering economic inclusion and reducing dependency on intermediaries.

Empowering local entrepreneurship, thereby allowing local entrepreneurs to access and create digital content, has empowered local entrepreneurs within underserved communities. Farmers are now equipped to explore diverse agricultural ventures, aided by digital tools that provide market insights, financial guidance, and relevant skill-building resources. Additionally, the accessibility of tailored digital content has streamlined knowledge transfer and skill development initiatives. Smallholder farmers can now access educational resources, training modules, and best practices, leading to improved agricultural techniques and increased productivity.

8. Conclusions

Our investigation into the effect of tailored digital content, accessibility, and creation capabilities in leveraging developmental benefits within agriculture has uncovered a paradigm shift in how smallholder farmers and underserved communities engage with digital services. Several vital conclusions emerge, illuminating the path forward for sustainable agricultural development.

As we navigate the ever-evolving landscape of digital agriculture, our findings illuminate a promising trajectory where technology becomes a catalyst for inclusive, sustainable, and prosperous agricultural practices. Further research is needed to increase knowledge and catalyse continued progress in this dynamic field. The following recommendations are proposed for future investigations: conduct longitudinal studies to assess the sustained impact of tailored digital content on the developmental benefits observed in smallholder farming and underserved communities; investigate smallholder farmers' user experience and adoption patterns in interacting with digital services; assess the effectiveness of digital literacy and training programmes in enhancing the ability of smallholder farmers to access and create digital content.

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The African Centre for Women, Information and Communications Technology (ACWICT), is a Kenyan-based ICT for Development (ICT4D) organisation with a regional reach whose mission is to promote women's and youth's access to and knowledge of ICTs as tools for sustainable development. ACWICT addresses challenges faced by high-potential but disadvantaged women and youth, particularly those from marginalised and underserved communities, to provide digital solutions that improve access to education, employment, food security, health, and food security for better livelihoods. Jimmy Macharia is a Professor of Information Systems and a researcher in ICT/ICT4D /K4D at the United States International University-Africa.

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