Vol.16 No.1(2025),1-14
DOI:https://doi.org/10.61841/turcomat.v16i1.14969

BUILDING A DYNAMIC CROPPING TREND VISUALIZATION SOFTWARE TO ASSESS FARMING PROGRESSIVENESS

MUHAMMAD ABDUL MANNAN[1], MD. MUNTASEER AL MAMUN, MD[2]. NAZIUR ISLAM LEMON[2], SHAMMI AKTER SIMA[2], MD. ASHIKUR RAHMAN[2], MAHRUPA TASNIM[3]

[1]Lecturer, Department of Agronomy, EXIM Bank Agricultural University Bangladesh, Chapai Nawabganj-6300, Bangladesh

[2] EXIM Bank Agricultural University Bangladesh, Chapai Nawabganj-6300, Bangladesh

[3]Sher-e-Bangla Agricultural University

Corresponding Author: Muhammad Abdul Mannan

Email: mamannan4975@gmail.com

ABSTRACT

This thesis presents a comprehensive study that unfolds in two key dimensions. Firstly, a novel cropping trend visualization software was developed, aiming to provide a dynamic and insightful tool for assessing farming progressiveness. This software, a product of meticulous design and implementation, serves as an innovative instrument for visualizing and analyzing cropping trends in agriculture. In the second part of the study, the software was utilized to gather descriptive and inferential statistical data from a sample of 111 farmers. The data analysis reveals noteworthy correlations between specific agricultural practices and farming progressiveness. Key findings indicate significant positive associations between technology adoption, climate adaptation, crop variety diversity, and environmentally sustainable practices with higher levels of farming progressiveness. While certain trends exhibit statistical significance, caution is advised in drawing robust conclusions for factors with limited statistical support. These empirical insights provide a valuable foundation for policymakers, agricultural extension services, and stakeholders to strategically promote practices that enhance the overall progressiveness of farmers. The dual contribution of the developed software and the derived insights from its application underscores the significance of integrating technology in advancing sustainable and progressive agricultural practices.

INTRODUCTION

Agriculture is the backbone of many economies (Newman, *et al.,* 2020). Agricultural development is one of the most powerful tools to end extreme poverty, boost shared prosperity, and feed a projected 10 billion people by 2050. Growth in the agriculture sector is two to four times more effective in raising incomes among the poorest compared to other sectors. Agriculture is also crucial to economic growth: accounting for 4% of global gross domestic product (GDP) and in some least developing countries, it can account for more than 25% of GDP (The World Bank, 2023).

However, the ever-increasing global population, coupled with the challenges of climate change and resource constraints, places significant pressure on agriculture to meet the world's food demands. In navigating this landscape, the continuous advancement of farming practices becomes imperative for sustaining food security and enhancing the livelihoods of farmers (Peter, *et al.,* 2019). Evaluating the progressiveness of farmers emerges as a critical task for policymakers and agricultural researchers alike. To address the growing demands on agriculture, understanding the factors that either facilitate or impede the adoption of modern, sustainable, and efficient farming practices is paramount (Davis, *et al.,* 2020).

Assessing the progressiveness of farmers involves various methods, including gauging their attitude towards adopting modern technologies (Magda, *et al.,* 1999), evaluating the sustainability of farming practices (Mattia, *et al.,* 2016), studying learning approaches and information sources (Stephens, 1991), examining social media utilization (Vikash, *et* *al.,* 2022), and assessing the effectiveness of formal communication channels (Yekinni, *et al.,* 2019). Additionally, socio-economic factors, such as education and organizational affiliations, play a role, with progressive farmers often exhibiting traits beyond agricultural practices (Van Den Ban, 1957). Investigations also highlight the significance of psycho-social factors, including scientific temperament and work satisfaction, suggesting their crucial contribution to farmers' overall progressiveness (Kumar, *et al.,* 2015). A holistic understanding of these diverse aspects provides valuable insights for policymakers and researchers in planning effective strategies for sustainable agricultural development.

However, existing methods for assessing farming progressiveness often lack the depth and dynamism needed to provide a comprehensive view of a farmer's practices. To address this gap, this research proposal aims to develop a dynamic cropping trend visualization software. This innovative software will not only categorize farmers into progressive, intermediate progressive, and non-progressive based on their responses to a carefully constructed questionnaire but will also provide a visual representation of their farming practices. By doing so, it will assist in identifying key areas of improvement and facilitating more targeted interventions for agricultural development.

Objectives

1. To develop a dynamic cropping trend visualization software for assessing the progressiveness of farmers.
2. To categorize farmers into different progressiveness levels based on their responses to the questionnaire.
3. To evaluate the potential impact of the software on agricultural development and sustainability.
4. To make policy recommendations based on the findings to improve farming practices.

CHAPTER III MATERIALS AND METHODS

In any scientific research. methodology plays an important role. Appropriate methodology helps the researcher to collect valid and reliable intonation and analyze the information properly in order to arrive at correct and meaningful conclusion. Methods and procedures that were followed in this study have been descried below:

3.1 Development of the Software:

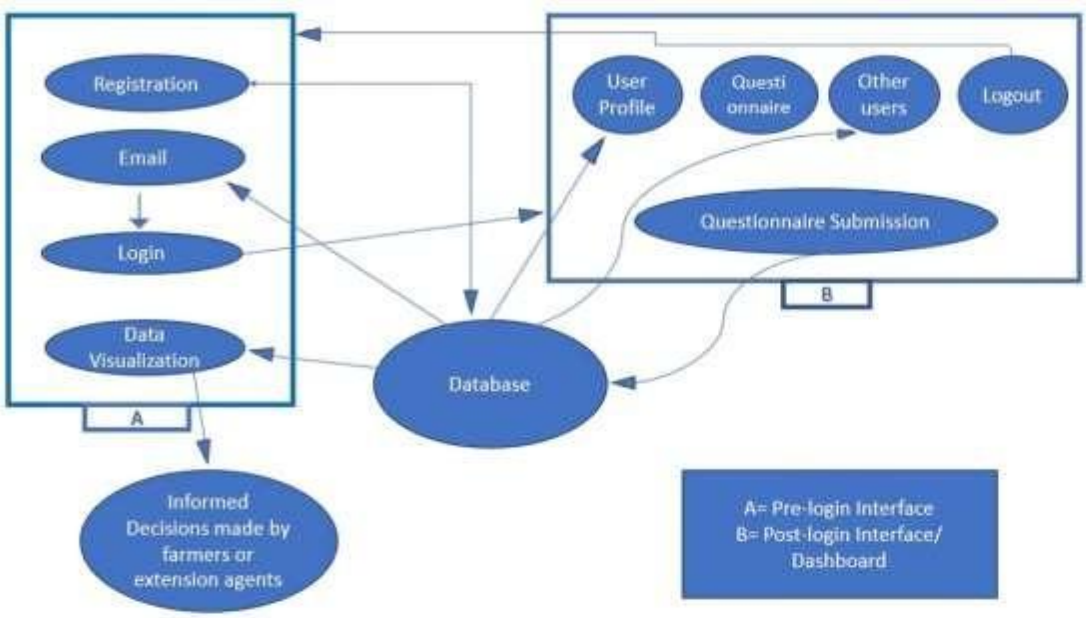

Figure 1. The schematic diagram showing the working principle of the software.

The cropping trend visualization software has three distinct parts. These are pre-login interface, post-login interface (dashboard), and the Database.

Pre-login Interface: This is the initial interface serves as the entry point for unregistered users. It typically provides information about the system's purpose, functionalities, and registration options (Kapinos *et al.,* 2020). It includes the registration and login system of the questionnaire participants including the visualization of the respondents' demographic conditions and the farming progressiveness.
Post-login Interface or Dashboard: Once the users are registered and logged in, they gain access to the system's core functionalities. This interface typically features dashboards displaying personal information, retrieved data visualizations, and other outputs generated by the system (Chaudhri *et al.,* 2009). In the current software, the dashboard has two core functionalities of displaying the users' profile and the questionnaire to response.
Database: A database is a structured collection of data that is organized and stored in a computer system. It is designed to efficiently manage, store, and retrieve information. Databases are fundamental components of modern computing and are used in various applications, including business systems, websites, and software applications (Blagojche *et al.,* 2023 and Mishra, 2023).

The creation of the software encompassed a structured progression involving sequential stages that integrated backend server-side scripting, frontend development, and meticulous database management. Presented below is a formalized account of the entire development process:

1. Database Setup
Objective: Establish a robust database infrastructure for the storage of user profiles and questionnaire responses.
Technologies Used: MySQL, PHPMyAdmin.
Procedural Steps:

a. Initiated the configuration of a MySQL database designated as "krishiso_users."
b. Implemented the creation of tables designed to store user profiles and questionnaire responses.

2. User Registration and Login System
Objective: Develop a secure user registration and login system to facilitate effective data tracking.
Technologies Used: PHP, MySQL, HTML, CSS.
Procedural Steps:

a. Formulated **register.php** and **login.php** to facilitate user registration and login functionalities.
b. Implemented password hashing techniques to bolster system security.
c. Established a mechanism for the persistent storage of user information within the database.

3. User Profile and Questionnaire
Objective: Enable users to furnish demographic and farming-related data via an interactive questionnaire.
Technologies Used: PHP, MySQL, HTML, JavaScript.
Procedural Steps:

a. Conceived **dashboard.php** to serve as the central hub for user interactions.
b. Developed an intuitive questionnaire interface in **index-body.php**.
c. Implemented robust data submission protocols to channel responses into the MySQL database.

4. Demographic Data Visualization:
Objective: Visualize demographic data through age and education graphs for enhanced interpretability.
Technologies Used: Chart.js (JavaScript library for charts).
Procedural Steps:

a. Formulated **age-graph.php** and **education-graph.php** to manifest graphical representations of demographic data.
b. Deployed Chart.js to craft dynamic and interactive visualizations.
c. Applied mathematical functions to categorize and illustrate user demographics.

5. Farming Progressiveness Graph:
Objective: Evaluate farming progressiveness predicated on questionnaire responses.
Technologies Used: Chart.js, PHP, MySQL, JavaScript.
Procedural Steps:

a. Engineered **progressiveness-graph.php** to compute individual scores based on questionnaire responses.
b. Classified users into Progressive, Intermediate Progressive, and Non-Progressive categories.
c. Utilized a bar chart to visually articulate progressiveness.

6. Upazilla-wise Progressiveness Search:
Objective: Provide insights into progressiveness at the upazila level for a comprehensive analysis.

Technologies Used: Chart.js, PHP, MySQL, JavaScript.
Procedural Steps:

a. Devised **filter.php** to enable upazila-wise filtering and selection.
b. Implemented a user-friendly form to designate district and upazila preferences.
c. Utilized a line chart for intuitive visualization of upazila-wise progressiveness.

7. Styling and Layout:
Objective: Enhance user experience through an aesthetically pleasing and responsive interface.
Technologies Used: HTML, CSS.
Procedural Steps:

a. Ensured the development of a visually engaging and user-friendly design.
b. Applied consistent styling principles across all pages.

8. Testing and Debugging:
Objective: Identify and rectify any software anomalies or issues.
Procedural Steps:

a. Conducted thorough testing across each functionality of the software.
b. Executed debugging procedures to resolve identified issues.

9. Documentation:
Objective: Deliver a comprehensive documentation resource for users and developers.
Procedural Steps:

a. Documented the features, usage guidelines, and functionalities of the software.
b. Provided detailed insights into the mathematical models and algorithms employed.

10. Deployment:
Objective: Make the software universally accessible to end-users.
Procedural Steps:

a. Executed the deployment of the software on a dedicated web server.
b. Ensured the establishment of server compatibility and stringent security protocols.

Technologies Used:

- **Backend:** PHP, MySQL.
- **Frontend:** HTML, CSS, JavaScript.
- **Charts:** Chart.js.
- **Database Management:** PHPMyAdmin.
- **Server:** Apache.

Mathematical Models and Functions

1. Mathematical Function for Average Age Calculation:
Let A be the set of ages for all farmers. The average age $\bar{A}$ is calculated as:

$$\bar{A} = \frac{1}{n} - \sum_{i=1}^{n} Ai$$

where n is the total number of farmers, and Ai is the age of the i-th farmer.

2. Mathematical Function for Education Categorization:
Let E be the set of education levels for all farmers.
The education category Ci for the i-th farmer is determined using a function:

$$C_i = f(E_i)$$

where Ei is the education level of the i-th farmer.

3. Mathematical Function for Progressiveness Score Calculation:
Let Q be the set of questionnaire responses for a farmer. The total score S_i for the i-th farmer is calculated as:

$$S_i = \sum_{j=1}^{m} W_j \, x \, Q_{ij}$$

where m is the number of questionnaire items, W_j is the weight for the j-th item, and Q_{ij} is the response of the i-th farmer to the j-th item.

4. Mathematical Function for Farmers' Categorization:

The category C_i of the i-th farmer is determined based on their total score Si: $C_i = g(S_i)$

5. Mathematical Function for Categorization:

Let U be the set of users in an upazila.

The count N_j of users in category j is calculated as:

$$N_j = \sum_{i=1}^{k} I(C_i = j)$$

where k is the total number of users in the upazila, C_i is the category of the i-th user, and I is the indicator function.

3.2 Data Collection, Retrieval and Data Analysis

Questionnaire Development

To categorize farmers in terms of progressiveness, a structured questionnaire with 13 questions covering various aspects of farming practices was developed and set in the software's dashboard. The questionnaire includes questions related to crop diversification, crop varieties and cultivars, crop rotation and timely planting, yield optimization, technology adoption, market sensitivity, climate resilience and environmental stewardship, government programs and problem-solving, learning, and community involvement. Each question has multiple-choice answers with assigned scores (e.g., A=3, B=2, C=1). The Questionnaire is as follows - **Crop Diversification:**

1. What types of crops do you commonly grow on your farm?
   - A. Diverse range of crops (staple, cash, vegetables)
   - B. Some diversity but primarily staple crops
   - C. Predominantly one or two staple crops

Crop Varieties and Cultivars:

2. How often do you adopt improved crop varieties and cultivars?
   - A. Always adopt improved varieties
   - B. Occasionally adopt improved varieties
   - C. Rarely adopt improved varieties

Crop Rotation and Timely Planting:

3. Do you practice crop rotation?
   - A. Yes, with a well-structured rotation pattern
   - B. Yes, but rotation is less structured
   - C. No, I don't practice crop rotation
4. How closely do you follow planting seasons for different crops?
   - A. Always plant crops on time
   - B. Generally plant on time but occasional delays
   - C. Frequent delays or disregard for planting times

Yield Optimization:

5. What best describes your efforts to maximize crop yields?
   - A. Constantly employ modern techniques for high yields
   - B. Use some modern techniques, but yield optimization is inconsistent
   - C. Minimal focus on yield optimization

Technology Adoption:

6. How open are you to adopting modern farming technologies?
   - A. Very open, actively incorporate new technologies
   - B. Somewhat open, selectively adopt technologies
   - C. Resistant to adopting new technologies

Market Sensitivity:

7. To what extent do you consider market demand and prices in your crop choices?
   - A. Always consider market trends and consumer demand
   - B. Occasionally consider market trends
   - C. Rarely consider market trends

Climate Resilience and Environmental Stewardship:

8. How do you adapt to changing climate conditions?
   - A. Actively use climate-smart practices and technologies

- B. Make some adjustments based on climate changes
- C. Limited or no efforts to adapt to climate changes

9. How conscious are you of the environmental impact of your farming practices?
- A. Take steps to minimize environmental impact
- B. Moderate consideration for environmental impact
- C. Minimal consideration for environmental impact

Government Programs and Problem Solving:

10. Do you actively engage with government agricultural programs and incentives?
- Actively participate in government programs
- Participate in some programs when convenient
- Rarely or never participate in government programs

11. How effectively do you address challenges in crop cultivation?
- A. Efficiently address challenges and find innovative solutions
- B. Address challenges but with limited innovation
- C. Struggle to address common constraints

Learning and Community Involvement (Questions 12 and 13):

12. How often do you seek new knowledge and learning opportunities related to farming?
- A. Continuously seek new knowledge and training
- B. Occasionally seek new knowledge and training
- C. Rarely engage in learning opportunities

13. Are you involved in community organizations and knowledge-sharing with other farmers?
- Actively involved in community organizations and share knowledge
- Somewhat involved in community activities and knowledge-sharing
- Minimal or no community involvement

Scoring and Categorization:

- For each question, a score was assigned (e.g., A=3, B=2, C=1).
- The scores were added up for all questions for each farmer.
- Farmers were categorized based on their total scores:
  - Total Score 35-39: **Progressive**
  - Total Score 20-34: **Intermediate Progressive**
  - Total Score 13-19: **Non-Progressive**

Data Variables:

Independent variables: The above 13 questions of the questionnaire were considered as the independent variables whereas the farming progressiveness - decided based on the scoring and categorization was considered as the dependent variables.

Data Collection and Analysis

Both descriptive and inferential data were collected from the software and analyzed partly by the software and partly by other analytical software like Statistix 10 and Microsoft Excel.

The descriptive data and graphs of the data were downloaded from the software along with the descriptive statistics. On the other hand, the inferential data to be analyzed was downloaded from the software as a CSV file containing the response of the questionnaire respondents. The CSV was then converted into excel file for the ease of analysis. Data analysis involved calculating the total score for each farmer based on their responses to the questionnaire. Farmers were categorized into progressive, intermediate progressive, and non-progressive based on their total scores.

RESULTS AND DISCUSSION

In this Chapter. the findings of the study and interpretation of results have been presented. Collected data were carefully edited, coded, computed. tabulated and analyzed in accordance with the objectives of the study.

4.1 Descriptive Data: Farmers' Demography

Age: Farmers' age was categorized into 6 broad groups – under 20, 20-29, 30-39, 40-49, 50-59, and 60 and above. Among the 111 questionnaire's respondents, the highest age group was 20-29 having 68 farmers, fully or partly engaged in farming activities. The second highest group was 30-39 having 24 farmers. This was followed by 40-49 (7), 50-59 (7), and 60 and above (5) groups. The average age of the respondents was 30.78 years. Therefore, from the graph

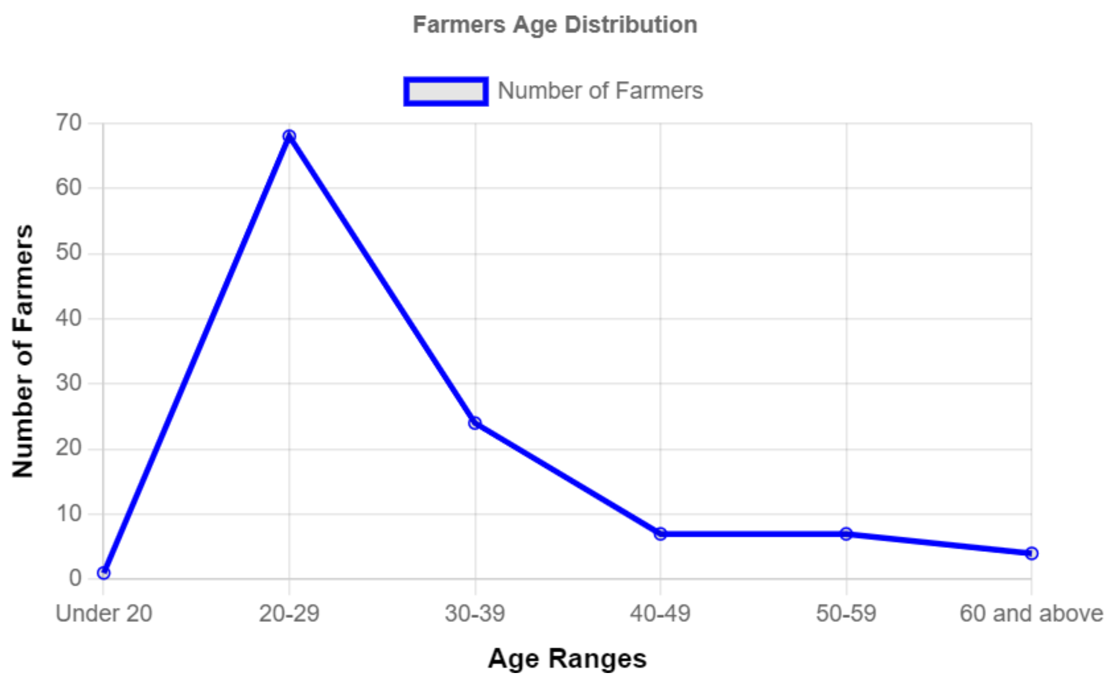

Figure 1: Farmers' age distribution (Source: the software. Available at https://krishisomogro.info/index.php)

Education: Farmers' education was categorized into 5 broad groups – primary, high school, higher secondary, undergraduate, and post-graduate. Among the 111 questionnaire's respondents, the highest education group was undergraduate having 65 farmers, fully or partly engaged in farming activities. The second highest group was post-graduate having 20 farmers. This was followed by Higher Secondary (11), primary (8), and high school (7) groups. Therefore, from the graph it can be concluded that most of the respondent farmers were highly educated and fell under the education group of undergraduate who has passed higher secondary and continuing their undergraduate.

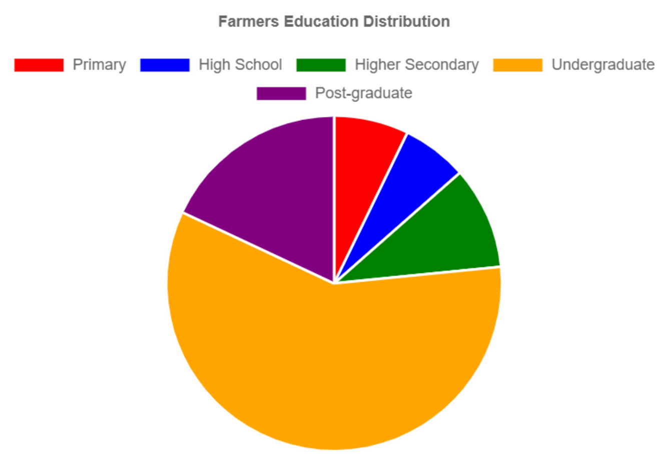

Figure 2: Farmers' education distribution (Source: the software. Available at https://krishisomogro.info/index.php)

4.2. Descriptive Data: Farming Progressiveness:
Farming progressiveness was categorized into 3 categories – progressive, intermediate progressive, and non-progressive. Among the 111 questionnaire's respondents, 52 farmers were fallen under progressive category (score: 35-39), 46 farmers under intermediate progressive (score: 20-34), and 6 farmers under the non-progressive category (score: 13-19). This indicates that the most of the respondents were aware of the good farming practices.

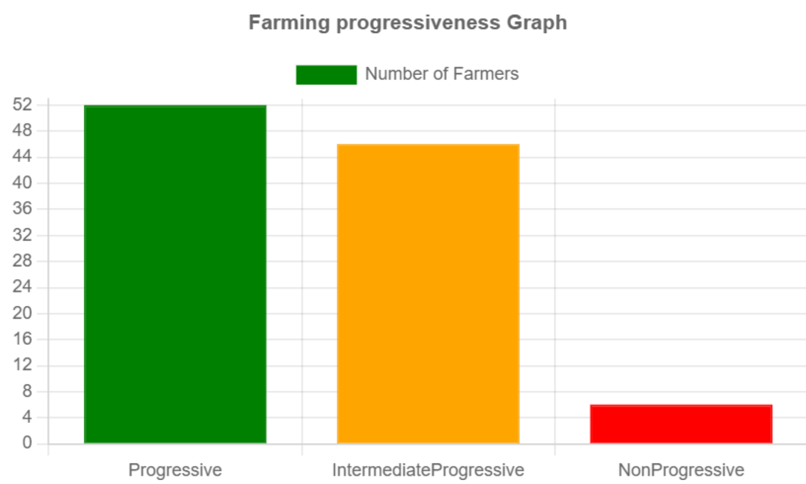

Figure 3: Farming progressiveness of the respondents (Source: the software. Available at https://krishisomogro.info/index.php)

4.3 Inferential Data: Do the selected farming factors influence farming progressiveness and highlight the cropping trend?

Independent Variable	Dependent Variables	Coefficient	P	R^2	Adjusted R^2	Standard Deviation
Farming Progressiveness	CT	0.05640	0.2809	0.8418	0.8206	0.27490
	Varieties	0.12135	0.0251			
	Rotation	0.04233	0.5514			
	PS	0.02628	0.6861			
	YO	0.08560	0.2600			
	TA	0.25061	0.0027			
	MS	0.08578	0.2447			
	CA	0.18896	0.0012			
	EI	0.19928	0.0086			
	GP	-0.01012	0.8922			
	AC	-0.09499	0.2004			
	LO	0.06333	0.3270			
	CI	0.02809	0.6436			

Table 1: Linear regression of the selected factors in relation to the farming progressiveness.

[CT = Crop Type, PS = Planting Seasons, YO = Yield Optimization, TA = Technology Adoption, MS = Market Sensitivity, CA = Climate Adaptation, EI = Environmental Impact, GP = Government Programs, AC = Address Challenges, LO = Learning Opportunities, CI = Community Involvement.]

Relationship of the selected 13 factors with the farming progressiveness

1. **Technology Adoption (TA)**
   - *Coefficient:* 0.25061, *P-value:* 0.0027
   - **Discussion:** The positive coefficient for Technology Adoption (TA) signifies that farmers embracing advanced agricultural technologies tend to exhibit higher progressiveness. The low p-value (0.0027) indicates that this relationship is statistically significant. Therefore, we can confidently conclude that there is a strong association between adopting technology and the progressiveness of farmers.
2. **Climate Adaptation (CA):**
   - *Coefficient:* 0.18896, *P-value:* 0.0012
   - **Discussion:** The positive coefficient for Climate Adaptation (CA) suggests that farmers adapting to changing climatic conditions tend to show higher progressiveness. The low p-value (0.0012) reinforces the significance of this relationship. Implementing climate-resilient practices could significantly contribute to the overall progressiveness of farmers.
3. **Crop Type (CT):**
   - *Coefficient:* 0.05640, *P-value:* 0.2809
   - **Discussion:** While the positive coefficient for Crop Type (CT) indicates a potential contribution to progressiveness, the higher p-value (0.2809) suggests that the relationship is not statistically significant at the conventional significance level of 0.05. Although there is a positive trend, caution should be exercised in drawing strong conclusions about the impact of crop type on progressiveness based on the given data.
4. **Address Challenges (AC):**
   - *Coefficient:* -0.09499, *P-value:* 0.2004
   - **Discussion:** The negative coefficient for Address Challenges (AC) implies that farmers perceiving challenges negatively impact progressiveness. However, the higher p-value (0.2004) suggests that this relationship may not be statistically significant at the 0.05 level. While the trend is noteworthy, further investigation is needed to confirm the impact of addressing challenges on progressiveness.

5. Varieties:

- *Coefficient:* 0.12135, *P-value:* 0.0251
- **Discussion:** The positive coefficient for Varieties indicates that farmers experimenting with different crop varieties tend to show higher progressiveness. The low p-value (0.0251) suggests statistical significance, supporting the notion that incorporating a variety of crops positively influences farmers' overall progressiveness.

6. Rotation:

- *Coefficient:* 0.04233, *P-value:* 0.5514
- **Discussion:** The positive coefficient for Rotation suggests that farmers practicing crop rotation may exhibit higher progressiveness. However, the high p-value (0.5514) indicates that this relationship is not statistically significant at the 0.05 level. Caution should be exercised in drawing strong conclusions about the impact of rotation on progressiveness based on the given data.

7. Planting Seasons (PS):

- *Coefficient:* 0.02628, *P-value:* 0.6861
- **Discussion:** The positive coefficient for Planting Seasons (PS) implies that farmers who consider planting seasons may have higher progressiveness. However, the high p-value (0.6861) suggests that this relationship is not statistically significant. Further investigation or additional data may be needed to draw conclusive insights about the impact of planting seasons on progressiveness.

8. Yield Optimization (YO):

- *Coefficient:* 0.08560, *P-value:* 0.2600
- **Discussion:** The positive coefficient for Yield Optimization (YO) suggests that farmers focused on optimizing yields may exhibit higher progressiveness. However, the moderate p-value (0.2600) indicates that this relationship is not statistically significant at the 0.05 level. While there is a positive trend, caution is advised in making strong claims about the impact of yield optimization on progressiveness based on the given data.

9. Market Sensitivity (MS):

- *Coefficient:* 0.08578, *P-value:* 0.2447
- **Discussion:** The positive coefficient for Market Sensitivity (MS) suggests that farmers who are sensitive to market trends may exhibit higher progressiveness. However, the moderate p-value (0.2447) indicates that this relationship is not statistically significant at the 0.05 level. Further exploration or additional data may be necessary to draw conclusive insights about the impact of market sensitivity on progressiveness.

10. Environmental Impact (EI):

- *Coefficient:* 0.19928, *P-value:* 0.0086
- **Discussion:** The positive coefficient for Environmental Impact (EI) suggests that farmers focusing on environmentally sustainable practices may show higher progressiveness. The low p-value (0.0086) indicates statistical significance, supporting the notion that environmental impact considerations positively influence farmers' overall progressiveness.

11. Government Programs (GP):

- *Coefficient:* -0.01012, *P-value:* 0.8922
- **Discussion:** The negligible coefficient for Government Programs (GP) and the high p-value (0.8922) suggest that the impact of government programs on progressiveness is minimal and not statistically significant. It appears that, based on the given data, government programs may not strongly influence the overall progressiveness of farmers.

12. Learning Opportunities (LO):

- *Coefficient:* 0.06333, *P-value:* 0.3270
- **Discussion:** The positive coefficient for Learning Opportunities (LO) suggests that farmers who have access to continuous learning opportunities may exhibit higher progressiveness. However, the moderate p-value (0.3270) indicates that this relationship is not statistically significant at the 0.05 level. While there is a positive trend, caution is advised in making strong claims about the impact of learning opportunities on progressiveness based on the given data.

13. Community Involvement (CI):

1. *Coefficient:* 0.02809, *P-value:* 0.6436
2. **Discussion:** The positive coefficient for Community Involvement (CI) implies that farmers engaged in community activities may show higher progressiveness. However, the high p-value (0.6436) suggests that this relationship is not statistically significant. Further investigation or additional data may be needed to draw conclusive insights about the impact of community involvement on progressiveness.

Implications for Policy and Interventions

1. **Strategic Technology Interventions:** Given the strong significance (low p-value) associated with Technology Adoption (TA), policymakers and agricultural extension services should strategically promote and support the adoption of advanced technologies. This may include subsidies, training programs, and technological infrastructure development.
2. **Climate-Resilient Farming Programs:** The significant relationship between Climate Adaptation (CA) and progressiveness suggests that interventions promoting climate-resilient farming practices can positively impact farmers' overall progress. Initiatives may include providing climate information services, promoting drought-resistant crops, and implementing water management strategies.
3. **Crop Type Considerations:** While Crop Type (CT) shows a positive trend, the lack of statistical significance suggests that the impact may vary among different crops. Further research or localized studies may be necessary to understand specific crop-related factors contributing to progressiveness.
4. **Addressing Challenges Pragmatically:** Despite the lack of strong statistical significance for Address Challenges (AC), the negative coefficient implies a potential negative impact of perceived challenges on progressiveness. Agricultural support systems should proactively identify and address challenges, collaborating with farmers to find practical solutions.

Implications for Agricultural Practices

1. **Promoting Crop Variety Diversity:** The statistically significant relationship between Varieties and progressiveness highlights the importance of encouraging farmers to experiment with different crop varieties. Agricultural extension services can provide information on diverse crop options suitable for specific regions, emphasizing the potential benefits in terms of progressiveness.

2. **Crop Rotation Considerations:** While there is a positive trend between Rotation and progressiveness, the lack of statistical significance suggests that the impact may vary. Localized studies or further research can explore specific factors influencing the relationship between crop rotation practices and overall progressiveness.

3. **Exploring Planting Seasons Impact:** The lack of statistical significance for Planting Seasons indicates the need for further investigation into the relationship between consideration of planting seasons and farmers' progressiveness. Research may focus on understanding the specific factors influencing planting decisions and their impact on overall progress.

4. **Balancing Yield Optimization Strategies:** While there is a positive trend between Yield Optimization and progressiveness, the lack of statistical significance suggests that other factors may influence the relationship. Farmers and policymakers should consider a holistic approach to agricultural practices, balancing yield optimization with other sustainable and progressive farming strategies.

Implications for Policy and Community Engagement

1. **Promoting Environmental Sustainability: The** statistically significant relationship between Environmental Impact (EI) and progressiveness highlights the importance of promoting environmentally sustainable practices among farmers. Policymakers can implement initiatives that incentivize and support eco-friendly farming methods.

2. **Reassessing Government Programs:** The lack of statistical significance for Government Programs (GP) indicates that the current set of government initiatives may not be significantly impacting farmers' progressiveness. Policymakers may need to reassess and possibly restructure existing programs to align better with the needs of farmers.

3. **Exploring Learning Opportunities Impact:** The lack of statistical significance for Learning Opportunities (LO) suggests that while there is a positive trend, the impact may vary. Policymakers and agricultural organizations can explore the effectiveness of existing educational programs and consider adjustments to better support farmers' learning needs.

4. **Encouraging Community Engagement:** While there is a positive trend between Community Involvement (CI) and progressiveness, the lack of statistical significance suggests that additional factors may influence this relationship. Promoting community-based initiatives and collaborations may be beneficial, and further research can help identify specific elements that contribute to progressiveness.

SUMMARY AND CONCLUSION

This chapter presents the summary of findings, conclusions and recommendations of the study.

Descriptive Data: Farmers' Demography Age:

Majority of respondent farmers (68) fell in the age group of 20-29, indicating a younger farming population. Average age of respondents was 30.78 years, showcasing a predominantly young demographic.

Education:

Undergraduate (65) emerged as the most common education level, followed by post-graduate (20). A highly educated group, with a significant number pursuing undergraduate studies.

Descriptive Data: Farming Progressiveness

Categorized into progressive (52), intermediate progressive (46), and non-progressive (6). Signifying a majority of farmers being aware and engaged in good farming practices.

Inferential Data: Factors Influencing Farming Progressiveness

1. **Technology Adoption (TA)**
    - *Significance:* Strong (p-value: 0.0027)
    - *Impact:* Positive correlation; embracing advanced technologies leads to higher progressiveness.

2. **Climate Adaptation (CA)**
    - *Significance:* Strong (p-value: 0.0012)
    - *Impact:* Positive correlation; adapting to changing climatic conditions contributes to higher progressiveness.
3. **Crop Type (CT)**
    - *Significance:* Limited (p-value: 0.2809)
    - *Impact:* Positive trend exists, but statistical significance is lacking at the conventional level.
4. **Address Challenges (AC)**
    - *Significance:* Limited (p-value: 0.2004)
    - *Impact:* Farmers addressing challenges may impact progressiveness, but further investigation is needed for confirmation.
5. **Varieties**
    - *Significance:* Strong (p-value: 0.0251)
    - *Impact:* Positive correlation; experimenting with different crop varieties positively influences overall progressiveness.
6. **Rotation**
    - *Significance:* Limited (p-value: 0.5514)
    - *Impact:* Positive trend suggests that crop rotation may contribute to higher progressiveness, but caution is advised due to lack of statistical significance.
7. **Planting Seasons (PS)**
    - *Significance:* Limited (p-value: 0.6861)
    - *Impact:* Positive trend, but non-significant; further investigation or additional data needed for conclusive insights.
8. **Yield Optimization (YO)**
    - *Significance:* Limited (p-value: 0.2600)
    - *Impact:* Positive trend exists, but lack of statistical significance suggests caution in making strong claims.
9. **Market Sensitivity (MS)**
    - *Significance:* Limited (p-value: 0.2447)
    - *Impact:* Positive trend, but non-significant; further exploration or additional data necessary for conclusive insights.
10. **Environmental Impact (EI)**
    - *Significance:* Strong (p-value: 0.0086)
    - *Impact:* Positive correlation; focusing on environmentally sustainable practices positively influences overall progressiveness.
11. **Government Programs (GP)**
    - *Significance:* Minimal (p-value: 0.8922)
    - *Impact:* Negligible influence; government programs may not strongly impact overall progressiveness based on the given data.
12. **Learning Opportunities (LO)**
    - *Significance:* Limited (p-value: 0.3270)
    - *Impact:* Positive trend, but lack of statistical significance at the 0.05 level; caution advised in making strong claims.
13. **Community Involvement (CI)**
    - *Significance:* Limited (p-value: 0.6436)
    - *Impact:* Positive trend, but non-significant; further investigation or additional data needed for conclusive insights.

Potential Impact of the Software on the agricultural development and sustainability

From the above discussion, it is crystal clear that the implemented software under this study in understanding the role technology can play in shaping the future of farming practices. Through rigorous analysis, the thesis aims to assess how the implemented software contributes to advancements in agricultural practices, emphasizing both development and sustainability. The evaluation encompasses aspects such as the adoption of advanced technologies, climate-resilient farming practices, and the overall progressiveness of farmers. By scrutinizing these dimensions, the research aims to provide valuable insights into the software's effectiveness in promoting sustainable agricultural development. The findings from this evaluation will not only contribute to the academic discourse on agricultural technology but also offer practical implications for policymakers, agricultural extension services, and farmers striving towards a more sustainable and progressive agricultural landscape.

Conclusion and Recommendation

The cropping trend visualization software was developed as part of this study, and the descriptive and inferential statistical data obtained and partially analyzed by the software reveal significant positive correlations between technology adoption, climate adaptation, experimentation with crop variety diversity, and environmentally sustainable practices with higher farming progressiveness. While discernible trends are evident, caution is warranted in making definitive conclusions for factors with limited statistical significance. Policymakers and agricultural stakeholders can utilize these findings to strategically advocate for practices that effectively contribute to farmers' progressiveness.

REFERENCES

1. Newman, C., Singhal, S., & Tarp, F. (2020). Introduction to understanding agricultural development and change: Learning from Vietnam. Food Policy, 101930. doi:10.1016/j.foodpol.2020.101930

2. Peter, Schröder., Andrés, Sauvêtre., Friederike, Gnädinger., Paolo, Pesaresi., Lucie, Chmelíková., Nedim, Doğan., Georg, Gerl., Ayhan, Gökçe., Chantal, Hamel., Rocío, Millán., Tomas, Persson., Sabine, Ravnskov., Beata,

3. Rutkowska., Thomas, Schmid., Wiesław, Szulc., Carmen, Teodosiu., & Valeria, Terzi. (2019). Discussion paper: Sustainable increase of crop production through improved technical strategies, breeding and adapted management - A European perspective.. Science of The Total Environment, 678:146-161. doi: 10.1016/J.SCITOTENV.2019.04.212

4. Davis, Kristin E., ed.; Babu, Suresh Chandra, ed.; and Ragasa, Catherine, ed. 2020. Agricultural extension: Global status and performance in selected countries. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/9780896293755

5. The World Bank (2023). Agriculture and Food. Retrieved from: https://www.worldbank.org/en/topic/agriculture/overview#1

6. Magda, Maria, Guilhermino., I., B., Sampaio. (1999). An approach to the characterization of english and welsh dairy farmers as to progressiveness and attitude toward computerized information systems. Archivos Latinoamericanos de Producción Animal, 7(1):53-61.

7. Mattia, Bertocchi., Eugenio, Demartini., Maria, Elena, Marescotti. (2016). Ranking Farms Using Quantitative Indicators of Sustainability: The 4Agro Method. Procedia - Social and Behavioral Sciences, 223:726-732. doi: 10.1016/J.SBSPRO.2016.05.249

8. Larry, Lowell, Stephens. (1991). Information sources and methods used by progressive farmers in the learning process. 1-215.

9. Vikash, Meena., K.C., Meena., Manju, Goyal., L., K., Meena., Rajesh, Kumar. (2022). Social Media Used by the Farmers in Sharing Farm Information. 954-960. doi: 10.9734/ajaees/2022/v40i1031164

10. O, T, Yekinni., Christiana., O., Afolabi. (2019). Farmers' Assessment of the Effectiveness of Extension Communication Methods Used in Ogbomoso Agricultural Zone of Oyo-State, Nigeria. The Journal of Agricultural Extension, 23(3):126-134. doi: 10.4314/JAE.V23I3.11

11. Kumar, R., Paul, S., Singh, P., & Chahal, V. P. (2015). Factors determining farmers' progressiveness: A principal component analysis. Indian Journal of Agricultural Sciences, 85(8), 1026–1029.

12. Van den Ban, A. W. (1957). Some characteristics of progressive farmers in the Netherlands. Rural Sociology, 22, 205-212. https://edepot.wur.nl/29519

13. Kapinos, R. J., Kingsbury, T. W., Li, S. W. and VanBlon, R. S. (2020). Executing applications prior to user

login. US107574B2. United States: Lenovo PC Int.

14. Chaudhri, I. A., Louch, J. O., Grignon, A. M. and Christie, G. N. (2009). User interface element with auxiliary function. US 2009/0125815 A1. United States. Individual.

15. Blagojche, N., Dimitrovska , G., & Joshevska , E. (2023). The importance of databases in web programming. *International Journal of Advanced Natural Sciences and Engineering Researches*, *7*(4), 319–322. https://doi.org/10.59287/ijanser.724

16. Mishra, P. (2023). Databases. In: Cloud Computing with AWS. Apress, Berkeley, CA. https://doi.org/10.1007/978- 1-4842-9172-6_8