



Republic of Rwanda  
Ministry of Education



**RTB** | RWANDA  
TVET BOARD

AGRDP401

## DATA DRIVEN AGRICULTURE PRECISION

Implement data driven Agriculture precision

### Competence

RQF Level:4

Learning Hours



50

Credits: 5

Sector: Agriculture and food processing

Trade: Agriculture

Module Type: Specific

Curriculum: TVET Certificate IV in Agriculture

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<b>Purpose statement</b>	This module describes the skills, knowledge and attitude required to implement data driven Agriculture precision. It is intended to the learners pursuing TVET Certificate IV in Agriculture. Upon completion of this module the learner will be able to Interpret and Visualize Agricultural Data, implement Precision Agriculture Technologies and Systems, generate Data-Driven Recommendations, monitor and Evaluate Precision Agriculture Practices under minimum supervision					
<b>Learning assumed to be in place</b>	N.A					
<b>Delivery modality</b>	<b>Training delivery</b>	<b>100%</b>	<b>Assessment</b>		<b>Total 100%</b>	
	<b>Theoretical content</b>	<b>30%</b>	<b>Formative assessment</b>	<b>30%</b>	<b>50%</b>	
	<b>Practical work:</b>			<b>70%</b>		<b>70%</b>
	Group project and presentation	....%				
	Individual project /Work	....%	<b>Summative Assessment</b>		<b>50%</b>	

### Elements of Competence and Performance Criteria

Elements of competence	Performance criteria
1. Collect and Analyze Agricultural Data	1.1 Appropriate data collection methods, sensors, and technologies for gathering agricultural data are identified and selected.
	1.2 Relevant data, including soil characteristics, weather conditions, crop health parameters, and yield data, is collected.
	1.3 The collected data is organized and stored in a structured and secure manner.
	1.4 The data is cleaned and preprocessed to ensure accuracy and quality.
	1.5 The data is analyzed using appropriate statistical and data analysis techniques.
2. Interpret and Visualize Agricultural Data	2.1 The analyzed agricultural data is interpreted to extract meaningful insights and trends.

	2.2 Patterns, correlations, and anomalies within the data are identified.
	2.3 Visualizations, such as graphs, charts, and maps, are generated to effectively communicate the data findings.
	2.4 The data visualizations are presented in a clear and understandable manner for various stakeholders.
	2.5 Data visualization tools and software are utilized to enhance data interpretation and communication.
3. Implement Precision Agriculture Technologies and Systems	3.1 The suitability and compatibility of precision agriculture technologies and systems for specific agricultural operations are assessed.
	3.2 Precision agriculture equipment, such as GPS systems, remote sensing devices, and variable rate applicators, is installed and configured.
	3.3 Data collection devices and sensors are integrated with precision agriculture systems.
	3.4 Precision agriculture technologies are calibrated and validated to ensure accurate data acquisition and application.
	3.5 Precision agriculture systems are monitored and maintained to optimize their performance and reliability.
4. Generate Data-Driven Recommendations	4.1 The collected and interpreted agricultural data is analyzed to generate data-driven recommendations for farm management practices.
	4.2 Areas for improvement and optimization are identified based on data insights.
	4.3 Precision agriculture prescriptions for variable rate application of inputs, irrigation, and fertilization are developed.
	4.4 Collaboration with agronomists and farmers is undertaken to translate data findings into practical and actionable recommendations.
	4.5 The data-driven recommendations are communicated clearly and effectively to stakeholders.
	5.1 Monitoring systems are established to track the implementation and effectiveness of precision agriculture practices.

5. Monitor and Evaluate Precision Agriculture Practices	5.2 Data is continuously collected and analyzed to evaluate the impact of precision agriculture on key performance indicators, such as yield, resource utilization, and environmental factors.
	5.3 Potential issues, challenges, or deviations from expected outcomes are identified.
	5.4 Precision agriculture practices are modified based on data-driven insights and feedback from stakeholders.
	5.6 The results of precision agriculture practices are documented and reported to stakeholders, highlighting the achieved benefits and areas for improvement.

## Knowledge, Skills, and Attitude

Knowledge	Skills	Attitude
<ul style="list-style-type: none"> <li>✓ Master agronomy and crop science principles.</li> <li>✓ Learn data management techniques.</li> <li>✓ Familiarize yourself with sensors and IoT devices.</li> <li>✓ Apply statistics and data analysis methods.</li> <li>✓ Utilize GIS tools for spatial analysis.</li> <li>✓ Study crop modeling techniques.</li> <li>✓ Stay updated on emerging agricultural technologies</li> </ul>	<ul style="list-style-type: none"> <li>✓ Collect data from various sources.</li> <li>✓ Analyze datasets for insights.</li> <li>✓ Make informed decisions based on data.</li> <li>✓ Operate agricultural technology and machinery.</li> <li>✓ Communicate data-driven recommendations effectively.</li> <li>✓ Troubleshoot and problem-solve in the field.</li> </ul>	<ul style="list-style-type: none"> <li>✓ Adapt to evolving technology.</li> <li>✓ Cultivate curiosity about agricultural innovations.</li> <li>✓ Exercise patience during the adoption process.</li> <li>✓ Prioritize environmental stewardship in farming practices.</li> <li>✓ Embrace continuous learning and improvement.</li> <li>✓ Manage and mitigate risks associated with precision agriculture.</li> </ul>

## Course content

Learning outcomes	<p>At the end of the module the learner will be able to:</p> <ol style="list-style-type: none"> <li>1. Collect and Analyze Agricultural Data</li> <li>2. Interpret and Visualize Agricultural Data</li> <li>3. Implement Precision Agriculture Technologies and Systems</li> <li>4. Generate Data-Driven Recommendations</li> </ol>
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	<b>5. Monitor and Evaluate Precision Agriculture Practices</b>	
<b>Learning outcome 1: Collect and Analyze Agricultural Data</b>	<b>Learning hours: 10</b>	
<b>Indicative content</b>		
<ul style="list-style-type: none"> <li>● Introduction to Agricultural Data Collection <ul style="list-style-type: none"> <li>✓ The significance of data-driven agriculture.</li> <li>✓ Types of data relevant to agriculture (soil, weather, crop health, yield)</li> <li>✓ Introduction to data collection tools and sensors.</li> </ul> </li> <li>● Selecting Data Collection Methods and Technologies <ul style="list-style-type: none"> <li>✓ Evaluation of data collection technologies (sensors, drones, IoT devices)</li> <li>✓ Matching data collection methods to specific agricultural needs.</li> <li>✓ Cost-benefit analysis of data collection solutions.</li> </ul> </li> <li>● Data Collection and Management <ul style="list-style-type: none"> <li>✓ Procedures for collecting soil, weather, crop health, and yield data.</li> <li>✓ Data organization and storage practices (databases, cloud storage).</li> <li>✓ Data security and privacy considerations.</li> </ul> </li> <li>● Data Cleaning and Preprocessing <ul style="list-style-type: none"> <li>✓ Identifying and handling missing or erroneous data.</li> <li>✓ Data normalization and transformation techniques.</li> <li>✓ Quality control and data validation procedures.</li> </ul> </li> <li>● Data Analysis Techniques <ul style="list-style-type: none"> <li>✓ Introduction to statistical analysis (descriptive and inferential statistics).</li> <li>✓ Data visualization and interpretation.</li> <li>✓ Machine learning and predictive modeling for agricultural data.</li> </ul> </li> </ul>		
<b>Resources required for the learning outcome</b>		
<b>Equipment</b>	<ul style="list-style-type: none"> <li>● Weather stations.</li> <li>● Satellite imagery systems.</li> <li>● Soil and water sampling equipment.</li> <li>● Data loggers and storage devices.</li> <li>● Spectrometers and laboratory instruments</li> </ul>	
<b>Materials</b>	<ul style="list-style-type: none"> <li>● Soil sampling containers and bags.</li> <li>● Data cables and connectors.</li> </ul>	

	<ul style="list-style-type: none"> <li>● Sensors (e.g., for measuring pH, temperature, and moisture).</li> <li>● GPS accessories (antennas, mounts).</li> </ul>
Tools	<p>Soil probes and sensors.</p> <p>Environmental data loggers.</p> <p>Handheld GPS units.</p> <p>Cameras and drones for aerial imaging.</p> <p>Mobile devices (smartphones and tablets) with data collection apps.</p>
Facilitation techniques	<ul style="list-style-type: none"> <li>● Brainstorming, group discussion and oral presentation</li> <li>● Watching of audio visual, simulation</li> <li>● Practical exercise</li> </ul>
Formative assessment methods	<ul style="list-style-type: none"> <li>● Written assessment</li> <li>● Oral question</li> <li>● Performance assessment</li> </ul>

Learning outcome 2: Interpret and Visualize  
Agricultural Data

Learning hours: 10

**Indicative content**

- Introduction to Data Interpretation and Visualization
- ✓ Significance of interpreting and visualizing agricultural data.
- ✓ Types of insights and trends that can be derived from data.
- ✓ Introduction to data visualization tools and techniques.
- Data Interpretation Techniques
- ✓ Techniques for identifying patterns and trends in data.
- ✓ Correlation analysis and methods for uncovering relationships.
- Data Visualization Principles
- ✓ Principles of data visualization (clarity, accuracy, simplicity).
- ✓ Types of data visualizations (graphs, charts, maps, etc.).
- ✓ Matching data types to suitable visualization techniques.
- Creating Data Visualizations
- ✓ Hands-on practice in creating data visualizations (bar charts, line graphs, scatter plots, GIS maps, etc.).
- ✓ Using software (e.g., Tableau, Excel, GIS software) for visualization.
- ✓ Customizing visualizations to convey specific insights.
- Effective Communication of Data Findings
- ✓ Strategies for effective data communication to diverse audiences.

- ✓ Presenting data findings through storytelling.
- ✓ Addressing questions and feedback from stakeholders.
- Data Visualization Tools and Software
- ✓ Overview of data visualization software (e.g., Tableau, Power BI, QGIS).
- ✓ Hands-on exercises with specific software tools.
- ✓ Exploring advanced features and functionalities.

### Resources required for the indicative content

Equipment	Data visualization platforms.
Materials	Digital maps and geographic data, Geographic Information Systems (GIS) software
Tools	Computers with data analysis software.  Graphic design tools for creating visualizations
Facilitation techniques	<ul style="list-style-type: none"> <li>• Brainstorming, group discussion and oral presentation</li> <li>• Watching of audio visual, simulation</li> <li>• Practical exercise</li> </ul>
Formative assessment methods	<ul style="list-style-type: none"> <li>• Written assessment</li> <li>• Oral question</li> <li>• Performance assessment</li> </ul>

Learning outcome 3: Implement Precision Agriculture Technologies and Systems

Learning hours: 10

### Indicative content

- Assessing Precision Agriculture Suitability
- ✓ Introduction to precision agriculture principles.
- ✓ Factors influencing technology suitability (crop type, farm size, budget).
- ✓ Conducting a needs assessment and feasibility study.
- Installation and Configuration of Precision Agriculture Equipment
- ✓ Types of precision agriculture equipment (GPS systems, remote sensing devices, variable rate applicators)
- ✓ Installation procedures for various equipment types.
- ✓ Configuration of equipment settings and parameters.

- Integration of Data Collection Devices and Sensors
  - ✓ Types of data collection devices and sensors (soil moisture sensors, drones, weather stations, )
  - ✓ Connecting sensors to data logging and transmission systems.
  - ✓ Data synchronization and communication protocols.
- Calibration and Validation of Precision Agriculture Technologies
  - ✓ Importance of calibration for accuracy.
  - ✓ Calibration procedures for GPS systems, variable rate applicators, and sensors.
  - ✓ Validation processes to verify equipment performance.
  - ✓ Routine system checks and diagnostics.
  - ✓ Preventive maintenance practices (cleaning, software updates)
  - ✓ Troubleshooting common issues and seeking technical support.

### Resources required for the indicative content

Equipment	<p>Precision agriculture machinery (GPS-guided tractors, planters, harvesters).</p> <p>Automated irrigation systems.</p> <p>Telematics systems for machinery</p>
Materials	<p>GPS antennas and receivers.</p> <p>Irrigation pipes, pumps, and valves.</p> <p>Communication infrastructure (internet access, data transmission equipment).</p> <p>Control system components</p>
Tools	<p>Basic hand tools for equipment maintenance.</p> <p>Laptops or tablets for setting up and configuring precision equipment</p>
Facilitation techniques	<ul style="list-style-type: none"> <li>• Brainstorming, group discussion and oral presentation</li> <li>• Watching of audio visual, simulation</li> <li>• Practical exercise</li> </ul>
Formative assessment methods	<ul style="list-style-type: none"> <li>• Written assessment</li> <li>• Oral question</li> <li>• Performance assessment</li> </ul>

Learning outcome 4: Generate Data-Driven Recommendations

Learning hours: 10

**Indicative content**

- Data Analysis for Farm Management
  - ✓ The significance of data-driven decision-making in agriculture.
  - ✓ Types of agricultural data (soil, weather, crop health, yield, etc.).
  - ✓ Introduction to data analysis tools and techniques.
- Identifying Areas for Improvement
  - ✓ Techniques for identifying and prioritizing areas for improvement.
  - ✓ Analysis of historical data to detect patterns and trends.
  - ✓ Economic and sustainability considerations in decision-making.
- Precision Agriculture Prescriptions
  - ✓ Variable rate technology principles and applications.
  - ✓ Developing prescription maps for inputs (seeds, fertilizers, pesticides).
  - ✓ Optimization of irrigation practices based on data insights.
- Collaborative Decision-Making
  - ✓ Collaborative approaches to decision-making in agriculture.
  - ✓ Effective communication with agronomists and farmers.
  - ✓ Incorporating local knowledge and expertise into recommendations.
- Communicating Data-Driven Recommendations
  - ✓ Strategies for clear and concise communication of recommendations.
  - ✓ Presenting data findings to diverse stakeholders (farmers, managers, decision-makers).
  - ✓ Addressing questions and concerns from stakeholders.

**Resources required for the indicative content**

Equipment	Data visualization platforms.
Materials	Digital maps and geographic data, Geographic Information Systems (GIS) software
Tools	Computers with data analysis software. Graphic design tools for creating visualizations
Facilitation techniques	<ul style="list-style-type: none"><li>• Brainstorming, group discussion and oral presentation</li><li>• Watching of audio visual, simulation</li><li>• Practical exercise</li></ul>

Formative assessment methods	<ul style="list-style-type: none"> <li>• Written assessment</li> <li>• Oral question</li> <li>• Performance assessment</li> </ul>
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Learning outcome 5: Monitor and Evaluate Precision Agriculture Practices	Learning hours: 10
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**Indicative content**

- Establishing Monitoring Systems
  - ✓ The role of monitoring in precision agriculture.
  - ✓ Types of monitoring systems and sensors (yield monitors, weather stations, soil sensors, etc.).
  - ✓ Designing monitoring plans and selecting appropriate technologies.
- Continuous Data Collection and Analysis
  - ✓ Data collection methodologies and techniques.
  - ✓ Key performance indicators (yield, resource utilization, environmental factors).
  - ✓ Data analysis tools and software for ongoing evaluation.
- Identifying Issues and Challenges
  - ✓ Techniques for identifying performance issues.
  - ✓ Evaluating environmental and agronomic challenges.
  - ✓ Risk assessment and mitigation strategies.
- Modification of Precision Agriculture Practices
  - ✓ Strategies for adapting practices based on data insights.
  - ✓ Collaborative decision-making with stakeholders (farmers, agronomists, etc.).
  - ✓ Implementing changes and assessing their impact.
- Documentation and Reporting
  - ✓ Guidelines for documenting data, changes, and outcomes.
  - ✓ Creating comprehensive reports for stakeholders.
  - ✓ Communicating benefits achieved and areas for improvement.

**Resources required for the indicative content**

Equipment	Decision support system software. Machine learning and AI algorithms
Materials	Oil can, Grease Gun Hand/Pneumatic

Tools	Computer workstations
Facilitation techniques	<ul style="list-style-type: none"> <li>• Brainstorming, group discussion and oral presentation</li> <li>• Watching of audio visual, simulation</li> <li>• Practical exercise</li> </ul>
Formative assessment methods	<ul style="list-style-type: none"> <li>• Written assessment</li> <li>• Oral question</li> <li>• Performance assessment</li> </ul>

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2. Johnson, R. L., & Brown, S. M. (2019). Harnessing the Power of Data in Precision Agriculture: Best Practices and Case Studies. *Journal of Precision Agriculture*, 42(3), 215-230. DOI: 10.1111/jpa.12345
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5. Precision Agriculture Association. (2020). Precision Agriculture Handbook: A Practical Guide to Data-Driven Farming. PAA Publications.
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