Republic of Rwanda
Ministry of Education

RTB | RWANDA TVET BOARD

WIRIS402

INSTALLATION OF SPRINKLER IRRIGATION SYSTEM

INSTALL SPRINKLER IRRIGATION SYSTEM

Competence

RQF Level:4

Learning Hours

80

Credits: 8

Sector: Agriculture and food processing

Trade: Water and Irrigation

Module Type: Specific

Curriculum: TVET Certificate IV in Water and Irrigation

1200

Issue Date: August,2023

<table>
<tr><td>Purpose statement</td><td colspan="5">This module describes the skills, knowledge and attitude required to install sprinkler irrigation system. At the end of this module, learners will be able to organize resources for installation of sprinkler irrigation system; assemble spans for moving and center pivot; complete assembly of sprinkler component; establish a drainage system for sprinkler irrigation scheme; complete installation work. Qualified learners deemed competent to this competency may work alone or with others on routine tasks in marshland, hillside, small scale irrigation, garden, greenhouses, agricultural land, rain water harvesting, In situ rain water harvesting and ground water harvesting related activities under minimum supervision.</td></tr>
<tr><td>Learning assumed to be in place</td><td colspan="5">N.A</td></tr>
<tr><td rowspan="6">Delivery modality</td><td colspan="2">Training delivery</td><td>100%</td><td colspan="2">Assessment</td><td>Total 100%</td></tr>
<tr><td colspan="2">Theoretical content</td><td>30%</td><td rowspan="4">Formative assessment</td><td>30%</td><td rowspan="4">50%</td></tr>
<tr><td colspan="2">Practical work:</td><td rowspan="3">70%</td><td rowspan="3">70%</td></tr>
<tr><td>Group project and presentation</td><td>20%</td></tr>
<tr><td>Individual project /Work</td><td>50%</td></tr>
<tr><td colspan="3"></td><td colspan="2">Summative Assessment</td><td>50%</td></tr>
</table>

Elements of Competence and Performance Criteria

Elements of competence	Performance criteria
1. Organize resources for installation of sprinkler irrigation system	1.1 Methodical interpretation of the technical drawings is done in consultation with the supervisor.
	1.2 Careful identification of any constraints and limitations within the construction site for the irrigation system and confirmation of methods to be used are performed according to the site landscape and work procedures.
	1.3 Proper selection of materials, tools, equipment, and machinery is carried out according to the irrigation system design requirements and technical specifications.

	1.4 Complete delivery of materials and equipment to the site is carried out according to the system drawings and specifications.
	1.5 Proper carrying out of pre-operational and safety checks of tools, equipment, and machinery is done according to manufacturer's and project specifications.
	1.6 Proper identification of occupational Health and Safety (OHS) hazards and relevant risk assessment is conducted according to site conditions.
	1.7 Proper selection and use of suitable safety and personal protective equipment (PPE) such as gloves and a helmet are performed in accordance with work requirements within the construction site.
	1.8 Proper checking of the water source to ensure that it is compatible with system specifications is performed.
2. Assemble spans for moving and center pivot	2.1 Proper joining of span pipes with correctly tensioned bolts for moving and center pivot sprinkler system is carried out.
	2.2 Tight connection of goosenecks and hose connectors is performed according to manufacturer's specifications.
	2.3 Appropriate mounting of wheels fitted to designed positions according to the length and number of the spans is done.
3. Complete assembly of sprinkler component	3.1 Careful setting out of trench main and sub main pipelines according to the designed layout and other technical drawings is executed.
	3.2 Proper assembling of PVC and steel pipes with specific fittings in the range of nominal diameter (DN) and working pressure is performed.
	3.3 Tight connection of High-density polyethylene (HDPE) pipes using a welding machine or simple coupling tools according to the nominal diameter (DN) is carried out.
	3.4 Proper assembling of sprinklers, pressure regulators, and hose connectors in compliance with design specifications is done.
	3.5 Adequate fitting of the gear box and control panel mounted on the pivot is performed.
	4.1 Careful checking of drainage necessity to prevent the effects of flooding and waterlogging within the irrigation scheme is undertaken.

4. Establish a drainage system for sprinkler irrigation scheme	4.2 Proper interpretation of the irrigation drainage system design for further implementation of construction works within the site is conducted.
	4.3 Technical carrying out of the preparatory work in terms of resources, setting out, and pegging is performed.
	4.4 Proper excavation of drainage channels according to designed specifications is executed.
	4.5 Adequate construction of drainage structures to ensure the removal of excess water is carried out.
	4.6 Appropriate testing of the drainage system to ensure the efficient conveyance of excess water is performed.
	4.7 Adequate correction of the malfunction to allow the proper functioning of the entire system is undertaken.
5.Complete installation work	5.1 Careful laying of pipes in excavated trenches according to technical specifications is done.
	5.2 Absolute removal of rocks and stones in backfilling materials to avoid damage to PVC pipes is ensured.
	5.3 Complete backfilling of the trenches with appropriate materials in compliance with enterprise work procedures is carried out.
	5.4 Proper identification and selection of waste material disposal site in an environmentally aware and safe manner according to enterprise work procedures are performed.
	5.5 Systematic restoring of the site and removal of waste material from the construction site to be disposed of in environmentally safe conditions are executed.
	5.6 Timely reporting of malfunctioning and any operating faults resulting from flow and pressure tests of the irrigation network is done.

Course content

Learning outcomes	At the end of the module the learner will be able to: 1. Organize resources for installation of sprinkler irrigation system

	2. Assemble spans for moving center pivot 3. Complete assembly of sprinkler component 4. Establish a drainage system for sprinkler irrigation scheme **5.** Complete installation work
Learning outcome 1: Organize resources for installation of sprinkler irrigation system	Learning hours: 10

Indicative content

- ✓ Sprinkler irrigation components:
  - Pressure generating units (Pump unit)
  - Water carrier units (Mainlines, sub mainlines, Laterals)
  - Water delivery units (riser pipes and Sprinklers)
  - Filtration unit
  - Ancillary units (Fertilizer and other chemical applicator)
  - Fittings and connectors
- ✓ Types of irrigation technical drawings:
- Piping and instrument diagram
- Erection drawing
- Assembly drawing
- Layout drawing
- Structural drawing
- Longitudinal and cross-sectional profiles
- ✓ Elements of technical drawing for sprinkler system:
  - Title of the drawing
  - Type of drawing
  - Drawing number and revision number
  - Date of the preparation
  - Scale of the drawing and measurement unit
  - Name of the organization and/or the person

- Special symbols for sprinkler irrigation components (Legend)
- North arrow

✓ Types of constraints within construction site:

- Economic constraints
- Legal constraints
- Environmental constraints
- Technical constraints
- Social constraint

✓ Types of Limitations within construction site:

- Site topography
- Accessibility
- Rain
- Lack of skilled labors

✓ Types of sprinkler irrigation system:

- Permanent Set
- Hand-move
- Wheel Lines
- Linear Move
- Center Pivot
- Traveling Sprinkler

✓ Selection criteria of sprinkler irrigation systems

✓ Types of machinery used in sprinkler irrigation system:

- Earth moving machinery (Excavator, grader, compactor, etc.)
- Lifting machinery (crane)

✓ Quality and size of materials:

- **Pipes PN and DN**

✓ Quality and size of equipment:

- Pump TDH

- Pump Discharge

✓ Types of tools, equipment and machinery

✓ Tool safety consideration criteria

✓ Types of hazards in the work place (chemical, biological, other health hazards)

✓ Hazard and risks associated with sprinkler irrigation project

✓ Types and use of Personal Protective Equipment (PPE)

✓ Types of water sources:

- Lakes
- Rivers

✓ Properties of water sources

Resources required for the learning outcome	
Equipment	• Tractor, Steel Rule, Feeler gauge, Engineer‟s square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack , T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Materials	• Oil can, Grease Gun Hand/Pneumatic
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, similation • Practical exercise
Formative assessment methods	• Written assessment • Oral question • Performance assessment

Learning outcome 2: Assemble spans for moving and center pivot	**Learning hours: 20**

Indicative content

- ✓ Center pivot components:
  - Pivot point
  - Spans
  - Overhang
  - Span tower
- ✓ Center pivot fittings
- ✓ Steps of assembling Center pivot

Resources required for the indicative content	
Equipment	Tractor, Steel Rule, Feeler gauge, Engineer‟s square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack , T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Materials	Oil can, Grease Gun Hand/Pneumatic
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, Hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, similation • Practical exercise
Formative assessment methods	• Written assessment • Oral question

	• Performance assessment

Learning outcome 3: Complete assembly of sprinkler component	Learning hours: 30

Indicative content

- ✓ Land survey
- Land slope measurement
- Cut and fill
- Trenches excavation guidelines
- ✓ Types of pipes:
  - Unplasticized polyvinyl chloride pipes (uPVC)
  - Higher density Polyethylene pipes (HDPE)
  - Hose pipes
  - Aluminum pipes
  - Steel pipes
- ✓ Fittings
- ✓ Pressure and water flow control devices:
- Pressure regulating valves
- Water flow control valves
- Air release valves
- Pressure gauges
- Flow meters
- ✓ Types of sprinkler heads:
- Plastic
- Metallic
- ✓ Types of drive systems:
- Electric

- Hydraulic
- ✓ Components of drive system:
- Electric motor
- Collector ring
- Electric power supply cable
- Drive shaft
- Wheel gear box
- Hydraulic offline
- Center master speed control valve
- ✓ Hydraulic motor and gear drive installation

Resources required for the indicative content	
Equipment	Tractor, Steel Rule, Feeler gauge, Engineer‟s square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack , T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Materials	Oil can, Grease Gun Hand/Pneumatic
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, Hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, similation • Practical exercise
Formative assessment methods	• Written assessment • Oral question • Performance assessment

Learning outcome 4: Establish a drainage system for sprinkler irrigation scheme	**Learning hours: 20**

Indicative content

- ✓ Source of excess water in the scheme:
  - Rainfall
  - Snow melting
  - Excess irrigation
  - Rising of ground water table (GWT)
  - Seepage from canals and reservoirs
  - Leaching of soil
  - Artesian wells
- ✓ Needs for drainage:
  - Control of water ponding
  - Control of water logging
  - Control of water salinisations
  - Control of water table
- ✓ Drainage system components:
  - Interception Channel
  - Field drains
  - Secondary drain
  - Main drains
  - Emissary channel
- ✓ Types of drainage technical drawings:
  - Piping diagram
  - Erection drawing
  - Assembly drawing
  - Layout drawing
  - Structural drawing
  - Longitudinal and cross sectional profiles
- ✓ Elements of technical drawing for drainage system:
  - Title of the drawing
  - Type of drawing
  - Drawing number and revision number
  - Date of the preparation
  - Scale of the drawing and measurement unit
  - Name of the organization and or the person
  - Special symbols for sprinkler irrigation components (Legend)
  - North arrow

- ✓ Land clearance
- ✓ Topographic survey:
  - Slope measurement
  - Structures mark out and plotting
  - Land leveling
- ✓ Trenches excavation guidelines
- ✓ Cut and fill operation
- ✓ Slope measurement
- ✓ Types of drainage systems:
  - Surface drainage
  - Subsurface drainage
- ✓ Types of cross drainage structures:
  - Culverts
  - Bridge
  - Aqueduct
  - Inverted siphon
- ✓ Water conveyance efficiency
- ✓ Laminar water flow
- ✓ Quality of channel walls and bed(shaping)
- ✓ Slope measurement
- ✓ Adjustment of drainage structures

Resources required for the indicative content	
Equipment	Tractor, Steel Rule, Feeler gauge, Engineer‟s square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack , T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Materials	Oil can, Grease Gun Hand/Pneumatic
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame

	adjustable, Allen Key set of 12 pieces, Hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, similation • Practical exercise
Formative assessment methods	• Written assessment • Oral question • Performance assessment

Learning outcome 5: Establish a drainage system for sprinkler irrigation scheme	**Learning hours: 20**
Indicative content	
✓ Pipe laying procedure: ✓ Safety measures and back filling process ✓ Site selection criteria for disposal of waste material from sprinkler construction site ✓ Environmental restoration techniques of sprinkler construction site ✓ Report formats	
Resources required for the indicative content	
Equipment	Tractor, Steel Rule, Feeler gauge, Engineer‟s square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack , T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Materials	Oil can, Grease Gun Hand/Pneumatic

Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, Hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Facilitation techniques	• Brainstorming, group discussion and oral presentation • Watching of audio visual, similation • Practical exercise
Formative assessment methods	• Written assessment • Oral question • Performance assessment

Integrated/Summative assessment

Integrated situation

Gakire, a farmer located in the Eastern Province's Nyagatare District, specifically in the Rwimiyaga Sector's Kirebe Cell, is engaged in cultivating maize across a 25-hectare expanse for seed production. However, the previous year witnessed a significant reduction in maize production. This decline was substantial enough to impede the supply of seeds, a departure from the yields of previous years. In response, Gakire has taken the decision to incorporate a sprinkler irrigation system on his farm. The primary aim of this system is to mitigate the impact of drought by providing essential moisture to the soil, thereby facilitating the production of the requisite maize seeds.

In his role as a sprinkler irrigation operator, Gakire has formally solicited your expertise to undertake the installation of a sprinkler irrigation system on his farm. This installation is intended to serve as a support mechanism for maize production. The task at hand is required to adhere to the following specifications:

- ✓ Organize the necessary resources for the installation of the sprinkler irrigation system.
- ✓ Thoroughly assemble all components essential to the sprinkler system.
- ✓ Establish an effective drainage system to complement the sprinkler irrigation scheme.
- ✓ The stipulated timeframe for the completion of this task is 5 hours

Equipment	Tractor, Steel Rule, Feeler gauge, Engineer‟s square, Divider spring joint, Drift punch copper, Pick punch, Drill electric hand, Air Compressor, Centre punch, Chisels Cross cut, Chisel cold, Hand reamer adjustable, Cross peen Hammer, Mallets (Wooden/plastic), Ball peen Hammer, Electric arc welding set portable, Horses and wheel choke, Hydraulic jack , T bar and ratchet, Chain and Pulley block, Work bench with 4 bench vices 12 cm jaw, Harrow, Plough, Seed Drill, Land Leveller
Tools	Hand files, Taps and Dies complete set in a box (metric) with handle, Ring spanner, Spanner adjustable (pipe wrench), Hydrometer, Torque wrench, Set of Screw driver, Divider spring joint, Scriber, Drift punch copper, Hacksaw frame adjustable, Allen Key set of 12 pieces, Hand vice, Spanner (adjustable), Spanner D E, Tachometer, Spanners socket of 8 with handles, Hand reamer adjustable
Materials/ Consumables	Oil can, Grease Gun Hand/Pneumatic

Assessable outcomes	Assessment criteria (Based on performance criteria)	Indicator	Observation		Marks allocation
			Yes	No	
1. Organize resources for installation of sprinkler irrigation system	1.1 Methodical interpretation of the technical drawings is done in consultation with the supervisor.	Methodical interpretation of the technical drawings is carried out through consultation with the supervisor.			
		Technical drawings are interpreted systematically in collaboration with the supervisor, ensuring accurate understanding and clarity.			
	1.2 Careful identification of any constraints and limitations within the construction site for the irrigation system and confirmation of methods to be used are performed according to the site landscape and work procedures.	Careful identification of constraints and limitations within the construction site for the irrigation system, along with confirmation of methods to be used, is executed in alignment with the site landscape and work procedures.			
		Constraints and limitations within the construction site are meticulously identified, and methods are confirmed based on			

		the site landscape and work procedures for effective implementation of the irrigation system.			
	1.3 Proper selection of materials, tools, equipment, and machinery is carried out according to the irrigation system design requirements and technical specifications.	Proper selection of materials, tools, equipment, and machinery is undertaken in accordance with the irrigation system design requirements and technical specifications.			
		Materials, tools, equipment, and machinery are chosen accurately, aligning with the irrigation system design requirements and technical specifications for optimal implementation.			
	1.4 Complete delivery of materials and equipment to the site is carried out according to the system drawings and specifications.	Complete delivery of materials and equipment to the site is conducted in strict accordance with the system drawings and specifications.			
		Materials and equipment are fully transported to the site, adhering to the system drawings and specifications, ensuring readiness for project execution.			
	1.5 Proper carrying out of pre-operational and safety checks of tools, equipment, and machinery is done according to manufacturer's and project specifications.	Proper execution of pre-operational and safety checks of tools, equipment, and machinery is accomplished according to both manufacturer's and project specifications.			
		Pre-operational and safety checks of tools, equipment, and machinery are performed accurately, following manufacturer's and project specifications for operational readiness.			
	1.6 Proper identification of occupational Health and Safety (OHS) hazards and relevant risk assessment is conducted according to site conditions.	Proper identification of occupational Health and Safety (OHS) hazards and relevant risk assessment is carried out in alignment with site conditions.			
		Occupational Health and Safety (OHS) hazards are accurately recognized, and risk assessment is conducted based on the site conditions, emphasizing safety protocols.			

	1.7 Proper selection and use of suitable safety and personal protective equipment (PPE) such as gloves and a helmet are performed in accordance with work requirements within the construction site.	Proper selection and utilization of suitable safety and personal protective equipment (PPE), such as gloves and a helmet, are undertaken in compliance with work requirements within the construction site.			
		Suitable safety and personal protective equipment (PPE) such as gloves and a helmet are chosen and used accurately, adhering to work requirements within the construction site for enhanced safety.			
	1.8 Proper checking of the water source to ensure that it is compatible with system specifications is performed.	Proper verification of the water source to ensure compatibility with system specifications is carried out.			
		The water source is checked accurately to ensure its alignment with system specifications, promoting effective system functionality.			
2. Assemble spans for moving and center pivot	2.1 Proper joining of span pipes with correctly tensioned bolts for moving and center pivot sprinkler system is carried out.	Proper joining of span pipes with correctly tensioned bolts for the moving and center pivot sprinkler system is executed.			
		Span pipes are joined accurately with appropriately tensioned bolts, ensuring the effectiveness of the moving and center pivot sprinkler system.			
	2.2 Tight connection of goosenecks and hose connectors is performed according to manufacturer's specifications.	Tight connection of goosenecks and hose connectors is achieved in accordance with manufacturer's specifications.			
		Goosenecks and hose connectors are tightly connected, adhering to manufacturer's specifications for secure integration.			
	2.3 Appropriate mounting of wheels fitted to designed positions according to the length and number of the spans is done.	Appropriate mounting of wheels fitted to designed positions, based on the length and number of spans, is accomplished.			
		Wheels are mounted correctly in positions that correspond to the designed layout, considering the length and number of spans for the desired functionality.			

3. Complete assembly of sprinkler component	3.1 Careful setting out of trench main and sub main pipelines according to the designed layout and other technical drawings is executed.	Careful execution of setting out trench main and sub main pipelines is undertaken according to the designed layout and other technical drawings.			
		Trench main and sub main pipelines are set out with precision, adhering to the designed layout and technical drawings.			
	3.2 Proper assembling of PVC and steel pipes with specific fittings in the range of nominal diameter (DN) and working pressure is performed.	Proper assembly of PVC and steel pipes with specific fittings within the range of nominal diameter (DN) and working pressure is carried out.			
		PVC and steel pipes are assembled accurately with designated fittings, conforming to the defined nominal diameter (DN) and working pressure.			
	3.3 Tight connection of High-density polyethylene (HDPE) pipes using a welding machine or simple coupling tools according to the nominal diameter (DN) is carried out.	Tight connection of High-density polyethylene (HDPE) pipes using a welding machine or simple coupling tools is accomplished in accordance with the nominal diameter (DN).			
		High-density polyethylene (HDPE) pipes are connected securely using welding machines or coupling tools, aligning with the specified nominal diameter (DN).			
	3.4 Proper assembling of sprinklers, pressure regulators, and hose connectors in compliance with design specifications is done.	Proper assembly of sprinklers, pressure regulators, and hose connectors is carried out in accordance with design specifications.			
		Sprinklers, pressure regulators, and hose connectors are assembled accurately, adhering to design specifications for proper functionality.			
	3.5 Adequate fitting of the gear box and control panel mounted on the pivot is performed.	Adequate fitting of the gear box and control panel mounted on the pivot is executed.			
		The gear box and control panel are fitted appropriately onto the pivot, ensuring proper placement and functionality.			
4. Establish a drainage	4.1 Careful checking of drainage necessity to prevent the effects of	Careful checking of drainage necessity is undertaken to prevent			

system for sprinkler irrigation scheme	flooding and waterlogging within the irrigation scheme is undertaken.	the impacts of flooding and waterlogging within the irrigation scheme.			
		Drainage necessity is meticulously assessed to prevent flooding and waterlogging within the irrigation scheme.			
	4.2 Proper interpretation of the irrigation drainage system design for further implementation of construction works within the site is conducted.	Proper interpretation of the irrigation drainage system design for further implementation of construction works within the site is conducted.			
		The irrigation drainage system design is interpreted accurately to facilitate the subsequent construction works within the site.			
	4.3 Technical carrying out of the preparatory work in terms of resources, setting out, and pegging is performed.	Technical execution of preparatory work in terms of resources, setting out, and pegging is performed.			
		Preparatory work involving resources, setting out, and pegging is executed with technical precision.			
	4.4 Proper excavation of drainage channels according to designed specifications is executed.	Proper excavation of drainage channels according to designed specifications is executed.			
		Drainage channels are excavated accurately, adhering to the specified design requirements.			
	4.5 Adequate construction of drainage structures to ensure the removal of excess water is carried out.	Adequate construction of drainage structures is carried out to ensure the effective removal of excess water.			
		Drainage structures are constructed appropriately to ensure the removal of excess water.			
	4.6 Appropriate testing of the drainage system to ensure the efficient conveyance of excess water is performed.	Appropriate testing of the drainage system to ensure the efficient conveyance of excess water is performed.			
		The drainage system is tested appropriately to verify its efficient conveyance of excess water.			
	4.7 Adequate correction of the malfunction to allow the proper functioning of the entire system is undertaken.	Adequate correction of the malfunction to enable the proper functioning of the entire system is undertaken.			

		Malfunctions are appropriately addressed to ensure the proper operation of the entire system.			
5.Complete installation work	5.1 Careful laying of pipes in excavated trenches according to technical specifications is done.	Careful laying of pipes in excavated trenches is performed in strict accordance with technical specifications.			
		Pipes are laid in excavated trenches with precision, adhering to specified technical requirements.			
	5.2 Absolute removal of rocks and stones in backfilling materials to avoid damage to PVC pipes is ensured.	Absolute removal of rocks and stones from backfilling materials is ensured to prevent damage to PVC pipes.			
		Rocks and stones are completely eliminated from backfilling materials, preventing potential harm to PVC pipes.			
	5.3 Complete backfilling of the trenches with appropriate materials in compliance with enterprise work procedures is carried out.	Complete backfilling of the trenches with appropriate materials is carried out in accordance with enterprise work procedures.			
		Trenches are thoroughly filled with suitable materials, following enterprise work procedures for proper execution.			
	5.4 Proper identification and selection of waste material disposal site in an environmentally aware and safe manner according to enterprise work procedures are performed.	Proper identification and selection of the waste material disposal site in an environmentally aware and safe manner are performed according to enterprise work procedures.			
		The waste material disposal site is accurately identified and chosen with environmental awareness and safety considerations, guided by enterprise work procedures.			
	5.5 Systematic restoring of the site and removal of waste material from the construction site to be disposed of in environmentally safe conditions are executed.	Systematic restoration of the site and removal of waste material from the construction site for disposal in environmentally safe conditions are executed.			
		The site is methodically restored, and waste material is taken away from the construction site for environmentally safe disposal.			
	5.6 Timely reporting of malfunctioning and any operating	Timely reporting of malfunctioning and any operating faults resulting			

	faults resulting from flow and pressure tests of the irrigation network is done.	from flow and pressure tests of the irrigation network is performed.			
		Malfunctioning and operating faults arising from flow and pressure tests of the irrigation network are reported promptly			
Total marks					100
Percentage Weightage					100%
Minimum Passing line % (Aggregate): 70%					

References

1. Abu-Zreig, M.M., Abe, Y. and Isoda, H. 2006. The Auto-regulative Capability of Pitcher Irrigation System. Agricultural Water Management, 85(3): 272-278.
2. Allen, R.G., Pereira, L.S., Raes, D. and Smith, M. 1998. Crop evapotranspiration: guidelines for computing crop water requirements. Irrigation and Drainage Paper No. 56. Rome: FAO.
3. Awulachew, S. B.; Merrey, D.J.; Kamara, A.B.; van Koppen, B.; Penning de Vries, F.; Boelee, E. with editorial assistance from G. Makombe. 2005. Experiences and Opportunities for Promoting Small-Scale/Micro Irrigation and Rainwater Harvesting for Food Security in Ethiopia. Working Paper 98. Colombo, Sri Lanka: International Water Management Institute.
4. Booher L.J. 1974 Surface Irrigation. Land and Water Development Division, FAO, Rome.
5. Bresler, E. and Yasutomi, R. 1990. Drip irrigation technology in semi-arid regions and international co-operation. Journal of Irrigation Engineering and Rural Planning 19:48–62.
6. Chamy, I.M., Selvaraj, P.K., Senthilvel, S. and Ali, A.M. 1997. Economic designs in drip irrigation. Publication No. 19/96-97. Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore. Coimbatore, India: TNAU Press.
7. Chapin, R.D. 1996. The Chapin Bucket Irrigation Kit: Bucket Kits for Vegetable Gardens. Chapin Living Water Foundation. Chapin Watermatics Inc., New York, USA. www.chapinlivingwaters.org

8. Doorenbos, J. and Kassam, A.H. 1986. Yield response to water. Irrigation and Drainage Paper No 33. Rome: FAO.
9. FAO, 1985. Layout of the basin irrigation methods. FAO, Rome.
10. FAO, 1986. Crop yield response to water. FAO, Rome.
11. FAO, 1989. Guidelines for designing and evaluating surface irrigation systems. Food and Agriculture Organization of The United Nations. Rome.
12. FAO, 1998. Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56. FAO - Food and Agriculture Organization of the United Nations, Rome.
13. FAO, 2010. Spate Irrigation Guidelines. FAO Irrigation and Drainage paper 65. van Steenbergen, F., Lawrence P, Haile, A.M. Salmand, M. and Faures J.M. (eds). FAO - Food and Agriculture Organization of the United Nations, Rome.
14. Field, W.P. and Collier, F.W. 1998. Checklist to assist preparation of small-scale irrigation projects in sub-Saharan Africa. International Commission on Irrigation and Drainage and DFID. UK.
15. Garg, S.K. 1991. Irrigation Engneering and Hydraulic Structures. Khanna Publishers, New Delhi. 1315p.
16. Hillel, D. (ed.). 1982. Advances in irrigation. Volume 1. New York: Academic Press.
17. Hillel, D. 1997. Small-scale irrigation for arid zones: principles and options. FAO Development Series 2. Rome: FAO.
18. Inocencio, A., D. Merrey, M. Tonosaki,, A. Maruyama, I. de Jong, and M. Kikuchi. 2007. Costs and Performance of Irrigation Projects: A Comparison of Sub-Saharan Africa and Other Developing Regions. IWMI Research Report 109. Colombo, Sri Lanka: IWMI. 93

19. Israelsen, O.W. and Hansen, V.E. 1962. Irrigation: principles and practice. New York: John Wiley.
20. IWMI, 2006 Agricultural water management technologies for small scale farmers in Southern Africa: An inventory and assessment of experiences, good practices and costs. Final report produced by the International Water Management Institute (IWMI) Southern Africa Regional Office Pretoria, South Africa. For Office of Foreign Disaster Assistance, Southern Africa Regional Office, United States Agency for International Development.
21. IWSD 2006. Experiences with micro irrigation technologies and practices: Swaziland. Report written for IWMI. Pretoria, South Africa: IWMI.
22. Jensen M.E. 1983 (ed). Design and operation of farm irrigation systems. Revised Printing. Amer. Soc. Agr. Engr. Mono. No. 3. St. Joseph, Michigan. 840 p.
23. Kay M. 1983 Sprinkler Irrigation: Equipment and Practice. Batsford, London.
24. Kay, M. 1986. Surface irrigation: systems and practice. Bedford, UK: Cranfield Press.
25. Lawrence, P. and van Steenbergen, F. 2005. Improving Community Spate Irrigation. HR Wallingford.
26. Mati, B.M, Mwepa, G. and Temu, R. 2008. Farmer Initiatives in Managing Water for Agriculture in Eastern and Southern Africa. A booklet of farmer innovations in agricultural water management in Eastern and Southern Africa. IMAWESA Working Paper 15. Nairobi.
27. Mati, B.M. 2007. 100 Ways to Manage Water for Smallholder Agriculture in Eastern and Southern Africa. A Compendium of Technologies and Practices. SWMnet Working Paper 13. Nairobi, Kenya.
28. Mati, B.M. 2008. Capacity development for smallholder irrigation in Kenya. Irrigation and Drainage. IRD 57(3): 332-340. Wiley InterScience.
29. Mati, B.M. 2010. Agricultural Water Management Delivers Returns on Investment in Africa: A Compendium of 18 Case Studies from Six Countries in Eastern and Southern Africa. VDM Verlag, 280p.
30. Mati, B.M. and Penning de Vries, F.W.T. 2005. bright spots on technology-driven change in smallholder irrigation. Case studies from Kenya. In: bright spots demonstrate community successes in African agriculture. International Water Management Institute. Working Paper 102: 27-47.
31. Michael, A. M. 1978. Irrigation, Theory and Practice. Vikas publishing House PVT Ltd, New Delhi. 801p.
32. Molden, D. (ed). 2007. Water for Food, Water for Life: The Comprehensive Assessment of Water Management in Agriculture. Earthscan, UK.

33. Muchangi, P., Sijali, I., Wendot, H. and Lempere, P. 2005. Improving the performance of irrigation in Africa. GoK, NIB, KARI and IWMI training handbook on irrigation.
34. Muya, E. M., Jura, M. O. and Mati, B.M. 2009. Water management in irrigated agriculture: A training module for technical staff. IMAWESA Training Manual No.4. Improved Management of Agricultural Water in Eastern and Southern Africa, Nairobi.
35. Muya, E.M., Gitau, K., Obanyi, S., Ngutu, M., Kuria, S., Sharfi, H., Dub, D.G., Bulle, H., Miano, D.M., Mureithi, J., Keya, G., Sjali, I.V., Mamo, S., Maingi, P.M. and Okoti, M. 2009. Characterizing sites for the design and development of integrated and sustainable irrigation scheme, Kalacha. EAFRO Journal (in press). 94

36. Muya, E.M., Karanja, N., Roimen, H., Okoth, P.F.Z. and Maingi, P.M. 2008. Ecosystem characteristics of below-ground biodiversity sites in Embu and Taita Districts, Kenya. Kenya Soil Survey, Miscellaneous Paper No. 65.
37. Nakayoma F.S. and Bucks D.A. 1986 (eds). Trickle Irrigation for Crop Production: Design, Operation and Management. Elsevier, New York. 393 p.
38. Ngigi, S.N. 2003. Rainwater harvesting for improved food security: Promising technologies in the Greater Horn of Africa. Greater Horn of Africa Rainwater Partnership (GHARP) and Kenya Rainwater Harvesting Association (KRA), with support from the United States Agency for International Development (USAID).
39. Ngigi, S.N. 2008. Technical Evaluation and Development of Low-Head Drip Irrigation Systems in Kenya. Irrigation and Drainage, 57(2008): 450-462. http://www.interscience.wiley.com.
40. Ngigi, S.N. 2009. Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa. The MDG Centre for East and Southern Africa, The Earth Institute at Columbia University, New York. 189p.
41. Sijali, I. V.; Okumu, R. A.; 2002. New irrigation technologies. In The changing face of irrigation in Kenya. Opportunities for anticipating change in Eastern and Southern Africa, eds. H.G. Blank; C.M. Mutero; H. Murray-Rust. IWMI, Sri Lanka, 55-71.
42. Sijali, I.V. 2001. Drip Irrigation: Options for Smallholder Farmers in Eastern and Southern Africa. Technical Handbook No. 24. RELMA, Nairobi.
43. Sivanappan, R.K. 1994. Prospects of micro irrigation in India. Irrigation and Drainage Systems 8:49–58.
44. Smith, M. 1992. CROPWAT: a computer program for irrigation planning and management. Irrigation and Drainage Paper No 46. Rome: FAO.
45. Stein, T. 1990. Development of Design Criteria for Pitcher Irrigation. Cranfield Institute of Technology, Silsoe College, MSc Dissertation, August 1990. Accessible via WCAinfoNET http://www.wca-infonet.org/id/91138.
46. Stern P.H. 1979 Small Scale Irrigation: A manual of low cost water technology. Intermediate Technology Publications, London.
47. UNDP/UNSO. 1999. Promoting farmer innovation in rain-fed agriculture in Sub-Saharan Africa. Report of the mid-term evaluation of PFI programs in Kenya, Tanzania and Uganda. Nairobi. UNDP.

48. Vermeiren L. and Jobling G.A. 1980 Localized irrigation: design, installation, operation and evaluation. Irrigation and Drainage Paper 36, FAO, Rome.
49. Vukasin, H. L.; Roos, L.; Spicer, N. H.O.; Davies, M. 1995. Production without destruction. A manual for trainers and a reference book for those practicing natural or organic farming. Natural Farming Network, Zimbabwe.
50. Withers, B. and Vipond, S. 1974. Irrigation design and practices. BT Batsford Limited.
51. World Bank. 2006. Re-engaging in Agricultural Water Management: Challenges, Opportunities and Trade-offs. Directions in Development Report. Washington, DC: World Bank.