THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

134/1 SCIENCE AND PRACTICE OF AGRICULTURE 1

(For school Candidates Only)

Time: 2:30Hours **ANSWERS** **Year: 2017**

Instructions

1. This paper consists of **ten (10)** questions in sections A, B and C
2. Answer **five (5)** questions choosing at least one question from each section.
3. Each question carries twenty marks

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1. (a) Briefly describe six criteria which are essential for selecting an appropriate source of farm power to use.

When selecting an appropriate source of farm power, consider the following criteria:

i. Farm Size and Type of Operations: Larger farms with extensive operations may benefit from mechanical power sources like tractors, while smaller farms might rely on human or animal power.

ii. Economic Considerations: The cost of acquiring, operating, and maintaining the power source should align with the farm's budget and financial capacity.

iii. Availability of Fuel and Spare Parts: Ensuring a consistent supply of fuel and availability of spare parts is crucial for the uninterrupted operation of mechanical power sources.

iv. Terrain and Soil Conditions: The topography and soil type of the farm influence the suitability of certain power sources; for instance, steep or rugged terrains may limit the use of heavy machinery.

v. Labor Availability: The availability and cost of labor can determine whether human, animal, or mechanical power is more appropriate.

vi. Environmental Impact: Considering the environmental effects, such as emissions and soil compaction, is essential when selecting a power source.

(b) The tractor engine is a four-stroke cycle engine. Enumerate four advantages of a four-stroke cycle engine.

Four-stroke cycle engines offer several advantages:

i. Fuel Efficiency: Four-stroke engines are generally more fuel-efficient due to their complete combustion process.

ii. Lower Emissions: They produce fewer emissions compared to two-stroke engines, making them more environmentally friendly.

iii. Durability: With a dedicated lubrication system, four-stroke engines experience less wear and tear, leading to longer engine life.

iv. Better Torque: These engines provide higher torque at lower RPMs, which is beneficial for various agricultural applications.

(c) Briefly explain the functions of the ten essential components of an Internal Combustion Engine.

An internal combustion engine comprises several essential components, each serving a specific function:

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i. Cylinder: Forms the combustion chamber where fuel combustion occurs.

ii. Piston: Moves up and down within the cylinder, converting the energy from combustion into mechanical work.

iii. Crankshaft: Transforms the reciprocating motion of the piston into rotational motion to drive machinery.

iv. Connecting Rod: Links the piston to the crankshaft, transmitting motion between them.

v. Camshaft: Controls the opening and closing of intake and exhaust valves, synchronized with the piston's movement.

vi. Valves (Intake and Exhaust): Regulate the flow of air-fuel mixture into the cylinder and exhaust gases out of the cylinder.

vii. Spark Plug (in gasoline engines): Ignites the air-fuel mixture within the cylinder to initiate combustion.

viii. Fuel Injector (in diesel engines): Sprays fuel into the combustion chamber for mixing with air.

ix. Flywheel: Maintains the engine's momentum between power strokes, ensuring smooth operation.

x. Lubrication System: Provides oil to engine components to reduce friction and wear.

2. (a) What is meant by a farm workshop?

A farm workshop is a designated area on a farm equipped with tools and machinery where construction, maintenance, and repair of farm equipment and structures are carried out.

(b) Outline the safety measures in the farm workshop concerning the following aspects:

(i) Housekeeping

Maintaining a clean and organized workshop is essential for safety:

Keep the workshop clean and organized to prevent accidents.

Ensure tools are stored properly after use.
(ii) Personal protection against injury

To protect individuals from injuries:

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Wear appropriate personal protective equipment (PPE) such as gloves, safety glasses, and protective footwear.

Avoid loose clothing that can get caught in machinery.

(iii) Protection against fire hazards

To mitigate fire risks:

Store flammable materials safely and away from ignition sources.

Equip the workshop with fire extinguishers and ensure they are accessible.

(c) What does the statement ‘appropriate use of farm workshop tools’ mean?

This statement refers to using the correct tools for their intended purposes, following the manufacturer's guidelines, and employing proper techniques to ensure safety and efficiency.

(d) Give the function(s) of each of the following workshop tools:

(i) Hacksaw

Used for cutting metal pipes, rods, and profiles.

(ii) Jack plane

Employed to smooth and flatten wooden surfaces.

(iii) Claw hammer

Designed for driving nails into wood and removing them using the curved claw.

(iv) Cold chisel
Utilized for cutting and shaping hard materials like metal and stone.

3. (a) (i) Define a word roof.

A roof is the topmost covering of a building or structure, designed to protect against weather conditions such as rain, wind, sun, and snow.

(ii) Enumerate seven roofing materials which are used in farm buildings.

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i. Corrugated metal sheets
ii. Concrete tiles
iii. Clay tiles
iv. Asphalt shingles
v. Wooden shingles
vi. Thatch (straw or reeds)
vii. Polycarbonate sheets

(iii) List nine types of roofs that are found in farm buildings.

i. Gable roof
ii. Hip roof
iii. Gambrel roof
iv. Mansard roof
v. Flat roof
vi. Shed (lean-to) roof
vii. Monitor roof
viii. Butterfly roof
ix. Arched roof

(b) Briefly describe six types of fences.

i. Barbed Wire Fence: Made of twisted wire with sharp barbs, commonly used to control livestock.

ii. Electric Fence: Uses electrified wires to deter animals and intruders.

iii. Woven Wire Fence: Strong fencing with wires woven to form a mesh, suitable for livestock and poultry.

iv. Chain-Link Fence: Made of interwoven steel wires, often used for securing perimeters.

v. Wooden Fence: Built with wooden planks or posts, often used for aesthetics and boundary marking.

vi. Stone Fence: Constructed from stacked stones, durable and requires minimal maintenance.

(c) Suggest ten functional requirements for the improved animal building.

i. Proper ventilation for air circulation.
ii. Adequate lighting, natural or artificial.
iii. Durable and weather-resistant materials.
iv. Proper drainage systems to manage waste.
v. Comfortable flooring to prevent injuries.
vi. Sufficient space for animal movement.

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vii. Proper feeding and watering facilities.
viii. Secure fencing to prevent escape.
ix. Temperature control systems for extreme climates.
x. Easy access for cleaning and maintenance.

4. (a) Give the meaning of primary tillage implements.

Primary tillage implements are tools or machinery used to break and loosen soil to a considerable depth, preparing the land for sowing crops.

(b) Account for the following primary tillage implements:

(i) Power Tiller: A self-propelled machine used to plow, weed, or level the soil.

(ii) Chisel Plough: Designed to break up compact soil layers without turning it over, preserving soil structure.

(iii) Disc Plough: Equipped with concave discs to cut through and invert soil, effective in hard or rocky soils.

(iv) Ox-Drawn Mouldboard Plough: A plough drawn by oxen, used to turn the soil over and prepare seedbeds in small-scale farming.

(v) Tractor-Operated Mouldboard Plough: A plough attached to a tractor, used for large-scale farming to invert soil and bury crop residues.

5. (a) What do you understand by the term ‘irrigation’?

Irrigation is the artificial application of water to soil or crops to ensure their growth and development, especially in areas with insufficient rainfall.

(b) Outline five maintenance actions for the surface irrigation system.

i. Regular cleaning of irrigation channels to remove debris.
ii. Repairing cracks or leaks in canals and ditches.
iii. Leveling the land to ensure uniform water distribution.
iv. Controlling vegetation growth along irrigation paths.
v. Inspecting and maintaining water control structures, such as gates and valves.

(c) Identify three management practices for the trickle irrigation system.

i. Regularly checking and cleaning emitters to prevent clogging.
ii. Monitoring water pressure to maintain consistent flow rates.

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iii. Periodic inspection of pipes and connectors for leaks or damage.

(d) Point out four merits and three demerits of the drip irrigation system.

Merits:
i. Reduces water wastage by delivering water directly to the roots.
ii. Minimizes soil erosion compared to other irrigation methods.
iii. Saves labor and time due to automated systems.
iv. Enhances crop yield by ensuring consistent water supply.

Demerits:
i. High initial installation cost.
ii. Emitters are prone to clogging, requiring regular maintenance.
iii. Not suitable for large-scale field crops.

(e) Under which three conditions would irrigation be recommended?

i. In areas with insufficient or erratic rainfall.
ii. During prolonged droughts to sustain crop growth.
iii. For high-value crops that require consistent water supply.

6. (a) Briefly explain the following terms:

(i) Bulk density

Bulk density is the mass of dry soil per unit volume, including the air space and mineral particles. It is expressed in grams per cubic centimeter (g/cm^3) and indicates soil compaction.

(ii) Particle density

Particle density refers to the mass per unit volume of the soil particles themselves, excluding pore spaces. It is typically around 2.65 g/cm^3 for mineral soils.

(iii) Porosity

Porosity is the percentage of the total soil volume occupied by pore spaces, which can be filled with air or water. It reflects the soil's ability to hold and transmit water and air.

(iv) Soil texture

Soil texture describes the relative proportions of sand, silt, and clay particles in a soil sample. It influences water retention, drainage, and nutrient availability.

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(b) Derive the relationship between porosity, bulk density, and particle density.

Solution :
Derivation of the Relationship Between Porosity, Bulk Density, and Particle Density

Definitions:
- Porosity (P): The percentage of the soil volume that is occupied by pores or voids.
  Formula:
  P = (Volume of pores / Total soil volume) × 100
- Bulk Density (BD): The mass of the soil particles divided by the total soil volume (including pore spaces).
  Formula:
  BD = Mass of soil particles / Total soil volume
- Particle Density (PD): The mass of soil particles divided by the volume of the solid soil particles (excluding pore spaces).
  Formula:
  PD = Mass of soil particles / Volume of soil particles

Step-by-step derivation:

Total soil volume is the sum of the volume of soil particles and the volume of pores.
  Total soil volume = Volume of soil particles + Volume of pores

Relating bulk density and particle density:
  The mass of soil particles is the same in both definitions of bulk density and particle density.
  From the formula for bulk density:
  BD = Mass of soil particles / Total soil volume

  From the formula for particle density:
  PD = Mass of soil particles / Volume of soil particles
  Rearranging to express total soil volume:
  Total soil volume = Mass of soil particles / BD

  Rearranging to express volume of soil particles:
  Volume of soil particles = Mass of soil particles / PD

Porosity is defined as the ratio of pore volume to total soil volume:
  P = (Volume of pores / Total soil volume) × 100

  Substituting Volume of pores = Total soil volume - Volume of soil particles:
  P = ((Total soil volume - Volume of soil particles) / Total soil volume) × 100

Substituting the relationships for total soil volume and volume of soil particles:

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Total soil volume = Mass of soil particles / BD
Volume of soil particles = Mass of soil particles / PD

P = (((Mass of soil particles / BD) - (Mass of soil particles / PD)) / (Mass of soil particles / BD)) × 100
P = (1 - (BD / PD)) × 100
Final relationship:

P = (1 - (BD / PD)) × 100
Where:

P is porosity in percentage
BD is bulk density
PD is particle density
This equation shows that as bulk density increases, porosity decreases, assuming particle density remains constant.
(c) A certain soil sample was analyzed for some soil physical parameters at Mlingano Soil Science Laboratory. The following data were recorded:

(i) Weight of wet soil = 250 g (ii) Volume of soil = 200 cm^3 (iii) Weight of oven-dry soil = 200 g (iv) Volume of pore space = 20 cm^3

Calculate the following soil physical parameters. Limit your answer to two decimal places:
Solution:
Given Data:
- Weight of wet soil = 250 g
- Volume of soil = 200 cm^3
- Weight of oven-dry soil = 200 g
- Volume of pore space = 20 cm^3

Required:
- Bulk density (BD)
- Particle density (PD)
- Percentage pore space (P)

- Bulk Density (BD)
Formula:
BD = Weight of oven-dry soil / Volume of soil

Substitute the values:
BD = 200 g / 200 cm^3
BD = 1.00 g/cm^3

Answer: Bulk density = 1.00 g/cm^3

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- Particle Density (PD)
Formula:
PD = Weight of oven-dry soil / (Volume of soil - Volume of pore space)

Substitute the values:
PD = 200 g / (200 cm^3 - 20 cm^3)
PD = 200 g / 180 cm^3
PD = 1.11 g/cm^3

Answer: Particle density = 1.11 g/cm^3

- Percentage Pore Space (P)
Formula:
P = (1 - (BD / PD)) × 100

Substitute the values:
P = (1 - (1.00 / 1.11)) × 100
P = (1 - 0.9009) × 100
P = 0.0991 × 100
P = 9.91%
Answer: Percentage pore space = 9.91%

(d) Examine four factors affecting soil bulk density.

i. Soil texture: Fine-textured soils like clays have lower bulk densities due to higher porosity, while sandy soils have higher bulk densities.

ii. Organic matter content: Higher organic matter reduces bulk density by increasing aggregation and pore space.

iii. Soil compaction: Compacted soils have higher bulk densities due to reduced pore space.

iv. Soil depth: Bulk density typically increases with soil depth because of lower organic matter and compaction from overlying layers.

7. (a) Briefly describe each of the following as applied in soil science:

(i) Saline-alkali soil

Saline-alkali soils, also known as saline-sodic soils, contain high concentrations of soluble salts and exchangeable sodium. They typically have an electrical conductivity (EC) greater than 4 dS/m and an

exchangeable sodium percentage (ESP) exceeding 15. The pH of these soils is variable but usually above 8.5, depending on the relative amounts of exchangeable sodium and soluble salts.

(ii) Salt-affected soil

Salt-affected soils are those that have accumulated excessive soluble salts, exchangeable sodium, or both, adversely affecting soil properties and plant growth. They are generally classified into three categories: saline, sodic (alkali), and saline-sodic soils.

(iii) Saline soil

Saline soils contain high levels of soluble salts, primarily chlorides and sulfates of sodium, calcium, and magnesium. They are characterized by an electrical conductivity (EC) greater than 4 dS/m, an exchangeable sodium percentage (ESP) less than 15, and a pH usually less than 8.5. These soils often exhibit a white crust of salts on the surface, leading to the term "white alkali" soils.

(iv) Alkali soil

Alkali soils, also known as sodic soils, have high levels of exchangeable sodium relative to other cations. They are defined by an exchangeable sodium percentage (ESP) greater than 15 and an electrical conductivity (EC) less than 4 dS/m. The pH of these soils is usually between 8.5 and 10.0. Historically, they were referred to as "black alkali" soils due to the dispersion of organic matter, which gives the surface a dark appearance.

(b) Account for three methods of controlling salt-affected soils.

- Leaching: Applying excess irrigation water to dissolve and flush soluble salts beyond the root zone. This method is effective for saline soils but requires adequate drainage to prevent waterlogging.

- Improving Drainage: Enhancing soil drainage through physical means, such as installing subsurface drainage systems, to facilitate the removal of excess salts and lower the water table.

- Application of Amendments: Adding chemical amendments like gypsum (calcium sulfate) to sodic soils helps replace exchangeable sodium with calcium, improving soil structure and permeability.

(c) Assess any two detrimental effects associated with each of the following in crop production:

(i) Saline soil

- Osmotic Stress: High salt concentrations in the soil solution reduce the availability of water to plants, leading to dehydration and stunted growth.

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- Nutrient Imbalance: Excessive salts can interfere with the uptake of essential nutrients, causing deficiencies and affecting plant health.

(ii) Alkali soil

- Soil Dispersion: High exchangeable sodium causes soil particles to disperse, leading to poor soil structure, reduced aeration, and impeded root growth.

- Toxicity: Elevated sodium levels can be toxic to plants, causing leaf burn, reduced photosynthesis, and lower crop yields.

8. (a) (i) What is the meaning of agricultural marketing?

Agricultural marketing encompasses all activities involved in moving agricultural products from producers to consumers. This includes planning production, growing and harvesting, grading, packing, transport, storage, agro- and food processing, distribution, advertising, and sale.

(ii) Name eight functions of marketing.

- Buying and Selling: Facilitating transactions between producers and consumers.

- Storage: Holding products until they are needed for consumption.

- Transportation: Moving products from production sites to places of consumption.

- Processing: Transforming raw products into forms more acceptable to consumers.

- Grading and Standardization: Classifying products based on quality and establishing standards.

- Financing: Providing credit facilities to carry out marketing activities.

- Risk Bearing: Assuming the risks associated with changes in price, demand, and supply.

- Market Information: Gathering and disseminating information about market conditions, prices, and trends.

(b) Elaborate six characteristics of pure or perfect market competition.

- Large Number of Buyers and Sellers: No single buyer or seller can influence the market price.

- Homogeneous Products: Goods offered are identical, with no differentiation.
- Free Entry and Exit: Firms can freely enter or exit the market without significant barriers.
- Perfect Information: All participants have complete knowledge of prices, products, and market conditions.
- Price Takers: Individual firms accept the market price as given, without the power to influence it.
- No Government Intervention: Prices and production are determined by market forces without regulatory interference.

(c) Evaluate eight benefits of agricultural marketing cooperatives to farmers in Tanzania.

- Market Access: Cooperatives provide collective bargaining power, enabling farmers to access larger and more lucrative markets.
- Better Prices: By eliminating intermediaries, cooperatives can secure better prices for members' produce.
- Access to Credit: Cooperatives often facilitate access to financial services and credit facilities for farmers.

9. (a) Define the term ‘price’.

In economics, price is the amount of money required to purchase a product or service. It serves as a measure of a product's value, reflecting what consumers are willing to pay and what producers are willing to accept in exchange.

(b) (i) What does price control and stabilization imply?

Price control refers to government-mandated minimum or maximum prices set for specific goods and services to manage their affordability. This includes price ceilings (maximum prices) and price floors (minimum prices).

Price stabilization involves efforts to prevent significant fluctuations in the general level of prices within an economy. Maintaining price stability entails avoiding prolonged phases of inflation or deflation, contributing to high employment and moderate long-term interest rates.

(ii) Analyze three importance of price control and stabilization.

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- Consumer Protection: Price controls can make essential goods and services more affordable during periods of high inflation or shortages, protecting consumers from price gouging.

- Economic Stability: Price stabilization helps maintain consistent price levels, reducing uncertainty in the economy. This predictability encourages investment and consumption, fostering economic growth.

- Inflation Control: By implementing price controls, governments can directly influence the inflation rate, preventing hyperinflation scenarios that can erode purchasing power and savings.

(iii) Suggest six suitable ways for managing price fluctuations in Tanzania.

- Monetary Policy Adjustments: The central bank can modify interest rates and control money supply to influence inflation and stabilize prices.

- Fiscal Policy Measures: Government spending and taxation policies can be adjusted to manage demand-pull inflation, thereby stabilizing prices.

- Buffer Stock Schemes: Establishing reserves of essential commodities can help stabilize prices by releasing stocks during shortages and purchasing during surpluses.

- Subsidies and Price Supports: Providing subsidies for essential goods can lower production costs, leading to more stable consumer prices.

- Diversification of the Economy: Reducing dependence on a narrow range of commodities can mitigate the impact of global price volatility on the domestic market.

- Strengthening Market Infrastructure: Improving supply chains, storage facilities, and transportation can reduce costs and minimize price fluctuations due to logistical issues.

(c) Enumerate four factors that cause change of each of the following:

(i) Demand of an agricultural good

- Income Levels: As consumer incomes rise, the demand for certain agricultural goods may increase, especially for higher-quality or organic products.

- Consumer Preferences: Shifts in tastes, such as a growing preference for plant-based diets, can alter the demand for specific agricultural goods.

- Population Growth: An increasing population raises the overall demand for food products.

- Price of Substitutes: If the price of a substitute good changes, it can affect the demand for the agricultural product in question. For example, a decrease in the price of poultry may reduce the demand for beef.

(ii) Supply of an agricultural good

- Weather Conditions: Adverse weather events like droughts or floods can decrease the supply of agricultural products.

- Technological Advancements: Improved farming techniques and equipment can increase supply by enhancing productivity.

- Input Costs: Rising costs of inputs such as seeds, fertilizers, and labor can reduce supply by making production less profitable.

- Government Policies: Subsidies, taxes, and regulations can either encourage or hinder agricultural production, thus affecting supply.