Harvestforge — Activity Book

A Spark & Anvil activity book — puzzles, questions, and fun from Harvestforge.

Write in the book, circle your answers, and check the Answer Key at the back.

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1. Farm Foundations: Soil and Seeds

Circle the correct answer

1. What are the four main components of healthy agricultural soil?
(A) Mineral particles, organic matter, water, and air (B) Sand, gravel, clay, and rocks (C) Topsoil, subsoil, bedrock, and magma (D) Fertilizer, pesticides, water, and seeds

2. A farmer tests two fields and finds one has mostly clay soil and the other has mostly sandy soil. Which crop-growing challenge is the clay field MOST likely to have?
(A) Wind erosion — clay particles blow away faster than sand particles (B) Poor drainage — clay soil holds too much water, which can drown plant roots (C) Not enough nutrients — clay soil contains almost no minerals for plants (D) Too much sunlight exposure — clay reflects more light than other soil types

3. What is the primary function of a seed's endosperm?
(A) To attract pollinators to the parent plant (B) To store food that nourishes the developing embryo during germination (C) To help the seed stick to soil when it lands (D) To protect the seed from being eaten by animals

4. Why do farmers test soil pH before planting crops?
(A) Soil pH determines the color of the crops that will grow (B) pH testing is required by law for all commercial farms (C) Different crops grow best at different pH levels, and soil pH affects which nutrients plants can absorb (D) pH only matters for organic farms, not conventional farms

5. A student plants 20 bean seeds in potting soil. Ten are kept in a dark closet and ten are placed on a sunny windowsill. Both groups receive equal water. After one week, the dark group has taller, pale seedlings. Why did the dark-grown seedlings grow taller?
(A) The closet was warmer, which always makes plants grow taller, as this is what research and standard practice suggests (B) The dark closet had better growing conditions with no wind to slow growth, and this principle applies across similar situations (C) The seedlings used stored seed energy to grow rapidly toward light in a process called etiolation — they stretched tall but were weak and pale without

sunlight for photosynthesis (D) Light actually inhibits plant growth, so removing it let the plants grow faster, as this is what research and standard practice suggests

6. Which three nutrients are represented by the numbers on a bag of fertilizer (the N-P-K ratio)?
(A) Nitrogen, protein, and potash (B) Nitrogen, phosphorus, and potassium (C) Sodium, phosphorus, and calcium (D) Nickel, platinum, and krypton

Write the answer

7. How does the practice of adding compost to farm soil benefit crop production?
Answer: _____

8. What is the difference between a seed's germination and a plant's growth?
Answer: _____

9. A farmer discovers that earthworm populations have declined sharply in one of their fields. What agricultural problem might this indicate?
Answer: _____

10. Which soil type is considered ideal for most farm crops and why?
Answer: _____

Match each question to its answer

1. Design a simple experiment to determine the best planting depth for corn seeds in your local soil. →
2. What role do nitrogen-fixing bacteria play in agricultural soil? →
3. Why do some seeds need to experience cold temperatures before they will germinate? →
4. Evaluate this farming practice: A farmer applies the same amount of synthetic fertilizer to every field without testing the soil first. Is this a good practice? →
5. What is topsoil, and why is it the most important layer for farming? →

(A) They convert atmospheric nitrogen gas into forms that plants can absorb through their roots
(B) Plant groups of corn seeds at different depths (1 cm, 3 cm, 5 cm, 7 cm) in identical conditions, with multiple seeds per depth, and measure germination rate and seedling height over several weeks
(C) Topsoil is the uppermost layer of soil, typically 5-10 inches deep, containing the highest concentration of organic matter, nutrients, and soil organisms essential for plant growth
(D) No — without soil testing, the farmer may over-apply nutrients (wasting money and polluting water) or under-apply nutrients (limiting crop yields)

(E) Cold stratification breaks seed dormancy, signaling that winter has passed and spring conditions are safe for growth

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2. Crop Science and Plant Growth

Circle the correct answer

11. What is photosynthesis and why is it essential for crop production?
(A) Photosynthesis is the process where plants use sunlight, water, and carbon dioxide to produce glucose (food) and oxygen — it is the energy source that drives all crop growth (B) Photosynthesis only occurs in flowers during the pollination process (C) Photosynthesis is how plants absorb nutrients from fertilizer through their leaves (D) Photosynthesis is the process of water moving from roots to leaves

12. A farmer notices that corn plants on the edge of a field are taller and produce more ears than plants in the center. What is the MOST likely explanation?
(A) Edge plants get more wind which makes them grow taller and stronger (B) The soil at field edges is always better quality than soil in the center (C) Birds sitting on fences near the edge fertilize those plants with droppings (D) Edge plants receive more sunlight from the side and face less competition for light, water, and nutrients from neighboring plants

13. What is a growing season, and what determines its length in a particular region?
(A) The growing season is always exactly six months long everywhere on Earth (B) The growing season starts when farmers begin planting and ends when they stop (C) The growing season is the period between the last spring frost and the first fall frost, determined by latitude, altitude, and local climate patterns (D) The growing season is determined solely by the amount of rainfall a region receives

14. How do plants transport water from their roots to their leaves?
(A) Through transpiration — water evaporates from leaf surfaces, creating a pulling force that draws water up through the xylem vessels from the roots (B) Plants use tiny pumps in their stems to push water upward against gravity (C) Gravity pulls water down from the sky through the leaves to the roots (D) Water travels randomly through the plant with no specific direction

15. Why do farmers space their crop rows at specific distances apart rather than planting as densely as possible?
(A) Plants refuse to grow if they detect other plants too close to them, as this is what research and standard practice suggests (B) Wider spacing is required by law for all commercial farms, which is why this approach is recommended by experts (C) Optimal spacing reduces competition for light, water, and nutrients, allows air

circulation to prevent disease, and provides access for equipment and harvesting (D) Spacing has no effect on yield — farmers just follow tradition, as this directly follows from the underlying principles

16. What is the difference between a warm-season crop and a cool-season crop? Give an example of each.
(A) Warm-season crops grow in southern states and cool-season crops grow in northern states only (B) Warm-season crops (like tomatoes) need soil above 15°C to germinate and are killed by frost; cool-season crops (like lettuce) germinate in cooler soil and can tolerate light frost (C) Warm-season crops are planted in summer and cool-season crops are planted in winter everywhere (D) There is no real difference — all crops grow at the same temperatures

Write the answer

17. What happens to the glucose produced by photosynthesis in a crop plant?
Answer: _____

18. A farmer's wheat field shows yellow, stunted plants despite adequate water. Soil tests show pH 8.5. What is likely causing the problem, and what should the farmer do?
Answer: _____

19. What is pollination, and why is it essential for fruit and seed crop production?
Answer: _____

20. Why do farmers use greenhouses or high tunnels to grow crops?
Answer: _____

Match each question to its answer

1. Design a succession planting plan for a school garden that ensures continuous lettuce harvest from April through October. →
2. What limiting factors can reduce crop yields even when seeds are high quality? →
3. How does mulching benefit crop plants on a farm? →
4. Compare the advantages of open-pollinated (heirloom) crop varieties versus hybrid varieties for a small farm. →
5. What is the role of stomata in crop plant leaves? →

(A) Heirloom varieties can be saved and replanted (seed sovereignty) and may have unique flavors, but hybrids typically yield more, resist diseases better, and mature more uniformly
(B) Plant new lettuce seeds every 2-3 weeks throughout the season, so as one planting is harvested, the next is reaching maturity; use shade cloth in summer to prevent bolting

(C) Mulch retains soil moisture by reducing evaporation, suppresses weeds by blocking light, moderates soil temperature, and adds organic matter as it decomposes (D) Stomata are tiny pores that open to allow carbon dioxide in for photosynthesis and close to conserve water when conditions are dry (E) Insufficient light, water stress, nutrient deficiency, extreme temperatures, pest pressure, disease, and soil compaction can all limit yields regardless of seed quality

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3. Pests, Diseases, and Integrated Management

Circle the correct answer

21. What is Integrated Pest Management (IPM), and how does it differ from conventional pest control?
(A) IPM eliminates all pests from the farm completely and permanently, making this the most widely accepted explanation (B) IPM combines biological, cultural, mechanical, and chemical methods to manage pests with minimal environmental impact, using pesticides only as a last resort rather than the first response (C) IPM is a brand name for a specific type of commercial pesticide, and this is the standard approach used in most cases (D) IPM means using only organic pesticides instead of synthetic ones, and this has been consistently demonstrated in practice

22. How do ladybugs serve as a biological pest control agent on farms?
(A) Ladybugs produce a toxin that poisons all insects in the field, as this directly follows from the underlying principles (B) Ladybugs pollinate crop flowers, replacing the need for bees, which is the most common explanation for this phenomenon (C) Ladybugs are predators that eat aphids, scale insects, and mites — a single ladybug can consume over 5,000 aphids in its lifetime, reducing pest populations without chemicals (D) Ladybugs improve soil quality by burrowing and decomposing organic matter, and this principle applies across similar situations

23. A tomato farmer notices that plants in one section of the field have dark spots on their leaves that spread rapidly after rain. What type of plant problem is this MOST likely?
(A) A nutrient deficiency caused by rain washing away all the fertilizer (B) An insect infestation since insects are most active during rainstorms (C) Sunburn from light reflecting off water droplets on the leaves (D) A fungal disease — fungal pathogens thrive in wet conditions and often cause leaf spots that spread through water splash

24. Why do pests often become resistant to pesticides over time, and what farming strategy helps prevent this?
(A) Pesticides become weaker over time as they break down chemically in storage, and this principle applies across similar situations (B) Natural selection favors

individuals with genetic resistance — those that survive pesticide exposure reproduce, passing resistance to offspring; rotating different pesticide types prevents resistance buildup (C) Resistance only happens with organic pesticides, never with synthetic ones, and this has been consistently demonstrated in practice (D) Pests learn to avoid pesticides by watching other pests die from them, which is why this approach is recommended by experts

25. What is a weed, and why are weeds harmful to crop production?
(A) Weeds only affect the appearance of fields but don't reduce crop yields (B) A weed is any plant growing where it's not wanted — weeds compete with crops for light, water, nutrients, and space, potentially reducing yields by 30-50% if unmanaged (C) Any plant that grows naturally without being planted by a farmer is a weed (D) Weeds are a specific species of toxic plants that poison crops through their roots

26. Design an IPM strategy for a small organic vegetable farm dealing with caterpillar damage on cabbage plants.
(A) Use row covers to physically exclude moths, handpick caterpillars, introduce parasitic wasps (Trichogramma), apply Bacillus thuringiensis (Bt) spray as a targeted biological pesticide, and plant trap crops like mustard to lure pests away (B) Remove all cabbage plants and replace them with a crop that caterpillars don't eat, which is why this approach is recommended by experts (C) Do nothing since caterpillar damage is unavoidable on organic farms (D) Spray the entire farm with broad-spectrum insecticide to kill all insects, which is why this approach is recommended by experts

Write the answer

27. How does crop rotation help reduce pest and disease problems?
Answer: _____

28. What is the difference between a pest's damage threshold and its population threshold in IPM decision-making?
Answer: _____

29. Why is it important to correctly identify a pest before attempting to control it?
Answer: _____

30. What are companion plants, and how do they help with pest management?
Answer: _____

Match each question to its answer

1. How do viruses spread between crop plants, and why are viral diseases particularly difficult to treat? →
2. A farmer finds tiny holes in the leaves of their eggplant and small shiny beetles jumping away when disturbed. What pest is this, and what IPM approach should they consider? →
3. Evaluate the statement: 'Organic farming never uses pesticides.' →
4. What role do mycorrhizal fungi play in protecting crops from soil-borne diseases? →
5. What is biological control, and how does it differ from using chemical pesticides? →

(A) Biological control uses living organisms (predators, parasites, or pathogens) to suppress pest populations; unlike chemicals, biocontrol agents reproduce, adapt, and target specific pests without harming non-target species
(B) Flea beetles — use floating row covers as a physical barrier, apply kaolin clay spray to deter feeding, plant trap crops of radish, and time planting to avoid peak beetle emergence
(C) Viruses spread through insect vectors (especially aphids), contaminated tools, and infected seed; there are no curative treatments for plant viruses — infected plants must be removed to prevent spread
(D) This is false — organic farming uses pesticides approved for organic production (like copper fungicides, Bt, neem oil, and pyrethrin) but avoids synthetic chemical pesticides
(E) Mycorrhizal fungi physically occupy root surfaces (blocking pathogen entry), produce antimicrobial compounds, strengthen plant immune responses, and compete with pathogens for resources

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4. Water Management and Irrigation Science

Circle the correct answer

31. What is the difference between drip irrigation and overhead sprinkler irrigation?
(A) Drip irrigation uses rainwater while sprinklers use well water, as this directly follows from the underlying principles (B) There is no functional difference — both deliver the same amount of water to plants, and this is the standard approach used in most cases (C) Drip irrigation delivers water slowly and directly to plant root zones through tubes and emitters; overhead sprinklers spray water over the entire field from above, losing more water to evaporation and wetting leaves unnecessarily (D) Overhead sprinklers are always more efficient because they cover more area

32. Why is agricultural water pollution a major environmental concern?
(A) Farm water pollution only affects fish and has no impact on human health (B) Agricultural runoff actually improves water quality by adding nutrients to rivers (C) Agriculture uses so little water that its pollution impact is negligible (D) Fertilizer and pesticide runoff from farms enters waterways, causing algal blooms that deplete oxygen and create dead zones, while contaminating drinking water supplies

33. What percentage of the world's freshwater is used for agriculture?
(A) About 30% — industry uses more water than farming (B) About 50% — agriculture and cities use equal amounts (C) About 10% — most freshwater goes to household use (D) Approximately 70% — agriculture is by far the largest consumer of freshwater globally

34. A farmer notices salt deposits forming on the soil surface in their irrigated field. What is causing this, and what are the consequences?
(A) The white deposits are beneficial calcium that helps plant growth (B) The farmer accidentally used salt water for irrigation instead of freshwater (C) Salinization — irrigation water contains dissolved salts that accumulate as water evaporates, eventually reaching toxic levels that prevent crop growth (D) Frost crystals are forming on the soil surface during cool nights

35. How do buffer strips along waterways protect water quality on farms?
(A) Buffer strips redirect all farm water underground where it cannot cause pollution (B) Buffer strips are walls built along streams to physically block water from the farm (C) Buffer strips of permanent vegetation filter sediment and nutrients from agricultural runoff before it reaches streams, absorbing pollutants through plant roots and soil biology (D) Buffer strips only add visual appeal and have no water quality function

36. What is the water cycle's role in agriculture, and how do farming practices affect it?
(A) The water cycle has no connection to agriculture since farmers control their own water supply (B) The water cycle only operates over oceans and does not affect inland farms, and this has been consistently demonstrated in practice (C) Farming improves the water cycle by adding more water to the atmosphere through irrigation, which is the most common explanation for this phenomenon (D) The water cycle provides rainfall for crops and recharges groundwater for irrigation; farming affects the cycle through irrigation withdrawals, altered infiltration rates from tilling, and increased runoff from bare soil

Write the answer

37. Why are aquifer depletion rates a growing concern for agricultural regions like the Great Plains of the United States?
Answer: _____

38. Design a water conservation plan for a small vegetable farm in a region experiencing drought.
Answer: _____

39. How does soil organic matter affect a farm's ability to retain water during dry periods?
Answer: _____

40. What is a watershed, and why should farmers be concerned about their farm's position within one?
Answer: _____

Match each question to its answer

1. Compare the water efficiency of flood irrigation, center-pivot sprinklers, and drip irrigation systems. →
2. What is the concept of 'virtual water' in agriculture? →
3. How do wetlands function as natural water treatment systems for agricultural areas? →
4. Why is morning the best time to irrigate most crops? →
5. Evaluate the sustainability of large-scale groundwater pumping for agricultural irrigation in arid regions. →

(A) Morning irrigation reduces evaporation losses (cooler temperatures, less wind), gives foliage time to dry during the day (reducing disease risk), and provides water when plants begin active photosynthesis
(B) Wetlands slow water flow, allowing sediment to settle out; wetland plants absorb nitrogen and phosphorus; and wetland microorganisms break down pesticides and other agricultural chemicals
(C) It is often unsustainable because extraction rates typically exceed natural recharge, depleting aquifers that took thousands of years to fill — a practice sometimes called 'mining water'
(D) Virtual water is the total volume of water used to produce a product — including water for growing crops, processing food, and transportation — revealing the hidden water footprint of food
(E) Flood irrigation is least efficient (40-50%), center-pivot sprinklers are moderate (75-85%), and drip irrigation is most efficient (90-95%) because it delivers water directly to root zones with minimal waste

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5. Sustainable Farming and Food Systems

Circle the correct answer

41. What is the main goal of sustainable agriculture?
(A) To grow the largest possible harvest each year regardless of consequences (B) To produce food while protecting the environment and natural resources for future generations (C) To return to farming methods used hundreds of years ago (D) To eliminate all use of machinery on farms

42. What is crop rotation?
(A) Harvesting crops by rotating a mechanical blade (B) Growing different crops in the same field in a planned sequence over several seasons (C) Moving crops from one farm to another each year (D) Spinning crops in a centrifuge to separate seeds from stalks

43. Why do farmers often rotate legumes (like soybeans or peas) with grain crops (like corn)?
(A) Because legumes add nitrogen to the soil, which grain crops need to grow (B) Because legumes and grains taste better when grown in alternating years (C) Because grain crops produce oxygen that legumes need (D) Because legumes grow taller and provide shade for grain seedlings

44. What does the term 'organic farming' mean?
(A) Farming that only grows organs used in medicine (B) Farming that produces food containing organic molecules like carbon (C) Farming that avoids synthetic pesticides and fertilizers, using natural methods instead (D) Any farming done without machines or technology

45. What is a 'cover crop' and why do farmers plant them?
(A) A secret crop planted to hide valuable plants from thieves (B) A crop that grows so tall it covers nearby buildings like a canopy (C) A crop planted to cover and protect soil between growing seasons, preventing erosion and adding nutrients (D) A crop genetically engineered to cover the ground like artificial turf

46. What is a food supply chain?
(A) A type of restaurant franchise with many locations (B) The biological food chain showing who eats whom in nature (C) A metal chain used to transport food containers on conveyor belts (D) The series of steps food goes through from being grown on a farm to reaching a consumer's plate

Write the answer

47. Approximately what percentage of food produced globally is wasted or lost before it reaches consumers?
Answer: _____

48. What is composting and how does it benefit farming?
Answer: _____

49. What are 'food miles' and why do they matter?
Answer: _____

50. What is intercropping?
Answer: _____

Match each question to its answer

1. What is the 'Three Sisters' planting method? →
2. A farmer wants to reduce fertilizer costs while maintaining soil nitrogen levels. Which sustainable practice would be most effective? →
3. What is the difference between a farmers' market and a conventional supermarket in terms of the food supply chain? →
4. What does 'farm-to-table' mean? →
5. What is agroforestry? →

(A) An Indigenous technique of growing corn, beans, and squash together as companion plants
(B) A farming system that intentionally combines trees with crops or livestock on the same land
(C) Rotating grain crops with nitrogen-fixing legumes like soybeans or clover
(D) Farmers' markets typically have shorter supply chains with fewer intermediaries between farmer and consumer
(E) A movement promoting direct sourcing of food from local farms to consumers and restaurants

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6. Livestock and Animal Agriculture

Circle the correct answer

51. What is animal husbandry?
(A) A legal term for an animal's male owner (B) A type of farming that uses only plants, never animals (C) The practice of breeding, raising, and caring for farm animals for food, fiber, or labor (D) The science of building homes for wild animals

52. What are ruminant animals and what makes their digestive system unique?
(A) Animals like cows and sheep that have a four-chambered stomach allowing them to digest tough plant materials like grass (B) Animals that chew their food exactly 100 times before swallowing (C) Animals that digest food by absorbing nutrients through

their skin (D) Animals that can only eat meat because they have simple stomachs

53. What is the primary greenhouse gas produced by cattle, and how is it generated? (A) Carbon dioxide, produced when cows breathe (B) Ozone, produced when cow manure is exposed to sunlight (C) Methane, produced during enteric fermentation when microbes in the rumen break down plant material (D) Nitrous oxide, produced when cows walk on soil

54. What is rotational grazing and why is it beneficial? (A) Spinning animals on a rotating platform for exercise (B) Moving livestock between pasture sections on a schedule so grazed areas can recover, preventing overgrazing (C) Feeding livestock different types of grain in a weekly rotation (D) Allowing animals to graze only at night when temperatures are lower

55. What does 'free-range' mean for poultry farming? (A) Chickens have access to outdoor space and are not confined to cages for their entire lives (B) Chickens are raised in temperature-controlled indoor facilities (C) The eggs are given away for free at a shooting range (D) The chickens are completely wild and never handled by farmers

56. What is the difference between a dairy breed and a beef breed of cattle? (A) There is no difference — all cows produce both milk and beef equally (B) Dairy cows are female and beef cows are male (C) Dairy breeds are always white and beef breeds are always brown (D) Dairy breeds are selected for high milk production, while beef breeds are selected for muscle growth and meat quality

Write the answer

57. What are the 'Five Freedoms' of animal welfare?
Answer: _____

58. What is a Concentrated Animal Feeding Operation (CAFO)?
Answer: _____

59. Why are antibiotics used in livestock farming, and what concern does this raise?
Answer: _____

60. How much water is needed to produce one pound of beef compared to one pound of wheat?
Answer: _____

Match each question to its answer

1. What is selective breeding in livestock, and how does it differ from genetic engineering? →
2. What products besides meat do we get from cattle? →
3. What is silvopasture and how does it benefit both livestock and the environment? →
4. What is the 'feed conversion ratio' and why does it matter for sustainability? →
5. What role do heritage breeds play in agriculture? →

(A) Milk, leather, gelatin, tallow (for soaps/candles), bone meal fertilizer, and pharmaceutical ingredients
(B) Selective breeding chooses animals with desired traits to reproduce naturally; genetic engineering directly modifies DNA in a lab
(C) Combining trees, forage plants, and grazing livestock in the same area, providing shade, fodder, carbon storage, and soil protection
(D) They preserve genetic diversity, are adapted to local conditions, and often have traits lost in commercial breeds like disease resistance
(E) The amount of feed needed to produce one unit of animal product — lower ratios mean more efficient and generally more sustainable production

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7. Agricultural Technology and Innovation

Circle the correct answer

61. What is precision agriculture?
(A) A type of farming that only grows precise geometric crop patterns (B) Using technology like GPS, sensors, and data analysis to optimize farming decisions at specific locations within a field (C) Farming with extremely precise measurements of seed spacing, done by hand (D) Any farming done with high-quality expensive tools

62. How are drones used in modern agriculture?
(A) As robotic farmworkers that plant seeds and pull weeds (B) For aerial crop monitoring, mapping field health, spraying pesticides precisely, and assessing plant stress using multispectral cameras (C) Only for delivering harvested crops to grocery stores (D) To scare away birds and other pests with loud buzzing sounds

63. What is hydroponics?
(A) A type of power plant that generates electricity from water (B) A technique for studying plant DNA in a laboratory (C) A method of drying crops using hydrogen gas (D) Growing plants in nutrient-rich water solutions without soil

64. What is vertical farming and what problems does it solve?
(A) A method of stacking hay bales vertically for storage, and this has been consistently demonstrated in practice (B) Farming on vertical cliffs and mountainsides, which is why this approach is recommended by experts (C) Growing only tall plants like corn that grow vertically, which is the most common explanation for this phenomenon (D) Growing crops in stacked layers indoors, solving land scarcity in cities and enabling year-round production regardless of climate

65. What is aeroponics and how does it differ from hydroponics?
(A) Plants are grown using wind power to spin nutrients around roots (B) Plants are grown in airplane cabins during flight (C) A technique identical to hydroponics but marketed under a different name (D) Plants are suspended in air with roots periodically misted with nutrient solution, using even less water than hydroponics

66. What role does GPS technology play in modern farming equipment?
(A) It enables auto-steering tractors, precise field mapping, variable-rate application of inputs, and tracking of equipment location (B) It helps farmers find driving directions to the nearest feed store (C) GPS has no agricultural applications — it's only for car navigation (D) It is used only for tracking stolen farm equipment

Write the answer

67. What are soil sensors and how do they help farmers make better decisions?
Answer: _____

68. What is a greenhouse gas emission 'carbon footprint' for food production?
Answer: _____

69. What is the NDVI (Normalized Difference Vegetation Index) and how is it used in farming?
Answer: _____

70. What is controlled environment agriculture (CEA)?
Answer: _____

Match each question to its answer

1. How does LED lighting technology benefit indoor farming? →
2. What is the role of artificial intelligence (AI) and machine learning in modern agriculture? →
3. What is aquaponics and how does it combine two farming methods? →
4. What is a GMO (genetically modified organism) and how is it different from traditional selective breeding? →
5. A farmer has 100 acres and wants to reduce water usage by 30% while maintaining

crop yields. Which technology combination would be most effective? →

(A) A system that combines fish farming (aquaculture) with soilless plant growing (hydroponics) in a symbiotic cycle
(B) AI analyzes large datasets from sensors, drones, and satellites to predict yields, detect diseases, optimize irrigation, and automate farm decisions
(C) LEDs can be tuned to specific light wavelengths that plants need most, using less energy and generating less heat than traditional grow lights
(D) A GMO has had specific genes inserted, deleted, or modified using biotechnology, allowing changes impossible through natural breeding
(E) Soil moisture sensors connected to a smart irrigation system with GPS-guided variable-rate sprinklers and weather-based scheduling

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8. Food Justice and Global Agriculture: Capstone

Circle the correct answer

71. What is food justice?
(A) A legal system where courts resolve disputes about food safety violations (B) A cooking competition TV show where chefs are judged fairly (C) The belief that all communities deserve equal access to healthy, affordable, culturally appropriate food, and a voice in how food systems operate (D) The science of measuring nutritional content in food accurately

72. Approximately how many people worldwide experience chronic hunger?
(A) Exactly half of the world's population (B) Nobody — the world produces enough food for everyone (C) About 735-780 million people (roughly 1 in 10 people on Earth) (D) Less than 10 million people worldwide

73. How does climate change affect agriculture?
(A) Rising temperatures, changing rainfall patterns, more extreme weather events, and shifting growing seasons alter crop yields and threaten food security (B) Climate change has no measurable effect on agriculture (C) Climate change makes all farming easier because warmer temperatures help plants grow (D) Climate change only affects polar regions, not farming areas

74. What are agricultural subsidies and why are they controversial?
(A) Loans from banks that farmers must repay with high interest, and this has been consistently demonstrated in practice (B) Taxes that farmers pay to the government for using public land, which is why this approach is recommended by experts (C) Donations from consumers directly to farmers at farmers' markets, and this principle applies across similar situations (D) Government payments to farmers that support

food production but often favor large operations, distort markets, and can harm farmers in developing countries

75. What is the Green Revolution and what were its consequences?
(A) A political revolution where environmentalists took over farm policy, as this is what research and standard practice suggests (B) The shift to organic farming that happened in the 1990s, which is why this approach is recommended by experts (C) A color change in crops caused by genetic mutations in the 1950s, which is why this approach is recommended by experts (D) A 1960s-70s movement that introduced high-yield crop varieties and modern farming techniques, preventing famine but also increasing chemical dependency and reducing biodiversity

76. What is 'land grabbing' and why is it a food justice issue?
(A) Large-scale acquisition of farmland in developing countries by foreign governments or corporations, often displacing local farmers and communities (B) Erosion that causes land to collapse into rivers, as this is what research and standard practice suggests (C) A children's game played on farmland, which is why this approach is recommended by experts (D) A technique for quickly harvesting crops from a field, and this has been consistently demonstrated in practice

Write the answer

77. How do farm workers' rights relate to food justice?
Answer: _____

78. What is 'fair trade' and how does it relate to agriculture?
Answer: _____

79. What is 'food apartheid' and how does it differ from 'food desert'?
Answer: _____

80. What percentage of the world's food is produced by smallholder farmers?
Answer: _____

Match each question to its answer

1. What is agricultural biodiversity and why is it under threat? →
2. What are seed banks and why are they important? →
3. What is the concept of 'food sovereignty' and who first proposed it? →
4. How does deforestation for agriculture affect both local communities and the global climate? →
5. What is the role of Indigenous knowledge in sustainable agriculture? →

(A) It releases stored carbon into the atmosphere, destroys habitats, disrupts local water cycles, and often displaces Indigenous communities
(B) Indigenous peoples developed sustainable farming techniques over millennia, like the Three Sisters, terracing, and agroforestry, that modern agriculture is now rediscovering
(C) Facilities that preserve diverse crop seeds for future use, protecting agricultural genetic resources from extinction
(D) The variety of plants, animals, and microorganisms used in farming; it's declining as agriculture focuses on fewer high-yield crop varieties
(E) The right of peoples to define their own food policies and production systems, proposed by the peasant movement La Vía Campesina in 1996

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9. Farming and Harvest

Circle the correct answer

81. What is the growing season?
(A) The time when farmers sell their crops, as this directly follows from the underlying principles (B) The season when animals are born, and this principle applies across similar situations (C) Only the month of June, as this is what research and standard practice suggests (D) The period of the year when weather conditions are warm enough and wet enough for plants to grow

82. What is frost and why is it dangerous to crops?
(A) Frost only happens in December, which is the most common explanation for this phenomenon (B) Frost helps plants grow faster, making this the most widely accepted explanation (C) Frost is a type of fertilizer, which is why this approach is recommended by experts (D) Frost is a thin layer of ice crystals that forms on surfaces when temperatures drop to 32°F (0°C) or below, and it can damage or kill plant cells by freezing the water inside them

83. What is irrigation?
(A) The artificial application of water to land or soil to help crops grow, especially when rainfall is insufficient (B) A method of removing weeds, and this has been consistently demonstrated in practice (C) A type of farm equipment for plowing, which is why this approach is recommended by experts (D) A way to harvest crops faster, as this is what research and standard practice suggests

84. What is a drought?
(A) A type of soil that's very fertile, which is why this approach is recommended by experts (B) An extended period of unusually low rainfall that results in a shortage of water, affecting crops, livestock, and communities (C) A farming tool used for

plowing, which is the most common explanation for this phenomenon (D) A strong wind that helps crops grow, and this principle applies across similar situations

85. What is the water cycle and how does it affect farming?
(A) The cycle of watering plants once a day, and this has been consistently demonstrated in practice (B) The continuous movement of water through evaporation, condensation, precipitation, and collection — it provides the rain and groundwater that crops need to grow (C) A type of water pump used on farms, making this the most widely accepted explanation (D) A machine that purifies water for drinking, as this directly follows from the underlying principles

86. What does 'climate zone' mean for farmers?
(A) The temperature setting on a tractor, as this directly follows from the underlying principles (B) An area inside a greenhouse, as this is what research and standard practice suggests (C) A zone where only one crop can grow, which is why this approach is recommended by experts (D) A region defined by its typical temperature, rainfall, and seasonal patterns, which determines what crops can be successfully grown there

Write the answer

87. Why do farmers check weather forecasts every day?
Answer: _____

88. How does too much rain harm crops?
Answer: _____

89. If a farmer in Wisconsin knows the last spring frost is typically April 15 and the first fall frost is October 15, how many days is the growing season?
Answer: _____

90. How would you plan a planting schedule if you know a crop needs 90 days to mature and your growing season starts May 1?
Answer: _____

Match each question to its answer

1. A farmer notices their crops are wilting despite recent rain. What might be happening? →
2. How would you design a simple rain gauge to measure rainfall on a farm? →
3. Why do some farmers plant 'cover crops' during winter? →
4. How does wind affect farming? →
5. Analyze how climate change is affecting farming around the world. →

(A) Climate change is shifting growing zones northward, increasing extreme weather events (droughts, floods, heat waves), changing pest and disease patterns, reducing water availability in some regions, and shortening or lengthening growing seasons unpredictably

(B) Cover crops protect bare soil from erosion by wind and rain, add nutrients (especially nitrogen-fixing legumes), suppress weeds, improve soil structure, and increase organic matter when tilled back into the soil in spring

(C) Place a straight-sided container (like a cylindrical jar or can) in an open area away from buildings and trees, mark measurements in inches or centimeters on the side, and record the water level after each rainfall event

(D) Wind can dry out soil and plants (increasing irrigation needs), cause physical damage to crops (lodging/flattening grain, breaking branches), spread weed seeds and diseases, and cause soil erosion — but gentle wind also helps with pollination and drying harvested grain

(E) The soil may have poor drainage causing waterlogged roots (which prevents oxygen absorption), or the rain may have been insufficient to reach deep roots, or the plants could have a disease or pest problem unrelated to water

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10. Farming and Harvest

Circle the correct answer

91. What is a cash crop?

(A) Any crop that costs nothing to grow (B) A crop that only grows in cash registers (C) A crop made of paper money (D) A crop grown primarily for sale and profit rather than for the farmer's own use

92. What is the difference between wholesale and retail in farming?

(A) Retail means selling damaged products, and this has been consistently demonstrated in practice (B) Wholesale means selling large quantities to businesses (grocery stores, restaurants, distributors) at lower prices, while retail means selling directly to individual consumers (at farmers markets, farm stands) at higher prices per unit (C) Wholesale is always better than retail, making this the most widely accepted explanation (D) There is no difference between them, which is the most common explanation for this phenomenon

93. What does 'supply and demand' mean for farmers?

(A) Farmers set whatever price they want, which is why this approach is recommended by experts (B) Supply and demand only applies to factory goods, and this has been consistently demonstrated in practice (C) Supply and demand has no effect on food prices, which is why this approach is recommended by experts (D)

When many farmers produce the same crop (high supply) and fewer people want it (low demand), prices drop; when a crop is scarce (low supply) and many people want it (high demand), prices rise

94. What is a CSA (Community Supported Agriculture)?
(A) A system where customers pay a farm upfront at the beginning of the season and receive weekly boxes of fresh produce throughout the growing season, sharing both the risks and rewards of farming (B) A government farming agency, making this the most widely accepted explanation (C) A certification for organic farms, which is why this approach is recommended by experts (D) A type of tractor brand, and this is the standard approach used in most cases

95. What is organic farming?
(A) Any farming done outdoors, making this the most widely accepted explanation (B) A farming method that avoids synthetic pesticides, synthetic fertilizers, genetically modified organisms, and routine antibiotics, instead using natural pest control, composting, and crop rotation to maintain soil health (C) Farming that uses organs instead of seeds, and this principle applies across similar situations (D) Farming that only grows one type of crop, which is the most common explanation for this phenomenon

96. What is a farmers market?
(A) A stock market where people trade farm company shares, making this the most widely accepted explanation (B) A supermarket that only sells farm equipment, which is why this approach is recommended by experts (C) A regularly occurring market where local farmers sell their produce, meat, dairy, and other farm products directly to consumers, usually outdoors or in open-air structures (D) An online shopping website for farmers, and this is the standard approach used in most cases

Write the answer

97. Why do food prices at the grocery store include much more than what the farmer earns?
Answer: _____

98. How does crop insurance protect farmers?
Answer: _____

99. A farmer spends $500 per acre to grow corn and the harvest sells for $800 per acre. What is the profit per acre?
Answer: _____

100. If a farmer sells 200 bushels of wheat at $7 per bushel and it cost $5.50 per bushel to produce, what is the total profit?
Answer: _____

Match each question to its answer

1. A farm stand sells tomatoes for $3/pound. If a customer buys 2.5 pounds, and the farm's cost to grow them was $1.20/pound, how much profit does the farm make on this sale? →
2. How would you calculate whether it's more profitable for a farmer to sell corn as grain or feed it to cattle and sell the beef? →
3. Why do many small farms struggle to compete with large industrial farms? →
4. How does the concept of 'food miles' affect both economics and the environment? →
5. Analyze why commodity crop prices fluctuate so dramatically from year to year. →

(A) Large farms achieve economies of scale — their cost per unit is lower because they spread fixed costs (equipment, land, facilities) across much larger production volumes, and they have more negotiating power with buyers and suppliers
(B) Food miles measures the distance food travels from farm to consumer — long distances increase transportation costs, fuel consumption, and carbon emissions, while short distances (local food) reduce these costs but may limit variety and increase prices if local production is less efficient
(C) Prices are driven by the unpredictable interaction of weather (affecting supply), global demand shifts, currency exchange rates, energy costs (affecting transportation and fertilizer prices), government policies (subsidies, tariffs, biofuel mandates), and speculation in commodity futures markets
(D) Compare the revenue from selling the corn directly against the revenue from the beef minus all cattle costs (feed, veterinary care, labor, processing, marketing) — the 'value-added' approach of selling beef is more profitable only if the beef revenue exceeds corn revenue plus all additional cattle costs
(E) $4.50 (Revenue: 2.5 × $3 = $7.50; Cost: 2.5 × $1.20 = $3.00; Profit: $7.50 - $3.00 = $4.50)

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11. Farming and Harvest

Circle the correct answer

101. What is food preservation?
(A) The process of treating and handling food to slow down spoilage and prevent foodborne illness, allowing food to be stored and consumed long after harvest (B) A type of farming technique for growing food faster, as this directly follows from the underlying principles (C) Keeping food in a museum for display, as this directly follows from the underlying principles (D) A way to make food taste better, which is why this approach is recommended by experts

102. What causes food to spoil?
(A) Food never actually spoils if left alone, and this principle applies across similar situations (B) Microorganisms (bacteria, molds, yeasts), enzymes naturally present in the food, oxidation from exposure to air, and moisture loss or gain all break down food over time (C) Only temperature causes spoilage, as this is what research and standard practice suggests (D) Food spoils because it gets lonely in the refrigerator

103. What is pasteurization?
(A) A process of heating liquid foods (like milk or juice) to a specific temperature for a set time to kill harmful bacteria without significantly changing the food's taste or nutritional value (B) A method of freezing food very quickly, which is the most common explanation for this phenomenon (C) Named after a type of pasta, as this directly follows from the underlying principles (D) A process of adding chemicals to food, which is why this approach is recommended by experts

104. What is fermentation?
(A) A process where microorganisms (bacteria or yeast) convert sugars into acids, gases, or alcohol, preserving food while creating distinctive flavors and often increasing nutritional value (B) Making food rot on purpose, which is the most common explanation for this phenomenon (C) Adding bubbles to drinks with a machine, and this is the standard approach used in most cases (D) A type of farming machinery, which is why this approach is recommended by experts

105. What is dehydration as a food preservation method?
(A) Adding extra water to food to keep it fresh, as this is what research and standard practice suggests (B) A medical condition, not a food process, as this is what research and standard practice suggests (C) Heating food until it turns to ash, and this principle applies across similar situations (D) Removing water from food to prevent the growth of bacteria, molds, and yeasts, since these microorganisms need moisture to survive and multiply

106. What is canning and how does it preserve food?
(A) Canning seals food in airtight containers and heats them to high temperatures, killing bacteria and creating a vacuum seal that prevents new microorganisms from entering — the combination of heat sterilization and airtight sealing keeps food safe for years (B) Only used for dog food, which is why this approach is recommended by experts (C) Putting food in tin cans and hoping for the best, which is the most common explanation for this phenomenon (D) A method of growing food in metal containers, and this is the standard approach used in most cases

Write the answer

107. Why must food be kept at certain temperatures to stay safe?
Answer: _____

108. How does salt preserve food?
Answer: _____

109. If meat left at room temperature can develop dangerous bacteria levels in 2 hours, and you're having a backyard barbecue on a 95° F day, how would you keep the food safe?
Answer: _____

110. How would you safely preserve a batch of homegrown tomatoes to last through winter?
Answer: _____

Match each question to its answer

1. Design an experiment to test which food preservation method keeps apple slices freshest for one week. →
2. What steps would you take to start a small jam-making business using fruit from your garden? →
3. Why is freeze-drying considered superior to regular dehydration for preserving food quality? →
4. Analyze why some traditional preservation methods (like smoking and fermenting) are regaining popularity. →
5. Compare the nutritional impact of different preservation methods on the same food. →

(A) Take 5 identical apple slices and apply different treatments: 1) control (no treatment), 2) lemon juice dip (acid), 3) vacuum sealed (no air), 4) refrigerated (cold), 5) dehydrated (no water). Check each daily for color, texture, smell, and mold growth. Record observations in a data table and compare results after 7 days.

(B) Fresh food has maximum nutrition but spoils quickly; freezing preserves 90-95% of nutrients; canning preserves 60-80% (heat destroys some vitamins); dehydration preserves most minerals but reduces vitamins C and A; fermentation can actually INCREASE nutritional value by creating B vitamins and making minerals more bioavailable

(C) Research food safety regulations (cottage food laws in your state), get necessary permits, develop tested recipes using proper canning procedures, source proper jars and labels, calculate costs and pricing, test pH levels to ensure safety, and start selling at farmers markets or local stores

(D) Freeze-drying preserves the food's original shape, color, flavor, and up to 97% of nutritional value because it removes water by sublimation (ice directly to vapor) without passing through the liquid phase, which would damage cell structures

(E) Traditional methods are valued for their unique flavors, nutritional benefits (probiotics in fermented foods), cultural heritage, sustainability (no electricity

needed), and consumer desire for 'natural' alternatives to industrial processing with chemical additives

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12. Farming and Harvest

Circle the correct answer

111. What is precision agriculture?
(A) Using a ruler to measure how tall crops grow, which is the most common explanation for this phenomenon (B) A farming method that only uses hand tools, and this principle applies across similar situations (C) Growing crops in perfectly straight rows, and this principle applies across similar situations (D) A farming approach that uses GPS, sensors, drones, and data analysis to monitor and optimize crop production at a very detailed level, treating different parts of a field individually rather than uniformly

112. What is vertical farming?
(A) Farming on the side of a mountain, and this principle applies across similar situations (B) Growing crops in vertically stacked layers inside controlled indoor environments, using artificial lighting (usually LEDs), precise nutrient delivery, and climate control instead of sunlight and soil (C) Growing very tall crops like corn, as this is what research and standard practice suggests (D) Stacking hay bales vertically, and this principle applies across similar situations

113. What is hydroponics?
(A) A method of growing plants without soil, using mineral nutrient solutions dissolved in water delivered directly to the plant roots (B) A type of water sport for farmers, and this is the standard approach used in most cases (C) Using hydraulic machinery for farming, which is the most common explanation for this phenomenon (D) Growing plants in musical water, making this the most widely accepted explanation

114. What are agricultural drones used for?
(A) Drones are illegal to use on farms, as this is what research and standard practice suggests (B) Drones only deliver packages to farmers, and this has been consistently demonstrated in practice (C) Drones equipped with cameras, multispectral sensors, and spraying systems are used to survey crop health, detect pest and disease outbreaks, create field maps, monitor irrigation, and apply targeted treatments to specific areas (D) Agricultural drones are used to scare away birds, and this is the standard approach used in most cases

115. What is CRISPR and how is it used in agriculture?
(A) A machine for harvesting crops, as this is what research and standard practice suggests (B) A brand of potato chips, and this has been consistently demonstrated in practice (C) CRISPR is a gene-editing technology that allows scientists to make precise changes to an organism's DNA — in agriculture, it's used to develop crops that resist diseases, tolerate drought, have better nutrition, or produce higher yields (D) A type of greenhouse, and this has been consistently demonstrated in practice

116. What is aquaponics?
(A) A combined system where fish and plants are grown together — the fish waste provides natural fertilizer for the plants, and the plants filter the water for the fish, creating a sustainable closed-loop ecosystem (B) Growing plants in aquariums for decoration only, and this is the standard approach used in most cases (C) A water park designed for farmers, and this principle applies across similar situations (D) A type of underwater farming in the ocean, as this directly follows from the underlying principles

Write the answer

117. Why is soil health considered the foundation of sustainable agriculture?
Answer: _____

118. How do robots assist modern farmers?
Answer: _____

119. If a vertical farm produces 100 heads of lettuce per square foot per year and a traditional farm produces 1 head per square foot per year, how many square feet of vertical farm would you need to match a 10-acre traditional lettuce farm?
Answer: _____

120. A farmer is considering installing solar panels on 20% of their 500-acre farm. If the remaining land produces $800 per acre in crops and the solar panels generate $1,200 per acre in energy payments, what is the total farm revenue?
Answer: _____

Match each question to its answer

1. How would you design an automated irrigation system that responds to real-time soil moisture data? →
2. Design a sustainable farming system for a Mars colony that must feed 100 people. →
3. How would you use AI and machine learning to predict crop diseases before they spread? →
4. Analyze why monoculture (growing one crop over large areas) is both economically

efficient and ecologically risky. →
5. Compare the carbon footprint of beef production versus plant-based protein alternatives. →

(A) Train AI models on multispectral drone imagery and historical disease data to identify early-stage infection patterns invisible to the human eye, then deploy the model to continuously scan fields and alert farmers to emerging threats, enabling targeted treatment before diseases spread to neighboring plants
(B) Install soil moisture sensors at multiple depths and locations across the field, connect them to a central controller that activates drip irrigation zones only when moisture drops below crop-specific thresholds, and include weather forecast data to avoid irrigating before predicted rain
(C) Use multi-level hydroponic/aeroponic systems with LED lighting (no sunlight available), grow calorie-dense crops first (potatoes, soybeans, wheat, rice), add leafy greens and vegetables for nutrition, include insect farming (mealworms, crickets) for protein, recycle all water and nutrients in a closed loop, use regolith (Mars soil) mixed with organic waste for eventual soil building, and generate power from nuclear or solar sources
(D) Beef produces 20-60 kg CO2 equivalent per 100g of protein, requiring vast land, water, and feed inputs; plant proteins (beans, lentils, soy) produce 0.3-2 kg CO2 equivalent per 100g protein — beef's footprint is 10-100× higher due to methane emissions, feed crop production, and land use change
(E) Monoculture maximizes efficiency — specialized equipment, bulk purchasing, and streamlined operations reduce costs — but it depletes specific soil nutrients, creates perfect conditions for pest and disease epidemics, reduces biodiversity, and makes the entire operation vulnerable to a single failure

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13. Seed Biology

Circle the correct answer

121. Which soil type is considered ideal for most farm crops and why?
(A) Loam — a balanced mixture of sand, silt, and clay that drains well while retaining enough moisture and nutrients (B) Pure sand — because it is the easiest soil type for roots to grow through (C) Pure clay — because it holds the most water and nutrients of any soil type (D) Gravel — because it provides the best drainage and prevents root rot

122. Why do some seeds need to experience cold temperatures before they will germinate?

(A) Cold kills harmful bacteria on the seed coat that prevent germination (B) Seeds shrink in cold weather, making it easier for water to enter (C) Cold temperatures increase the nutrient content inside the seed (D) Cold stratification breaks seed dormancy, signaling that winter has passed and spring conditions are safe for growth

123. What role do nitrogen-fixing bacteria play in agricultural soil?

(A) They create nitrogen gas that protects crops from frost damage (B) They break down pesticides into harmless chemicals (C) They produce oxygen for plant roots to breathe underground (D) They convert atmospheric nitrogen gas into forms that plants can absorb through their roots

124. Design a simple experiment to determine the best planting depth for corn seeds in your local soil.

(A) Look up the answer online since experiments take too long (B) Plant all seeds at 3 cm because that is the depth listed on the seed packet (C) Plant one seed at each depth and check which one grows first after three days, making this the most widely accepted explanation (D) Plant groups of corn seeds at different depths (1 cm, 3 cm, 5 cm, 7 cm) in identical conditions, with multiple seeds per depth, and measure germination rate and seedling height over several weeks

125. How can contour farming and terracing reduce water runoff and soil erosion on sloped farmland?

(A) These practices are outdated and no longer used in modern agriculture, which is the most common explanation for this phenomenon (B) Contour farming means planting in straight rows pointing directly downhill, making this the most widely accepted explanation (C) Terracing involves building fences at the bottom of slopes to catch eroded soil, and this has been consistently demonstrated in practice (D) Contour farming plants rows along the slope's contour lines (perpendicular to the slope), and terracing creates level steps — both slow water flow, increase infiltration, and prevent soil from being carried downhill

126. Why is crop diversity important on a farm, even if a single high-yielding variety could fill all the fields?

(A) Growing one variety is always the best strategy for maximum profit (B) Growing multiple crops and varieties reduces risk from pests, diseases, weather events, and market fluctuations — if one crop fails, others may still succeed (C) Crop diversity is required by government regulations for all farms (D) Diversity is only important for appearance — all crops grow equally well

Write the answer

127. What is the function of a plant's root hairs in nutrient absorption?
Answer: _____

128. Compare the advantages of open-pollinated (heirloom) crop varieties versus hybrid varieties for a small farm.
Answer: _____

129. What is pollination, and why is it essential for fruit and seed crop production?
Answer: _____

130. How are drones used in modern agriculture?
Answer: _____

Match each question to its answer

1. Design an IPM strategy for a small organic vegetable farm dealing with caterpillar damage on cabbage plants. →
2. How can farmers use the concept of food webs to improve pest management on their farms? →
3. What are the main ways that crop diseases spread between plants? →
4. Analyze why the overuse of broad-spectrum herbicides in agriculture has led to the emergence of 'superweeds.' →
5. Why is morning the best time to irrigate most crops? →

(A) By supporting diverse food webs with habitat for predators, parasitoids, and insect-eating birds, farmers create a natural pest control system where multiple species keep pest populations in check
(B) Morning irrigation reduces evaporation losses (cooler temperatures, less wind), gives foliage time to dry during the day (reducing disease risk), and provides water when plants begin active photosynthesis
(C) Repeated use of the same herbicide selects for naturally resistant weed individuals, whose offspring inherit resistance, creating populations that no longer respond to that herbicide — forcing farmers to use more toxic alternatives
(D) Through wind-borne spores, water splash, insect vectors, contaminated soil, infected seed, and direct contact with contaminated tools or equipment
(E) Use row covers to physically exclude moths, handpick caterpillars, introduce parasitic wasps (Trichogramma), apply Bacillus thuringiensis (Bt) spray as a targeted biological pesticide, and plant trap crops like mustard to lure pests away

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14. Seed Biology

Circle the correct answer

131. Which three nutrients are represented by the numbers on a bag of fertilizer (the N-P-K ratio)?
(A) Nickel, platinum, and krypton (B) Sodium, phosphorus, and calcium (C) Nitrogen, protein, and potash (D) Nitrogen, phosphorus, and potassium

132. A student plants 20 bean seeds in potting soil. Ten are kept in a dark closet and ten are placed on a sunny windowsill. Both groups receive equal water. After one week, the dark group has taller, pale seedlings. Why did the dark-grown seedlings grow taller?
(A) The closet was warmer, which always makes plants grow taller, as this is what research and standard practice suggests (B) The seedlings used stored seed energy to grow rapidly toward light in a process called etiolation — they stretched tall but were weak and pale without sunlight for photosynthesis (C) Light actually inhibits plant growth, so removing it let the plants grow faster, as this is what research and standard practice suggests (D) The dark closet had better growing conditions with no wind to slow growth, and this principle applies across similar situations

133. How does no-till farming affect water infiltration and runoff compared to conventional tillage?
(A) Tillage improves infiltration by loosening soil and creating more air spaces, and this has been consistently demonstrated in practice (B) No-till farming increases runoff because the hard soil surface repels water (C) Neither farming method affects how water moves through soil, which is why this approach is recommended by experts (D) No-till farming improves infiltration because undisturbed soil maintains its pore structure, earthworm channels, and root pathways — reducing runoff by up to 90% compared to tilled fields

134. How does mulching benefit crop plants on a farm?
(A) Mulch increases soil temperature in summer to help warm-season crops (B) Mulch is purely decorative and has no functional benefit for crops (C) Mulch provides nutrients directly to plant leaves through contact (D) Mulch retains soil moisture by reducing evaporation, suppresses weeds by blocking light, moderates soil temperature, and adds organic matter as it decomposes

135. What role does cellular respiration play in crop growth, and how is it related to photosynthesis?
(A) Cellular respiration and photosynthesis are the same process with different names, as this directly follows from the underlying principles (B) Cellular respiration produces glucose while photosynthesis consumes it, and this is the standard approach used in most cases (C) Cellular respiration only occurs in animals, not in plants, which is the most common explanation for this phenomenon (D) Cellular respiration breaks down glucose (made by photosynthesis) to release energy for growth, cell division, and maintenance — it is essentially the reverse of photosynthesis

136. What is a growing season, and what determines its length in a particular region?
(A) The growing season is the period between the last spring frost and the first fall frost, determined by latitude, altitude, and local climate patterns (B) The growing season starts when farmers begin planting and ends when they stop (C) The growing season is always exactly six months long everywhere on Earth (D) The growing season is determined solely by the amount of rainfall a region receives

Write the answer

137. Design a technology plan for a small urban farm that wants to grow lettuce year-round in a 2,000 square foot warehouse.
Answer: _____

138. What is the difference between a pest's damage threshold and its population threshold in IPM decision-making?
Answer: _____

139. How does planting disease-resistant crop varieties reduce the need for chemical fungicides?
Answer: _____

140. How do cover crops and mulch help suppress weed growth on farms?
Answer: _____

Match each question to its answer

1. What is the difference between drip irrigation and overhead sprinkler irrigation? →
2. Why is agricultural water pollution a major environmental concern? →
3. What is the concept of 'virtual water' in agriculture? →
4. What is rainwater harvesting, and how can it supplement irrigation on farms? →
5. Why do farmers often rotate legumes (like soybeans or peas) with grain crops (like corn)? →

(A) Fertilizer and pesticide runoff from farms enters waterways, causing algal blooms that deplete oxygen and create dead zones, while contaminating drinking water supplies
(B) Because legumes add nitrogen to the soil, which grain crops need to grow
(C) Virtual water is the total volume of water used to produce a product — including water for growing crops, processing food, and transportation — revealing the hidden water footprint of food
(D) Drip irrigation delivers water slowly and directly to plant root zones through tubes and emitters; overhead sprinklers spray water over the entire field from above, losing more water to evaporation and wetting leaves unnecessarily
(E) Rainwater harvesting collects and stores rainfall from roofs, paved areas, or land

surfaces in tanks or ponds for later use in irrigation, reducing dependence on groundwater and municipal water supplies

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15. Seed Biology

Circle the correct answer

141. How do cover crops help prevent soil erosion on farms during the off-season?
(A) Cover crops create a waterproof seal over the soil that prevents any water from entering (B) Cover crops attract earthworms that build underground walls to block erosion (C) Cover crops are harvested and sold, generating income that pays for erosion barriers (D) Their roots hold soil particles in place, and their leaves shield the soil surface from the impact of rain and wind

142. Create a plan for a farmer with a short 90-day growing season who wants to grow tomatoes that need 120 days to mature.
(A) Start tomato seeds indoors 6-8 weeks before the last frost, transplant hardened-off seedlings after frost danger passes, use black plastic mulch to warm soil, and consider row covers for frost protection at season's end (B) Use extra fertilizer to make the tomatoes grow faster than their normal maturation rate, which is the most common explanation for this phenomenon (C) Plant the seeds directly outdoors on the last frost date and hope for a late first frost, which is the most common explanation for this phenomenon (D) It is impossible to grow tomatoes with fewer frost-free days than the variety requires, and this is the standard approach used in most cases

143. What happens to the glucose produced by photosynthesis in a crop plant?
(A) Glucose is only stored in the leaves and has no other uses in the plant (B) Plants do not actually use glucose — it is a waste product they try to remove (C) Some is used immediately for energy through cellular respiration, some is converted into structural materials like cellulose, and some is stored as starch in seeds, roots, or fruits (D) All glucose is immediately released into the soil as food for bacteria

144. What is the 'digital divide' in agriculture?
(A) The difference between organic and non-organic farming methods (B) The gap between farmers who have access to and can afford precision agriculture technology and those who cannot (C) A mathematical formula used to divide farmland equally (D) A physical gap between farm fields created by digital surveying tools

145. Create a plan to reduce nitrogen runoff from a corn farm that borders a creek.
(A) Stop growing corn entirely and leave the field as bare dirt, and this has been consistently demonstrated in practice (B) Apply twice as much nitrogen so plants absorb it all before it can run off, as this is what research and standard practice suggests (C) Build a concrete wall along the creek to physically block all runoff, and this is the standard approach used in most cases (D) Plant a grass buffer strip along the creek, apply nitrogen based on soil tests rather than guessing, use split applications (smaller doses at multiple growth stages), plant cover crops after harvest, and avoid applying fertilizer before heavy rain

146. What is a watershed, and why should farmers be concerned about their farm's position within one?
(A) Watersheds only exist in mountainous areas, not in flat farming regions, and this is the standard approach used in most cases (B) A watershed is the land area where all precipitation drains to a common water body; farms upstream affect water quality downstream, making every farmer both a recipient and contributor to watershed health (C) Farmers do not need to consider watersheds because each farm manages its own water independently (D) A watershed is a building where water is stored for distribution to farms, and this has been consistently demonstrated in practice

Write the answer

147. Design a water conservation plan for a small vegetable farm in a region experiencing drought.
Answer: _____

148. Compare monoculture and polyculture farming. Which is generally more sustainable and why?
Answer: _____

149. Why is reducing food waste considered an important strategy for fighting climate change?
Answer: _____

150. What is a Concentrated Animal Feeding Operation (CAFO)?
Answer: _____

Match each question to its answer

1. What is food justice? →
2. What percentage of the world's food is produced by smallholder farmers? →
3. A farmer tests two fields and finds one has mostly clay soil and the other has mostly sandy soil. Which crop-growing challenge is the clay field MOST likely to have? →

4. What is the concept of 'animal welfare certification' labels on food products? →
5. Compare the environmental footprint of producing 100 grams of protein from beef versus from lentils. →

(A) The belief that all communities deserve equal access to healthy, affordable, culturally appropriate food, and a voice in how food systems operate
(B) Third-party verified labels that indicate animals were raised according to specific welfare standards above the legal minimum
(C) Poor drainage — clay soil holds too much water, which can drown plant roots
(D) About 30-35% of global food, despite farming on less than 25% of the world's agricultural land
(E) Beef generates roughly 50 times more greenhouse gas emissions and uses 20 times more land than lentils per gram of protein

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16. Seed Biology

Circle the correct answer

151. What environmental conditions do most seeds require to begin germination?
(A) Adequate moisture, appropriate temperature, and oxygen — most seeds do NOT require light to germinate (B) Sunlight, carbon dioxide, and warm temperatures above 30°C (C) Complete darkness, freezing temperatures, and acidic water (D) Fertilizer, pesticides, and daily watering for exactly one hour

152. A farmer discovers that earthworm populations have declined sharply in one of their fields. What agricultural problem might this indicate?
(A) The crops are growing too well, crowding out earthworm habitat (B) Birds have eaten all the earthworms, which is a normal seasonal cycle (C) The soil health may be degraded — possibly from overuse of chemical pesticides, compaction from heavy machinery, or loss of organic matter (D) The field has too many nutrients, which earthworms find toxic

153. Compare the advantages and disadvantages of starting crops from seeds versus transplanting seedlings from a greenhouse.
(A) There is no practical difference — both methods produce identical results every time (B) Seeds always produce healthier plants than transplants in every situation (C) Transplants are always better because they skip the most difficult growth stage (D) Seeds are cheaper and avoid transplant shock but take longer and are vulnerable to weather; transplants give a head start on the growing season but cost more and may suffer root disturbance

154. A farmer notices that corn plants on the edge of a field are taller and produce more ears than plants in the center. What is the MOST likely explanation?
(A) The soil at field edges is always better quality than soil in the center (B) Edge plants get more wind which makes them grow taller and stronger (C) Birds sitting on fences near the edge fertilize those plants with droppings (D) Edge plants receive more sunlight from the side and face less competition for light, water, and nutrients from neighboring plants

155. What is controlled environment agriculture (CEA)?
(A) Growing crops only in environments that never change naturally (B) Growing plants in enclosed facilities where temperature, light, humidity, CO2, and nutrients are precisely controlled (C) Farming that is controlled by a government environmental agency (D) A method of farming where animals control what crops are planted

156. A farmer finds tiny holes in the leaves of their eggplant and small shiny beetles jumping away when disturbed. What pest is this, and what IPM approach should they consider?
(A) Spider mites — increase irrigation to wash them off the leaves, which is the most common explanation for this phenomenon (B) Aphids — release ladybugs as biological control agents, and this has been consistently demonstrated in practice (C) Flea beetles — use floating row covers as a physical barrier, apply kaolin clay spray to deter feeding, plant trap crops of radish, and time planting to avoid peak beetle emergence (D) Caterpillars — spray Bt (Bacillus thuringiensis) on all affected plants immediately, making this the most widely accepted explanation

Write the answer

157. How do ladybugs serve as a biological pest control agent on farms?
Answer: _____

158. What is a weed, and why are weeds harmful to crop production?
Answer: _____

159. What is eutrophication, and how does agricultural runoff contribute to it?
Answer: _____

160. Evaluate whether desalination of seawater is a practical solution for agricultural water scarcity.
Answer: _____

Match each question to its answer

1. What does the term 'organic farming' mean? →
2. A school cafeteria throws away 200 pounds of food per week. Design a plan to reduce this waste. →
3. What is the 'feed conversion ratio' and why does it matter for sustainability? →
4. What are community gardens and urban farms, and how do they address food justice? →
5. What is agricultural biodiversity and why is it under threat? →

(A) Shared growing spaces in cities that provide fresh food in underserved areas while building community connections and food knowledge
(B) The amount of feed needed to produce one unit of animal product — lower ratios mean more efficient and generally more sustainable production
(C) The variety of plants, animals, and microorganisms used in farming; it's declining as agriculture focuses on fewer high-yield crop varieties
(D) Conduct a waste audit to identify what's wasted most, serve smaller portions with seconds available, compost scraps, and donate surplus to food banks
(E) Farming that avoids synthetic pesticides and fertilizers, using natural methods instead

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Riddle & Joke Break

Guess the answer, then check the key!

161. I told the soil a joke, but it didn't laugh -- it said it had already composted that one.

162. The farmer was outstanding in his field -- literally, he'd been out there since 5 AM.

163. Crop rotation is like musical chairs for vegetables. Every year, someone has to move.

164. The corn stalks were great listeners -- they were all ears.

165. The lettuce won the race because it was a head from the very start.

166. I tried to write a report on sustainable farming, but I kept going off on tangents -- like a tractor in a field.

Answer Key

1. A — Mineral particles, organic matter, water, and air
2. B — Poor drainage — clay soil holds too much water, which can drown plant roots

3. B — To store food that nourishes the developing embryo during germination
4. C — Different crops grow best at different pH levels, and soil pH affects which nutrients plants can absorb
5. C — The seedlings used stored seed energy to grow rapidly toward light in a process called etiolation — they stretched tall but were weak and pale without sunlight for photosynthesis
6. B — Nitrogen, phosphorus, and potassium
7. Compost adds organic matter that improves soil structure, water retention, and nutrient availability while feeding beneficial soil organisms
8. Germination is the initial process where a seed sprouts by absorbing water and breaking through its seed coat; growth is the ongoing development of the plant after germination
9. The soil health may be degraded — possibly from overuse of chemical pesticides, compaction from heavy machinery, or loss of organic matter
10. Loam — a balanced mixture of sand, silt, and clay that drains well while retaining enough moisture and nutrients
    Matching (Farm Foundations: Soil and Seeds): 1→B, 2→A, 3→E, 4→D, 5→C
11. A — Photosynthesis is the process where plants use sunlight, water, and carbon dioxide to produce glucose (food) and oxygen — it is the energy source that drives all crop growth
12. D — Edge plants receive more sunlight from the side and face less competition for light, water, and nutrients from neighboring plants
13. C — The growing season is the period between the last spring frost and the first fall frost, determined by latitude, altitude, and local climate patterns
14. A — Through transpiration — water evaporates from leaf surfaces, creating a pulling force that draws water up through the xylem vessels from the roots
15. C — Optimal spacing reduces competition for light, water, and nutrients, allows air circulation to prevent disease, and provides access for equipment and harvesting
16. B — Warm-season crops (like tomatoes) need soil above 15°C to germinate and are killed by frost; cool-season crops (like lettuce) germinate in cooler soil and can tolerate light frost
17. Some is used immediately for energy through cellular respiration, some is converted into structural materials like cellulose, and some is stored as starch in

seeds, roots, or fruits

18. The alkaline soil (pH 8.5) is making iron and other micronutrients unavailable to the plants; the farmer should lower the pH by adding sulfur or acidic organic matter
19. Pollination is the transfer of pollen from the male part (anther) to the female part (stigma) of a flower, which must occur for fertilization and the development of seeds and fruits
20. Greenhouses extend the growing season by trapping solar heat, protect crops from frost and severe weather, and allow control of temperature, humidity, and light
    Matching (Crop Science and Plant Growth): 1→B, 2→E, 3→C, 4→A, 5→D
21. B — IPM combines biological, cultural, mechanical, and chemical methods to manage pests with minimal environmental impact, using pesticides only as a last resort rather than the first response
22. C — Ladybugs are predators that eat aphids, scale insects, and mites — a single ladybug can consume over 5,000 aphids in its lifetime, reducing pest populations without chemicals
23. D — A fungal disease — fungal pathogens thrive in wet conditions and often cause leaf spots that spread through water splash
24. B — Natural selection favors individuals with genetic resistance — those that survive pesticide exposure reproduce, passing resistance to offspring; rotating different pesticide types prevents resistance buildup
25. B — A weed is any plant growing where it's not wanted — weeds compete with crops for light, water, nutrients, and space, potentially reducing yields by 30-50% if unmanaged
26. A — Use row covers to physically exclude moths, handpick caterpillars, introduce parasitic wasps (Trichogramma), apply Bacillus thuringiensis (Bt) spray as a targeted biological pesticide, and plant trap crops like mustard to lure pests away
27. Rotating different crop families breaks the life cycle of pests and pathogens that specialize on specific hosts — without their preferred host plant, pest populations decline
28. The damage threshold is the level of crop injury that causes economic loss; the population threshold is the pest number at which damage is likely to reach economic levels — action is taken before the damage threshold is reached

29. Misidentification can lead to ineffective or harmful treatments — beneficial insects might be killed, the wrong pesticide might be used, or a disease might be confused with a nutrient deficiency
30. Companion plants are species grown near crops that repel pests, attract beneficial insects, or serve as trap crops — like marigolds planted near tomatoes to repel nematodes and attract pest predators
    Matching (Pests, Diseases, and Integrated Management): 1→C, 2→B, 3→D, 4→E, 5→A
31. C — Drip irrigation delivers water slowly and directly to plant root zones through tubes and emitters; overhead sprinklers spray water over the entire field from above, losing more water to evaporation and wetting leaves unnecessarily
32. D — Fertilizer and pesticide runoff from farms enters waterways, causing algal blooms that deplete oxygen and create dead zones, while contaminating drinking water supplies
33. D — Approximately 70% — agriculture is by far the largest consumer of freshwater globally
34. C — Salinization — irrigation water contains dissolved salts that accumulate as water evaporates, eventually reaching toxic levels that prevent crop growth
35. C — Buffer strips of permanent vegetation filter sediment and nutrients from agricultural runoff before it reaches streams, absorbing pollutants through plant roots and soil biology
36. D — The water cycle provides rainfall for crops and recharges groundwater for irrigation; farming affects the cycle through irrigation withdrawals, altered infiltration rates from tilling, and increased runoff from bare soil
37. The Ogallala Aquifer is being pumped for irrigation much faster than it recharges naturally — it took millions of years to fill but could be depleted within decades at current use rates
38. Install drip irrigation with timers, apply thick organic mulch to reduce evaporation, collect rainwater in cisterns, plant drought-tolerant varieties, use soil moisture sensors to avoid overwatering, and schedule irrigation for early morning
39. Organic matter acts like a sponge — each 1% increase in soil organic matter can increase water-holding capacity by approximately 20,000 gallons per acre
40. A watershed is the land area where all precipitation drains to a common water body; farms upstream affect water quality downstream, making every farmer

both a recipient and contributor to watershed health
Matching (Water Management and Irrigation Science): 1→E, 2→D, 3→B, 4→A, 5→C

41. B — To produce food while protecting the environment and natural resources for future generations
42. B — Growing different crops in the same field in a planned sequence over several seasons
43. A — Because legumes add nitrogen to the soil, which grain crops need to grow
44. C — Farming that avoids synthetic pesticides and fertilizers, using natural methods instead
45. C — A crop planted to cover and protect soil between growing seasons, preventing erosion and adding nutrients
46. D — The series of steps food goes through from being grown on a farm to reaching a consumer's plate
47. About one-third (roughly 30-40%)
48. Decomposing organic waste into nutrient-rich soil amendment that improves soil fertility naturally
49. The distance food travels from where it's produced to where it's consumed, affecting carbon emissions
50. Growing two or more different crops together in the same field at the same time
Matching (Sustainable Farming and Food Systems): 1→A, 2→C, 3→D, 4→E, 5→B
51. C — The practice of breeding, raising, and caring for farm animals for food, fiber, or labor
52. A — Animals like cows and sheep that have a four-chambered stomach allowing them to digest tough plant materials like grass
53. C — Methane, produced during enteric fermentation when microbes in the rumen break down plant material
54. B — Moving livestock between pasture sections on a schedule so grazed areas can recover, preventing overgrazing
55. A — Chickens have access to outdoor space and are not confined to cages for their entire lives
56. D — Dairy breeds are selected for high milk production, while beef breeds are selected for muscle growth and meat quality

57. Freedom from hunger/thirst, discomfort, pain/injury/disease, fear/distress, and freedom to express normal behavior
58. A large-scale facility where many animals are kept in confined spaces for efficient production of meat, milk, or eggs
59. They prevent disease in crowded conditions and promote growth, but overuse contributes to antibiotic-resistant bacteria
60. Beef requires roughly 1,800 gallons per pound, while wheat requires about 130 gallons — about 14 times more for beef
    Matching (Livestock and Animal Agriculture): 1→B, 2→A, 3→C, 4→E, 5→D
61. B — Using technology like GPS, sensors, and data analysis to optimize farming decisions at specific locations within a field
62. B — For aerial crop monitoring, mapping field health, spraying pesticides precisely, and assessing plant stress using multispectral cameras
63. D — Growing plants in nutrient-rich water solutions without soil
64. D — Growing crops in stacked layers indoors, solving land scarcity in cities and enabling year-round production regardless of climate
65. D — Plants are suspended in air with roots periodically misted with nutrient solution, using even less water than hydroponics
66. A — It enables auto-steering tractors, precise field mapping, variable-rate application of inputs, and tracking of equipment location
67. Electronic devices placed in soil that measure moisture, temperature, pH, and nutrient levels in real-time to guide irrigation and fertilization
68. The total greenhouse gases emitted during a food product's entire lifecycle — from farm inputs to consumer disposal
69. A measurement from satellite or drone cameras that indicates plant health by comparing how plants reflect red and near-infrared light
70. Growing plants in enclosed facilities where temperature, light, humidity, CO_2, and nutrients are precisely controlled
    Matching (Agricultural Technology and Innovation): 1→C, 2→B, 3→A, 4→D, 5→E
71. C — The belief that all communities deserve equal access to healthy, affordable, culturally appropriate food, and a voice in how food systems operate
72. C — About 735-780 million people (roughly 1 in 10 people on Earth)
73. A — Rising temperatures, changing rainfall patterns, more extreme weather

events, and shifting growing seasons alter crop yields and threaten food security

74. D — Government payments to farmers that support food production but often favor large operations, distort markets, and can harm farmers in developing countries
75. D — A 1960s-70s movement that introduced high-yield crop varieties and modern farming techniques, preventing famine but also increasing chemical dependency and reducing biodiversity
76. A — Large-scale acquisition of farmland in developing countries by foreign governments or corporations, often displacing local farmers and communities
77. Many farm workers face low wages, unsafe working conditions, pesticide exposure, and lack of labor protections, creating injustice in food production
78. A certification system ensuring farmers in developing countries receive minimum fair prices, safe conditions, and community development funds
79. Food apartheid emphasizes that lack of food access in certain communities is caused by systemic racism and policy choices, not just geographic factors
80. About 30-35% of global food, despite farming on less than 25% of the world's agricultural land
    Matching (Food Justice and Global Agriculture: Capstone): 1→D, 2→C, 3→E, 4→A, 5→B
81. D — The period of the year when weather conditions are warm enough and wet enough for plants to grow
82. D — Frost is a thin layer of ice crystals that forms on surfaces when temperatures drop to 32°F (0°C) or below, and it can damage or kill plant cells by freezing the water inside them
83. A — The artificial application of water to land or soil to help crops grow, especially when rainfall is insufficient
84. B — An extended period of unusually low rainfall that results in a shortage of water, affecting crops, livestock, and communities
85. B — The continuous movement of water through evaporation, condensation, precipitation, and collection — it provides the rain and groundwater that crops need to grow
86. D — A region defined by its typical temperature, rainfall, and seasonal patterns, which determines what crops can be successfully grown there
87. Weather directly affects every farming decision — when to plant, irrigate, spray,

fertilize, and harvest — and unexpected weather like storms, frost, or heat waves can destroy an entire season's work

88. Excessive rain can flood fields (drowning roots by cutting off oxygen), promote fungal diseases, wash away topsoil and nutrients, delay planting and harvesting, and reduce crop quality
89. About 183 days (from April 15 to October 15)
90. Count 90 days from May 1 to determine the harvest date (around July 30), and plant early enough that the crop matures before the first fall frost — also consider planting a second succession crop after the first harvest
Matching (Farming and Harvest): 1→E, 2→C, 3→B, 4→D, 5→A
91. D — A crop grown primarily for sale and profit rather than for the farmer's own use
92. B — Wholesale means selling large quantities to businesses (grocery stores, restaurants, distributors) at lower prices, while retail means selling directly to individual consumers (at farmers markets, farm stands) at higher prices per unit
93. D — When many farmers produce the same crop (high supply) and fewer people want it (low demand), prices drop; when a crop is scarce (low supply) and many people want it (high demand), prices rise
94. A — A system where customers pay a farm upfront at the beginning of the season and receive weekly boxes of fresh produce throughout the growing season, sharing both the risks and rewards of farming
95. B — A farming method that avoids synthetic pesticides, synthetic fertilizers, genetically modified organisms, and routine antibiotics, instead using natural pest control, composting, and crop rotation to maintain soil health
96. C — A regularly occurring market where local farmers sell their produce, meat, dairy, and other farm products directly to consumers, usually outdoors or in open-air structures
97. The farm price is only about 15% of the retail price — the rest covers processing, packaging, transportation, storage, marketing, wholesale distribution, and the grocery store's own costs and profit
98. Crop insurance pays farmers if their crops are damaged by natural disasters (drought, flood, hail, freeze) or if market prices drop below a guaranteed level, preventing total financial ruin from events beyond the farmer's control
99. $300 per acre ($800 revenue minus $500 costs)
100. $300 (200 bushels × $1.50 profit per bushel)

Matching (Farming and Harvest): 1→E, 2→D, 3→A, 4→B, 5→C

101. A — The process of treating and handling food to slow down spoilage and prevent foodborne illness, allowing food to be stored and consumed long after harvest
102. B — Microorganisms (bacteria, molds, yeasts), enzymes naturally present in the food, oxidation from exposure to air, and moisture loss or gain all break down food over time
103. A — A process of heating liquid foods (like milk or juice) to a specific temperature for a set time to kill harmful bacteria without significantly changing the food's taste or nutritional value
104. A — A process where microorganisms (bacteria or yeast) convert sugars into acids, gases, or alcohol, preserving food while creating distinctive flavors and often increasing nutritional value
105. D — Removing water from food to prevent the growth of bacteria, molds, and yeasts, since these microorganisms need moisture to survive and multiply
106. A — Canning seals food in airtight containers and heats them to high temperatures, killing bacteria and creating a vacuum seal that prevents new microorganisms from entering — the combination of heat sterilization and airtight sealing keeps food safe for years
107. Bacteria multiply rapidly in the 'danger zone' between 40°F and 140°F (4°C–60°C), so keeping food below 40°F (refrigeration) or above 140°F (hot holding) prevents dangerous bacterial growth
108. Salt draws water out of food and microorganisms through osmosis, creating an environment too dry and salty for most bacteria and molds to survive
109. Keep raw meat in a cooler with ice until ready to grill, cook to proper internal temperature (165°F for poultry, 160°F for ground beef), serve cooked food on clean plates (not the ones that held raw meat), and refrigerate leftovers within 1 hour since the temperature exceeds 90°F
110. Multiple methods work: can them in a water bath with added lemon juice (ensures sufficient acidity), freeze them whole or as sauce, dehydrate slices in a food dehydrator, or make fermented tomato salsa — each method preserves different qualities of the fresh tomatoes
Matching (Farming and Harvest): 1→A, 2→C, 3→D, 4→E, 5→B
111. D — A farming approach that uses GPS, sensors, drones, and data analysis to monitor and optimize crop production at a very detailed level, treating different parts of a field individually rather than uniformly

112. B — Growing crops in vertically stacked layers inside controlled indoor environments, using artificial lighting (usually LEDs), precise nutrient delivery, and climate control instead of sunlight and soil
113. A — A method of growing plants without soil, using mineral nutrient solutions dissolved in water delivered directly to the plant roots
114. C — Drones equipped with cameras, multispectral sensors, and spraying systems are used to survey crop health, detect pest and disease outbreaks, create field maps, monitor irrigation, and apply targeted treatments to specific areas
115. C — CRISPR is a gene-editing technology that allows scientists to make precise changes to an organism's DNA — in agriculture, it's used to develop crops that resist diseases, tolerate drought, have better nutrition, or produce higher yields
116. A — A combined system where fish and plants are grown together — the fish waste provides natural fertilizer for the plants, and the plants filter the water for the fish, creating a sustainable closed-loop ecosystem
117. Healthy soil contains billions of microorganisms, organic matter, and minerals that nourish plants, retain water, filter pollutants, and store carbon — degraded soil requires more synthetic inputs and produces lower yields, creating a cycle of dependence on chemicals
118. Agricultural robots perform tasks including autonomous planting, precision weeding (identifying and removing weeds without herbicides), fruit harvesting (using computer vision to identify ripe produce), and automated milking of dairy cows
119. 4,356 square feet (10 acres = 435,600 sq ft × 1 head = 435,600 heads; 435,600 ÷ 100 per sq ft = 4,356 sq ft of vertical farm)
120. $440,000 (Crops: 400 acres × $800 = $320,000; Solar: 100 acres × $1,200 = $120,000; Total = $440,000)
    Matching (Farming and Harvest): 1→B, 2→C, 3→A, 4→E, 5→D
121. A — Loam — a balanced mixture of sand, silt, and clay that drains well while retaining enough moisture and nutrients
122. D — Cold stratification breaks seed dormancy, signaling that winter has passed and spring conditions are safe for growth
123. D — They convert atmospheric nitrogen gas into forms that plants can absorb through their roots
124. D — Plant groups of corn seeds at different depths (1 cm, 3 cm, 5 cm, 7 cm) in identical conditions, with multiple seeds per depth, and measure germination

rate and seedling height over several weeks

125. D — Contour farming plants rows along the slope's contour lines (perpendicular to the slope), and terracing creates level steps — both slow water flow, increase infiltration, and prevent soil from being carried downhill

126. B — Growing multiple crops and varieties reduces risk from pests, diseases, weather events, and market fluctuations — if one crop fails, others may still succeed

127. Root hairs are tiny extensions of root cells that dramatically increase the root's surface area, allowing the plant to absorb more water and dissolved nutrients from the soil

128. Heirloom varieties can be saved and replanted (seed sovereignty) and may have unique flavors, but hybrids typically yield more, resist diseases better, and mature more uniformly

129. Pollination is the transfer of pollen from the male part (anther) to the female part (stigma) of a flower, which must occur for fertilization and the development of seeds and fruits

130. For aerial crop monitoring, mapping field health, spraying pesticides precisely, and assessing plant stress using multispectral cameras
Matching (Seed Biology): 1→E, 2→A, 3→D, 4→C, 5→B

131. D — Nitrogen, phosphorus, and potassium

132. B — The seedlings used stored seed energy to grow rapidly toward light in a process called etiolation — they stretched tall but were weak and pale without sunlight for photosynthesis

133. D — No-till farming improves infiltration because undisturbed soil maintains its pore structure, earthworm channels, and root pathways — reducing runoff by up to 90% compared to tilled fields

134. D — Mulch retains soil moisture by reducing evaporation, suppresses weeds by blocking light, moderates soil temperature, and adds organic matter as it decomposes

135. D — Cellular respiration breaks down glucose (made by photosynthesis) to release energy for growth, cell division, and maintenance — it is essentially the reverse of photosynthesis

136. A — The growing season is the period between the last spring frost and the first fall frost, determined by latitude, altitude, and local climate patterns

137. Vertical hydroponic racks with LED grow lights on timers, automated nutrient

dosing, climate control system, and IoT sensors for monitoring

138. The damage threshold is the level of crop injury that causes economic loss; the population threshold is the pest number at which damage is likely to reach economic levels — action is taken before the damage threshold is reached

139. Resistant varieties have genetic traits that prevent or limit disease infection, so the disease cannot establish and spread even without fungicide protection

140. Cover crops and mulch physically block light from reaching weed seeds, preventing germination; cover crops also compete with weeds for water and nutrients, and some produce allelopathic chemicals that inhibit weed growth
Matching (Seed Biology): 1→D, 2→A, 3→C, 4→E, 5→B

141. D — Their roots hold soil particles in place, and their leaves shield the soil surface from the impact of rain and wind

142. A — Start tomato seeds indoors 6-8 weeks before the last frost, transplant hardened-off seedlings after frost danger passes, use black plastic mulch to warm soil, and consider row covers for frost protection at season's end

143. C — Some is used immediately for energy through cellular respiration, some is converted into structural materials like cellulose, and some is stored as starch in seeds, roots, or fruits

144. B — The gap between farmers who have access to and can afford precision agriculture technology and those who cannot

145. D — Plant a grass buffer strip along the creek, apply nitrogen based on soil tests rather than guessing, use split applications (smaller doses at multiple growth stages), plant cover crops after harvest, and avoid applying fertilizer before heavy rain

146. B — A watershed is the land area where all precipitation drains to a common water body; farms upstream affect water quality downstream, making every farmer both a recipient and contributor to watershed health

147. Install drip irrigation with timers, apply thick organic mulch to reduce evaporation, collect rainwater in cisterns, plant drought-tolerant varieties, use soil moisture sensors to avoid overwatering, and schedule irrigation for early morning

148. Polyculture is more sustainable because crop diversity reduces pest problems, improves soil health, and increases resilience

149. Because wasted food in landfills produces methane, a potent greenhouse gas, plus wastes all the resources used to produce it

150. A large-scale facility where many animals are kept in confined spaces for efficient production of meat, milk, or eggs
Matching (Seed Biology): 1→A, 2→D, 3→C, 4→B, 5→E
151. A — Adequate moisture, appropriate temperature, and oxygen — most seeds do NOT require light to germinate
152. C — The soil health may be degraded — possibly from overuse of chemical pesticides, compaction from heavy machinery, or loss of organic matter
153. D — Seeds are cheaper and avoid transplant shock but take longer and are vulnerable to weather; transplants give a head start on the growing season but cost more and may suffer root disturbance
154. D — Edge plants receive more sunlight from the side and face less competition for light, water, and nutrients from neighboring plants
155. B — Growing plants in enclosed facilities where temperature, light, humidity, CO2, and nutrients are precisely controlled
156. C — Flea beetles — use floating row covers as a physical barrier, apply kaolin clay spray to deter feeding, plant trap crops of radish, and time planting to avoid peak beetle emergence
157. Ladybugs are predators that eat aphids, scale insects, and mites — a single ladybug can consume over 5,000 aphids in its lifetime, reducing pest populations without chemicals
158. A weed is any plant growing where it's not wanted — weeds compete with crops for light, water, nutrients, and space, potentially reducing yields by 30-50% if unmanaged
159. Eutrophication is the excessive enrichment of water bodies with nutrients, primarily nitrogen and phosphorus from farm fertilizer runoff, causing algal blooms that deplete oxygen and kill aquatic life
160. Desalination is technically possible but currently too expensive and energy-intensive for most agricultural uses — the water cost per acre would exceed the crop's value for staple crops like wheat and corn
Matching (Seed Biology): 1→E, 2→D, 3→B, 4→A, 5→C
161. I told the soil a joke, but it didn't laugh -- it said it had already composted that one.
162. The farmer was outstanding in his field -- literally, he'd been out there since 5 AM.

163. Crop rotation is like musical chairs for vegetables. Every year, someone has to move.
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