FIELD DECISIONS

Real-world case studies in corn and irrigation management

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KSUTAPS
TESTING AG PERFORMANCE SOLUTIONS

Field Decisions: Real World Case Studies in Corn and Irrigation Management

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Funded by TAPS Interdisciplinary Project

Overview:

This case study curriculum engages high school and undergraduate students in exploring corn as a biological system and agricultural commodity. Students study corn growth, management decisions such as planting dates, hybrid selection, irrigation, and soil fertility, and examine the use of herbicides and pesticides. Through real-world scenarios, they analyze how soil health, water access, and pest control affect yield. This interdisciplinary approach connects plant science, sustainability, and economics, helping students understand corn's significance in local and global food systems.

	Topics in the Case	***Recommended Prior Knowledge***	***Resources Needed***	***Time***
Case #1: Against the Grain: Growing Corn in a Land of Little Rain	- *Planting Date* - *Hybrid Selection* - *Growing Degree Days* - *Crop Development*	- *Basic plant growth requirements* - *Growing Degree Day Basics*	- *Kansas Corn Production Guide* - *Kansas Corn Staging Guide* - *Data Set*	*40 min*
Case #2: From Seed to Stalk: The Impact of Water and Technology on Corn Growth	- *Water management* - *Technology*	- *Water Cycle and Basic Irrigation Concepts* - *Precision Ag Basics*	- *Data Set*	*40 min*
Case #3: The Root of the Problem: Soil and Pest Solutions in Cornfields	- *Soil Management* - *Herbicides and Pesticides*	- *Nutrient/Soil Basics* - *Basic Pesticide terminology* - *Basic concept of IPM*	- *KSRE Chemical Weed Control Guide* - *KSRE Corn Insect Pest Management Guide* - *Data Set*	*40 min*

**The table includes three corn production-based case study descriptions, including topics, recommended prior knowledge, resources needed, and instructional time. Cases address dryland corn management, water and technology impacts, and soil, weed, and pest management.*

Data Set and Supporting Information

TAPS Case Studies

Location: Colby, KS
Irrigation: Valley VRI Linear
Previous Crops:

- 2023: Soybean
- 2017-2022: Corn
- 2015-2016: Grain Sorghum

Pesticide and Herbicide Management

- Pre-Emergence Herbicide
  - April 19th, 2024
  - Product per acre
    - AMS
    - Valor: 2.5 ounces
    - Dicamba: 16 ounces
    - Atrazine: 32 ounces
    - MSO: 128 ounces per 100 gallons
- 2nd Application
  - Date: May 22nd, 2024
  - Product per acre
    - Resicore: 2.5 qt/acre
    - Atrazine: 32 oz
    - Glyphosate: 32 oz
    - NIS 1 qt per gallon of water
    - 12 GPA

Planting

- First Planting
  - Date: May 7 and 8, 2024
  - Equipment: Four-row precision planter
  - Speed: 2.5 mph
  - Depth: 2.25 inches
- Second Planting
  - Date: May 15, 2024
  - Equipment: Four-row precision planter
  - Speed: 2.5 mph
  - Depth: 2.25 inches
- Third Planting
  - Date: May 29, 2024
  - Equipment: Four-row precision planter
  - Speed: 2.5 mph
  - Depth: 2.25 inches

Harvest Date: October 15, 2024

Table 1: Temperature and Precipitation					
Date	Tmin	Tmin	Tmax	Tmax	Precip
(m/d/y)	(°c)	(°F)	(°c)	(°F)	(mm)
4/1/2024	1.7	35.06	13	55.4	0
4/2/2024	0.3	32.54	16.6	61.88	0
4/3/2024	0	32	18.7	65.66	0
4/4/2024	-2.7	27.14	21.5	70.7	0
4/5/2024	4.5	40.1	27.8	82.04	0
4/6/2024	3.7	38.66	19.8	67.64	0
4/7/2024	0.8	33.44	16.4	61.52	0
4/8/2024	-3.4	25.88	18.3	64.94	0
4/9/2024	-4.5	23.9	18.7	65.66	0
4/10/2024	0.7	33.26	20	68	0
4/11/2024	-2.4	27.68	17.8	64.04	0
4/12/2024	-0.3	31.46	25	77	0
4/13/2024	4.5	40.1	31.6	88.88	0
4/14/2024	7.6	45.68	30.6	87.08	0
4/15/2024	9.8	49.64	31.7	89.06	0
4/16/2024	6.4	43.52	20.9	69.62	1.78
4/17/2024	1	33.8	26.4	79.52	0
4/18/2024	2.6	36.68	8.3	46.94	0
4/19/2024	2.1	35.78	9.8	49.64	1.52
4/20/2024	-1.1	30.02	2.5	36.5	2.03
4/21/2024	-0.7	30.74	15.3	59.54	0
4/22/2024	4.3	39.74	27.9	82.22	0
4/23/2024	7.4	45.32	20.8	69.44	0
4/24/2024	7.5	45.5	19.3	66.74	0
4/25/2024	11.8	53.24	25.8	78.44	16.26
4/26/2024	10.1	50.18	21	69.8	0
4/27/2024	7.3	45.14	13.3	55.94	17.53
4/28/2024	5.9	42.62	14.2	57.56	0.51
4/29/2024	2.7	36.86	23.7	74.66	0
4/30/2024	9.6	49.28	24.3	75.74	0
5/1/2024	8	46.4	18	64.4	4.32
5/2/2024	6	42.8	18.6	65.48	0.25
5/3/2024	4.6	40.28	24.9	76.82	5.59
5/4/2024	1.8	35.24	16.2	61.16	0

Table 1: Temperature and Precipitation					
5/5/2024	6.2	43.16	19.6	67.28	0
5/6/2024	5.4	41.72	23.1	73.58	0
5/7/2024	3.4	38.12	23.4	74.12	0
5/8/2024	5.7	42.26	19.7	67.46	0
5/9/2024	2.3	36.14	18.5	65.3	0
5/10/2024	4.5	40.1	20.8	69.44	0
5/11/2024	4.1	39.38	23	73.4	0
5/12/2024	11.2	52.16	19.1	66.38	2.79
5/13/2024	7.9	46.22	23.6	74.48	0
5/14/2024	7.6	45.68	28.1	82.58	1.02
5/15/2024	8.7	47.66	22.5	72.5	0
5/16/2024	3.9	39.02	26.1	78.98	0
5/17/2024	9.8	49.64	31	87.8	0
5/18/2024	12.9	55.22	25.2	77.36	6.1
5/19/2024	11.9	53.42	26.1	78.98	5.33
5/20/2024	12.7	54.86	21.3	70.34	0.25
5/21/2024	8.7	47.66	18.5	65.3	3.56
5/22/2024	5.2	41.36	22.7	72.86	0.25
5/23/2024	12.1	53.78	26.9	80.42	0.51
5/24/2024	8.5	47.3	22.7	72.86	0
5/25/2024	9.6	49.28	30.6	87.08	0
5/26/2024	8.9	48.02	26.2	79.16	0
5/27/2024	6.2	43.16	27.3	81.14	0
5/28/2024	12.9	55.22	23.4	74.12	7.11
5/29/2024	11.1	51.98	28	82.4	0
5/30/2024	13.3	55.94	27.2	80.96	1.27
5/31/2024	13.5	56.3	24.5	76.1	33.53
6/1/2024	12.5	54.5	27.9	82.22	0
6/2/2024	15.2	59.36	29.6	85.28	0
6/3/2024	14.8	58.64	30.2	86.36	1.02
6/4/2024	15.3	59.54	28	82.4	4.06
6/5/2024	11.5	52.7	33.5	92.3	0
6/6/2024	13.7	56.66	27.9	82.22	0
6/7/2024	15	59	37.2	98.96	0
6/8/2024	15.4	59.72	27.4	81.32	4.83
6/9/2024	14.1	57.38	24.5	76.1	0
6/10/2024	11.9	53.42	27.2	80.96	0
6/11/2024	14.3	57.74	30.6	87.08	0

Table 1: Temperature and Precipitation					
6/12/2024	17.6	63.68	38.7	101.66	0
6/13/2024	17.3	63.14	37.3	99.14	0
6/14/2024	17.9	64.22	30.6	87.08	1.52
6/15/2024	16.9	62.42	33.4	92.12	0

Table 2: Hybrid Data and Management

	Planting	Company	Seeding Rate	Nitrogen	Irrigation	Yield @15.5%
Plot #	Date	Hybrid	(plants/ac)	(lbs/ac)	(inches)	(bu/ac)
205	5/8/24	AgVenture AV8614AM	24,000	274	13.25	192.5
602	5/8/24	AgVenture AV8614AM	24,000	274	13.25	172.4
1903	5/8/24	AgVenture AV8614AM	24,000	274	13.25	210.8
2704	5/8/24	AgVenture AV8614AM	24,000	274	13.25	168.5
501	5/8/24	Axis 63F60 SSPRIB	23,500	137	7.5	167.6
1005	5/8/24	Axis 63F60 SSPRIB	23,500	137	7.5	179.1
1502	5/8/24	Axis 63F60 SSPRIB	23,500	137	7.5	170.1
2004	5/8/24	Axis 63F60 SSPRIB	23,500	137	7.5	158.8
304	5/8/24	Pioneer P1122AML	28,000	19	0.25	87.3
1102	5/8/24	Pioneer P1122AML	28,000	19	0.25	63.0
1806	5/8/24	Pioneer P1122AML	28,000	19	0.25	128.5
2301	5/8/24	Pioneer P1122AML	28,000	19	0.25	80.2
301	5/8/24	Pioneer P1122AML	26,500	240	10.25	184.5
505	5/8/24	Pioneer P1122AML	26,500	240	10.25	188.2
2303	5/8/24	Pioneer P1122AML	26,500	240	10.25	182.7
2504	5/8/24	Pioneer P1122AML	26,500	240	10.25	218.4
901	5/8/24	Pioneer P0859AM	31,000	239	7.25	148.4
1006	5/8/24	Pioneer P0859AM	31,000	239	7.25	137.1
1803	5/8/24	Pioneer P0859AM	31,000	239	7.25	183.6
2505	5/8/24	Pioneer P0859AM	31,000	239	7.25	196.0
506	5/8/24	Pioneer P1122AML	24,000	144	6.9	155.1
601	5/8/24	Pioneer P1122AML	24,000	144	6.9	144.1
1804	5/8/24	Pioneer P1122AML	24,000	144	6.9	160.2

Table 2: Hybrid Data and Management

2503	5/8/24	Pioneer P1122AML	24,000	144	6.9	178.3
1104	5/8/24	Dekalb DKC61-41	22,000	179	7.25	190.1
1503	5/8/24	Dekalb DKC61-41	22,000	179	7.25	162.4
1506	5/8/24	Dekalb DKC61-41	22,000	179	7.25	144.3
2201	5/8/24	Dekalb DKC61-41	22,000	179	7.25	176.0
303	5/8/24	DynaGro D54VC14RIB	28,000	169	10.35	179.4
604	5/8/24	DynaGro D54VC14RIB	28,000	169	10.35	215.1
1706	5/8/24	DynaGro D54VC14RIB	28,000	169	10.35	197.3
2401	5/8/24	DynaGro D54VC14RIB	28,000	169	10.35	219.9
801	5/8/24	Pioneer P1122AML	24,000	184	6.85	159.0
906	5/8/24	Pioneer P1122AML	24,000	184	6.85	142.1
2402	5/8/24	Pioneer P1122AML	24,000	184	6.85	176.4
2404	5/8/24	Pioneer P1122AML	24,000	184	6.85	146.2
203	5/8/24	AgriGold A643-52VT2RIB	28,000	184	7.65	105.2
1304	5/8/24	AgriGold A643-52VT2RIB	28,000	184	7.65	134.8
1605	5/8/24	AgriGold A643-52VT2RIB	28,000	184	7.65	139.3
1701	5/8/24	AgriGold A643-52VT2RIB	28,000	184	7.65	176.2
404	5/8/24	Dekalb DKC108-64RIB	25,000	199	11.25	204.8
903	5/8/24	Dekalb DKC108-64RIB	25,000	199	11.25	193.5
2206	5/8/24	Dekalb DKC108-64RIB	25,000	199	11.25	202.9
2502	5/8/24	Dekalb DKC108-64RIB	25,000	199	11.25	218.8
1003	5/8/24	Channel 200-48VT2PRIB	23,000	254	8.05	164.4
1105	5/8/24	Channel 200-48VT2PRIB	23,000	254	8.05	165.3
2002	5/8/24	Channel 200-48VT2PRIB	23,000	254	8.05	135.2
2204	5/8/24	Channel 200-48VT2PRIB	23,000	254	8.05	131.2
503	5/8/24	Channel 213-19VT2	28,000	249	9.6	144.9
606	5/8/24	Channel 213-19VT2	28,000	249	9.6	203.3
2205	5/8/24	Channel 213-19VT2	28,000	249	9.6	158.1
2602	5/8/24	Channel 213-19VT2	28,000	249	9.6	207.1
306	5/8/24	Beck's 6414V2P	24,000	139	2	84.1
1001	5/8/24	Beck's 6414V2P	24,000	139	2	71.4
1705	5/8/24	Beck's 6414V2P	24,000	139	2	57.0
2403	5/8/24	Beck's 6414V2P	24,000	139	2	135.7
603	5/8/24	Pioneer P1122AML	36,000	199	7.75	155.5

Table 2: Hybrid Data and Management						
1306	5/8/24	Pioneer P1122AML	36,000	199	7.75	193.1
1904	5/8/24	Pioneer P1122AML	36,000	199	7.75	186.3
2601	5/8/24	Pioneer P1122AML	36,000	199	7.75	191.4
804	5/8/24	Channel 212-02VT2PRIB	25,000	219	11.55	217.4
1202	5/8/24	Channel 212-02VT2PRIB	25,000	219	11.55	191.6
2606	5/8/24	Channel 212-02VT2PRIB	25,000	219	11.55	240.6
2701	5/8/24	Channel 212-02VT2PRIB	25,000	219	11.55	172.7
403	5/8/24	Golden Harvest G16Q82 DV	28,000	214	9.25	114.5
1106	5/8/24	Golden Harvest G16Q82 DV	28,000	214	9.25	170.6
1801	5/8/24	Golden Harvest G16Q82 DV	28,000	214	9.25	187.4
2304	5/8/24	Golden Harvest G16Q82 DV	28,000	214	9.25	185.1
605	5/8/24	Pioneer P1122AML	25,500	194	9.25	166.1
2406	5/8/24	Pioneer P1122AML	25,500	194	9.25	205.1
2603	5/8/24	Pioneer P1122AML	25,500	194	9.25	194.4
206	5/8/24	Pioneer P1122AML	26,000	129	11.25	197.2
1301	5/8/24	Pioneer P1122AML	26,000	129	11.25	240.2
2302	5/8/24	Pioneer P1122AML	26,000	129	11.25	192.9
2605	5/8/24	Pioneer P1122AML	26,000	129	11.25	199.1
803	5/8/24	Channel 212-02VT2PRIB	28,000	199	15.25	224.8
1004	5/8/24	Channel 212-02VT2PRIB	28,000	199	15.25	245.4
1601	5/8/24	Channel 212-02VT2PRIB	28,000	199	15.25	260.2
1905	5/8/24	Channel 212-02VT2PRIB	28,000	199	15.25	222.4
401	5/8/24	Brevant B04Z92AM	28,000	109	6.65	135.5
904	5/8/24	Brevant B04Z92AM	28,000	109	6.65	179.7
1505	5/8/24	Brevant B04Z92AM	28,000	109	6.65	122.5
1602	5/8/24	Brevant B04Z92AM	28,000	109	6.65	162.5
1002	5/8/24	Brevant B04Z92AM	28,000	109	7.65	173.7
1504	5/8/24	Brevant B04Z92AM	28,000	109	7.65	143.7
1703	5/8/24	Brevant B04Z92AM	28,000	109	7.65	170.5
2305	5/8/24	Brevant B04Z92AM	28,000	109	7.65	152.5
504	5/8/24	Brevant B04Z92AM	28,000	169	7.65	194.0
902	5/8/24	Brevant B04Z92AM	28,000	169	7.65	168.6
1603	5/8/24	Brevant B04Z92AM	28,000	169	7.65	171.3
2705	5/8/24	Brevant B04Z92AM	28,000	169	7.65	193.1

Table 2: Hybrid Data and Management						
1702	5/8/24	Pioneer P1122AML	28,000	109	7.65	171.9
2706	5/8/24	Pioneer P1122AML	28,000	109	7.65	203.9
802	5/15/24	Pioneer P1122AML	25,000	159	6.25	135.8
905	5/15/24	Pioneer P1122AML	25,000	159	6.25	137.5
1606	5/15/24	Pioneer P1122AML	25,000	159	6.25	156.3
2001	5/15/24	Pioneer P1122AML	25,000	159	6.25	180.3
805	5/15/24	Golden Harvest G10L16 DV	26,000	199	7.65	120.2
2203	5/15/24	Golden Harvest G10L16 DV	26,000	199	7.65	201.5
2506	5/15/24	Golden Harvest G10L16 DV	26,000	199	7.65	199.8
405	5/15/24	Channel 204-54TRERIB	23,000	229	6.9	147.5
1201	5/15/24	Channel 204-54TRERIB	23,000	229	6.9	211.3
1704	5/15/24	Channel 204-54TRERIB	23,000	229	6.9	167.9
2702	5/15/24	Channel 204-54TRERIB	23,000	229	6.9	195.1
305	5/15/24	Golden Harvest G10L16 DV	22,000	229	7.65	148.1
1906	5/15/24	Golden Harvest G10L16 DV	22,000	229	7.65	187.4
2501	5/15/24	Golden Harvest G10L16 DV	22,000	229	7.65	202.8
806	5/15/24	Pioneer P1366AML	30,000	159	7.25	130.8
1501	5/15/24	Pioneer P1366AML	30,000	159	7.25	220.6
2405	5/15/24	Pioneer P1366AML	30,000	159	7.25	159.4
204	5/15/24	Pioneer P1366AML	34,000	279	11.35	177.3
1303	5/15/24	Pioneer P1366AML	34,000	279	11.35	161.2
2202	5/15/24	Pioneer P1366AML	34,000	279	11.35	207.2
2306	5/15/24	Pioneer P1366AML	34,000	279	11.35	250.3
406	5/15/24	DynaGro D56TC44RIB	28,000	239	7.15	157.0
1302	5/15/24	DynaGro D56TC44RIB	28,000	239	7.15	135.1
2003	5/15/24	DynaGro D56TC44RIB	28,000	239	7.15	139.0
2604	5/15/24	DynaGro D56TC44RIB	28,000	239	7.15	184.5
1103	5/15/24	Pioneer P1366AML	28,000	239	5.45	134.9
1205	5/15/24	Pioneer P1366AML	28,000	239	5.45	103.8
1902	5/15/24	Pioneer P1366AML	28,000	239	5.45	135.6
201	5/31/24	Channel 214-78DGVT2PRIB	33,000	264	9.75	225.7

Table 2: Hybrid Data and Management						
1204	5/31/24	Channel 214-78DGVT2PRIB	33,000	264	9.75	178.5
2005	5/31/24	Channel 214-78DGVT2PRIB	33,000	264	9.75	147.0
2703	5/31/24	Channel 214-78DGVT2PRIB	33,000	264	9.75	181.4
1101	5/31/24	Dekalb DKC105-33RIB	28,000	189	8.85	206.3
1206	5/31/24	Dekalb DKC105-33RIB	28,000	189	8.85	209.9
1802	5/31/24	Dekalb DKC105-33RIB	28,000	189	8.85	192.0
1805	5/31/24	Dekalb DKC105-33RIB	28,000	189	8.85	118.8
1203	5/31/24	Beck's 5864AM	24,000	199	10.25	174.6
1305	5/31/24	Beck's 5864AM	24,000	199	10.25	142.5
1604	5/31/24	Beck's 5864AM	24,000	199	10.25	124.8
1901	5/31/24	Beck's 5864AM	24,000	199	10.25	211.9

Against the Grain: Growing Corn in a Land of Little Rain

Teacher Version

<u>Grade Level</u>: High School

<u>Time</u>: 40 min

<u>Objectives:</u>

Students will be able to:

- Interpret climate to determine the best planting window for corn in Northwest Kansas.
- Evaluate corn hybrid traits to make informed decisions based on environmental conditions and water availability.
- Calculate Growing Degree Days (GDD) and use the results to predict crop development stages.
- Apply real-world agronomy principles by using data to solve a simulated crop planning scenario.

<u>Materials:</u>

- Student Case Study
- Supporting Data and Information Document
- Kansas Corn Production Guide
- Kansas Corn Staging Guide

<u>KSDE Career Technical Core and CTE Course Competencies</u>

Plant and Animal Sciences

Benchmark 6: Plant Structures and Systems

6.2: Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

6.3: Determine the influence of environmental factors on plant growth (light, water, temperature, etc).

6.6: Demonstrate the proper use of plants in their environment.

Plant and Soil Sciences

Benchmark 3: Plant Structures/Systems

3.12: Relate the growing degree day concept to crop development.

3.13: Understand how temperature is important in plant development and growth.

Introduction:

Corn is an important crop in Northwest Kansas, but growing it successfully takes careful planning. The climate in Northwest Kansas is semi-arid, meaning it has hot summers, cold winters, and low rainfall. Summer temperatures often reach the 90s°F, while winters can drop well below freezing. Since rainfall is usually between 18 and 22 inches per year, irrigation is essential to support crop growth. Farmers in this region often rely on water from the **Ogallala Aquifer**, a large underground water source. Since this water is slowly running out, farmers must utilize various tools, such as efficient hybrids and planting dates, to maximize production with limited resources.

The Scenario:

You are a farmer managing a 2,000-acre corn farm in Colby, Kansas (Thomas County). Your overall goal is to maximize corn production while using water and resources efficiently and making smart financial decisions. Here are some factors to consider, planting date, hybrid selection, growing degree days, and crop development.

1. **Planting Date**

Figure 1: Suggested Corn Planting Dates in Kansas

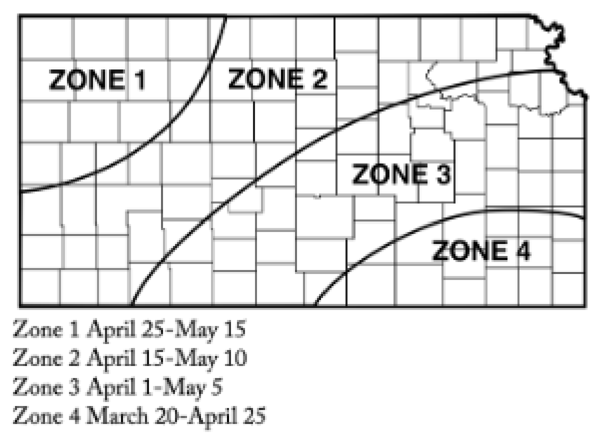

Photo Credit: KSRE Corn Production Guide
A map of Kansas showing 4 corn planting zones with recommended dates from March 20^{th} to May 15^{th} moving earlier from west to east.

Typically, farmers plant their corn crops from mid-April to mid-May, depending on the soil temperature and moisture conditions. The ideal soil temperature for planting is at least 50 degrees Fahrenheit. Planting too early may expose the crop to **late spring frost**, damaging young plants, and increasing the risk of disease. Planting too late may push pollination into the extreme heat of summer, reducing kernel development. Ensuring the correct moisture of the soil is also an important factor to consider when deciding on the planting date. Planting in soil that has too much moisture may result in crusting, making it difficult for the crop to emerge, while planting in soil that is too dry may result in the seed remaining inert until moisture is restored.

Questions:

a. **Of the three planting dates in "Table 2: Hybrid Data and Management," which date would you plant your corn? Describe why?**

***Guide students to analyze frost risk, heat during pollination, and soil moisture. Reference the Supporting Information and Figure 1.*
***Students should only write about one of the possible dates. Example responses and rationale are below.*

May 8th offers the best potential for high yields because it allows the crop to take full advantage of the growing season. Soil temperatures are usually warm enough by this date for good germination, and it helps ensure that critical growth stages like pollination and grain fill occur before the peak summer heat in July. However, early planting may come with a higher risk of crusting or cooling soil conditions if spring weather is delayed. If the field is well-prepared and the forecast is stable, May 8th is the most optimal date for yield.

May 15th falls within the recommended window for corn planting in most of Kansas. It balances yield potential with reduced early-season risks. By mid-May, soil temperatures are usually adequate, and the chance of a cold snap is minimal. This date still allows for strong development before the intense heat of July and August. For many producers, this is a practical and commonly used planting date that fits typical equipment and labor availability.

May 31st is considered late for Kansas corn planting. Although it might be necessary in years with excessive spring moisture, it often results in lower yields. The crop may face higher heat stress during pollination and shorter grain fill periods, especially in western Kansas. Additionally, late planting increases the risk of fall frost, affecting maturity. If planting is delayed to this point, switching to a shorter-season hybrid may help manage risk.

b. **What are <u>three</u> risks associated with delayed corn planting?**

***Student should only write about three (3) of the possible risks. Example responses and rationale are below.*

Heat and drought stress during pollination: *Delayed planting pushes pollination into hotter, drier periods of the summer. This can reduce kernel set and limit grain fill, ultimately decreasing yield.*
Shortened growing season: *Later planting reduces the time available for vegetative and reproductive growth. This limits the crop's ability to fully develop, which can negatively impact yield potential.*
Increased risk of fall frost damage: *Late-planted corn is more likely to experience frost before reaching physiological maturity. This can result in poor grain fill, lower test weight, and overall poor grain quality.*
Emergence and soil condition challenges: *Delayed planting can increase the chance of soil crusting, excessive moisture leading to compaction, or overly dry soil conditions. All of these can reduce uniform seedling emergence and stand establishment, which further impacts final yield.*

c. **What strategies will you use to help reduce potential risks to ensure an optimal crop? Use the KSRE Kansas Corn Production Guide, page 10, to support your answer.**

To reduce risks like crusting, excessive moisture, and dry soil, farmers should ***carefully monitor soil temperature and moisture before planting****. Corn should be planted when the soil reaches at least 50°F to avoid damage from late frosts or disease. Planting in too-wet soil can lead to crusting, making it hard for seedlings to emerge, while planting in dry soil may delay germination. Waiting for proper moisture helps ensure good seed-to-soil contact and even emergence. Sticking to the* ***mid-April to mid-May planting window*** *also avoids pollination during extreme summer heat, improving kernel development and yield.*

2. **Relative Maturity and Hybrid**

Different types of corn (hybrids) take different amounts of time to grow to reach harvest maturity. Shorter season hybrids (90-100 days) mature quickly, which can be useful in areas with limited water or high heat stress. Short-season hybrids can utilize moisture before the hottest part of the season, making for an earlier harvest. These periods of time are called Relative Maturity (RM). Longer RM hybrids (105-115 days) take more time to mature but typically produce higher yields. These hybrids are better suited for areas with more reliable water. Some hybrids are bred for drought tolerance, allowing them to survive better in years with limited rainfall or irrigation restrictions. Plant populations should be adjusted to match the requirements of each hybrid. Early hybrids often perform better when planted at populations higher than those normally used for full-season hybrids. Planting several maturities over a several-week period provides insurance against severe weather losses, and if done carefully, spreads harvest over a longer period.

Questions:

a. **Of the 20 hybrid options in "Table 2: Hybrid Data and Management", which three would you select based on the current water restrictions in this region?**

Pioneer P1122AML (Plots 304, 1102, 1806, 2301)

Irrigation: 0.35 in

Seeding Rate: 32,000 seeds/ac

Avg Yield: 204.2 bu/ac

This hybrid is exceptionally efficient. It uses the least irrigation, a moderate seeding rate, and still delivers a strong yield, a clear fit for extreme water-limited conditions.

Becks 6414V2P (Plots 306, 1001, 1705, 2403)

Irrigation: 2.0 in

Seeding Rate: 32,000 seeds/ac

Avg Yield: 242.6 bu/ac

This hybrid hits a sweet spot — low irrigation, standard seeding rate, and very high yields. It's an ideal pick for moderate water restriction areas.

Wyffels W7878RIB (Plots 205, 602, 1903, 2704)

Irrigation: 7.5 in

Seeding Rate: 32,000 seeds/ac

Avg Yield: 274.2 bu/ac

Though it uses more water, Wyffels W7878RIB maximizes yield. Its standard seeding rate and consistently high productivity make it a great choice where moderate irrigation is available, and yield is prioritized.

***They may select a different hybrid. You will have to use the table to check if they selected the right data to back it up. The three above are the most correct options.*

b. **For this area of Kansas, which Relative Maturity Rating is optimal? Why is that the most optimal RM?**

105-110 RM

A 110-day hybrid generally requires around 2,670 GDD to reach physiological maturity. This aligns well with the growing-season GDD accumulation in northwest Kansas, allowing the crop to mature before the onset of fall frost and late-season heat or drought risks. A mid-season RM like 105–110 allows for a full grain fill period without stretching into mid-summer heat extremes. Using too long an RM risks pollination (R1) and grain fill during high-temperature periods, reducing kernel set and yield. Too short a RM limits biomass accumulation and yield potential. There is also a minimized harvest risk. A 105-day RM will mature well ahead of the first freeze, giving enough drying time before the first frost.

c. **Compare and contrast high and low seeding rates in relation to specific hybrids. Reference the data to explain your reasoning.**

High Seeding Rate Example = 30,000 – 36,000 seeds per acre

Low Seeding Rate Example = 18,000 – 22,000 seeds per acre

High Seeding Rate (I need to look at data for the highest and lowest)

- *Avg Yield: 255.6*
- *Consistently achieved the highest yields.*
- *Under full irrigation, high seeding rates are effective in maximizing yield. The hybrids in these plots respond well to denser planting when adequate water and nutrients are available.*

Low Seeding Rate

- *Avg. Yield: 165.9 bu/ac*
- *All under limited irrigation*

The best-performing hybrids at high seeding rates are likely bred for aggressive growth and high-input systems. They benefit from more plants per acre when resources are abundant. In contrast, low-seeding-rate hybrids seem adapted to conserve resources, maximizing yield per plant instead of per acre. These hybrids are suited to semi-arid, stress-prone areas of northwest Kansas where full irrigation isn't feasible.

3. **Growing Degree Days and Development**

Corn development is tracked using Growing Degree Days (GDD), which measures heat accumulation over time.

The formula for GDD per day is:

GDD = $= \frac{(\text{Tmax} + \text{Tmin})}{2} - 50$

Tmax = Max Daily Temperature in F

Tmin = Min Daily Temperature in F

Temperatures above 86 are capped at 86, and any value lower than 50°F is set to 50. A hybrid with 105 RM may require about 2,500 GDD, while a 115 RM hybrid may require 2,700-2,800 GDD to reach maturity. Hotter-than-average summers may accelerate GDD accumulation, leading to earlier-than-expected maturity, while cooler-than-normal seasons may delay harvest. For a fully mature corn crop, it needs 2,700 growing degree days.

Growing Degree Days of Corn Stages	
Stage	**GDD**
VE – Emergence	125
V6 – Tassel initiation	475
VT – Tassel emergence	1,150
Silking	1,400
R4 – Dough stage	1,925
R5 – Dent stage	2,450
R6 – Physiological maturity or black-layer	2,700
Note: Content from the KSRE Corn Production Guide	

Questions:

a. **Using "Table 1: Temperature and Precipitation", calculate the GDD for your corn field from June 10th to June 15th.**

*** Use this example problem to walk through before letting them do it independently: Find the GDD for June 1st to 3rd.*

Date	*Tmin (F)*	*Tmax (F)*	*GDD Formula*	*GDD*
6/1	*54.5*	*82.22*	*((54.5+82.22)/2)-50*	*18.36*
6/2	*59.36*	*85.28*	*((59.36+85.28)/2)-50*	*22.32*
6/3	*58.64*	*86*	*((58.64+86)/2)-50*	*22.32*

Sum of Daily GDDs: 18.36+22.32+22.32 = ***63 GDD***

Answer:

Date	*Tmin (F)*	*Tmax (F)*	*GDD Formula*	*GDD*
6/10	*53.42*	*80.96*	*((53.42+80.96)/2)-50*	*17.19*
6/11	*57.74*	*87.08*	*((57.74+86)/2)-50*	*21.87*
6/12	*63.68*	*101.66*	*((63.68+86)/2)-50*	*24.84*
6/13	*63.14*	*99.14*	*((63.14+86)/2)-50*	*24.57*
6/14	*64.22*	*87.08*	*((64.22+86)/2)-50*	*25.11*
6/15	*62.42*	*92.12*	*((62.42+86)/2)-50*	*24.21*

*Sum of Daily GDDs: 17.19+21.87+24.84+24.57+25.11+24.21 = **137.79 GDD***

b. How might the GDD be affected as you move North and South in the United States from Kansas?

Southern U.S.

- *Warmer Temperatures*
- *Longer growing season*
- *Higher GDD accumulation = crops can reach maturity faster or support longer maturity hybrids*
- *In the South, frost-free days are much more numerous, allowing growers to plant earlier and harvest later, adding more total GDD across the season.*
- *Southern regions can grow full-season hybrids with high GDD requirements (e.g., 3,000+ GDD).*

Northern U.S.

- *Cooler temperatures*
- *Shorter growing seasons*
- *Lower daily GDD accumulation, so hybrids must mature faster or have lower GDD requirements to avoid frost damage.*
- *In the North, the risk of spring and fall frost limits the planting and harvest windows, which restricts the total available GDD.*
- *Northern regions require early-maturing hybrids (e.g., 2,200–2,400 GDD) to ensure they reach maturity before frost.*

As you move south, GDD increases → you can use longer-maturity, higher-yielding hybrids. As you move north, GDD decreases → you need shorter-maturity hybrids to avoid frost risk.

c. Using Figure 2 above and the data given in "Table 1: Temperature and Precipitation", what date had the most heat stress? What date has the fewest growing degree days? What date had the most moisture?

Date with the most heat stress: June 12, 2024, at 38.7 degrees C or 101.7 degrees F

Heat stress in corn is most severe when daytime temperatures are very high, especially above 32 °C (90 °F). Corn plants can suffer during pollination and grain fill under high heat. High temperatures can cause pollen sterility, poor kernel set, and reduced grain quality. Even if water is adequate, extreme heat can still damage the yield potential.

Date with the fewest GDD: May 4, 2024, at 0 GDD

Days with low or zero GDD slow down crop development. During these periods, corn emergence and early growth are delayed. In a practical sense, if planting occurs before these cool periods, seedlings can struggle with cold stress or crusting.

Date with the most moisture: May 31, 2024, at 33.5 mm or 1.3 in

Heavy rainfall can cause soil crusting, which makes it harder for young seedlings to emerge. Waterlogging reduces oxygen to roots and may cause stunted growth or cause stand loss. Delayed fieldwork or planting, if it occurs before emergence.

4. **Corn Growth and Development**

Corn growth is divided into 2 main phases: vegetative (V) and reproductive (R). Each phase is identified using a staging system that helps farmers monitor development and manage the crop efficiently. The **Vegetative Stages** are V1-VT. V1 indicates one visible leaf with a collar, V2 indicates two visible leaves with a collar, and so on. VT marks the tasseling stage, where the plant has developed all its leaves and the tassel appears, also the beginning of the reproductive phase. The **Reproductive Stages** are R1-R6. R1 begins with silk, when silks emerge from the ear, and pollination begins. R2 is the blister stage where kernels resemble blisters. R3 is the milk stage when kernels fill with a “milky” fluid. R4 is the dough stage, where a “doughy” consistency is inside the kernels. R5 is the dent stage when a dent forms on the kernel, and the milk line progresses towards the kernel tip. R6 is the black layer or physiological maturity. Physiological maturity is when the kernels have reached their final moisture, and dry down begins. Crop scouting is essential during growth stages to monitor pests, nutrient deficiencies, and moisture stress.

Question:

a. **Using the attached KSRE *Corn Staging Guide*, which indicative and descriptive stage(s) of corn growth are the most critical concerning water and nutrients? *(There is more than one correct answer, but you only need to provide one.)***

***Any one of these is correct. They only need to provide one.*

***V6 to V8 Stage (6-8 leaf collars visible)** – Approx. 475-650 GDD*

The growing point (apical meristem) is just above the soil surface and starts with rapid vertical growth. The plant begins to determine potential ear size and sets the number of kernel rows. Rapid nutrient uptake begins, especially nitrogen. Leaf areas rapidly increase; roots expand rapidly. Stress at this point (drought or nutrient deficiency) reduces leaf area, weakens root development, and lowers final yield potential.

***V12 to VT (Tasseling)** – Approx. 900-1400 GDD*

The plant determines the number of potential kernels per row. High water and nutrient demand — the period of peak nitrogen and potassium uptake. Pollination is extremely sensitive to stress. Ear shoots and tassel development are in the final phases internally. Drought or nutrient stress can reduce kernel sets and cause poor pollination, directly impacting yield.

***R1 (Silking)** – Approx. 1500-1700 GDD*

The most sensitive stage for water stress; even a few days of drought can drastically reduce kernel number and grain yield. Silks must remain moist and healthy to successfully capture pollen and develop kernels. Corn plants consume the most water during this time (peak daily water use ~0.25–0.33 inches/day). Nutrient uptake is still significant, though lower than pre-tassel.

b. **Using your inferences from previous questions, how can the precise timing of resources make a difference in both plant productivity and resource conservation?**

***Any combination of these are acceptable answer. Focus on them, highlighting the need for water during critical growth stages (i.e., pollination and reproduction).*

Corn has peak nutrient demand from V6 through R1 (about 475–1700 GDD), especially for nitrogen and potassium. Providing nutrients during this window ensures they are taken up efficiently and directly used for building leaf area, ear development, and kernel set.

This results in better ear size, more kernels per row, higher kernel weight → higher yields.

During V12–R1, daily water use peaks (~0.25–0.33 inches/day). Precise irrigation during these stages prevents silk desiccation, ensures good pollination, and reduces kernel abortion.

This results in healthier ears and less yield loss from drought stress.

Early vegetative stages (before V6): Too much fertilizer or water is often wasted, since uptake is still low, and roots are small. Late reproductive stages: Plants take up fewer nutrients; excesses at this time can leach or run off.

This avoids waste, prevents stress, and ensures the plant focuses on filling kernels efficiently.

Applying nitrogen closer to peak demand minimizes unused nitrogen that can move into groundwater or waterways. Split applications (e.g., starter fertilizer, then side-dress at V6–V8) ensure nitrogen is available when plants can use it best.

Instead of broadcasting high amounts of fertilizer early, precise timing allows lower rates and better efficiency. Fewer irrigation events targeted peak water use to save fuel, electricity, and water. Nitrogen is available when plants can use it best.

Less excess nitrogen and phosphorus entering streams means healthier ecosystems. Better soil moisture management reduces erosion risk and conserves soil structure.

Against the Grain: Growing Corn in a Land of Little Rain

Student Version

Introduction:

Corn is an important crop in Northwest Kansas, but growing it successfully takes careful planning. The climate in Northwest Kansas is semi-arid, meaning it has hot summers, cold winters, and low rainfall. Summer temperatures often reach the 90s°F, while winters can drop well below freezing. Since rainfall is usually between 18 and 22 inches per year, irrigation is essential to support crop growth. Farmers in this region often rely on water from the **Ogallala Aquifer**, a large underground water source. Since this water is slowly running out, farmers must utilize various tools, such as efficient hybrids and planting dates, to maximize production with limited resources.

The Scenario:

You are a farmer managing a 2,000-acre corn farm in Colby, Kansas (Thomas County). Your overall goal is to maximize corn production while using water and resources efficiently and making smart financial decisions. Here are some factors to consider, planting date, hybrid selection, growing degree days, and crop development.

1. **Planting Date**

Typically, farmers plant their corn crops from mid-April to mid-May, depending on the soil temperature and moisture conditions. The ideal soil temperature for planting is at least 50 degrees Fahrenheit. Planting too early may expose the crop to **late spring frost**, damaging young plants, and increasing the risk of disease. Planting too late may push pollination into the extreme heat of summer, reducing kernel development. Ensuring the correct moisture of the soil is also an important factor to consider when deciding on the planting date. Planting in soil that has too much moisture may result in crusting, making it difficult for the crop to emerge, while planting in soil that is too dry may result in the seed remaining inert until moisture is restored.

Figure 1: Suggested Corn Planting Dates in Kansas

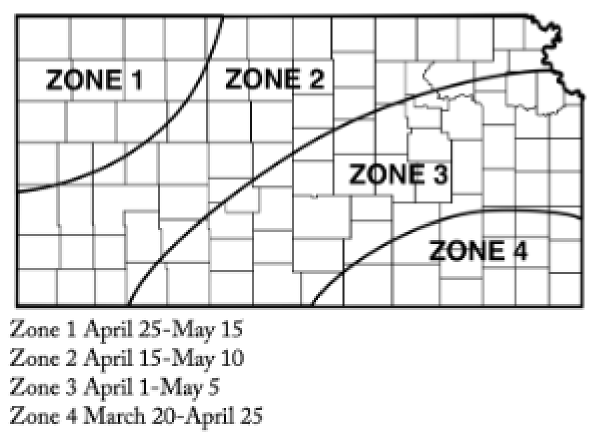

Photo Credit: KSRE Corn Production Guide
A map of Kansas showing 4 corn planting zones with recommended dates from March 20th to May 15th moving earlier from west to east.

Questions:

a. **Of the three planting dates in "Table 2: Hybrid Data and Management," which date would you plant your corn? Describe why?**

b. **What are <u>three</u> risks associated with delayed corn planting?**

c. **What strategies will you use to help reduce potential risks to ensure an optimal crop? Use the KSRE Kansas Corn Production Guide, page 10, to support your answer.**

2. **Relative Maturity and Hybrid**

Different types of corn (hybrids) take different amounts of time to grow to reach harvest maturity. Shorter season hybrids (90-100 days) mature quickly, which can be useful in areas with limited water or high heat stress. Short-season hybrids can utilize moisture before the hottest part of the season, making for an earlier harvest. These periods of time are called Relative Maturity (RM). Longer RM hybrids (105-115 days) take more time to mature but typically produce higher yields. These hybrids are better suited for areas with more reliable water. Some hybrids are bred for drought tolerance, allowing them to survive better in years with limited rainfall or irrigation restrictions. Plant populations should be adjusted to match the requirements of each hybrid. Early hybrids often perform better when planted at populations higher than those normally used for full-season hybrids. Planting several maturities over a several-week period provides insurance against severe weather losses, and if done carefully, spreads harvest over a longer period.

Questions:

a. **Of the 20 hybrid options in "Table 2: Hybrid Data and Management", which three would you select based on the current water restrictions in this region?**

b. **For this area of Kansas, which Relative Maturity Rating is optimal? Why is that the most optimal RM?**

c. **Compare and contrast high and low seeding rates in relation to specific hybrids. Reference the data to explain your reasoning.**

3. **Growing Degree Days and Development**

Corn development is tracked using Growing Degree Days (GDD), which measures heat accumulation over time.

The formula for GDD per day is:

GDD = $= \frac{(\text{Tmax} + \text{Tmin})}{2} - 50$

Tmax = Max Daily Temperature in F

Tmin = Min Daily Temperature in F

Temperatures above 86 are capped at 86, and any value lower than 50°F is set to 50. A hybrid with 105 RM may require about 2,500 GDD, while a 115 RM hybrid may require 2,700-2,800 GDD to reach maturity. Hotter-than-average summers may accelerate GDD accumulation, leading to earlier-than-expected maturity, while cooler-than-normal seasons may delay harvest. For a fully mature corn crop, it needs 2,700 growing degree days.

Growing Degree Days of Corn Stages	
Stage	**GDD**
VE – Emergence	125
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R4 – Dough stage	1,925
R5 – Dent stage	2,450
R6 – Physiological maturity or black-layer	2,700
Note: Content from the KSRE Corn Production Guide	

Questions:

a. **Using "Table 1: Temperature and Precipitation", calculate the GDD for your corn field from June 10th to June 15th.**

b. **How might the GDD be affected as you move North and South in the United States from Kansas?**

c. **Using the table above and the data given in “Table 1: Temperature and Precipitation”, what date had the most heat stress? What date has the fewest growing degree days? What date had the most moisture?**

4. **Corn Growth and Development**

Corn growth is divided into 2 main phases: vegetative (V) and reproductive (R). Each phase is identified using a staging system that helps farmers monitor development and manage the crop efficiently. The **Vegetative Stages** are V1-VT. V1 indicates one visible leaf with a collar, V2 indicates two visible leaves with a collar, and so on. VT marks the tasseling stage, where the plant has developed all its leaves and the tassel appears, also the beginning of the reproductive phase. The **Reproductive Stages** are R1-R6. R1 begins with silk, when silks emerge from the ear, and pollination begins. R2 is the blister stage where kernels resemble blisters. R3 is the milk stage when kernels fill with a “milky” fluid. R4 is the dough stage, where a “doughy” consistency is inside the kernels. R5 is the dent stage when a dent forms on the kernel, and the milk line progresses towards the kernel tip. R6 is the black layer or physiological maturity. Physiological maturity is when the kernels have reached their final moisture, and dry down begins. Crop scouting is essential during growth stages to monitor pests, nutrient deficiencies, and moisture stress.

Questions:

a. **Using the KSRE *Corn Staging Guide*, which indicative and descriptive stage(s) of corn growth are the most critical concerning water and nutrients?** ***(There is more than one correct answer, but you only need to provide one.)***

b. **Using your inferences from previous questions, how can the precise timing of resources make a difference in both plant productivity and resource conservation?**

From Seed to Stalk: The Impact of Water and Technology on Corn Growth

Teacher Version

Grade Level: High School

Time: 40 min

Objectives:

Students will be able to:

- Explain the importance of irrigation and water management for corn production.
- Describe and evaluate how precision agriculture technologies improve crop yield and sustainability.
- Research new emerging technology that can benefit corn production, explaining how it supports efficiency and resource conservation.
- Interpret data from tables, graphs, and technology tools to make informed decisions about irrigation and farm management strategies.

Materials:

- Student case study
- Supporting Data and Information Document

KSDE Career Technical Core and CTE Course Competencies

Plant and Soil Sciences
Benchmark 2: Basic Soil Properties and Fertility
2.7: Describe and distinguish between the different soil management practices in Ag.

Benchmark 6: Crop Evaluation
6.3: Identify principles of irrigated water vs. dry land in crop growth, seed formation, and quality.

Sustainable-Alternative Agriculture
Benchmark 5: Identify Pests and Determine Control Methods on Plant and Animal Production
5.1: Explain water requirements for different crops.
5.2: Recognize critical periods of water use.
5.3: Explain soil moisture.

5.4: Determine the frequency of irrigation and the amount of water needed.
5.5: Describe different methods of irrigation.

<u>Introduction</u>:

Northwest Kansas, part of the vast High Plains region, is a major agricultural hub. Corn is the dominant crop. However, this region faces unique challenges due to its semi-arid climate, which is characterized by low rainfall and high evapotranspiration rates. Colby, KS, represents the high elevations in northwest Kansas that have a relatively short growing season. Successful corn production here hinges on a deep understanding of water management, especially with the decline of the Ogallala aquifer, irrigation, and technologies.

<u>The Scenario</u>:

You are a farmer managing a 2,000-acre corn farm in Colby, Kansas (Thomas County). Your overall goal is to maximize corn production while utilizing the knowledge and resources available. Here are some factors to consider:

1. **Irrigation and Water Management**

Corn requires 20-25 inches of water throughout its growing season, which it gets through a combination of rainwater and irrigation. Most farmers in Kansas use a **center pivot irrigation system**, which covers a large area with efficient circular watering. With proper irrigation systems, we can reduce water waste by 25%. These systems can include digital controls through smartphones or computer apps. Another method of irrigation is **subsurface drip irrigation** (SDI), which uses underground tubing to deliver water directly to the roots of the plant. An essential concept in irrigation planning is **evapotranspiration**, or ET. ET is the sum of evaporation from soil and transpiration from plants. Farmers can use ET to estimate how much water their crops are using and adjust irrigation accordingly. High ET rates typically occur during hot, dry, and windy days when plants lose more water. Low ET rates are typically on cooler or humid days that require less irrigation. Knowing the ET rates of corn in a farmer's area can help them avoid over- or under-watering and better match water application to plant needs.

Questions:

a. **Using your knowledge of the water cycle and irrigation, which type of irrigation would be the most efficient in a corn field? Explain your answer.**
   SDI delivers water directly to the roots through underground tubing, which reduces water loss from evaporation compared to other methods like center pivot irrigation that spray water above the soil surface. Since evapotranspiration (ET) causes water

loss through evaporation from soil and transpiration from plants, especially on hot, dry, and windy days, applying water directly to the root zone minimizes this loss. This precision helps farmers avoid overwatering and ensures water is used more effectively by plants, conserving water while meeting crop needs.

While center pivot irrigation covers large areas efficiently and can be digitally controlled, it still loses more water to evaporation than SDI. Therefore, SDI is generally the most efficient irrigation method to optimize water use in corn production, especially in semi-arid regions like Northwest Kansas.

b. Based on the data given in "Table 1: Hybrid Data and Management" and your response above, determine which variety yields the highest with the least amount of irrigation.

Plot 1501 achieved a high yield of 220.6 bushels per acre while using a moderate irrigation amount of 7.25 inches, indicating it produced the highest yield relative to lower water use among the options provided.

Compared to other plots with the same amount of irrigation:

Plot 504: 7.65 inches, 194.0 bu/ac

Plot 902: 7.65 inches, 168.6 bu/ac

Plot 1104: 7.25 inches, 190.1 bu/ac

Plot 2505: 7.25 inches, 196.0 bu/ac

In a place with limited water, the goal is to get as much yield as possible per inch of irrigation. Plot 1501's combination of high yield and moderate water use demonstrates that it utilizes each inch of water very effectively, making it the most efficient choice from both economic and environmental perspectives.

c. If your 2000-acre field needs 24 inches of water per season, but only 12 inches comes from rainfall, how many gallons of water per acre and for your entire field do you need to irrigate for the rest of the season? Show your work.

a. Use these conversions to solve this problem: 27,154 gallons/acre-inch.

Sample Problem: If you have a 500-acre field, and you need to apply 8 inches of water, how many gallons of water per acre and the entire field do you need?

*8 acre-in/field*1 field/500 acre * 27,154 gal/acre =* ***434.46 gal/acre***

Total Gallons of Water = ***217,232 gallons***

Answer:

Total water needed per season: 24 inches.

Water from rainfall: 12 inches

Irrigation needed: 12 inches --> 24-12=12inches

Gallon per acre inch conversion: 27,154 gallons/acre-in

*12 acre-in/field*1 field/2000 acre * 27,154 gal/acre =* ***162.92 gal/acre***

Total Irrigation = ***325,848 gallons***

2. **Technology**

Efficient water management is essential for having an innovative corn farm in Kansas. On larger farms, combining modern technology with smart farming practices helps conserve water, reduce costs, and boost yields. For irrigation to be truly effective, it must be timed and measured precisely. Several companies offer tools that help farmers understand exactly how much water the soil holds, how much the plant needs, and when to irrigate:

- **AquaSpy** uses deep soil probes with multiple sensors to measure moisture at different depths. It shows how deep roots are growing and whether water is reaching them, which helps farmers avoid underwatering and overwatering.
- **Arable** combines weather, crop, and soil data into one device. It tracks rainfall, evaporation, sunlight, and crop health, allowing farmers to make data-driven irrigation decisions.
- **CropX** offers smart soil sensors paired with software that gives real-time irrigation and nutrient advice. It maps soil variability across the field, so water can be applied only where it is truly needed.
- **GroGuru** installs permanent soil sensors that monitor soil moisture, temperature, and salinity below ground year-round. It works with wireless networks to provide updates to farmers' phones or computers.

In addition to this data collection technology, other technologies that are more common in commercial production, include:

1. **Global Positioning System** (GPS), which is used to map out fields and guide irrigation and equipment. This ensures accurate and precise planting, harvesting, and watering.
2. **Variable Rate Technology** (VRT) works with GPS and soil maps to apply different amounts of water or fertilizer to different areas of the field based on what it needs, which increases crop efficiency.

The combination of all these technologies allows for a more efficient and sustainable crop production system.

Questions:

a. **How do soil moisture monitoring tools like AquaSpy and CropX work with GPS and VRT to make more precise decisions? Explain.**
Soil moisture tools like AquaSpy and CropX collect detailed data about how much water is in the soil, how deep it goes, and what the plant needs.
When this data is combined with GPS mapping, farmers can see exactly where different soil types or dry spots are in the field. Then, using Variable Rate Technology (VRT), they can adjust how much water (or fertilizer) is applied in each specific area.

For example:
If AquaSpy shows one part of the field is drier than another, the farmer can use VRT to send more water only to that dry area instead of watering the whole field equally. GPS ensures this is done precisely and accurately, so no area is over- or under-watered.
This combination helps farmers make precise, data-based decisions that conserve water and improve plant health.

b. **How might precision agriculture tools like GPS and variable rate help improve both crop yield and sustainability?**

GPS and VRT help farmers use resources exactly where they are needed. Crops get the right amount of water and nutrients at the right time and place, which keeps them healthier and growing at their best potential. This results in higher and more consistent yields across the field. By avoiding overwatering and over-fertilizing, farmers reduce waste, prevent nutrient runoff into rivers and groundwater, and save water. This protects the environment and saves money on inputs (like water and fertilizer).

c. **Research a new agricultural technology that would benefit your corn farm and is not discussed above. Be sure to give a short description of the technology.**

**Students should use credible sources to find new technology that could improve corn farming. Examples might include drone technology, autonomous tractors, AI-based crop monitoring, advanced weather prediction tools, or gene-edited corn hybrids. Students should also explain how it would benefit a corn farm in Kansas,* *focusing on improving yield, conserving resources (like water or fertilizer), or making farm operations more efficient. Encourage students to relate the new technology to the concepts they learned in the case study, such as water management, precision agriculture, or sustainability. They should explain why this technology would be useful, specifically for a farm in Northwest Kansas, considering climate, water limitations, or field size.*

***Optional extension*

Have students create a visual (poster, infographic, or slide) showing how the new technology would be used on the farm. Students could present their findings to the class to practice communication and persuasion skills.

From Seed to Stalk: The Impact of Water and Technology on Corn Growth

Student Version

Introduction:

Northwest Kansas, part of the vast High Plains region, is a major agricultural hub. Corn is the dominant crop. However, this region faces unique challenges due to its semi-arid climate, which is characterized by low rainfall and high evapotranspiration rates. Colby, KS, represents the high elevations in northwest Kansas that have a relatively short growing season. Successful corn production here hinges on a deep understanding of water management, especially with the decline of the Ogallala aquifer, irrigation, and technologies.

The Scenario:

You are a farmer managing a 2,000-acre corn farm in Colby, Kansas (Thomas County). Your overall goal is to maximize corn production while utilizing the knowledge and resources available. Here are some factors to consider:

1. **Irrigation and Water Management**

Corn requires 20-25 inches of water throughout its growing season, which it gets through a combination of rainwater and irrigation. Most farmers in Kansas use a **center pivot irrigation system**, which covers a large area with efficient circular watering. With proper irrigation systems, we can reduce water waste by 25%. These systems can include digital controls through smartphones or computer apps. Another method of irrigation is **subsurface drip irrigation** (SDI), which uses underground tubing to deliver water directly to the roots of the plant. An essential concept in irrigation planning is **evapotranspiration**, or ET. ET is the sum of evaporation from soil and transpiration from plants. Farmers can use ET to estimate how much water their crops are using and adjust irrigation accordingly. High ET rates typically occur during hot, dry, and windy days when plants lose more water. Low ET rates are typically on cooler or humid days that require less irrigation. Knowing the ET rates of corn in a farmer's area can help them avoid over- or under-watering and better match water application to plant needs.

Questions:

a. **Using your knowledge of the water cycle and irrigation, which type of irrigation would be the most efficient in a corn field? Explain your answer.**

b. **Based on the data given in "Table 1: Hybrid Data and Management" and your response above, determine which variety yields the highest with the least amount of irrigation.**

c. **If your 2000-acre field needs 24 inches of water per season, but only 12 inches comes from rainfall, how many gallons of water per acre and for your entire field do you need to irrigate for the rest of the season? Show your work.**
    a. Use these conversions to solve this problem: 27,154 gallons/acre-inch.

2. **Technology**

Efficient water management is essential for having an innovative corn farm in Kansas. On larger farms, combining modern technology with smart farming practices helps conserve water, reduce costs, and boost yields. For irrigation to be truly effective, it must be timed and measured precisely. Several companies offer tools that help farmers understand exactly how much water the soil holds, how much the plant needs, and when to irrigate:

- **AquaSpy** uses deep soil probes with multiple sensors to measure moisture at different depths. It shows how deep roots are growing and whether water is reaching them, which helps farmers avoid underwatering and overwatering.
- **Arable** combines weather, crop, and soil data into one device. It tracks rainfall, evaporation, sunlight, and crop health, allowing farmers to make data-driven irrigation decisions.
- **CropX** offers smart soil sensors paired with software that gives real-time irrigation and nutrient advice. It maps soil variability across the field, so water can be applied only where it is truly needed.
- **GroGuru** installs permanent soil sensors that monitor soil moisture, temperature, and salinity below ground year-round. It works with wireless networks to provide updates to farmers' phones or computers.

In addition to this data collection technology, other technologies that are more common in commercial production, include:

1. **Global Positioning System** (GPS), which is used to map out fields and guide irrigation and equipment. This ensures accurate and precise planting, harvesting, and watering.
2. **Variable Rate Technology** (VRT) works with GPS and soil maps to apply different amounts of water or fertilizer to different areas of the field based on what it needs, which increases crop efficiency.

The combination of all these technologies allows for a more efficient and sustainable crop production system.

Questions:

a. **How do soil moisture monitoring tools like AquaSpy and CropX work with GPS and VRT to make more precise decisions? Explain.**

b. **How might precision agriculture tools like GPS and variable rate help improve both crop yield and sustainability?**

c. **Research a new agricultural technology that would benefit your corn farm and is not discussed above. Be sure to give a short description of the technology.**

The Root of the Problem: Soil and Pest Solutions in Cornfields

Teacher Version

Grade Level: High School

Time: 40 min

Objectives:

Students will be able to:

- Explain the importance of soil health for profitable corn production in Kansas.
- Describe the advantages and disadvantages of different soil textures for water retention and nutrient holding capacity.
- Describe the purpose and methods of Integrated Weed Management (IWM) and Integrated Pest Management (IPM).
- Discuss the importance of monitoring pest populations and using targeted chemical applications to protect beneficial insects and reduce resistance risk.

Materials:

- Student Case Study
- Supporting Data and Information Document
- KSRE Chemical Weed Control Guide
- KSRE Corn Insect Pest Management Guide

KSDE Career Technical Core and CTE Course Competencies

Plant and Soil Sciences

Benchmark 2: Basic Soil Properties and Fertility

2.1: Define soil texture and structure.

2.2: Use the textural triangle to identify classification.

2.7: Describe and distinguish between the different soil management practices in Ag.

2.11: List and differentiate between micro and macro soil nutrients.

2.12: Outline the impact of soils on crop yields.

2.15: Explain considerations for determining N, P, and K for soil fertility and plant growth.

Benchmark 4: Weed, Disease, and Pest Control

4.4: Calculate pesticide application rates.

4.7: Describe the general principles of IPM.

4.12: Recognize the role of natural selection in disease, weed, and pest control in a cropping practice.

4.13: Determine the best control measure for a given pest.

4.14: Relate how insect behavior is linked with a cropping practice.

4.20: Describe the effects of herbicides: adjuvants, contact, systemic.

Introduction:

In the dry, windy climate of northwest Kansas, successful corn farming depends on more than just planting seeds and hoping for rain. In Colby, producing corn can come with many challenges, like weed pressure, pest infestations, and soil health issues. Using integrated practices and modern tools, these issues can be resolved.

The Scenario:

You are a farmer managing a 2,000-acre corn farm in Colby, Kansas (Thomas County). Your overall goal is to maximize corn production while utilizing the knowledge and resources available. Here are some factors to consider:

1. **Soil Factors and Management**

Figure 1: Soil Texture Triangle

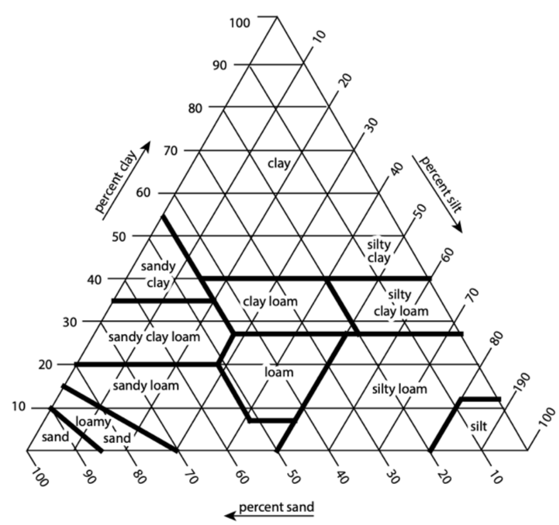

Photo Credit: KSRE Important Agricultural Soil Properties

Soil health is key to growing profitable corn. The main soil type in Colby, KS, is silt loam, which has good fertility, water-holding capacity, and nutrient content. Not all soils are created equally, though. Farmers use a tool called the **soil texture triangle** to determine the texture class of the soil, made up of three different components. **Sand** has coarse particles that drain water quickly but do not hold nutrients well. While **Silt**, a medium-sized particle that is smooth or floury, can still hold nutrients and water better than sand, it contributes to fertile soil. **Clay** has very fine particles that hold water and nutrients well, but can become compacted easily with slow drainage. Good soil texture is not enough on its own, but it needs careful management to keep it productive.

Farmers can manage soil health by using different methods of soil management. No-till or strip tilling can help reduce erosion and maintain soil structure. To help maintain soil nutrients and prevent pests, rotate corn with crops like wheat or sorghum. Cover crops are also a great tool to add organic matter and protect the soil from erosion.

Essential nutrients in the soil vital for corn growth are the macronutrients of **nitrogen** (N), **phosphorus** (P), and **potassium** (K). Nitrogen helps promote leaf and stalk development, and phosphorus supports root growth and early plant health. All while potassium aids in water regulation, disease resistance, and kernel development. Secondary nutrients are calcium, magnesium, and sulfur, which play a role in plant structure and enzyme activity. Micronutrients are needed in small amounts, but are still critical for healthy plant function, including zinc, iron, boron, and manganese. Farmers regularly test the soil for these nutrients and can adjust fertilizer plans accordingly.

Questions:

a. **Based on the given data in "Table 2: Hybrid Data and Management", which hybrid had the most efficient nitrogen application that resulted in a higher yield?**

   Students may find it easier to use the Plot Number to find the answer, then find the hybrid associated with the Plot Number.

   Plot 1301: 129 lbs N → 240.2 bu/ac

   Plot 2706: 109 lbs N → 203.9 bu/ac

   Plot 206: 129 lbs N → 197.2 bu/ac

   Plot 2605: 129 lbs N → 199.1 bu/ac

   *All these most efficient and high-yielding plots use **Pioneer P1122AML**. They produced high yields (up to 240 bu/ac) at moderate N rates (129 lbs/ac or even 109 lbs/ac). They also consistently performed across different seeding rates and irrigation levels. Strong nitrogen-use efficiency (NUE) indicates good genetics and adaptability.*

b. **If a soil has 30% clay, 50% sand, and 20% silt, what is the texture? Do you think this soil texture will have good water retention?**

   ***Students will use the Soil Texture Triangle above to answer this question.*

The soil texture is Sandy Clay Loam, which will have moderate water retention. This is not as good a soil compared to soils with higher clay and silt content, such as silt loam. This soil will drain faster than clay-heavy soils, hold more water than pure sandy soils, and be more prone to drying out in a drought.

c. **If Plot #2 used 100 lbs./acre of N preplant, 7.25 lbs./acre of N starter, 80 lbs./acre of N at plant, and 60 lbs./acre of N side dress, how many total pounds of nitrogen would you use on your 2,000-acre field? What would the total cost be if a ton of Nitrogen cost $246.42? Show your work.**

***This is a math problem.*

Find total pounds of nitrogen per acre. (100+7.25+80+60) =247.25 lbs N/acre

*Find total pounds per field (,2000 acres). 247.25 lbs N/acre*2000 acres= 494,500 lbs N/field*

Convert pounds to tons. 494,500 lbs N/field / 2000 lbs in a ton = 247.25 ton of N

*Find price per field. 247.25 ton of N * $246.42/ton = $60,927.35*

2. **Herbicides and Pesticides**

Weeds and pests can damage crops and reduce yields if they are not controlled. To manage these threats, farmers rely on herbicides to control weeds and pesticides to manage insects and diseases, while also using these chemicals carefully to avoid harming the environment. Herbicides and pesticides can be identified as “contact”, which activate on contact with the plant, or “systemic”, which are absorbed and translocated through the plant.

Herbicides are chemicals used to control weeds. Farmers choose herbicides based on their mode of action or how they affect weed biology. Common modes of action include:

- **Photosynthesis inhibitors,** which stop the weed from making energy through photosynthesis.
- **Amino acid synthesis inhibitors,** which prevent protein production in the plant.
- **Cell membrane disruptors** destroy plant cells.

While these are not all modes of action, they are the most used. Using a herbicide with different MOAs or mixing herbicides with different MOAs in the tank helps prevent herbicide-resistant weeds from developing. This is called Integrated Weed Management.

Pesticide control targets are insects like corn rootworm, armyworms, and aphids that can chew on roots, leaves, and ears of corn. Farmers use Integrated Pest Management, or IMP, to reduce pesticide use. Pesticides include insecticides and fungicides:

- **Insecticides** target pests like corn rootworms and armyworms. Some are contact-based based while others are systemic and absorbed through the plant.
- **Fungicides** protect against diseases like gray leaf spot and rusts by preventing or stopping fungal growth.

IPM includes multiple control methods with a combination of chemical (herbicides), mechanical (tillage), biological (predator pests), and cultural (crop rotations/hybrids) methods. Using this targeted approach helps protect beneficial insects like bees and reduces the risk of pesticide resistance.

Questions:

a. **In the "Pesticide and Herbicide Management" section of the Supporting Information, choose <u>one</u> of the herbicides used and find the total amount needed and cost that was used for the 2,000-acre field. Use the *KSRE Chemical Weed Control Guide* to help find your answer.**
    a. The following herbicides were used on your field: Valor, Dicamba, Atrazine, Resicore, and Glyphosate
    b. Please provide your answer in gallons per field and dollars per field.

    ***Note there can be more/less steps to get to the same answer depending on the conversions used.*

    ***Approximate retail cost of herbicides is found on pages 14 - 16 of the 2025 KSRE Chemical Weed Control Guide. Prices may vary based on year of book used.*

    <u>Valor</u>:

    *2.5 oz per acre * 2000 acres = 5000 oz*

    5000 oz / 32 oz per quart = 156.25 quarts

    156.25 quarts / 4 quarts in a gallon = 39.1 gallons

    *39.1 gallons *$4.55/oz * 128oz/gal = $22,771.84 16*

    Total Amount Needed: ***39.1 gallons.***

    Total Price: ***$22,771.84***

Dicamba*: 250 gallons*

*16 fl oz per acre *2000 acres = 32,000 oz*

32,000 oz /128 oz per gallon = 250 gallons

*250 gallons * $47.55/gal= $11,887.50 pg14*

*Total Amount Needed: **250 gallons.***

*Total Price: **$11,887.50***

Atrazine*: 500 gal (pre)+ 500 gal (2nd) = 1000 gal*

*32 oz per acre *2000 acres = 64,000 oz*

64,000 oz / 128 oz in a gallon = 500 gallons

*500 gallons * 2 applications = 1,000 gallons*

*1,000 gallons *$19.05/gal = $19,050*

*Total Amount Needed**: 1,000 gallons.***

*Total Price: **$19,050***

Resicore*: 1250 gallons*

*2.5 qt per acre *2000 acres = 5,000 qt*

5,000 qt / 4 qts in a gallon = 1,250 gallons

*1,250 gallons * $71.40/gal = $89,250*

*Total Amount Needed: **1,250 gallons.***

*Total Price: **$89,250***

Glyphosate*: 500 gallons*

*32 oz per acre * 2,000 acres = 64,000 oz*

64,000 oz / 128 oz in a gallon = 500 gallons

*500 gallons * $15/gal = $7,500*

*Total Amount Needed: **500 gallons.***

*Total Price: **$7,500***

b. **What three additional practices would allow you to have a more integrated pest management system? Use the *KSRE Corn Insect Pest Management Guide* to support your answer.**

*** Not all of these are needed for the answer.*

- *Regular Scouting and Economic Thresholds (Page 6, 9)*
  - *What to look for*
    - *Scouting fields regularly*
    - *Decisions to spray are based on pest levels or thresholds*
  - *Text Support*
    - *Cutworm-susceptible fields should be "scouted frequently."*
    - *Rootworm adult scouting is needed to decide next year's management*
- *Hybrid and Trait Selection (Page 2)*
  - *What to look for*
    - *Use of Bt corn or resistant hybrids*
    - *Matching traits to known pest problems*
  - *Text Support*
    - *Bt corn is the "primary means of preventing damage" from corn borers*
    - *Some hybrids are resistant to rootworm larvae*
- *Bt Refuge compliance (Page 2)*
  - *What to look for*
    - *Mention of refuges or resistant management*
    - *Preventing pests from becoming resistant*
  - *Text support*
    - *Non-Bt refuges are required to reduce "resistant evolution."*
- *Selective and risk-based seed treatment use (Page 2)*
  - *What to look for*
    - *Seed treatments are used in only in certain fields*
    - *References to CRP ground or known insect pressure*
  - *Text support*
    - *Seed treatment in Kansas is not economically justified unless specific risk conditions exist*
- *Responsible insecticide use and application accuracy (Page 1, 4)*
  - *What to look for*
    - *Calibration of equipment*
    - *Protecting bees, Wildlife, or water*

        - *Following the label directions*
    - *Text support*
        - *Equipment should be calibrated yearly*
        - *Insecticides should be used "only when needed"*
        - *Consider honeybees and non-target insects*

The Root of the Problem: Soil and Pest Solutions in Cornfields

Student Version

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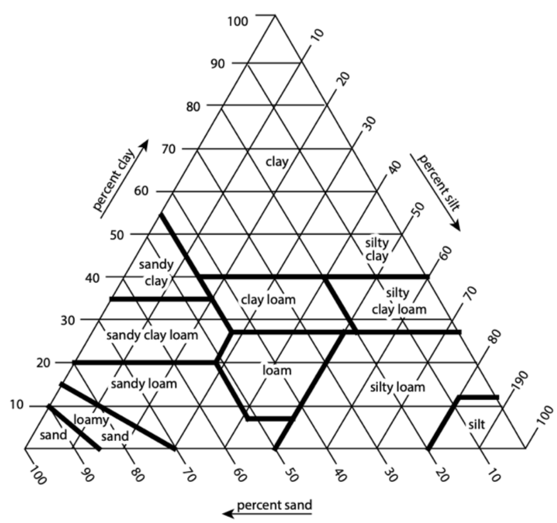

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