Activity 17 Grain Storage on the Farm

by Robert Oakes

Study Question: How do farmers store grain on the farm?

Activity: Students measure mathematically and organize grain bins by plans to see how grain is stored on the farm.

Curriculum Fit:

Grade Six - Mathematics
- Measure area and volume using formulas.
- Geometry using protractors for angles.

Agriculture Concept: The amount of grain storage on the farm site can be calculated mathematically before building bins.

Purpose:
- To create an awareness that planning is essential to success in agriculture.
- To put geometry and measuring skills learned in class to practical use.

Materials Required:
- Task sheets (included with lesson)
- protractor
- ruler
- calculator (optional)
- pencils

Time Required: Two class periods.

Background — For the Teacher

Farmers store grain on their farms in bins. The shape and size of bin determines the storage capacity and may also affect placement or arrangement of the storage site.

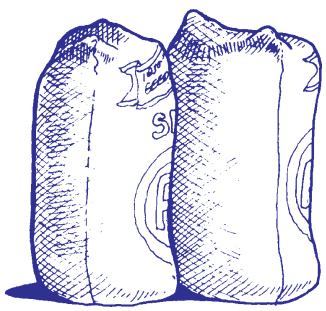
Procedure

Preparation

1. Collect samples of several geometric shapes to bring to class. They should be large enough to be seen clearly by the class. Find a few pictures of grain bins of different sizes and shapes. Also have on hand the Student Resource Sheet with formulas on it; Student Task Sheet; protractors; Storage Volume Worksheet; and the Conversion Constants information sheet. If possible obtain a copy of "On Farm Grain Handling and Storage Layouts", 1989 published by Alberta Agriculture, Print Media Branch. Also copies of owners and users manuals for constructing grain bins may be available from local bin dealers such as U.F.A. Manufacturers such as Westeel and Twister may also help.

Introduction

2. Introduce the lesson by explaining that the class will be learning about measurement and geometry by using agriculture as the basis of study. Explain that farm buildings and structures exhibit a variety of geometric shapes. Review the basic shapes by showing each of the shapes you collected earlier. Next mention that grain storage bins have some of these shapes. Show the pictures and have students identify the shapes in them.



Activity

3. Now switch to the Student Resource Sheet. Ask the students to identify the formulas they know. Do a quick review of these on the chalk board or overhead projector using numbers the students supply. Make sure they know the formulas for the area and volume of a rectangle and the area of a triangle. They should know how to find the circumference of a circle using diameter and the area using the radius. The last formula is the volume of a cylinder. Do a couple of class problems with these formulas. The remaining formulas on the sheet are for enrichment and not required for regular grade six math.
4. Hand out the Student Task Sheet and have it completed.

Answers to questions:

1. a) 16 m″ b) 24 m″ c) 25 m″ d) 50.24 m″ e) 28.26 m″ f) 12.56 m″.
2. a) 48 m≈ b) 72 m≈ c) 75 m≈ d) 150.72 m≈ e) 84.78 m≈ f) 37.68 m≈
3. a) 3.14 x (2.5)2 x 6 = 117.75 m≈, b) 3 x 4 x 5 = 60 m≈

5. Hand out the Storage Volume Work Sheet. Explain that wheat, barley and canola are grains grown by farmers. The term **"bu/ac"** means **bushels per acre**. Suitable numbers can be supplied by the teacher or class. "Wheat" could be 30 to 50 bu/ac, "barley" 50-80 bu/ac, "canola" 20-50 bu/ac and "other" could be oats or rye 60 bu/ac. Calculate the total number of bushels for each grain. Add these totals and you will know how much grain has come from those fields in bushels. To know how much will fit in each bin, multiply.

   No. of bushels x 0.36 = cubic metres (m≈). If you know the cubic measure of your bin then you will know how many bushels approximately will go into that bin, eg. 4000 bu x 0.36 = 144 m≈. 4000 bushels will fit in a circular bin with a diameter of 6.4 m and a height of 4.5 m. 4000 bushels will also fit in a rectangular bin 5 m x 5 m x 6 m.
   If you have an "Owners and Users Manual" for building grain bins you will find tables for bushel capacity. Now calculate the size of grain bins needed to hold each of the crops you have on the storage volume sheet.

5. Use protractors to measure the angles at the top and bottom of the bins on the next work page.

Answers:

Angle a) 30°, b) 120°, c) 30°, d) 60°, e) 40°, f) 100°, g) 40°, h) 40°, i) 45°, j) 90°, k) 45°, l) 57°

Conclusion

6. By using math calculations a person can know how much storage space is required for a certain number of bushels of grain. The size of each bin can be determined and also the number of bins.

Discussion Questions

1. Which type of bin would be the better bin to build? Why?
2. Should farmers set up lines in one central location or spread them around the farm? Why?
3. Would storage such as this be suitable for storage on moon colonies or skylabs?
4. Can grain bins be shapes other than rectangles or circles? If so what shapes? If not, why not?

Related Activities

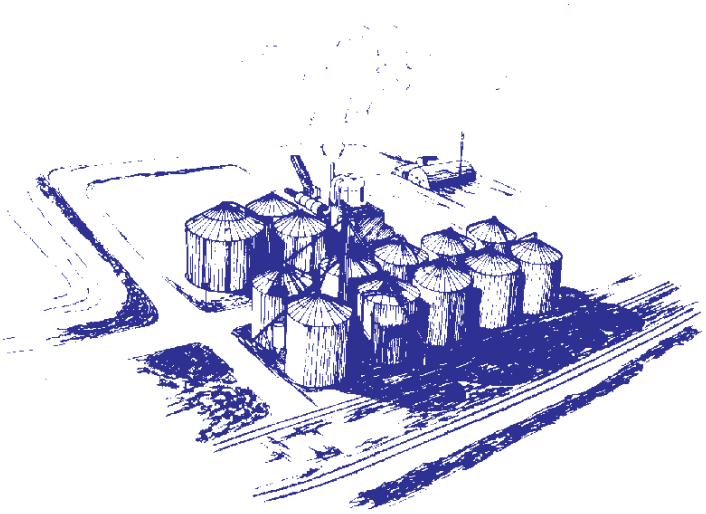
1. Using the information in the bin diagrams have the students draw a storage system for a farm of 1000 acres, 2000 acres, 5000 acres.
2. Students can build grain bins of cardboard over their desks to create a storage system in the classroom. Each desk will be inside a bin. Leave a hole at the top for light.
3. Attempt to design a bin that is neither circular nor round. Hexagonal? Pyramid?
4. Search out information concerning insect pests in stored grain.
5. Build a storage site of plasticine or clay.
6. Draw a farm to scale and place the storage bins on the drawing.
7. When trucks deliver grain to the storage area try to calculate how much room they need to turn among the lines.
8. Measure or calculate auger lengths needed to lift or move grain in a particular system.
9. Find the measurements of the Calgary Saddledome or the Edmonton Coliseum and calculate how many bushels of grain it could hold. What length of auger would be needed to reach the top.
10. If a super tanker grain ship can hold 200,000 t of grain, how many of your bins of grain would this ship hold?

***** Before leaving this lesson try to do at least two of the related activities to give more meaning to the math work.

Evaluation Strategy

1. Understanding of the mathematical concepts and formulas.
2. Completeness and accuracy of the geometry and measurement activity sheets.

***** Math work should be evaluated at an 80% level for mastery. The related activities can be graded on 30% for math work and 30% for effort and participation and 40% creativity or thinking skills. Do not discourage strange or unusual designs or grain bin configurations.



TASK SHEET A

Do the following problems using the correct formula and show your work.

1. What is the area of the floor for the following bins;

a) 4m by 4m

b) 6m by 4m

c) 5m by 5m

d) radius of 4m

e) radius of 3m

f) radius of 2m

2. Using the bin sizes from question one calculate the volume of the bins if they have a height of 3m.

a)

b)

c)

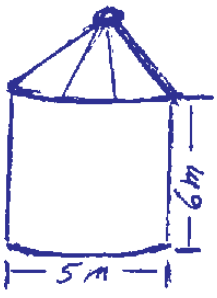
d)

e)

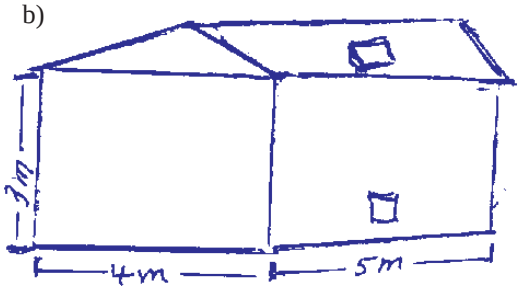
f)

3. Calculate the volume of the eaves for each bin below

a)

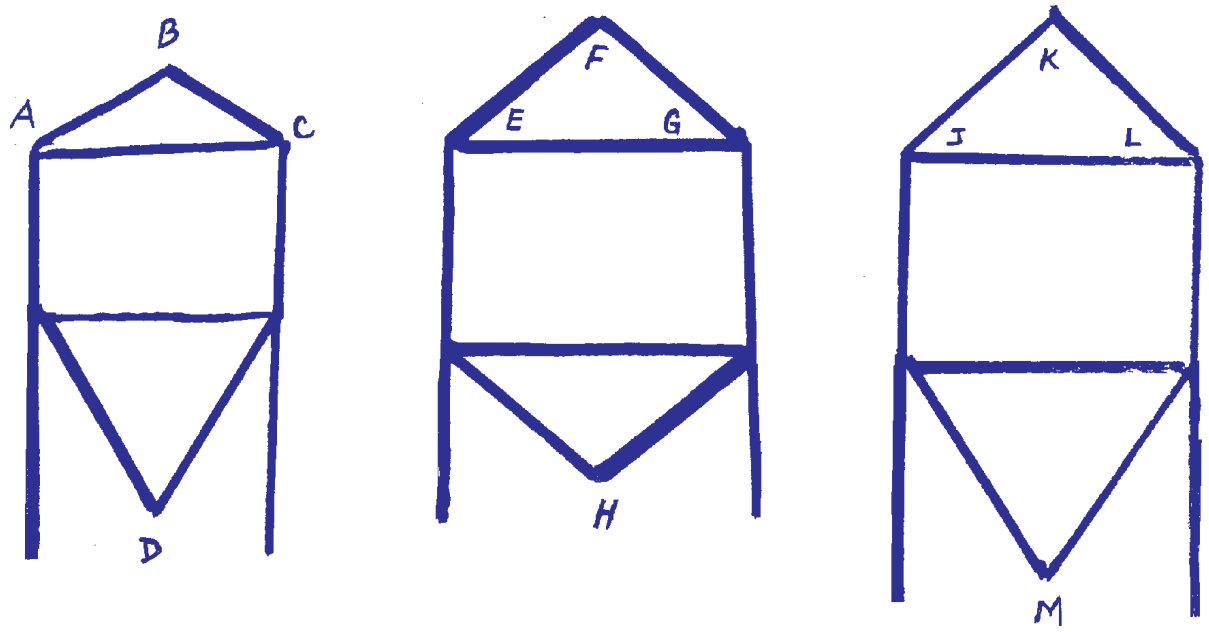


b)



TASK SHEET B

Using protractors measure the angles at the top and bottom of the bins.



<A

<B

<C

<D

<E

<F

<G

<H

<J

<K

<L

<M

TASK SHEET C

Draw 3 rectangular grain bins. Mark some reasonable measurements on them. Each bin should be able to hold at least 5000 bushels of grain. Draw 3 circular grain bins to also hold 5000 bushels. Compare your bins with others in the class.

Formulas:

Students will need these formulas:

$A = L \times W$	rectangle area
$V = L \times W \times H$	rectangle volume
$C = \pi d$	circle circumference
$A = \pi r''$	circle area
$V = \pi r'' h$	cylinder volume
$V = \frac{\pi ddh}{4}$	cone volume (Enrichment)
$V = \frac{L \times W \times H}{3}$	pyramid volume (Enrichment)
$A = \frac{B \times W \times H}{2}$	triangle area (W=B base)
$V = \frac{L \times W \times H}{2}$	triangle volume (Enrichment)

A = area	D = diameter
V = volume	π(pi) = 3.14
C = circumference	r = radius
L = length	h = height
W = width	b = base

Conversion Constants:

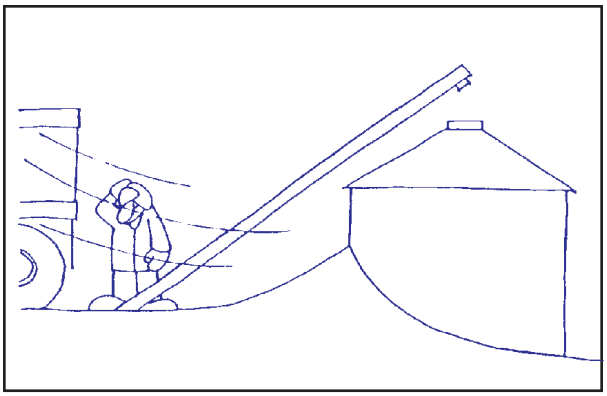
Imperial Units	Multiply by	Results In
1 foot (ft)	x .3048	metre (m)
1 mile	x 1.61	kilometre(km)
1 square foot	x .093	square metre (m″)
1 bushel	x .036	cubic metre (m≈)
1 cubic foot	x .0283	cubmic metre (m≈)
1 cubic foot per minute (cfm)	x .47	litres per second (L/S)
1 cubic foot per minute per bushel (cfm/bu)	x 13	litre per second per cubmic metre (L/S m≈)
1 inch of water (pressure)	x 250	pascals (Pa) (pressure)

Storage Volume

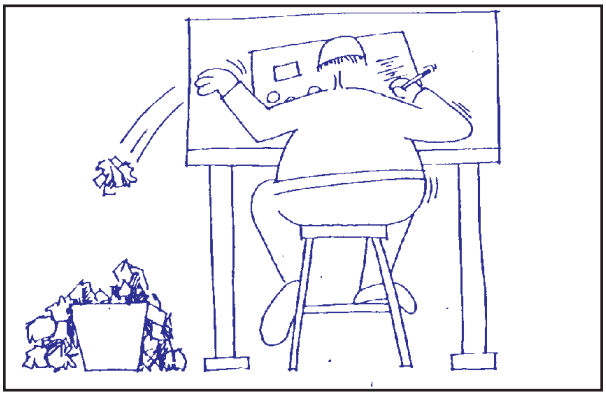
		expected yield	area	storage volume
Wheat	1.	bu/ac x	acres =	bushels
	2.	bu/ac x	acres =	bushels
	3.	bu/ac x	acres =	bushels
Barley	1.	bu/ac x	acres =	bushels
	2.	bu/ac x	acres =	bushels
Canola	1.	bu/ac x	acres =	bushels
	2.	bu/ac x	acres =	bushels
Other	1.	bu/ac x	acres =	bushels
			Total =	bushels

Before You Build that Bin . . .

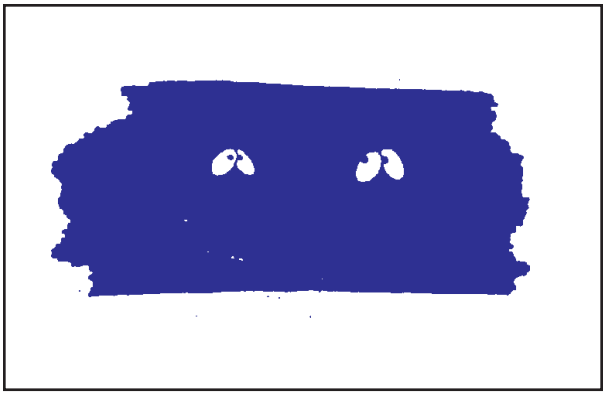
DO'S AND DON'TS:



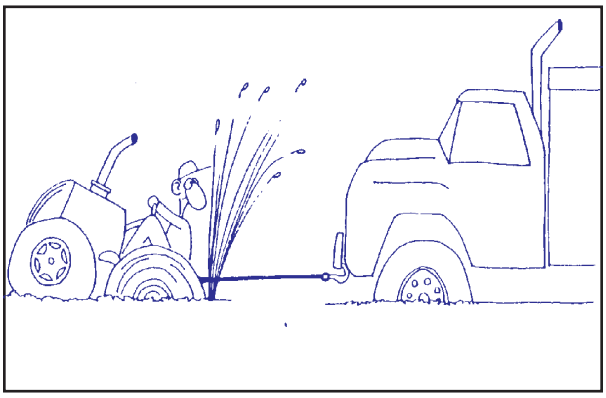
Consider winter snow drifting.



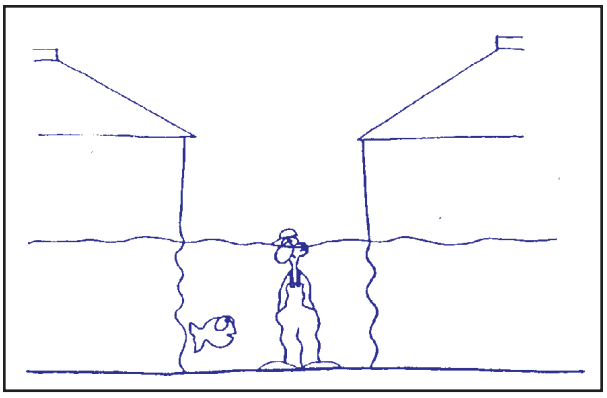
Have a plan before you start.



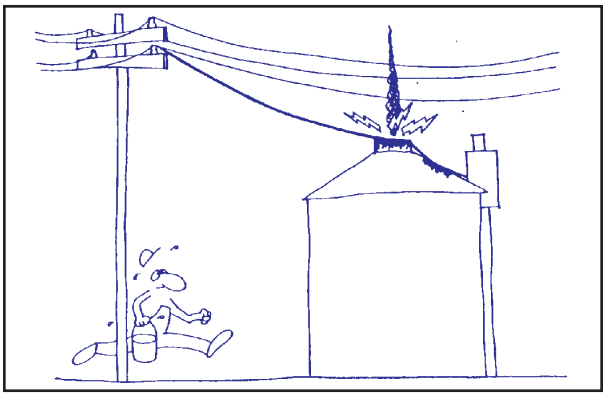
Be sure of adequate electrical supply.



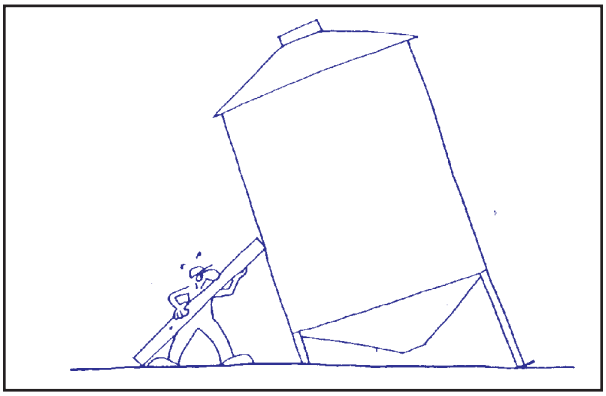
Provide all weather roads.



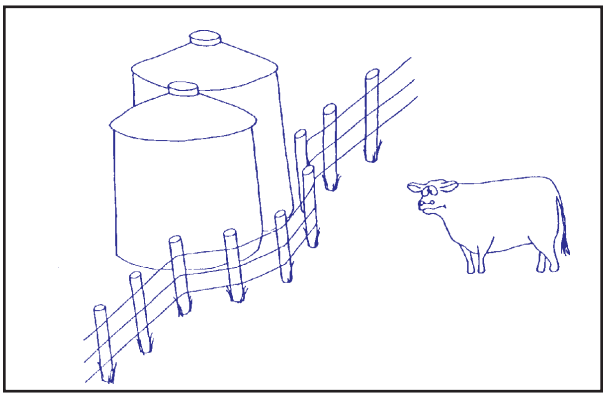
Choose a well drained site.



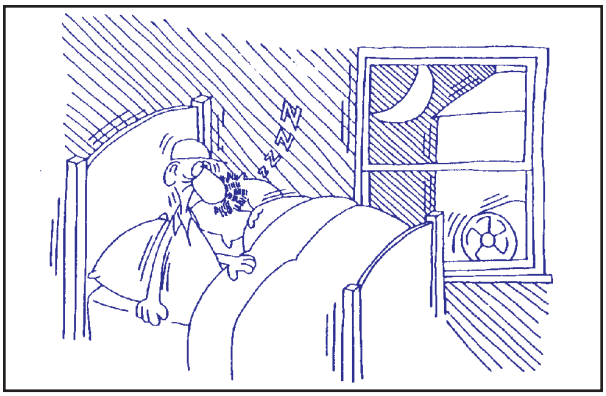
Check overhead clearances.



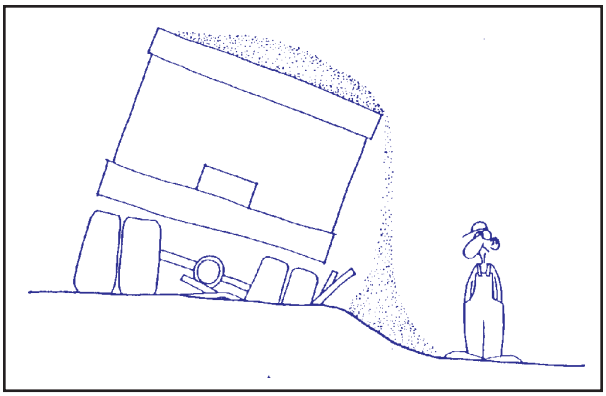
Be sure soil will support the load.



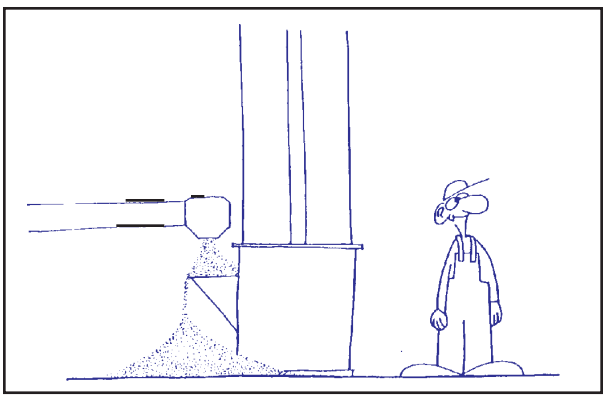
Leave room to expand.



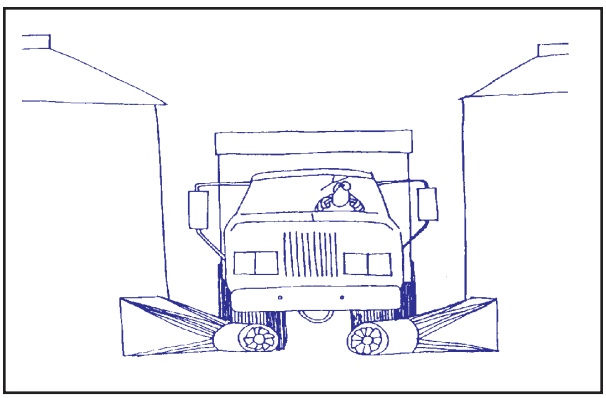
Consider orientation.



Be sure drive over pits are strong enough.



Consider component capacities.



Allow ample space for larger vehicles.

BIN ARRANGEMENT

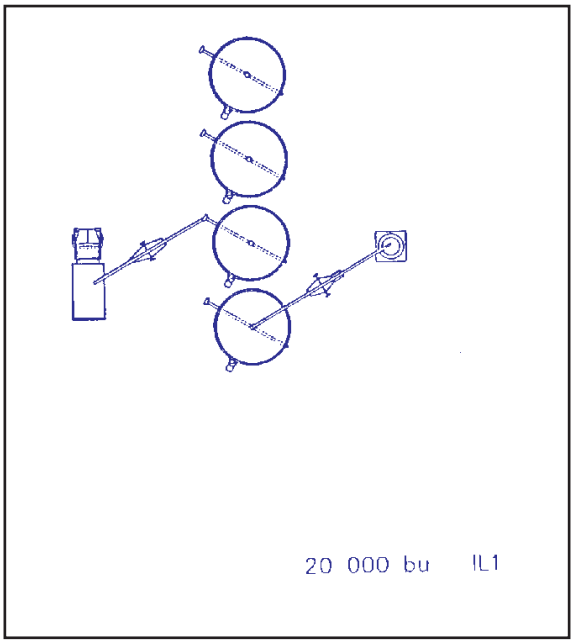
IN-LINE LAYOUT - STAGE 1

A in-line bin arrangement is one way to centralize grain storage on a smaller farm. This start up phase is suitable for once-in-once-out grain handling. Unloading can be through man doors but should be developed to include an under floor auger. Unloading tubes should be positioned to facilitate future expansion.

Components:
- four 5,000 bushel bins (equipped with aeration floors and unloading tubes)
- one 51 ft portable farm auger (receiving)
- one 36 ft portable farm auger (unloading)

Advantages
- minimum of handling equipment needed
- bins can be different height and diameter
- easier snow removal than circular
- capability of expansion in stages

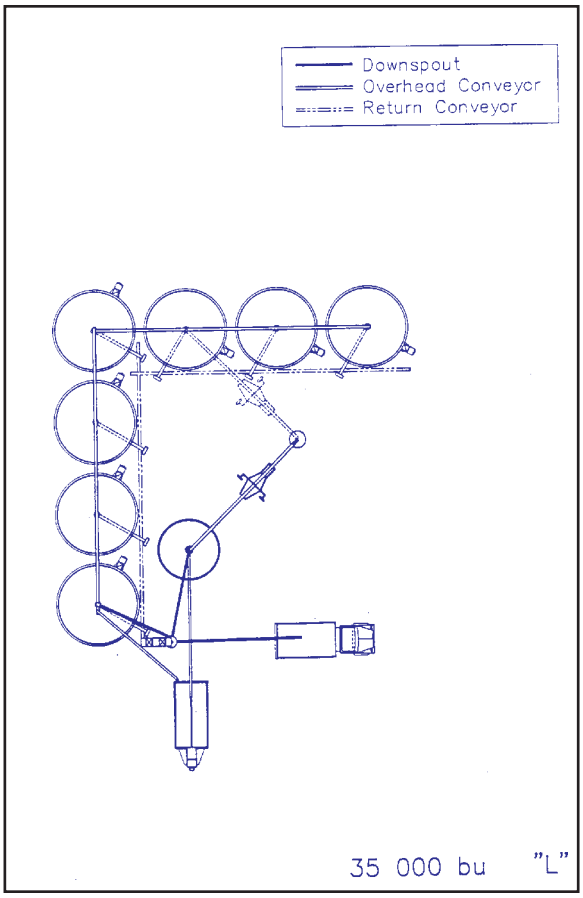
Disadvantages
- several unloading points
- difficult to transfer grain from bin to bin
- auger(s) must be moved from bin to bin to receive grain



"L" LAYOUT

If the bins are arranged in a "L" layout close to a shelterbelt, the grain movement can be mechanized by using a series of horizontal conveyors and a short bucket elevator. The drying system uses the hopper bin or alternatively one of the grain storage bins for wet surge capacity. Dry grain from the field can be loaded directly into storage bins while drying the other crop. Two horizontal conveyors (return) bring grain back to the bucket elevator for unloading or recirculation.

Components:
- seven 5,000-bushel bins (all equipped with aeration floors and unloading tubes)
- one 1,600-bushel hopper bin (wet surge)
- one grain dryer
- one bucket elevator and spouting
- two utility transfer augers
- one portable farm auger
- two overhead horizontal conveyors (receiving)
- two horizontal conveyors (return)



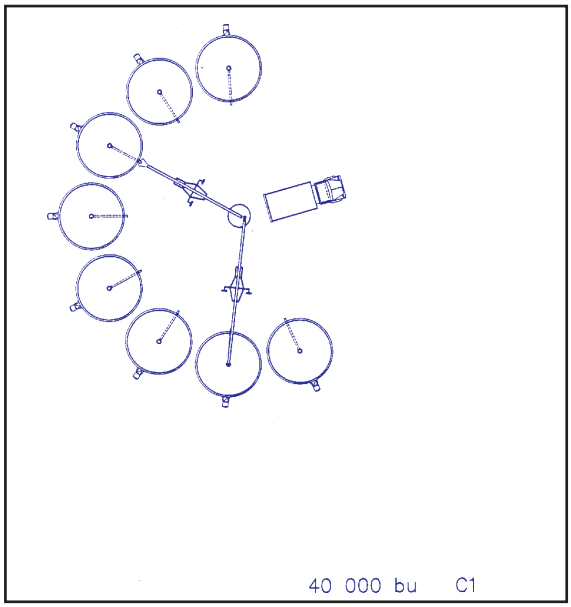
CIRCULAR LAYOUT - STAGE 1

In the circular arrangement bins can occupy more than half of the circle. This system provides the most storage space utilizing portable augers. Grain is transferred to central pit to unload or transfer the grain from bin to bin. This system will be limited in expansion posssibilities if yard space is small.

Components:
- eight 5,000-bushel bins (equipped with aeration floors and unloading tubes)
- two portable augers

Advantages
- minimal equipment requirements
- grain transfer from bin to bin is possible

Disadvantages
- high degree of auger movement will require good snow removal



SEMI-CIRCULAR LAYOUT - STAGE 5

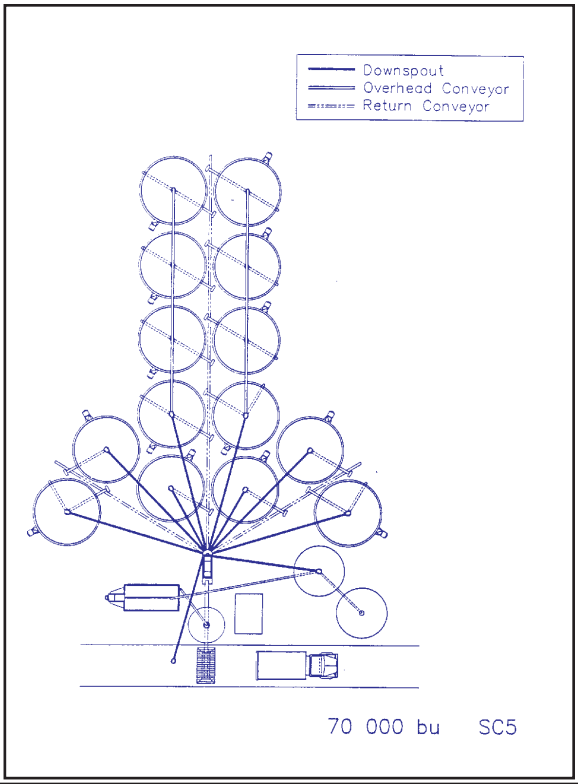
A bucket elevator is added to fully mechanize grain transfer. Gravity spouts are connected from the bucket elevator to the bins in the semi- circle. This allows room for two additional bins to be added inside the semi-circle. Horizontal conveyors at ground level are employed to return grain to the bucket elevator for loadout. To make receiving more convenient, a driveway with a drive-over pit is added.

A dry surge bin would be needed to allow the bucket elevator to handle both wet and dry grain. A control center is added to house the electrical panel and controls.

Components:
- fourteen 5,000-bushel bins (all equipped with aeration floors and unloading tubes)
- two 1,600-bushel hopper bins (wet surge)
- one 350-bushel hopper bin (dry surge)
- one grain dryer
- two overhead horizontal conveyors (receiving)
- three horizontal conveyors (return)
- three utility transfer augers
- bucket elevator and spouting
- raised driveway and receiving pit
- cross conveyor (receiving pit to bucket elevator)

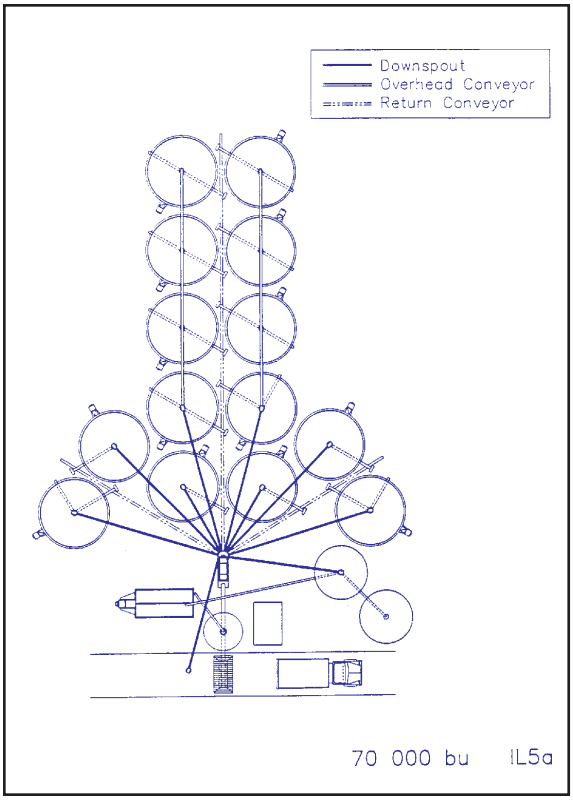
Advantages
- fully mechanized grain handling
- can receive dry grain from field while drying other crop
- one unloading point (over driveway)
- bin to bin grain transfer easily done

Disadvantages
- expansion to bucket elevator expensive while not adding significant storage capacity



IN-LINE LAYOUT - STAGE 5A

A bucket elevator is added to stage 1L4a to fully mechanize grain transfer. Gravity spouts are run to the semi-circle bins. This allows room for two additional bins to be added inside the semi-circle. Horizontal conveyors at ground level are used to return grain to the bucket elevator for loadout. To make receiving more convenient, a driveway with drive-over pit has been added. A dry surge bin would be needed to allow the bucket elevator to handle both wet and dry grain. A control center is added to house the electrical panel and controls.



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Volume Calculations