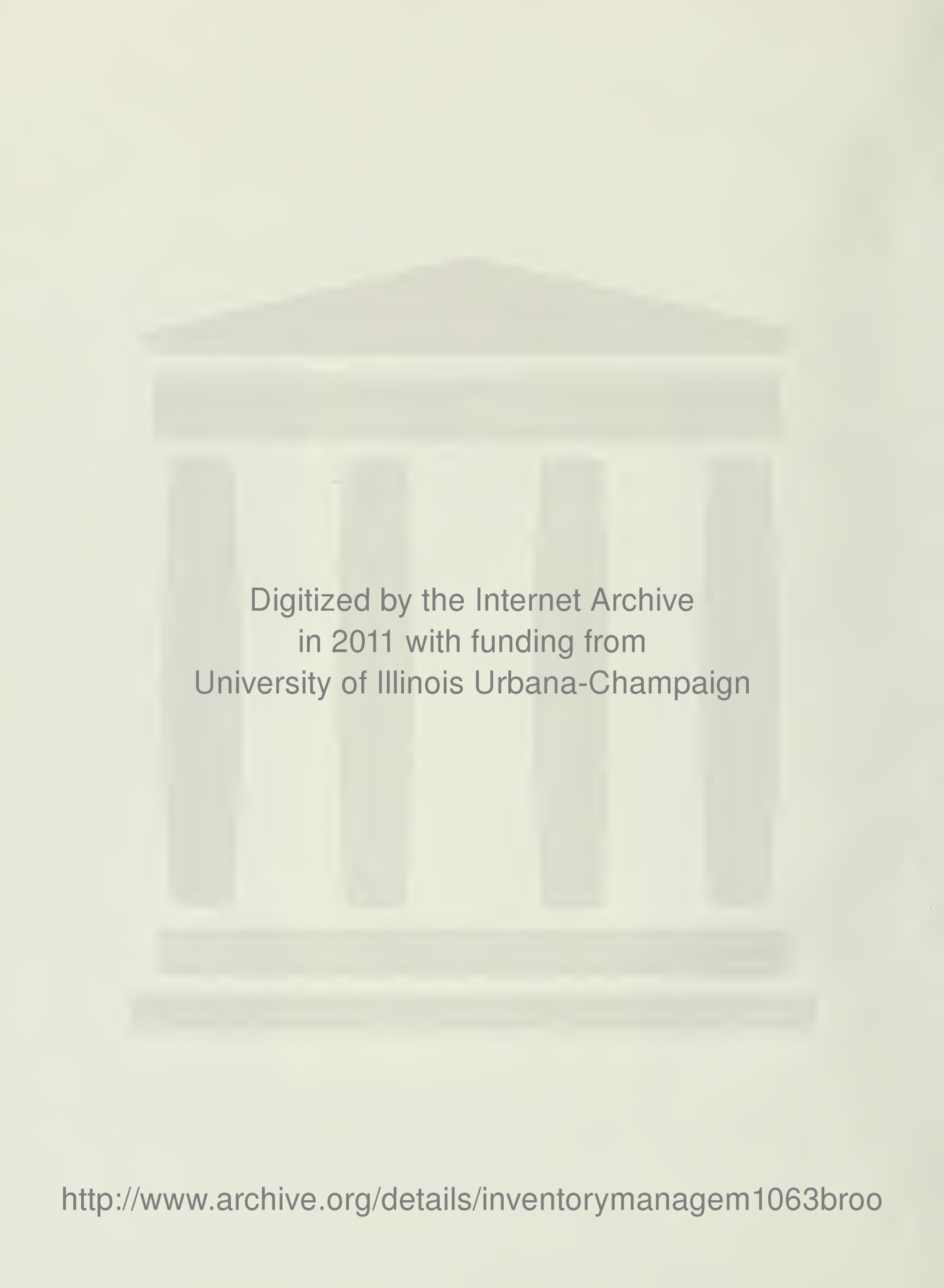

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE CIRCULAR 1063

INVENTORY MANAGEMENT AND CONTROL IN AGRICULTURAL MARKETING AND SUPPLY BUSINESSES

INVENTORY MANAGEMENT AND CONTROL concerns most managers of agricultural marketing and supply businesses, whether they are retail, wholesale, or service oriented.

The value of a manager to an agricultural marketing and supply business depends on his ability to manage inventories effectively. The total cost of maintaining the desired inventory level must be held down to a reasonable figure, but the inventory must also be large enough to permit the company to effectively merchandise the products and services it sells. If the manager doesn't control his inventories to accomplish both of these objectives, the business may not be able to prosper or even to survive against competition.

The information in this circular suggests to the manager ways on how best to do four things:

- How to control inventories.
- How to visualize the inventory costs to be included in determining how much inventories are costing the company.
- How to determine the level of inventory that is most profitable.
- How to determine how much to order and how often to order.

Controlling Inventories

Purchase systematically. Place orders for materials long enough beforehand so there will not be a shortage between ordering and delivery.

Let the inventory become relatively low before reordering but keep enough on hand to meet current needs. There are costs associated with keeping large inventories. Likewise, there are costs if you deplete your stock.

Don't hold "dead" lines or items.

Keep track of inventories. When stock is received, be sure that what was ordered was delivered. Make sure that the amount received is added to the inventory.

Physical inventories should be taken frequently to find out which items are not selling so you can discontinue them as quickly as possible, to spot shortages in merchandise that may be due to theft, to note deterioration that may occur, and to decide when to reorder.

Make someone responsible for checking the inventory. Delegate the responsibility for specific parts of the total inventory effort to the persons in the organization who are best qualified to do the job.

Be sure those to whom you delegate responsibility know exactly what they are supposed to do.

Use storage facilities efficiently. Assign space to each item in stock. Arrange the storage area to permit the handling of stock with the least amount of effort and in such a way that stock can be easily found, the quantity determined and recorded, and the stock removed if necessary.

Arrange the warehouse and sales area so the items that sell rapidly can be most easily picked up by the customer or restocked in the display area readily by the employees.

Use mechanical means to handle and move supplies whenever the volume warrants it. This will reduce the amount of labor used in handling stock.

Plan to use space interchangeably with seasonal items and thus reduce the cost of storage space.

Be aware of inventory turnovers. Know what the turnover of each commodity is and if possible compare this with the turnover of the same items by other similar firms.

Inventory turnover ratio is determined by dividing the volume of sales of merchandise by the level of inventory at a point in time, such as the first of each month. For example, the sales of fertilizer in May amounted to $143,000 and the fertilizer inventory at the end of May was $16,300. The inventory turnover ratio for May thus was $143,000 ÷ $16,300, or 8.8 to 1. That is, there was a $8.80 turnover of fertilizer for every dollar's worth in stock at the end of the period in question.

A zero inventory, which would give you a ratio of infinity, would not be desirable because the objective of management is to maintain the level of inventory at a level that will permit the most effective merchandising.

The most profitable inventory turnover ratio varies with each commodity. Generally, high inventory is needed for rapidly moving commodities if the merchandising effort is going to be efficient and effective. Good examples of this are feed and grain. Other commodities move more slowly but require that a small stock be on hand at all times. Farm machinery is a good example of this. The demand for some items, such as seed, is seasonal and requires large inventories at certain times of the year.

Increase selling efforts or reduce the average stock of slow-moving items. If an item can't be sold, discontinue stocking it immediately. Dead items are real losers.

Know the costs of inventories. Because costs of inventories are very closely related to size of inventories, the manager should keep his inventory as small as possible consistent with a good merchandising program.

The costs of carrying inventories can be a large percentage of the sale value of the inventory. The costs are often 20 to 25 percent or more of the total value of the inventory. The manager should know the costs of holding an inventory and then try to reduce the price of an item to the inventory holding cost to dispose of the items instead of holding them in inventory.

Avoid holding lines of merchandise that compete with one another. Stocking too many lines is asking for inventory problems. Choose the lines of merchan-

dise carefully and then vigorously sell a limited number of lines. Duplication of items that occurs when the company carries multiple lines can more easily result in larger inventories and increased inventory holding costs.

Determining Inventory Costs

Inventory costs are real but they are also difficult to determine because they can not be taken directly from accounting records. Inventory costs for individual items make it necessary to prorate costs of equipment, space, labor for handling, utilities, insurance, taxes on land and buildings, depreciation on buildings and handling equipment, clerical help, unemployment insurance for certain personnel, social security for all "space," "handling," and "inventory service" personnel, and a proportionate share of administrative overhead. The cost of holding inventories may make the payoff so great that the manager can't afford not to do it. Also, when inventory costs have been determined once, it is a much simpler task to make the necessary adjustments in each of the costs.

One way to view the total annual cost of carrying inventory is as a percentage of total inventory value. For example, if a company's average inventory is $25,000 and the average inventory carrying cost is 20 percent, it will cost the company $5,000 per year to carry an average inventory of $25,000.

An inventory holding cost that is 20 percent of the average value of inventory is probably too low. Estimates of inventory holding costs for agricultural supply businesses usually range from 20 to 35 percent.

The costs that need to be included in the total inventory carrying cost are:

Storage space costs. These include taxes on land and buildings; insurance on buildings; depreciation on buildings and warehouses owned; rent (if paid); materials for repairs and maintenance on buildings; utilities; and janitor, watchman, and maintenance costs.

Handling costs. These include depreciation on equipment; fuel for equipment; maintenance and repair of equipment; and insurance and taxes on equipment.

Risk costs on inventory. These include insurance on inventory; obsolescence of inventory; physical deterioration of inventory; pilferage; and losses resulting from inventory price declines.

Inventory service costs. These include taxes on inventory; labor costs of handling and maintaining stock; clerical costs for inventory records; contribution to Social Security by employer based on prorated time devoted to inventories by employees; unemployment compensation insurance based on prorated time of "inventory involved" personnel; employer contribution to pension plans, and group life, health, and accident insurance programs based on prorated time of "inventory involved" personnel; and an appropriate proportionate share for administrative overhead, including all taxes, Social Security, pension, and employer contributions to insurance programs for administrative personnel who are involved.

Capital costs. These include interest on money invested in inventory; interest on money invested in inventory handling and control equipment; and interest on money invested in land and buildings to store inventory (if land and buildings are owned).

Cost summary. The information about the hypothetical company that follows shows how a manager can develop a better understanding of how he can use the knowledge he has about inventory holding costs to make better management decisions.

The company management thinks they have a high cost of inventory holding but they don't know exactly what that cost is. Consequently they ask the manager to compute this cost. The average inventory value in 1971 was $25,000. This figure is arrived at by adding the quarterly inventory values, which were $21,000 on March 31, $33,000 on June 30, $29,000 on September 30, and $18,000 on December 31, to get a total of $101,000. This results in a quarterly average of $25,250 which is rounded to $25,000. The manager computed the holding costs on the average inventory and found that they were as follows:

Obsolescence cost based on the value of the average inventory	$1,500.00
Cost of capital on the average inventory	2,500.00
Deterioration of average inventory or its prevention	1,250.00
Handling and distribution costs of average inventory	2,000.00
Transportation	250.00
Taxes on average inventory	187.50
Insurance of average inventory	125.00
Storage facilities cost on average inventory	500.00
Total	$8,312.50

The manager also had available the average industry-wide inventory holding costs listed below.

Obsolescence	4 to 7 percent
Cost of capital	8 to 12 percent
Deterioration or its prevention	4 to 5 percent
Handling and distribution	2 to 3 percent
Transportation	.5 to 1 percent
Taxes	.5 to .75 percent
Insurance	.25 percent
Storage facilities	.25 to .75 percent
Total	19.5 to 29.75 percent

The manager now compared his company's costs with these percentages by computing the percentages that each of the company's average inventory holding costs were of his total inventory costs. These computations yielded the following information:

Obsolescence	$1,500 is 6 percent of	$25,000
Cost of capital	2,500 is 10 percent of	25,000
Deterioration or its prevention	1,250 is 5 percent of	25,000
Handling and distribution	2,000 is 8 percent of	25,000
Transportation	250 is 1 percent of	25,000
Taxes	187.50 is .75 percent of	25,000
Insurance	125 is .5 percent of	25,000
Storage facilities	500 is 2 percent of	25,000
Total	$8,312.50 is 33.25 percent of	$25,000

Comparing these percentages with the industry-wide averages, the manager discovered that most of his costs were on the high side compared to those of the industry. For example, his cost for handling and distribution was 8 percent of the average value of his inventory while the industry standard for handling and distribution of average inventory was 2 to 3 percent of the average inventory value.

The manager then decided to summarize each of his costs and compare them with the industry standards to get a clear picture regarding which of his individual inventory costs were higher than the industry standards. He would then know which of his costs should receive his attention. He prepared a summary of the percentage his costs were of the total average value of his inventory and compared each of the costs with the inventory standards as shown below:

	Range for industry (percent)	Computed cost for company (percent)	Percent above or below maximum industry cost
Obsolescence	4 to 7	6	− 1
Cost of capital	8 to 12	10	− 2
Deterioration	4 to 5	5	...
Handling and distribution	2 to 3	8	+ 5
Transportation	.5 to 1	1	...
Taxes	.5 to .75	.75	...
Insurance	.25	.50	+ .25
Storage facilities	.25 to .75	2	+ 1.25
Total difference			+ 3.5

These figures indicated to the manager that he should reduce inventory handling and distribution costs and the costs of the storage space being used for the inventory being carried by the company. The manager now wondered whether he should also reduce his average inventory which would consequently reduce the cost of holding the inventory. He knew that he would lose some sales and possibly some customers if he did because he would not have a 100-percent stock position at all times. So he decided that he would try to determine what would be his most profitable level of inventory.

Determining the Most Profitable Level of Inventory

There is another cost associated with inventory management in addition to those discussed previously. This cost results when an item is not available or your inventory for the item is zero. This kind of situation results in the loss of sale immediately and might permanently lose a customer. Although a business doesn't want to lose sales nor customers permanently, should it maintain a 100-percent in-stock condition, with associated high inventory costs, to forestall these situations? Or would it be more profitable to have a 95-percent in-stock position? Any inventory management system must weigh these alternatives and the manager must decide whether to maintain a 100-percent in-stock position and pay additional inventory costs or to carry a less than 100-percent in-stock position and lower his inventory costs while risking possible loss of sales and customers. How can the manager make this decision?

Let's go back to the hypothetical company. The manager knows that for the $25,000 average value inventory he carries, it costs him $8,312.50. He also knows that he carries about 22,000 items in his average inventory with an average value of $1.15 per item. The average inventory holding cost per item is thus about 37 and ¾ cents ($8,312.50 ÷ 22,000). Now, suppose he decides to decrease his average inventory in five successive steps which will reduce his inventory holding cost to zero. But he also knows he will lose sales because he will be out of stock in some items when his customers ask for them. He estimates that the decrease in sales with each successive 20-percent decrease in inventory holding cost will be as follows:

Inventory holding decrease	Decrease in units sold[1]
4,400 units	600
4,400 units	1,800
4,400 units	3,600
4,400 units	6,800
4,400 units	7,200

[1] Decrease in sales is cumulative. That is, the first cut in inventory results in a decrease of 600 in the number of items sold, the next one in 1,800 plus the previous 600, or 2,400, and so forth.

By reducing the inventory by 20,000 units, the company will lose $23,000 (20,000 × $1.15) in sales. This is far more than the $8,312.50 in inventory holding costs.

At what point should the manager stop cutting his inventory, given the above decrease in sales with each successive cut in inventory he makes? Table 1 gives the results of the manager's computations.

It is obvious from Table 1 that the average inventory holding costs are reduced as a result of each cut. But sales are also reduced, so what is gained is partially or totally lost by decreased sales. The manager decides to cut his average inventory by about 10,000 units, thus reducing his average inventory holding costs by about $3,775. His sales will be reduced by a similar amount. Any further reduction in inventory would not reduce the average inventory holding costs as much as the reduction in sales and would result in a reduction of gross income.

A manager cannot reduce inventory to zero without losing sales volume. He can, however, reduce inventory as well as the costs of holding inventory to a certain point, which can be determined, that will be an optimum point for holding inventory from a cost versus loss-of-sales standpoint. A manager can do this only if he knows his inventory holding costs and can then estimate within a reasonable degree of accuracy what will happen to his sales when he cuts his inventory.

Determining How Much and How Often to Order[1]

The order cycle is the period of time that elapses between the order of the goods and the receipt of the

[1] Adapted from unpublished material prepared by Richard Fenwick, Extension Economist, Agricultural Business Management, University Extension Division, University of Missouri-Columbia.

order. For example, if the company has sales of $700,000, the average daily inventory must be at least $2,000 ($700,000 ÷ 365 days). The longer the order cycle, the larger the inventory requirements. Thus, if the order cycle is 15 days, the average inventory must be at least $30,000. If the order cycle is shortened to 10 days, then the average inventory requirement is at least $20,000.

There is a technique that can be used to determine how much should be ordered. This technique is called the Economic Order Quantity (EOQ). To determine the EOQ, a businessman must trade off two costs — ordering costs and inventory carrying costs. Ordering costs are the expenses involved in placing a single order times the frequency orders are made. The smaller the quantity ordered per order, the greater the ordering costs because more orders are placed with suppliers. The fewer the orders placed, the lower the ordering costs but the higher the average inventory and higher inventory holding costs.

Table 2 below shows how a least-cost solution for EOQ determination can be made. In this example, assume that the business has determined (1) carrying costs equal to 15 percent of average inventory value (if the unit cost is $1, carrying costs are 15 cents), (2) order costs are $15 per order, (3) average inventory holding costs are one-half of the order quantity, and (4) total sales are 5,200 units per year.

The lowest total cost in Table 2 if found at five orders per year. This is $153. However, there is no assurance that five orders represent the lowest cost because the total cost for four units or for six units is not known. A mathematical formula can be used to determine the EOQ.

The components of the EOQ formula are:

a = ordering cost per order,
s = annual sales rate,
i = interest cost per unit per year.

The formula is:

$$EOQ = \sqrt{\frac{2as}{i}}.$$

Given the data in the previous example:

a = $15,
s = 5,200 units,
i = $0.15 per unit,

then:

$$EOQ = \sqrt{\frac{2(15)\ (5{,}200)}{.15}}$$

$$EOQ = \sqrt{\frac{156{,}000}{.15}}$$

$$EOQ = \sqrt{1{,}040{,}000}$$

$$EOQ = 1{,}019 \text{ units.}$$

Thus, for lowest total cost, 1,019 units should be ordered about five times a year.

Table 1. — Results of Successive Inventory Cuts

Inventory cut no.	Inventory holding decrease in units[a]	Decrease in units sold with each cut in inventory[b]	Decrease in inventory holding cost[c]	Decrease in sales volume[d]	Net gain or loss from inventory decrease[e]
1	4,400	600	$1,661	$ 690	$ 971 gain
2	4,400	2,400	3,322	2,760	562 gain
3	4,400	6,000	4,983	6,900	1,917 loss
4	4,400	12,800	6,644	14,720	8,076 loss
5	4,400	20,000	8,305	23,000	14,695 loss

[a] Total inventory is 22,000 units and the manager plans to cut 20 percent in five successive cuts, or .20 × 22,000 = 4,400 units.
[b] Decrease in units sold is 600 for first cut, 600 plus 1,800 for second cut, 600 plus 1,800 plus 3,600 for third cut, etc., until the fifth cut when sales are reduced a total of 20,000 units by reducing the inventory to zero.
[c] Inventory holding costs are decreased about $1,661 each time (37 and ¾ cents × 4,400 units).
[d] Decrease in dollar sales volume is the decrease in units sold with each cut time $1.15 per unit.
[e] Net gain or loss is the amount saved by reducing inventory cost minus the decrease in dollar volume as a result of reduced sales.

Table 2. — Economic Order Quantity (EOQ) Formulation

	Number of orders						
	1	2	5	10	15	20	25
Size of order (units)	5,200	2,600	1,040	520	347	250	208
Average inventory (units)	2,600	1,300	520	260	173	125	104
Carrying cost	$390	$195	$ 78	$ 39	$ 26	$ 19	$ 16
Order cost	15	30	75	150	225	300	375
Total cost	$405	$225	$153	$189	$251	$319	$391

Prepared by B. L. Brooks, Professor of Agricultural Economics.

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