

UNIVERSITY OF IDAHO
AGRICULTURAL EXPERIMENT STATION
Department of Agricultural Engineering

Bulk Handling Grain from the Hillside Type Combine

By
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Summary

Handling grain in bulk offers a means of lowering production costs provided a sufficient volume of grain is handled to warrant the necessary investment in equipment.

The reduction in the labor required and the prevention of grain loss and possible injury to livestock may make bulking profitable under adverse conditions.

The hazard encountered when handling bulked grain on steep hillsides requires careful selection of equipment and good management on the part of the operator.

Good roads and reliable transportation facilities are essential to successful bulking operations.

The direct haul method is adapted to short hauls and level fields where the contact by the motor trucks and combine may be made without delay.

The use of an intermediate field bin will permit the bulking of grain from hillsides which are too steep for motor trucks and where the distance to the elevator would require more trucks than could be owned economically by one operator.

The combination of temporary storage and the direct haul method from the combine to the elevator is advantageous when it is possible to utilize the motor trucks on day and night shifts.

The farm storage of grain provides the most flexible and convenient means of bulk handling direct from the combine.

Portable farm elevators may be adapted readily to the transfer of bulk grain to intermediate field bins or the direct loading of railroad cars when the grain is shipped in bulk from the farm to the terminal warehouse.

Blue print plans for the construction of the bulking equipment described in this circular may be secured for the cost of printing from the Department of Agricultural Engineering, University of Idaho, Moscow.

The names and addresses of the owners and operators of the equipment described in this circular may be secured upon request.

Bulk Handling Grain from the Hillside Type Combine

By

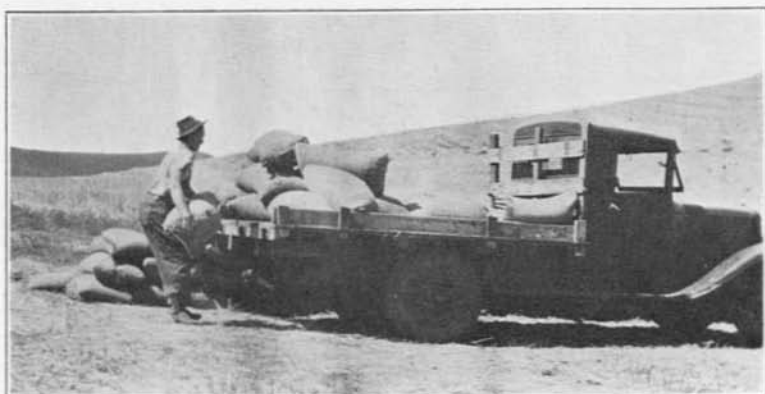
HOBART BERESFORD AND E. N. HUMPHREY*

WHEAT growers in the northwest have found the bulk system of handling grain from the hillside type combine one means of lowering production costs and thus forcing more profit from low market prices. The change from the sack to the bulk method of handling grain has been slower in the northwest than in other sections of the wheat belt due to the steep hillsides and rough characteristics of the country in which the wheat is grown. This condition has made it difficult to carry the grain tanks on the hillside combines and to reach the combine with wagon or motor truck when the grain tank was to be emptied. With the improvement in roads and transportation equipment, storage and warehouse facilities have been added that make it possible to handle a large portion of the annual wheat crop in bulk. When the change is finally made from the sack to the bulk method of handling grain, less labor is required, loss of grain is reduced, and the drudgery of handling the sacked grain by hand is entirely eliminated. The transfer of the wheat in bulk from the combine to the warehouse or elevator requires careful planning and selection of equipment, close supervision of details, and good management on the part of the operator.

Direct Haul Method

On farms where the fields will permit the use of motor trucks for removing the wheat direct from the combine grain tank and hauling it to the warehouse, the direct haul method may be used. For short hauls on fairly level fields and good roads one motor truck may be able to do the job. For example a two ton truck hauling 120 bushels on an average of 11½

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When bulking is practiced, the drudgery of handling the sacked grain by hand is entirely eliminated.

miles was able to keep a 20 foot combine operating in wheat that produced 15 bushels per acre. It was necessary for the truck to contact the combine twice before securing a full load. Under some conditions two or three contacts may be necessary, depending upon the size of the combine tank and the truck box. When depending upon one truck for delivering grain from a combine it is essential that adequate storage be available, and that no delay be caused from waiting to unload, or from truck or tire trouble on the highway.

In addition to the distance the wheat must be hauled, the yield per acre influences the number and capacity of the trucks required. When the hauling distance is from four to five miles, two trucks equipped with 80 bushel boxes will be required to take the wheat from a 14 foot combine when a yield of 25 to 30 bushels per acre is secured. The investment required for the equipment needed when this method is employed is rather high and is warranted only when 600 to 1000 acres of grain is to be harvested by an individual operator. For smaller acreages it is usually more economical to hire the trucks depending upon the farmers' use for a truck throughout the year. If the fields are rough or steep considerable skill is required in managing the trucks and combine. Flag signals are sometimes used to notify the truck driver when and where the most advantageous approach to the combine can be made.



Direct haul method from combine to warehouse with motor trucks.

Equipment recommended—Hillside type combine with 45 to 60 bushel grain tank equipped with auger type delivery. One or two motor trucks equipped with 70 to 120 bushel grain boxes depending upon the length of haul, yield per acre, and the condition of the fields.

Intermediate Field Bin Method

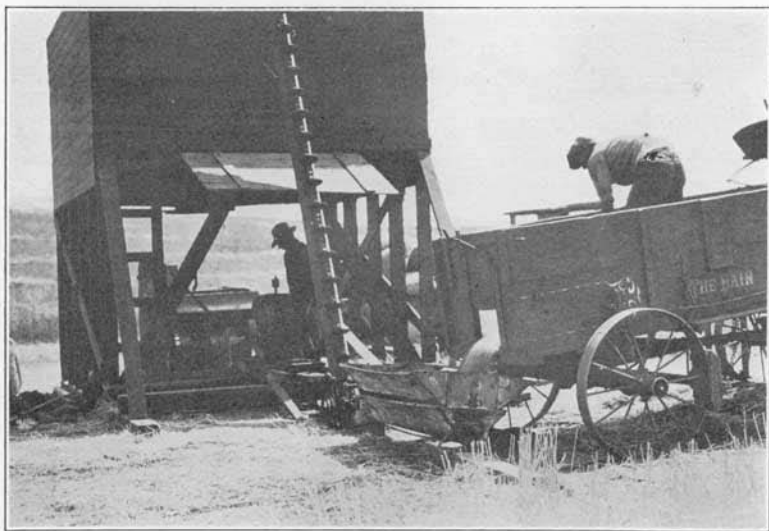
When the fields are too steep for motor truck operation, an intermediate temporary field bin may be used with teams and wagons to transfer the grain from the combine tank preparatory to loading in the motor truck. Two teams and wagons equipped with 60 bushel boxes were able to haul, up to $1\frac{1}{4}$ miles, all of the grain threshed from a 14 foot combine harvesting in wheat that averaged 30 bushels per acre. The wheat was transferred from the wagon by means of a portable pony elevator operated by a three horsepower gasoline engine. The 400 bushel field bin was mounted in an elevated position for the purpose of filling the 70 bushel truck box by gravity. The truck made 187 trips averaging 4.85 miles haul to the warehouse; hauling a total of 400.12 tons of grain, or 1940.58 ton miles in 17 days' operating time. For handling the above

grain it was necessary for the teams to make 215 trips averaging 0.6 of a mile for the haul from the combine to the field bin.

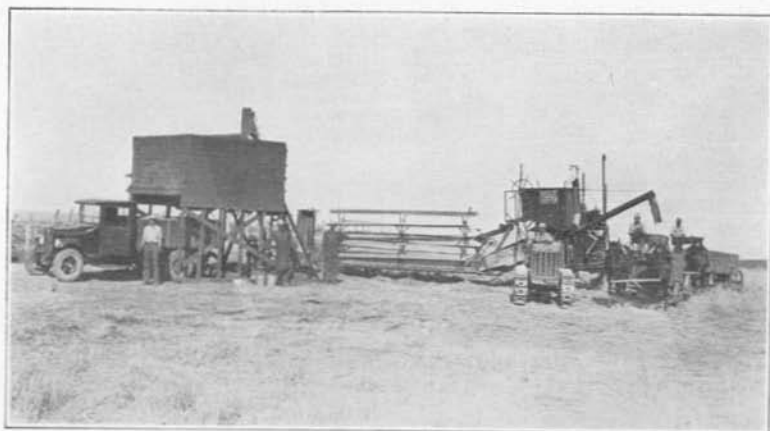
Illustrating Intermediate Field Bin Method



Field transfer from the combine tank to the grain box.



Unloading from the wagon into the portable elevator.



Intermediate field bin method of bulking grain from the hillside type combine.

Equipment recommended—Hillside type combine with 45 to 60 bushel tank equipped with auger type delivery. Two teams and wagons equipped with 60 bushel grain boxes. One 400 to 600 bushel elevated intermediate field bin with portable elevator and three horsepower gasoline engine. A one ton motor truck equipped with 70 to 80 bushel grain box.

Combination Direct Haul and Temporary Storage Method

The intermediate field bin has been used in combination with the direct haul method when the hauling distance was greater than could be covered by two trucks during combining hours. One of the trucks was used to haul direct from the combine tank to the warehouse and the other hauled from the combine to the 2200 bushel field bin during the day. The grain stored in the intermediate field bin was then hauled to the warehouse during the night. This plan required a night shift for the operation of one of the trucks and necessitated the continuous operation of the warehouse. Day and night operation of the truck gives full utilization of equipment; however, the advantage gained should be carefully weighed against the investment in the storage bin and elevating equipment.



Combination direct haul and temporary storage method.

Equipment recommended—Hillside type combine with 45 to 60 bushel grain tank equipped with auger type delivery. One 2200 bushel elevated temporary storage bin equipped with truck dump, elevator, and three horsepower gasoline engine. One or two motor trucks equipped with 70 to 120 bushel grain boxes depending upon the length of haul, yield per acre and the condition of the fields.

Farm Storage Method

When the haul from the combine to the market is too great to permit harvest delivery, farm storage may be used. This method furnishes greater flexibility than the preceding methods. The grain may be hauled to the farm granary by either team or truck and delivered to market at the farmer's convenience. The granary used may be either a permanent storage elevator or portable bins. Regardless of the type of storage structure used, mechanical means should be provided for both the loading and unloading of the bins. On farms

where an advantageous location of the bins is possible, the gravity system may be used for filling the bins during harvest and the truck boxes when the grain is hauled to market.



Note the grain chutes (marked X) used for loading the truck boxes when the wheat is to be hauled to market.



Field storage bin. Note gravity chute on the side.

Field storage bins may be made of lumber on the farm, or may be purchased ready for assembly from equipment dealers. Galvanized steel bins are also available in a variety of types and sizes.

Types of Elevators

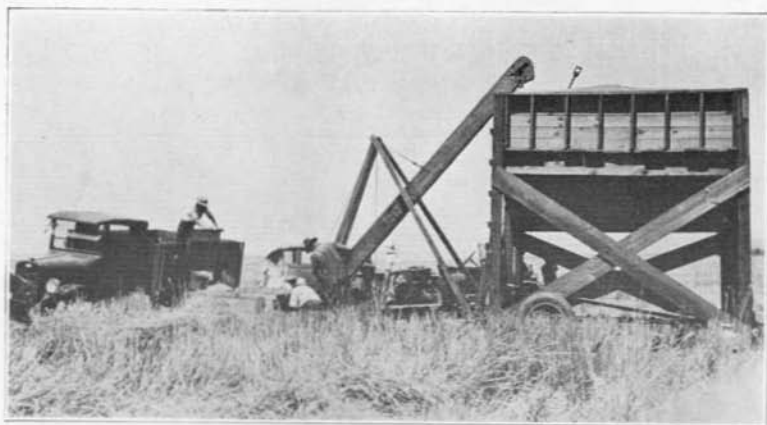


Blower type elevator located at farm storage plant and operated by three horsepower electric motor.

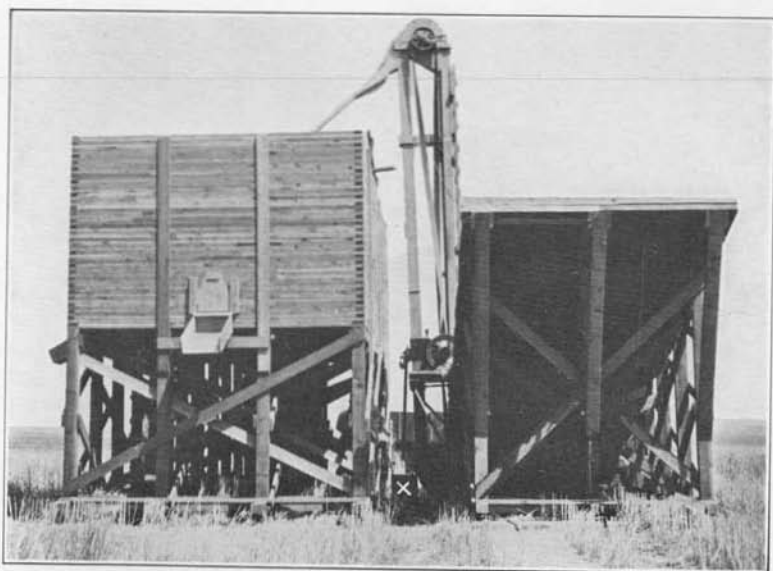
Various types of elevators have been used successfully for handling the bulk grain in the field and at the farm storage plant. The following pictures and descriptions are of the elevators used for handling the grain by the methods discussed in this circular.



Portable type elevator, employing endless chain and drag links, operated by a three horsepower gasoline engine. Note end delivery into movable elevator hopper, also power lift for gravity dump.



Portable type elevator employing an endless chain and drag links. This elevator was operated with a three horsepower gasoline engine. Note side delivery dump into stationary elevator hopper.

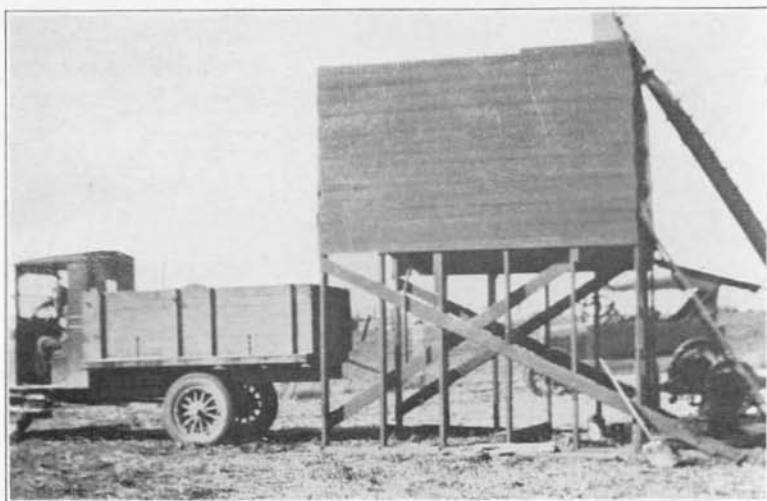


Vertical endless belt and bucket type of elevator requiring a three horsepower gasoline engine for operation. Note the engine exhaust pipe which is directed into an open oil drum half filled with water (marked X).

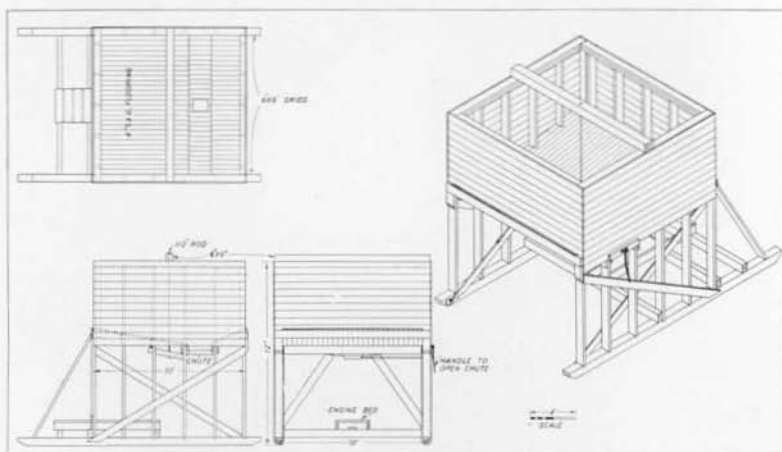
This precaution eliminates danger of fire from the engine exhaust.

Types of Field Bins

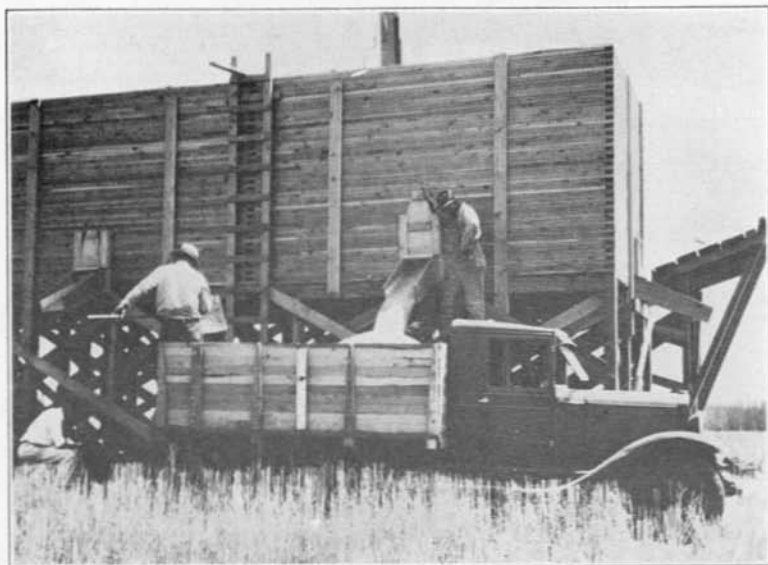
Several types of field bins have been used for carrying out the methods of bulking discussed in this circular. The following plans and descriptions apply to the methods previously outlined.



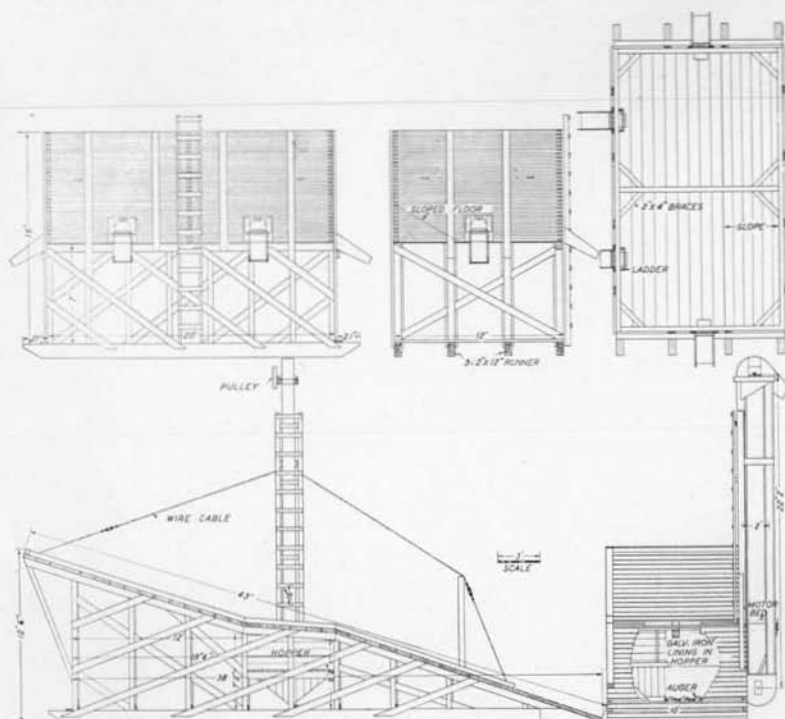
The grain is transferred from the combine to this 400 bushel capacity field bin by means of two teams and wagons.



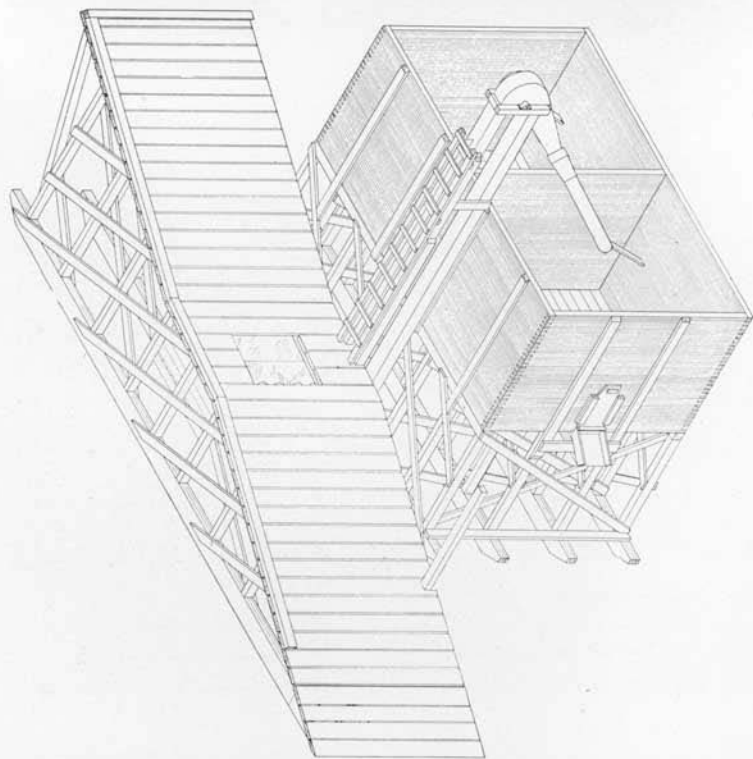
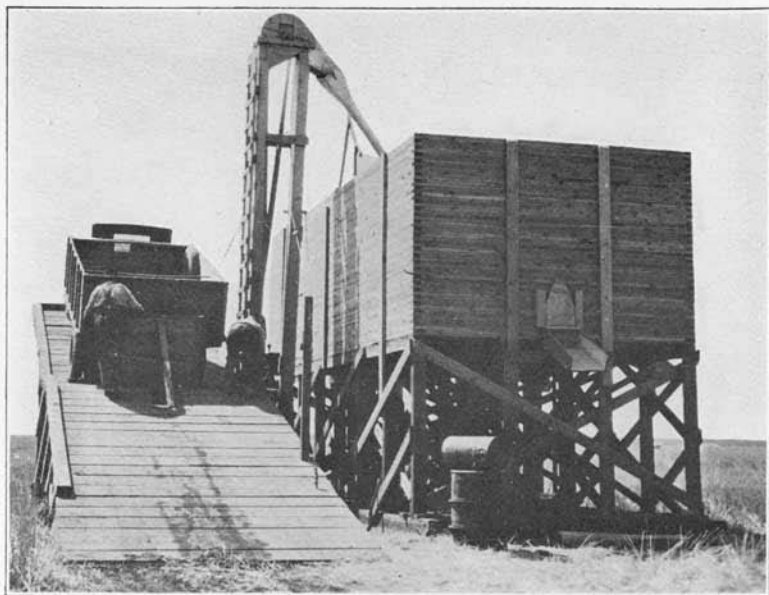
Intermediate field bin using hopper bottom and center grain chute.



Temporary storage bin of 2200 bushel capacity using side grain chutes.

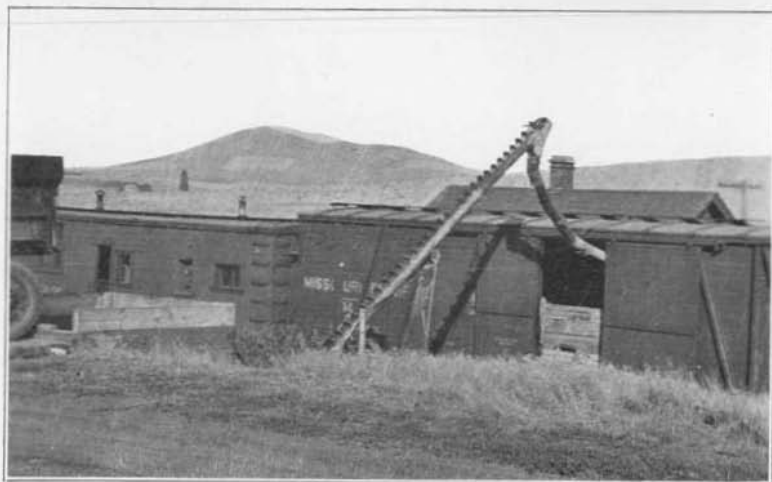
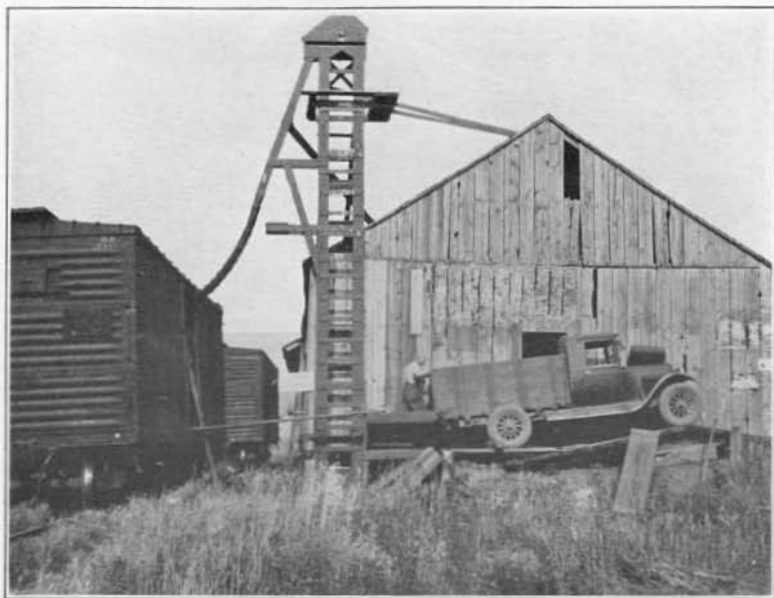


Drawing showing construction details of 2200 bushel capacity temporary storage plant.



Temporary storage bin showing truck dump and elevator arrangement.

Farm Shipment of Bulk Grain

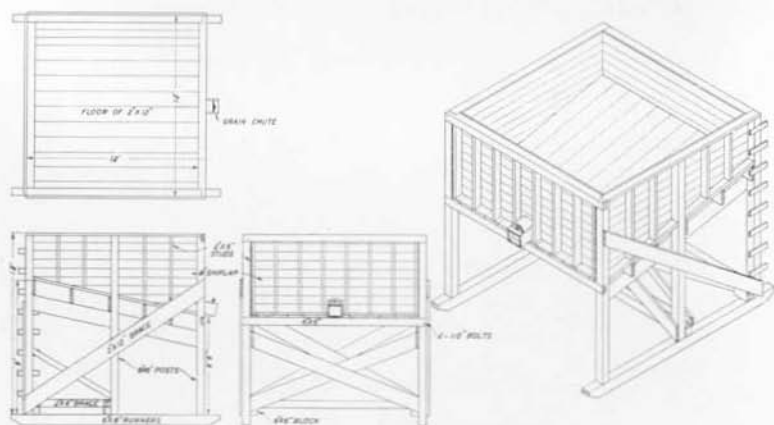


Methods of loading used for direct railroad shipment of wheat from farm to terminal warehouse.

The portable farm elevator may be readily adapted to loading bulk grain when railroad facilities permit direct shipment.



Intermediate field bin using sloping floor and side grain chute.



Intermediate field bin using a sloping floor and side grain chute.

Direct Haul Method Costs

Summary of daily operating costs for one season for two trucks making direct contact with a hillside type combine. Average hauling distance of 5 miles from combine to elevator. Total grain delivered 4,433 bushels of barley and 12,760 bushels of wheat.

Cost of Trucks New	Days Used per Year	Days Used in Harvest	Overhead Costs per Day	Operating Costs per Day	Total Cost per Day	Bushels Delivered per Day	Cost per Bushel
\$1400.00	200	34	\$1.52	\$7.42	\$ 8.94	Total Both Trucks	
\$1345.00	200	34	\$1.53	\$7.42	\$ 8.95		
			\$3.05		\$17.89	506	\$0.0353

Summary of Truck Operation

Total Average for Both Trucks

Average Distance to the Warehouse	No. of Trips per Day	Grain Delivered per Day in Lbs.	Ton Miles per Day	Cost per Ton Mile
5.0	6.117	28,790 lbs.	71.95	\$0.248

Intermediate Field Bin Method Costs

Summary of daily operating costs for two seasons' operation of a one-ton capacity motor truck used to haul from an intermediate field bin to warehouse. Average hauling distance of 4.9 miles from intermediate bin to warehouse. Total grain delivered 3,555 bushels of barley and 21,493 bushels of wheat.

Cost of Trucks	Days Used per Year	Days Used in Harvest	Overhead Costs per Day	Operating Costs per Day	Total Cost per Day	Bushels Delivered per Day	Cost per Bushel
Used \$ 900.00	100	17	\$1.72	\$9.14	\$10.86	810	\$0.0134
New \$1265.00	100	15	\$2.79	\$7.30	\$10.09	750	\$0.0134
					Total Average		\$0.0268 \$0.0134

Summary of Truck Operation

	Average Distance to the Warehouse	No. of Trips per Day	Grain Delivered per Day in Lbs.	Ton Miles per Day	Cost per Ton Mile
	4.85 miles	11.0	47,072 lbs.	114.12	\$0.095
	4.95 miles	9.13	40,133 lbs.	99.30	\$0.101
Total	9.80 miles	20.13	87,205 lbs.	213.42	\$0.196
Average	4.9 miles	10.06	43,602 lbs.	106.71	\$0.098

Intermediate Field Bin Transfer Costs

Summary of daily operating costs for two seasons' operation of two teams and grain wagons used to haul from the combine to the intermediate field bin. Average hauling distance 0.6 miles from combine to field bin. Total grain transferred 2,780 bushels of barley and 21,193 bushels of wheat.

Overhead Costs			Operating Costs			Total Cost	Bushels Delivered	Cost per Bushel
Two Teams	Equipment	Total	Two Teams	Equipment	Total	per Day	per Day	
\$2.59	\$3.12	\$5.71	\$ 9.95*	\$0.25	\$10.20	\$15.91	811	\$0.0196
\$2.59	\$3.67	\$6.26	\$11.44	\$0.25	\$11.69	\$17.95	672	\$0.0267
Total								\$0.0463
Average								\$0.0231

Summary of Transfer Wagon Operation

	Average Distance from the Combine to the Field Bin	No. of Trips per Day	Grain Delivered per Day in Lbs.	Ton Miles per Day	Cost per Ton Mile
	0.6 miles	12.64	47,072 lbs.	14.12	\$1.126
	0.6 miles	15.26	40,000 lbs.	12.00	\$1.495
Total	1.2 miles	27.90	87,072 lbs.	26.12	\$2.621
Average	0.6 miles	13.95	43,536 lbs.	13.06	\$1.31

Total Cost of Intermediate Field Bin Method		Total Cost per Ton Mile of Intermediate Field Bin Method	
	Average Cost per Bushel		Average Cost per Ton Mile
Truck	\$0.0134	Truck	\$0.098
Transfer Wagons	\$0.0231	Transfer Wagons	\$1.31
Total	\$0.0365	Weighted Average†	\$0.23

Comparison of Bulking Methods

Indirect Haul Method	\$0.0365 per bushel
Direct Haul Method	\$0.0353 per bushel

\$0.0012 per bushel in favor of Direct Haul Method.

A comparison of the direct haul and intermediate field bin methods shows that under the conditions studied the cost per bushel varied from \$0.0353 to \$0.0365 or \$0.0012 in favor of the direct haul method. The operator using the two motor trucks for direct field contact of the combine operated his trucks twice as many days during the year and for the harvest period 34 days as compared with 16.5 days for the intermediate field bin method. Due to the delays in truck operation which necessarily occur when the direct haul method is practiced the cost per ton mile varied from \$0.248 to \$0.23 which is \$0.018 in favor of the intermediate field bin method. Increasing the number of days of yearly operation of the motor trucks for the intermediate field bin method and harvesting for equal periods with both methods, would show a like variation between cost per ton mile and cost per bushel. This comparison

* \$2.00 per day difference in labor costs for the two seasons.

† Proportional to distance hauled for each method.

has been made to show how a farmer handling a relatively small acreage with the intermediate field bin method may secure as low a cost per bushel as is obtainable by the direct haul method using multiple trucks for handling a larger acreage.

The overhead costs for the operation of the motor trucks include: license fee, property tax, insurance, storage, depreciation and interest on the depreciated value* of the machine computed at 8 per cent. The depreciation on the trucks is calculated for a seven year life by the "compound interest" method which allows for an annual depreciation charge to be made each year. The amount of depreciation charge increases with the age of the equipment and is sufficient, if allowed to accumulate at compound interest and added to the depreciated value, to replace the machine at any period in its service life. The same method is used for calculating the depreciation on the other equipment which is allowed a ten year service life.

Laying Out Fields for Bulk Combining

When the topography of the fields will permit combining without following the contours on the hillsides, considerable time and mileage may be saved the bulking truck by using the following scheme:

Make the entrance to the field at a point readily accessible by both combine and motor truck and at the shortest hauling distance from the storage elevator or the field bin. A back swath is then cut by the combine which is operated over the nearest feasible hauling route to the approximate center of the field, from which the grain is cut in a spiral swath until the boundaries of the field are reached. On the last complete swath, the corners of the field are harvested in turn. The path made by the combine when it first entered the field is used by the motor truck for hauling out the bulked grain. This system allows the truck a minimum haul to the warehouse or field bin regardless of the location of the machine when the combine tank is full.

* The "depreciated value" is that which remains after the depreciation has been subtracted from the cost new.

