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UNIVERSITY OF NOTTINGHAM

Department of Agricultural Economics

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Grain Marketing

ECONOMICS OF GRAIN DRYING AND STORAGE

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ECONOMICS OF GRAIN DRYING AND STORAGE.

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SEPTEMBER, 1955.

CONTENTS.

	Page.
PREFACE.	-
Problems Associated with the Marketing of Grain.	1
Objective of Survey.	10
Ventilated Bins and Silos.	12
Cost of Installation.	13
Operating Costs.	14
Average Costs.	15
Platform or In-Sack Driers.	19
Cost of Installation	20
Operating Costs.	20
Continuous Driers.	21
Cost of Installation.	21
Operating Costs.	22
Effect of throughput on Fixed cost per ton.	25
Does it pay to install Grain Drying and Storing Equipment.	27
Costing Methods.	29

PREFACE.

In view of the greatly increased importance of grain drying and storage equipment on farms during recent years this Department decided to carry out an enquiry into the economics of such equipment at present in use on East Midland farms.

Even from this small survey it is obvious that different systems of grain drying and storage have been successful on different farms. Thus a farmer planning the installation of grain drying and storage equipment should carefully consider the special possibilities on his farm before deciding upon the system to choose.

I wish to thank the farmers who through their willing co-operation made this survey possible.

KNUD RASMUSSEN.

Provincial Agricultural Economist.

PROBLEMS ASSOCIATED WITH THE MARKETING OF GRAIN.

With the return to free methods of marketing and the increase in number of combine harvesters, the storage of grain on the farm has become an important problem. It is generally considered to be in the farmer's own interest to store his grain until he is ready to sell, but in order to do this successfully, steps must be taken to prevent deterioration of the grain in storage. This brings in another problem associated with storage, that is, reducing the moisture content of the grain to allow safe storage. Cereal grains like all living organisms, respire, producing heat, water, and carbon dioxide, and it is the low level at which life is carried on that makes the grain stable in storage. If the moisture content of the grain is too high, this stability is affected, the mass of grain becomes hot, is liable to be attacked by moulds and, if sufficiently damp, by bacteria.

MOISTURE LIMITS FOR SAFE STORAGE OF GRAIN.

	Moisture content should not exceed:-
For storage in Bulk -	
Up to one month	16%
More than one month	14%
For storage in Sacks -	
Up to one month	20% ✲
More than one month	18%

✲ Provided that sacks are stored only one row deep and are kept under observation.

In perhaps no other farm product is the problem of storage so acute as it is with grain, a crop harvested in a month, but marketed over twelve or more. Before the coming of the combine harvester, the bulk of the harvest was taken from binder to stack; the subsequent threshing and sale of the corn could be spread over the months ahead. The combine harvester brought great advantages to the farmer in harvesting, but it also created the problem of the drying and storing of grain. Between 1948 and 1954 the number of combine harvesters has increased from 4,970 to 21,117(1) and last year a million tons more grain were combined than storage facilities on farms for threshed grain could accommodate.

The number of grain driers on farms has also increased, but not to the extent that will be needed if all the farmers who use combine harvesters

(1) Source: Ministry of Agriculture & Fisheries. Agricultural Machinery January 1954 Census.

are to hold their grain or at least a good part of it, for some time after harvest. The last census(1) of agricultural machinery was taken in January 1954 but it is likely that many more plants have been installed(2) since then as farmers have realised that the grain market, particularly for feed barley, may be glutted for three or four months in the autumn.

Grain Driers (England & Wales) — January 1954

	Number
Continuous Grain flow	1,480
Tray	264
Platform (in-sack)	834
Ventilated Bins or Silos	967
	3,545

Grain Driers (East Midlands) — January 1954

	Grain Driers				Combine Harvesters
	Continuous	Tray	Platform	Ventilated Bins	
Lincoln (Kesteven)	41	4	11	15	541
Lincoln (Lindsey)	51	2	13	24	820
Nottinghamshire	16	5	11	21	362
Derbyshire	-	8	3	3	94
Leicestershire	15	3	7	16	296
Rutland	2	-	1	2	134
T O T A L	125	22	46	81	2,247

Seasonal Variations in Sales of grain off Farms.

Wheat.

Graph A shows that in 1940-41 substantial quantities were sold each month from August to the following March and April. It also shows that since the expansion of the use of combines, there has been a great concentration of sales in August to October, but the month with the heaviest marketings has varied with the season.

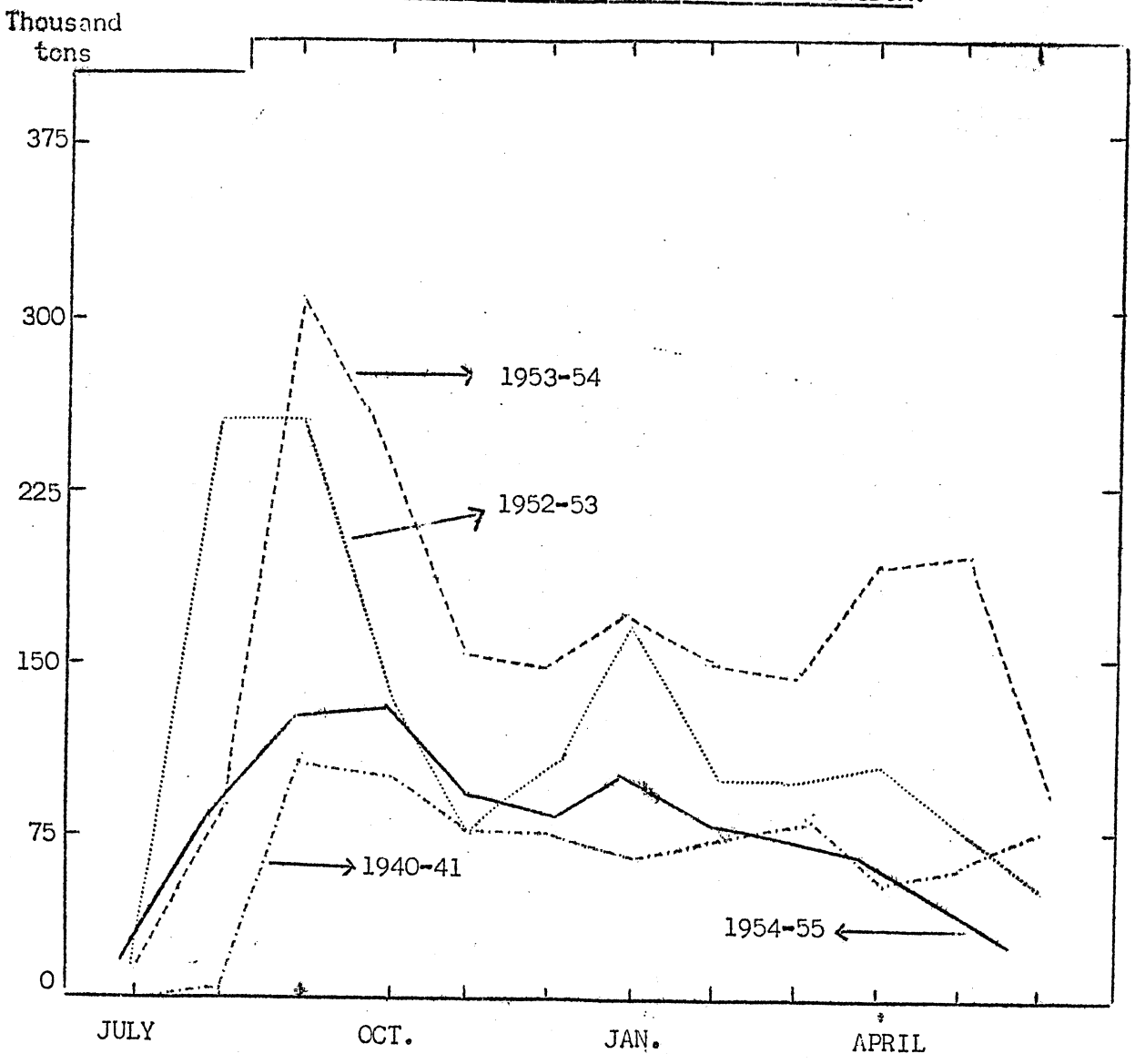
(1) Source: Ministry of Agriculture & Fisheries. Agricultural Machinery, January 1954 Census.

(2) Farmers' Weekly August 5th, 1955, estimates that there are 26,500 combines and 5,000 grain driers on farms.

GRAPH A

WHEAT

SEASONAL VARIATIONS IN SALES OFF FARMS UNITED KINGDOM.



Source: Central Statistical Office, Monthly Digest of Statistics. Issued by H.M. Stationery Office, London.

Central Statistical Office. Statistical Digest of the War. (History of the Second World War). 1951. Longmans, Green and Co., and H.M. Stationery Office, London.

This grain not only comes in a rush, but barley sales are equally concentrated and in some seasons a high percentage of the grain may be wet and will require drying.

Barley.

In 1940-41, sales of barley remained high from August to January. During this time most of the grain which found a malting market was disposed of, since maltsters bought most of their requirements before Christmas.

The current pattern of sales as shown in Graph B is one of very heavy sales before the end of October straight from the combine. In wet years like 1954 grain may have a moisture content of 20% of more, and contain fragments of weeds and legumes.

The graphs show that with the increase in numbers of combine harvesters, the majority of the grain harvested is put on the market during August, September, and October. The main limitations on the use of combine harvesters where no drying equipment is installed is this need of selling damp grain straight off the combine to the merchant, or alternatively, of getting it dried by contract, usually a difficult matter at that time of year, especially in a wet season.

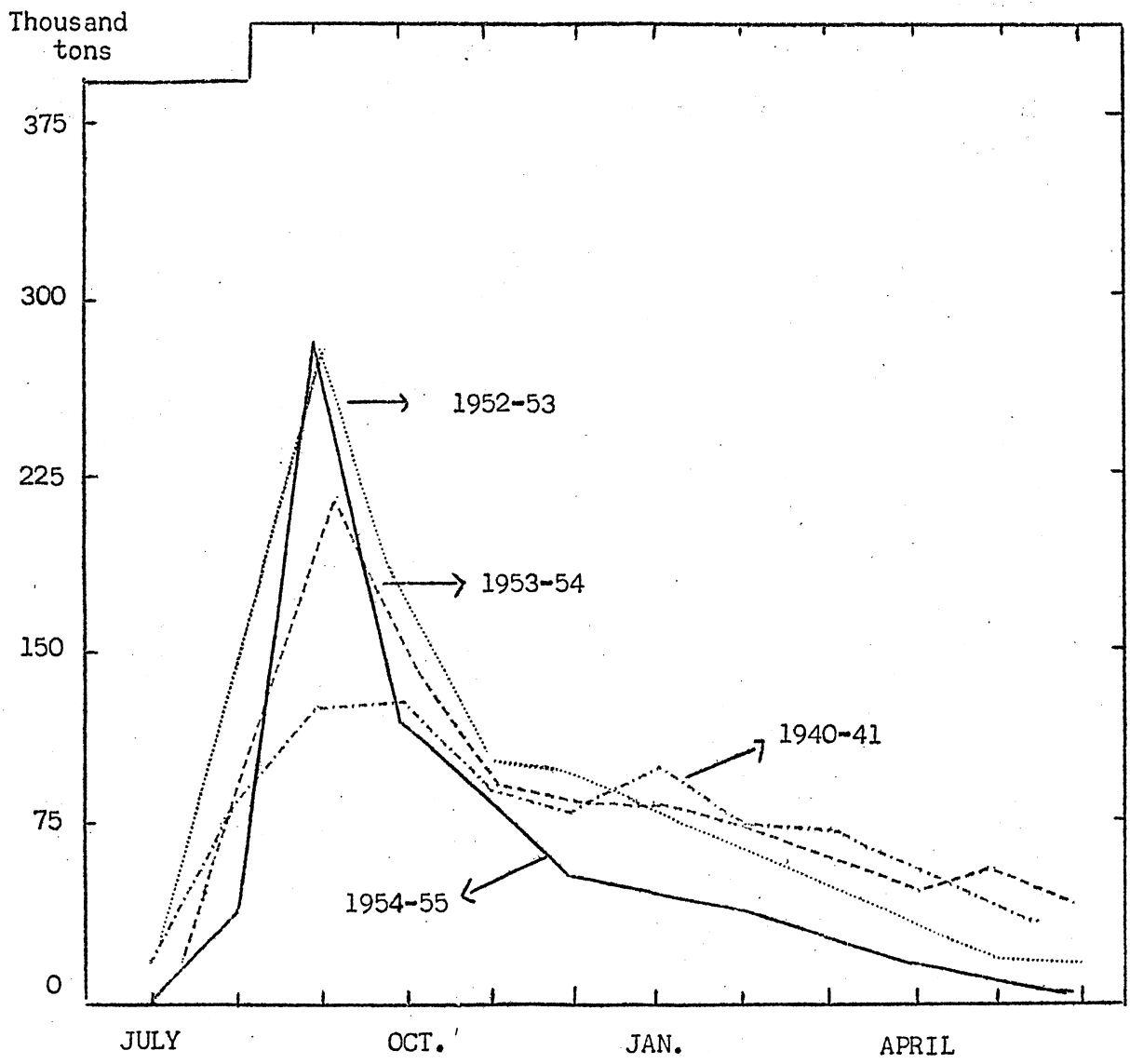
Taking the extreme view, however, grain at harvest will almost invariably be cheap, due to the flood of grain on to the market; but if the farmer has his own drying and storage facilities, this will considerably strengthen his bargaining position. Proper storage accommodation also facilitates the use of grain for feeding. Many of the advantages derived from drying are seen to be due in fact to the longer storage of the grain which drying makes possible and adequate storage facilities are an essential part of any grain drying installations. Also, if a drier is installed, harvesting may be carried out in bad weather and the whole process becomes less dependent on climate than the older harvesting methods.

Farm storage of grain relieves the grower of the necessity of finding an immediate market, and this may confer a substantial economic advantage. By holding wheat until December, according to the present guaranteed prices, an advantage of 2s. 6d. per cwt. could be obtained, whilst a maximum price increase of 5s. Od. per cwt. is possible if the crop is held until the following May.

GRAPH B

BARLEY

SEASONAL VARIATIONS IN SALES OFF FARMS UNITED KINGDOM



Source: Central Statistical Office, Monthly Digest of Statistics. Issued by H.M. Stationery Office, London.

Central Statistical Office. Statistical Digest of the War. (History of the Second World War). 1951. Longmans, Green and Co., and H.M. Stationery Office, London.

The seasonal standard prices for wheat and the accounting periods were as follows:-

Period.	Seasonal Standard Price Per cwt. s. d.
July/September, 1954	28. 10.
October/November, 1954	30. 4.
December, 1954/February, 1955	31. 10.
March/April, 1955	33. 1.
May/June, 1955	33. 10.

As in 1954-55 the cereal year 1955-56 will be divided into five periods and the standard price of 30s. Od. for the year will be converted into a rising scale of seasonal standard prices, to encourage marketing of wheat.

The following are the seasonal prices during 1955-56:-

Period.	Seasonal Standard Prices. Per cwt. s. d.
July/September, 1955	27. 11.
October/November, 1955	29. 5.
December, 1955/February, 1956	30. 11.
March/April, 1956	32. 2.
May/June, 1956	32. 11.

Similar guaranteed scales do not apply to the other cereals, but prices are likely to rise as the season progresses. The storing of barley and oats has been a good economic proposition during the 1954-55 winter, as the price of barley and oats increased considerably from harvest time to March.

	September, 1954	March, 1955(1)
Barley	22s. 6d. per cwt.	28s. 10d. per cwt.
Oats	22s. 6d. per cwt.	28s. Od. per cwt.

The above were the average market prices obtained in the following East Midlands markets:- Boston, Doncaster, Leicester, Lincoln and Newark.

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(1) Source:- Farmers' Weekly.

Price Movements of Home Grown Cereals, 1954-55.

The following graph shows the prices of wheat, barley and oats sold off farms in England and Wales from July, 1954 to June, 1955. The price paid for wheat fell from 34s. 0d. per cwt. at the beginning of July to below 20s. 0d. during September and October last year. Afterwards the price increased gradually to a maximum of 25s. 2d. in February.

It will be noticed that the price paid for Oats and Barley was lowest during harvest time, and then gradually increased to a peak during February and March, when 30s. 3d. per cwt. was paid for barley and 28s. 7d. per cwt. for oats. The following budget shows that it was an economic proposition to store barley last year.

	£. s. d.
Receipts per ton from barley sold at harvest	22. 0. 0.
" " " " " " in March	30. 5. 0.
Margin	8. 5. 0.
Average cost of drying and storing per ton	1. 10. 0.
Additional revenue per ton obtained from storing barley from harvest, 1954 until March, 1955	6. 15. 0.

Cereals Deficiency Payments for 1954-55.

Below are particulars of payments under the Home Grown Deficiency Payments Scheme, 1954.

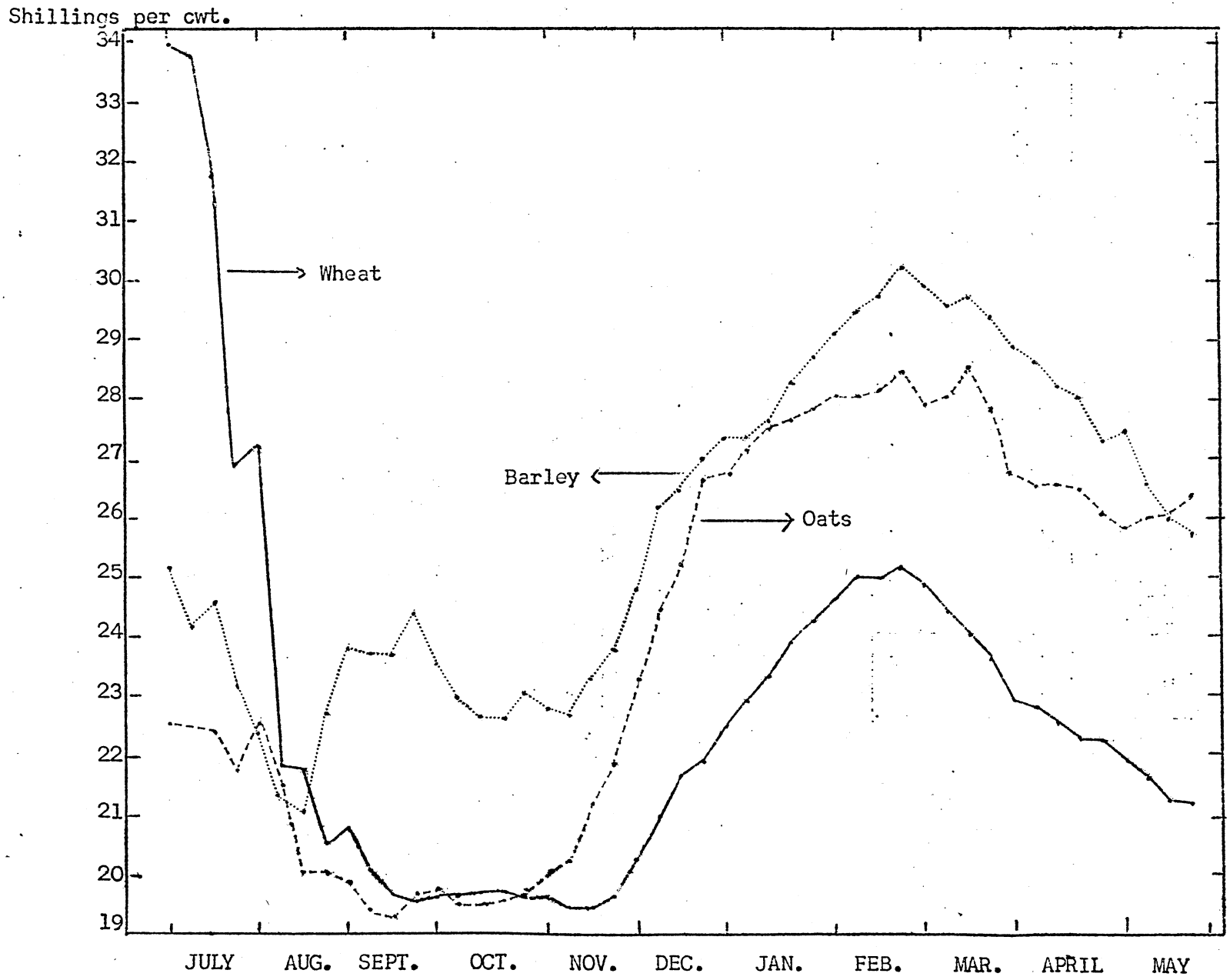
Wheat.

Accounting period	Seasonal standard price per cwt.	Ascertained average price per cwt.	Deficiency payment per cwt.	Quantity qualifying for deficiency payment	Total payments	Number of growers receiving payments
1954:	s. d.	s. d.	s. d.	million cwts.	£ millions	
1st July - 30th Sept.	28. 10.	19. 7.9	9. 2.1	5.7	2.6	15,000
1st Oct. - 30th Nov.	30. 4.	19. 8.7	10. 7.3	11.6	6.2	45,000
1st Dec.1954 - 28th Feb. 1955	31. 10.	23. 9.4	8. 0.6	12.7	5.1	25,000
1955:						
1st March - 30th April	33. 1.	22. 11.7	10. 1.3	7.9	4.0	30,000
1st May - 30th June(1)	33. 10.	21. 4.0	12. 6.0	10.0	6.3	30,000

(1) The figures for the period 1st May to 30th June, 1955 other than the seasonal standard price are provisional.

GRAPH C.

PRICE MOVEMENTS OF HOME GROWN CEREALS 1954-55 ENGLAND AND WALES.



Barley.

	Yearly standard price per cwt.	Average "at farm" price per cwt. for lower priced Barley	Price deficiency per cwt.	Deficiency payment per acre	Acreage qualifying for deficiency payment	Total payments	Number of growers receiving payments
	s. d.	s. d.	s. d.	£. s. d.	Million acres	£ Millions	
Cereal Year 1st July, 1954, to 30th June, 1955.	25.6.	20. 11.92	4. 6.6	4. 6. 6.	2.0	8.7	73,000

Oats and Mixed corn.

The ascertained United Kingdom average "at farm" price realised by growers for homegrown oats during the cereal year 1954-55 is 24s. 2.69d. per cwt. As this exceeded the standard price of 24s. Od. per cwt. there will be no deficiency payments for oats, and consequently, none for mixed corn, of the 1954 harvest.

Total Deficiency Payments on Cereals for 1954-55.

The total amount of the deficiency payments on cereals for the cereal year 1954-55 was approximately £33.1 millions made up as follows:-

	£ (Millions)
Wheat	24.2
Rye	0.2
Barley	8.7
Oats and Mixed corn	none
	33.1

OBJECTIVE.

During the harvest season 1954-55, a survey was carried out by this Department into the economics of grain drying and storing in the East Midlands Province. The objective of this survey was to determine the fixed and variable costs involved in drying and storing grain and the capital investment required for such an enterprise.

The Survey Area.

The area covered was the East Midlands Province[1] but the majority of the co-operators were situated in Lincolnshire and Nottinghamshire.

The Sample.

Data were obtained from 40 farmers who had installed grain drying plants. The farms were predominantly arable, with the main source of income from cash crops. Three main drying systems were investigated:-

a) 30 ventilated bins and silos with porous or perforated floors.

b) 3 platform type driers for drying grain in-sacks.

c) 7 continuous driers.

Climate.

The 1954 harvest was exceptionally wet and a very high percentage of the grain harvested by combine had to be dried to about 14% moisture content before it could be stored safely in bulk. Nearly every year a considerable proportion of combine harvested grain needs drying before it can be stored safely but this proportion can often be reduced by increasing a farm's combine strength, then full advantage may be taken of the most favourable hours of the day and of the best harvesting weather for combining the cereal crops.

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(1) The East Midlands Province of the Provincial Agricultural Economics Service includes Lincolnshire (Kesteven and Lindsey), Derbyshire, Nottinghamshire, Leicestershire and Rutland.

The East Midlands Province is situated in the lower rainfall areas of the country and consequently is able to harvest grain with a lower moisture content than the higher rainfall areas of the West can. This Province lies in an area having an average of less than 30 inches of rain per annum, and much of it has a rainfall of less than 25 inches; this low rainfall is suitable for cereal production. In common with the rest of Britain, there is little variation in the average rainfall from year to year. The seasonal averages show the summer months, June, July and August, to be the wettest, whilst Spring is the driest season. The rainfall is thus distributed throughout the year in a way least advantageous to farmers. There is a comparatively dry season in the spring when moisture is needed for plant growth and an increased amount of rain at harvest time when dry cloudless weather is required.

ACREAGES OF SURVEY FARMS.

TABLE 1.

Acreage Group	Number of Farms	Percentage of total
0 to 200 acres	4	10
201 to 400 "	13	33
401 to 600 "	15	37
601 acres and over	8	20
Total	40	100

The average size of the farms in the survey was 488 acres, the smallest being 87 acres and the largest 1,308. On average, 239 acres of cereals were grown on each farm. This amounted to 49% of the total acreage but the percentage under cereals varied from 29% to 79% of the total acreage of the sample farms.

VENTILATED BINS AND SILOS.

A ventilated bin or silo drying and storage installation consists essentially of silos or bins with porous floors or a system of ducting to distribute the air evenly through the mass of grain, an air heater, a ventilating fan and a power unit. Auxiliary equipment normally added includes a grain receiving hopper, grain conveyors, a grain cleaner, and equipment for sacking off and weighing.

The principle of drying in ventilated silo driers depends on the fact that the moisture in the grain tends to come in a state of equilibrium with the moisture in the air surrounding it. The silo drier provides a means of controlling the grain atmosphere (i.e., the air in contact with the stored grain), and through it the moisture content of the grain itself.

This is a practical method of drying combine harvested grain in the lower rainfall areas. It has been suggested that this sytem is not ideal where the bulk of the grain cannot be harvested at 20% moisture or less, although during this harvest the greater bulk of the grain was harvested with a moisture content of over 20%, some of the grain having a moisture content of over 25%, and this was dried satisfactorily.

The average size of the farms on which ventilated bins were found was 466 acres, the smallest farm being 87 acres and the largest 1,308 acres. The storage capacity of the bins or silos averaged 242 tons. The smallest plant was capable of storing only 20 tons, whilst the largest plant was capable of storing 700 tons. The total storage capacity of the plants surveyed was 7,269 tons, but the total amount dried was 9,395 tons at an average moisture content of 22%. The average throughput per plant was 313 tons.

A greater quantity of grain passed through the bins than the actual storage capacity because many farmers sold off some of their barley and wheat immediately after drying and others bagged off the grain after drying to empty the bins so that room could be made to dry wet grain. A few farmers kept a ventilated bin empty so that they could dry grain on contract for their neighbours, although this was of minor importance, as only 200 tons were dried on contract. The total amount of grain stored in these plants at the end of November, 1954, was 6,013 tons, made up as follows:-

Wheat	Barley	Oats	Miscellaneous Crops.
4,003 tons	1,524 tons	329 tons	157 tons.

The wheat stored amounted to 66% of the total tonnage, this no doubt being due to the guaranteed seasonal price increases offered for wheat.

Capital Costs.

The capital cost of ventilated bins and their auxiliary equipment, (which may include holding bins for damp grain, dressers, several conveyors and elevators and bagging and weighing equipment), usually accounts for the major part of the cost of drying, the total running costs, comprising fuel, power, labour and maintenance charges being relatively small. It is, therefore, most important to match the size of the drier to its expected throughput, and so avoid unnecessarily high capital costs.

Generally speaking, ventilated bin driers are more economical as large installations than as small ones, because the cost of erecting the necessary buildings and fittings does not increase proportionately to their capacity. The emphasis in this type of plant is on storage and less capital is tied up on purely drying machinery. The equipment usually consists of a receiving hopper, conveyors, elevators, precleaners and silos, together with the necessary ventilating fans and heater for the drying process. The costs of installing driers of this type are less affected by the fluctuations from season to season in the amount of grain needing drying, since storage accommodation is required whether the grain is wet or dry and this represents the bulk of the capital outlay.

Cost of Installation.

The costs of installing plants of this type varied from £5. 18s. Od. per ton of grain stored, for a plant capable of storing 660 tons of grain to £29. 10s. Od. for a small plant capable of storing only 60 tons. For the 30 ventilated bins surveyed the average cost of installation per ton of grain stored was £11. 2s. Od.

Installation costs depend very much upon the nature of the building work involved since this forms an important part of the undertaking. The building costs varied a great deal owing to the fact that on some farms existing buildings or dutch barns were converted into ventilated bins, whilst on others, entirely new buildings were erected. The most popular buildingsfor converting into ventilated bins were dutch barns. With combine harvesting replacing the traditional harvesting methods, many dutch barns are only used for storing straw. The straw can easily be stacked, leaving the barns free to be converted to other useful purposes. Many farmers were able to reduce installation costs by using the existing farm labour force in constructing their ventilated bin driers. Capital costs

again varied as to the type of materials used in the construction of the building. The cost of the floors used in the ventilated bins depends on the materials used. Wedge wire floors were the most expensive and did not block up like some of the foam slag floors, which were the cheapest. A number of foam slag floors had to be replaced after a few years due to their efficiency being reduced by getting blocked up with dust. It seems that it is false economy to put in these floors that get blocked up and therefore reduce the efficiency of the drying plant; these have to be replaced, thus involving additional costs of removing and relaying the floors.

It is difficult to give an exact comparison between costs of various installations, due to the wide diversities of layouts and equipment used. Some plants were fitted with very elaborate cleaning and dressing equipment, also bagging and weighing off machinery, whilst others utilised less elaborate equipment, for example, one farmer used his old threshing machine for dressing the grain.

The majority of these "improvised" ventilated bin driers were found on the smaller farms, where storage of approximately 60 - 100 tons of grain was required. Bins were erected in existing barns, and the minimum of equipment was purchased. Labour costs in running such plants were usually higher because of the lack of facilities for bulk handling of the grain. Construction costs were in some cases kept low by utilising farm labour to construct the bins, and using concrete blocks instead of bricks, these being easier for the unskilled labour to lay. The installation costs of constructing five plants capable of storing on average 89 tons was £7. 10s. 0d. per ton of stored grain. These plants were constructed mostly by farm labour, the more skilled jobs being done by contractors, e.g., electrical fitting, joinery, etc.

Construction cost of an entirely new building set up as a ventilated bin drier was far higher than that of the less elaborate ones built by the farmers themselves, by converting an existing building etc. The average construction cost per ton of grain stored in new buildings was £12. 10s. 0d. for 16 plants with an average storage capacity of 280 tons. The storage capacity ranged from 120 tons to 700 tons.

Operating Costs.

In owning or renting a drier of any kind, two types of cost will be incurred - fixed costs, which result through owning equipment, and these include depreciation, and interest on capital invested; in the case of a tenant the rent charged for the plant is a fixed cost. Included in the fixed costs will be any insurance charges. In the survey, only a quarter of the farmers insured their plants. These costs will be fixed for a number of years ahead. The fixed costs per ton for a given plant decrease as the tonnage dried is increased. Fixed costs are of great importance

and they amount to 67% of the total operating costs.

The other type of costs incurred are "variable costs" - which are related to the use of the equipment and include such things as labour, repairs, fuel, electricity and tractor use. A factor affecting the variable costs is the moisture content of the grain. Grain with a high moisture content naturally needs more drying than that with a low moisture content, consequently, fuel costs are affected by the amount of drying required.

Average costs.

The average costs per ton for drying and storing grain in 30 ventilated bins and silo driers are given in the following table:-

COSTS OF VENTILATED BIN OR SILO DRIERS 1954-55.

TABLE 2.

	Per ton	Percentage of total costs
FIXED COSTS.	£. s. d.	%
Depreciation	10.10.	36.6
Interest	8. 2.	27.6
Rent on buildings	8.	2.3
Insurance on buildings and contents	3.	.8
TOTAL FIXED COSTS OF DRYING STORES	19.11.	67.3
VARIABLE COSTS.		
Fuel and power	6.10.	23.0
Repairs	6.	1.7
Labour	2. 4.	8.0
TOTAL VARIABLE COSTS	9. 8.	32.7
TOTAL COSTS	1. 9. 7.	100.0

The average costs totalled £1. 9s. 7d. per ton. Of this total, fixed costs accounted for 67.3% whilst variable costs accounted for 32.7%

The cost per ton of drying and storing was distributed as shown in the following table.

RANGE OF DRYING AND STORING COSTS.

TABLE 3.

Cost per ton	Number of plants	Tons dried	Average moisture content
			%
10s.0d. to 19s.11d.	4	2,959	22.0
20s.0d. to 29s.11d.	8	2,295	21.1
30s.0d. to 39s.11d.	9	2,117	22.5
40s.0d. to 49s.11d.	6	1,169	22.6
50s.0d. to 59s.11d.	2	815	22.4
60s.0d. to 69s.11d.	-	-	-
70s.0d. to 79s.11d.	-	-	-
80s.0d. to 89s.11d.	-	-	-
90s.0d. to 99s.11d.	1	40	25.0
TOTAL	30	9,395	

The plant with the lowest costs dried 493 tons of grain with an average moisture content of 22% for 14s. 2d. per ton. In this case fixed costs accounted for only 40% of total costs. The plant with the highest costs dried only 40 tons of grain with a moisture content of 25%, for £4. 11s. 0d. per ton.

The average moisture content of the incoming wet grain was 22%, and this was dried down to 14% on average for safe storing.

Source of heat for drying the grain.

In the investigation carried out into the economics of ventilated bins and silos, there were three sources of heat used in different plants for drying grain, viz., electricity, tractor, and oil.

Electricity.

19 of the ventilated bins obtained their heat for drying the grain, and also power for moving the grain, from electricity. The use of electricity involved additional capital expenditure in purchasing electric motors and heaters etc. On the credit side is the convenience of using electricity as a source of heat and power.

The following table shows the average costs of drying and storing grain in ventilated bins and silos using electricity as a source of heat and power.

AVERAGE COSTS OF DRYING AND STORING IN VENTILATED BINS AND SILOS USING ELECTRICITY AS SOURCE OF HEAT

TABLE 4.

	Per ton	% of total
FIXED COSTS	£. s. d.	%
Depreciation	10. 3.	33.3
Interest	7. 8.	24.9
Rent	1. 1.	3.5
Insurances	4.	1.1
TOTAL FIXED COSTS OF DRYING AND STORING	19. 4.	62.8
VARIABLE COSTS		
Electricity (Fuel and power)	8. 2.	26.6
Repairs	10.	2.7
Labour	2. 5.	7.9
TOTAL VARIABLE COSTS	11. 5.	37.2
TOTAL COSTS	1. 10. 9.	100.0

Tonnage dried = 5,842

Average moisture content = 22.2%

Tractor.

10 ventilated bins and silos utilising waste heat from tractors were investigated. Generally, an old tractor was housed in a shed, and was used to drive the fan, the waste heat generated from the tractor being utilised to raise the temperature of the surrounding air.

The following table shows the average costs of drying and storing grain in ventilated bins and silos utilising waste heat from tractors for drying the grain.

AVERAGE COSTS OF DRYING AND STORING IN VENTILATED BINS AND SILOS USING TRACTORS AS SOURCE OF HEAT.

TABLE 5.

	Per ton	% of total
FIXED COSTS	£. s. d.	%
Depreciation	11. 6.	42.2
Interest	8. 7.	31.5
Insurance	2.	.6
TOTAL FIXED COSTS	1. 0. 3.	74.3
VARIABLE COSTS		
Electricity	5.	1.5
Tractor costs	4. 6.	16.5
Repairs	-	-
Labour	2. 1.	7.7
TOTAL VARIABLE COSTS	7. 0.	25.7
Total Cost of Drying	1. 7. 3.	100.0

Tonnage dried = 3,407

Average moisture content = 22%

Using a tractor as a source of heat was found to be more inconvenient than electricity. The tractor needed starting and re-fuelling etc., and it needed more supervision than electric motors. Also, tractors were unreliable for running throughout the night, and the noise was a source of annoyance if they were near to the farmhouse etc. In these plants electricity was used as a source of power for moving the grain.

Oil.

In the investigation only one operator used oil as a source of heat, and the following were the costs per ton of drying and storing grain in this plant.

COST OF DRYING AND STORING FOR ONE PLANT USING OIL AS SOURCE OF HEAT.

TABLE 6.

	Per ton	% of total
FIXED COSTS	£. s. d.	%
Depreciation	1. 0. 6.	49.1
Interest	15. 5.	36.9
TOTAL FIXED COSTS	1. 15. 11.	86.0
VARIABLE COSTS		
Oil	3. 9.	9.0
Labour	2. 1.	5.0
TOTAL VARIABLE COSTS	5. 10.	14.0
Total costs of drying and storing	2. 1. 9.	100.0

Total tonnage = 146

Moisture content = 22%

The running costs of this plant were very low amounting to only 5s.10d. per ton of grain dried and stored. The total costs were high due to the heavy capital investment in this plant. A new building had been erected to house the silos and other machinery. Labour costs were low due to bulk handling facilities being available. This plant was designed to reduce labour requirements during harvest time; and it needed little supervision.

PLATFORM OR IN-SACK DRIERS.

The chief merit of this type of drier is that the installation costs are very low, and it is also simple in construction so that much of the work of erection can be carried out by the farm staff. This type of drier is suitable for the small man, where the high capital costs of the continuous and ventilated bin types of drier would be prohibitive. This type of drier has the drawback of requiring considerably more labour in handling the corn, and also there is no means provided of storing the grain when dried, so that provision for this must be made separately. These plants are suitable for the grower of small acreages of cereals who has existing granaries or storage space for his grain. If storage silos and cleaning and conveying equipment have to be purchased, the capital cost per ton will be almost as high as that for the larger plants.

Cost of Installation.

In the investigation, only three driers of this type were costed, and the capital cost of installation worked out at an average of £5 per drying grid. In these plants, there was no need to do any alterations to the existing buildings, so that the capital expenditure consisted of purchasing a platform upon which the sacks were laid, and the heating unit which provided the current of warm air for drying purposes.

Operating Costs.

The operating costs of in-sack driers are somewhat high, in comparison with ventilated bins, where storage facilities are also available. The following table shows the cost of drying grain in each of the three plants investigated.

COSTS PER TON OF DRYING BY THREE IN-SACK DRIER PLANTS.

TABLE 7.

	Plant "A"	Plant "B"	Plant "C"
FIXED COST	£. s. d.	£. s. d.	£. s. d.
Depreciation	5. 0.	6.	11. 8.
Interest	3. 9.	4.	8. 9.
TOTAL FIXED COST	8. 9.	10.	1. 0. 5.
VARIABLE COST			
Electricity	10. 9.	-	9. 10.
Tractor	-	6. 1.	-
Coke	-	-	3. 9.
Repairs	3.	7.	-
Labour	1. 6.	2. 3.	2. 2.
TOTAL VARIABLE COSTS	12. 6.	8. 11.	15. 9.
Total Cost of Drying	1. 1. 3.	9. 9.	1. 16. 2.
Amount of grain dried (tons)	78	380	63
Moisture content	22%	22%	22%

It will be noticed that the fixed costs per ton in plant "B" were very low indeed; this was due to the fact that a large tonnage was dried with this plant, whilst in the other two plants the amount of grain dried was much smaller.

It must be remembered that the labour costs are for drying alone, and no account has been taken of the extra costs of handling the grain during

storage. It is probable that the costs of drying using an in-sack drier plus specially built storage facilities would exceed the costs of using ventilated bins or continuous driers where the grain can be handled in bulk.

CONTINUOUS DRIERS.

The seven continuous driers costed were of varying makes and sizes, the smallest having a throughput of eight cwts. per hour, whilst the largest was capable of drying four tons per hour. All the driers included pre-cleaning and grading equipment. Six of the machines used oil for fuel, whilst one used electricity. Electricity was used on all plants to supply power. All the installations had storage facilities of one kind or another, either in bins or silos, or using sack storage in existing buildings or granaries.

All the driers had substantial throughputs, ranging from 116 tons in the smallest plant to 1,155 tons in the largest. The total tonnage dried was 2,638 tons of which 2,137 tons were stored.

Driers of this type are most suitable for the larger farms. They are capable of handling a large amount of grain and are not economically operated on a small throughput, due to the high capital costs of installation.

The average size of farm on which these plants were was 525 acres, and an average of 268 acres of cereals was grown per farm.

Costs of Installation.

The capital costs of installing a continuous drier and the necessary storage, depends on the size of plant and the amount of storage required. The capital cost of the drier and its auxiliary equipment again usually accounts for the major part of the cost of drying. So it is, therefore, most important to match the size of the drier to its expected throughput, and so avoid unnecessarily high overhead costs.

The capital expenditure varied from £1,000 for a small plant capable of drying eight cwts. per hour, with the grain stored in sacks in an existing building, whilst another plant capable of drying three to four tons per hour, and storage room for 450 tons of grain in silos, involved a capital expenditure of £10,000.

Operating Costs.

Below are given the average costs of drying and storing per ton in each individual plant investigated.

INDIVIDUAL COSTS OF DRYING AND STORING
BY SEVEN CONTINOUS DRIER PLANTS

TABLE 8.

Per ton

Plants	A	B	C	D	E	F	G
	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.	£. s. d.
FIXED COSTS							
Depreciation	7. 7.	14. 7.	12. 6.	1.10.11.	2. 7.	1. 9.	3.11.
Interest	5. 8.	11. 0.	9. 5.	1. 3. 2.	2. 0.	1. 4.	2.10.
Rent	2. 7.	-	-	-	-	2. 1.	-
Insurance	-	-	5.	-	-	-	9.
TOTAL FIXED COST	15.10.	1. 5. 7.	1. 2. 4.	2.14. 1.	4. 7.	5. 2.	7. 6.
VARIABLE COSTS							
Electricity	3. 9.	2. 5.	3. 4.	1. 1.	10.	8.	8.
Oil	-	3. 9.	7. 5.	4. 1.	1. 7.	2. 6.	6. 9.
Repairs	-	2.	1. 6.	-	-	1.	10.
Labour	7. 3.	6. 0.	4. 2.	3. 7.	4. 0.	3. 1.	4. 9.
TOTAL VARIABLE COST	11. 0.	12. 4.	16. 5.	8. 9.	6. 5.	6. 4.	13. 0.
Total Costs	1. 6.10.	1.17.11.	1.18. 9.	3. 2.10.	11. 0.	11. 6.	1. 0. 6.
	cwts.	cwts.	tons	tons	cwts.	tons	tons
Drying capacity per hour	8	13	2	4	15	3	1
Tonnage dried	116	260	250	450	153	1,155	254
Moisture content of wet grain	21%	24%	25%	22%	20%	20%	23%
Moisture content of dried grain	17%	14%	15%	14%	15%	16%	15%
Method of storing	sacks	silos	silos	bins	sacks	sacks	bins

The photograph on the cover and Plate I show a ventilated bin type of grain drying and storage plant which was constructed on a farm of 210 acres growing an average of 90 acres of corn annually. The plant is installed in two bays of an existing dutch barn and comprises of three 30 ton concrete bins. Drying is carried out by means of a fan run by a tractor which is housed in a shed. The elevators used are portable ones. This plant dried 173 tons of grain during the 1954 harvest. The installation costs were £8. per ton of storage capacity. This type of plant is ideal for installing on a mixed farm which grows cereal crops, and where there is no storage space available for the dried grain.

The photograph on Plate II shows an in-sack drier, with a tractor used to drive the fan. The platform is housed in a Nissen hut, and the grain is stored "in-bulk" in some other Nissen huts which are available for this purpose. During the 1954 harvest this plant dried 380 tons of grain. Such a plant is ideal for the grower of a small acreage of cereals, or a mixed farm where the acreage of cereals grown is small, who has existing granaries or storage space for the grain. The chief merit of this type of drier is that the installation costs are very low, and it is also simple in construction so that much of the work can be carried out by the farm staff. The installation costs work out at approximately £5. per drying grid.

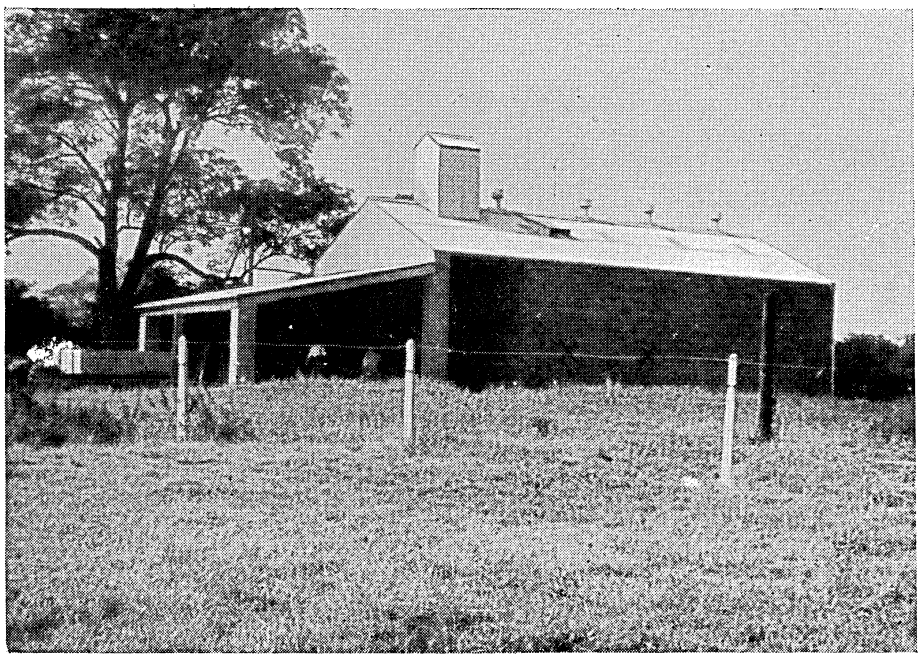


PLATE III

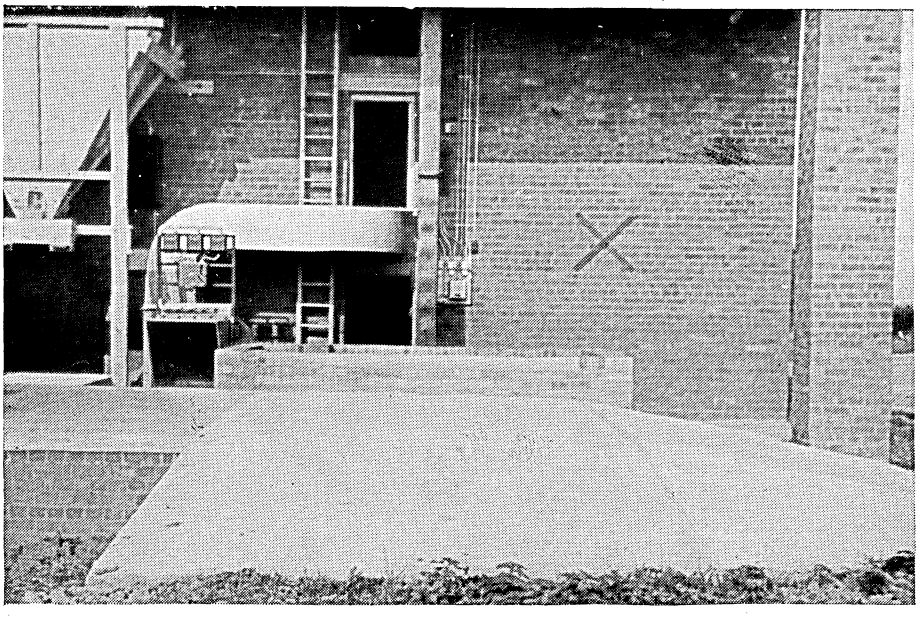


PLATE IV

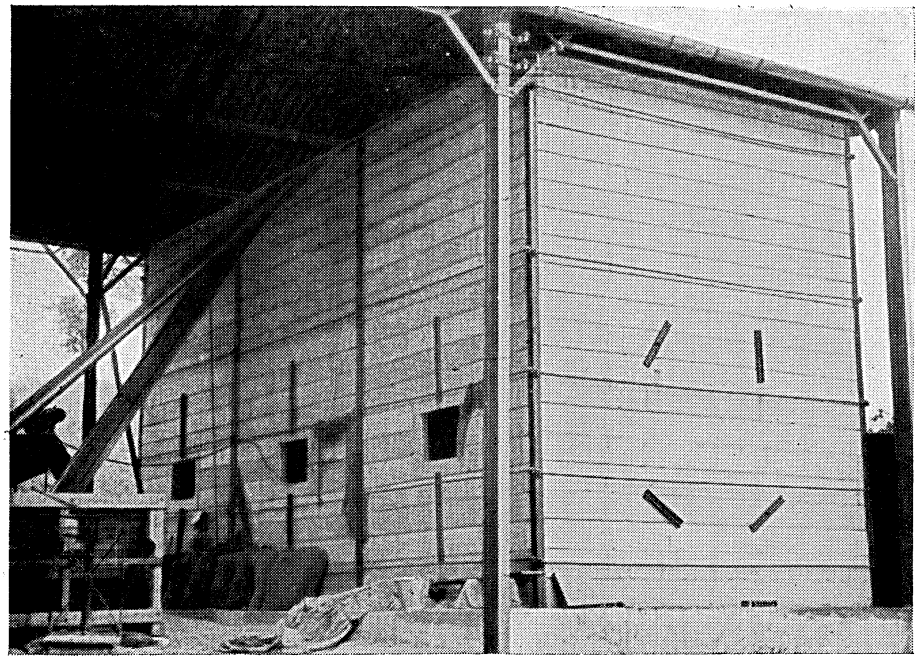


PLATE I

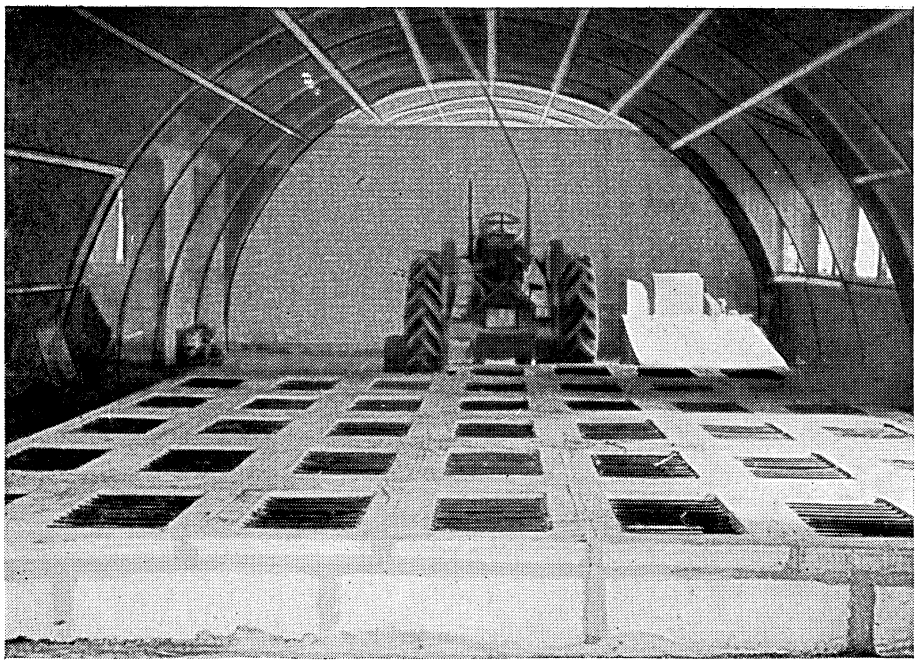


PLATE II

Plate III shows an entirely new building set up as a ventilated bin drier. This plant is capable of storing 300 tons of grain. The installation costs were low due to the fact that the farm staff did most of the work in building this plant, except the skilled work required. The source of heat for drying the grain is electricity.

Plate IV shows the bulk handling devices on the above plant. Lorries or trailers can be reversed to the receiving pit which is situated under a leanto shed, the grain can then be tipped into the pit and is then elevated and conveyed into the ventilated bins. The bulk handling of grain reduces labour costs appreciably, and no labour is required to handle heavy sacks of grain. The plant is capable of running on its own with periodic supervisory inspections.

It will be seen that the fixed charges on average account for more than 60% of the total costs. Fuel accounts for 19% of the total, and labour 11%, whilst the other items are of minor importance.

EFFECT OF THROUGHPUT ON FIXED COSTS PER TON.

Graph D shows the cost curves incurred by three ventilated bin driers each with a maximum storage capacity of 200 tons. One plant was a new building put up solely for drying and storing grain, whilst the other was an existing dutch barn converted for this purpose, and the third plant was an existing building converted by farm labour into a ventilated bin drier. The construction cost of the new building per ton of storage was £15.10s.0d., and that of the modified dutch barn was £9, whilst that of the modified building cost £7.10s.0d.

The average variable cost of drying and storing 200 tons of grain has been taken as 9s. 8d. per ton.

It can be seen from the graph that if only 100 tons of grain were dried and stored in the new building, the fixed cost per ton would be 73s. 4d., but if the maximum storage capacity of 200 tons were used, the fixed cost per ton is reduced to 37s.

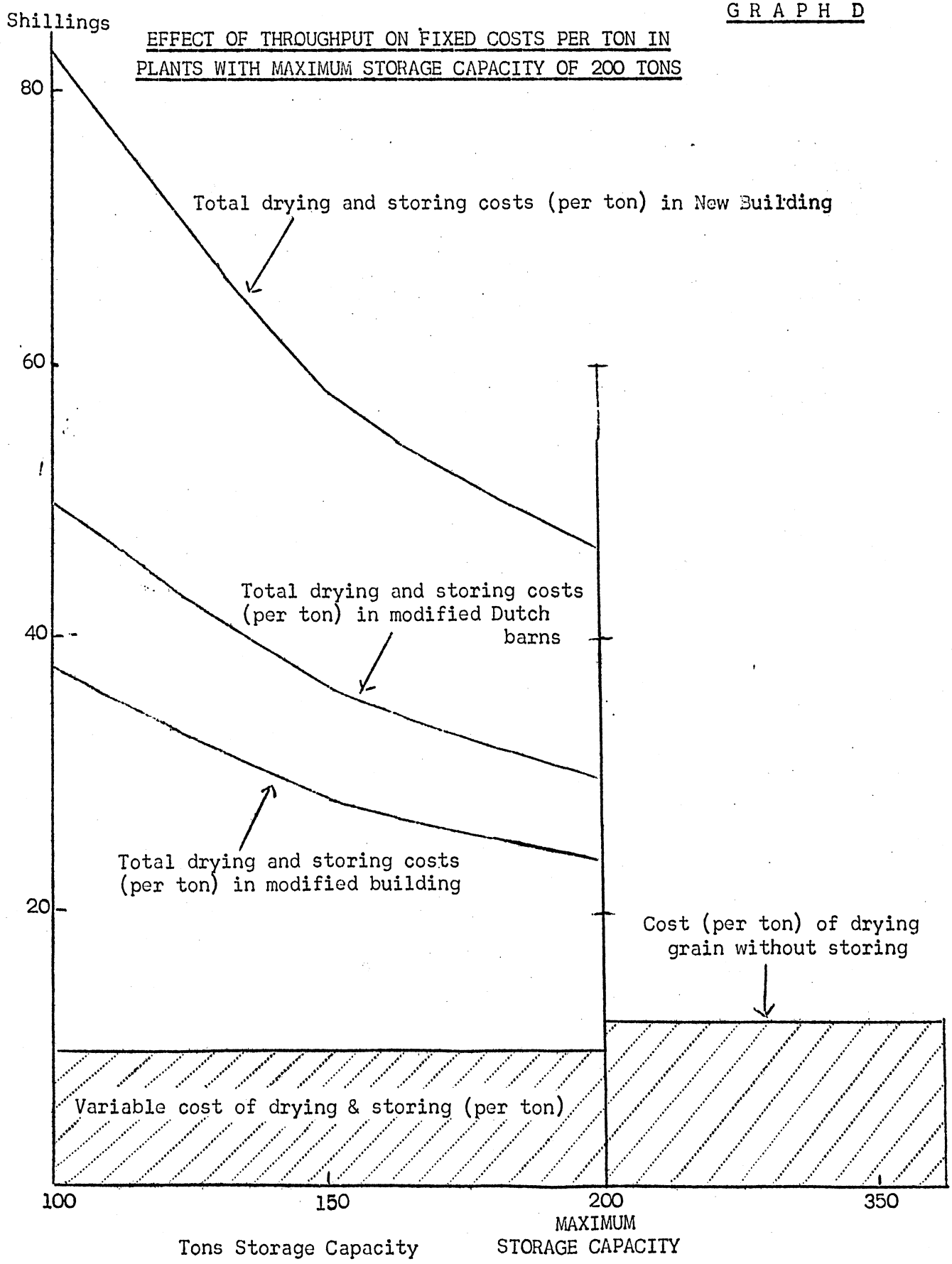
In the case of the converted dutch barn, the fixed costs per ton with a throughput of only 100 tons would be 40s. 1d. With using the maximum storage capacity the fixed costs per ton are reduced to 20s. 4d.

In the modified building, the fixed cost per ton with a throughput of only 100 tons would be 28s., but with using the maximum storage capacity of 200 tons, this is reduced to only 14s. 4d. per ton.

Thus by increasing the throughput of grain to the maximum capacity of the plant, the fixed cost of drying and storing per ton can be reduced to the minimum possible. It is, therefore, most important to match the size of the drier to its expected throughput, and so avoid unnecessarily high capital costs. It is possible to dry a greater tonnage of grain than there is actual storage capacity for, and some plants did this; one plant with a storage capacity for only 200 tons actually dried 493 tons. This was made possible by keeping a number of bins for drying grain only; the bins were emptied as soon as the grain was dry, thus making room for other grain that required drying. The dried grain was sacked off and either stored elsewhere on the farm or sold off.

The variable cost of drying the extra grain without storing was increased by 2s. 4d. per ton. The additional cost was due to the fact that labour was required to sack off the grain and power needed to empty the bins etc. No fixed costs are allocated against this extra grain dried, as in constructing ventilated bins the majority of the costs are incurred in the erection of storage space, so the fixed costs have been allocated against the grain that has been stored in the bins.

GRAPH D


Shillings
EFFECT OF THROUGHPUT ON FIXED COSTS PER TON IN PLANTS WITH MAXIMUM STORAGE CAPACITY OF 200 TONS
80
60
40
20
Total drying and storing costs (per ton) in New Building
Total drying and storing costs (per ton) in modified Dutch barns
Total drying and storing costs (per ton) in modified building
Cost (per ton) of drying grain without storing
Variable cost of drying & storing (per ton)
100
150
200
350
MAXIMUM STORAGE CAPACITY
Tons Storage Capacity

DOES IT PAY TO INSTALL GRAIN DRYING AND STORING EQUIPMENT?

To the farmer who combines his grain, there are three courses of action open for him to follow as regards the disposal of his grain. Firstly, he can sell his corn straight off the combine to the merchant. A very high proportion of the harvested grain comes on to the market at this time, and consequently, the price is low, and the farmer having no drying and storage facilities is not in a strong bargaining position. Also the farmer will not be able to take advantage of any enhanced prices that may be obtained by storing the grain for some time. Selling the grain straight off the combine usually means that some of the grain is wet, and this was the case during the 1954 harvest. The farmer usually has to meet the drying charges and also the charges of transporting the grain to the drier, and the farmer is paid on the weight of dried grain and not wet grain.

Secondly, the farmer may decide to have his grain dried and stored by a contractor such as Recommissioned Mills Ltd. Here he will be able to take advantage of the guaranteed seasonal increase in the price of stored wheat and any other increase in price that may be obtained for barley and oats.

Lastly, the farmer may decide to invest capital on his own drying and storage plant. Many farmers may feel that the capital cost of storage is not worthwhile, when the future of grain growing does not look as good as it did a few years ago.

This problem of storage of grain can be divided into two classes. Firstly, we have that of the large cereal producer whose problems call for carefully planned installations; secondly, we have the smaller cereal growers and mixed farmers, whose problems can be answered largely by improvisation.

The specialist cereal grower has many possible answers to his problems these days. Silos will almost certainly be one answer, and the type selected will largely be a matter of preference and economies between steel, timber, and other materials. In making the decision, however, the farmer must not be led away by elaborate installations, the cost of which is out of all proportion to what can be achieved.

The small grower can improvise, and make a few alterations to existing buildings so that his small tonnage can be stored in bulk or in sacks.

The following budget is designed to show whether the capital expenditure on drying and storage equipment can produce a genuine saving and a

probable increase in revenue which covers the annual cost by a substantial margin. The budget makes a comparison between the costs incurred by drying and storing on the farm, and that incurred by having the grain dried and stored by a contractor.

It is assumed that the farmer grows 300 tons of grain annually, of which 100 tons is wheat. The capital cost to alter an existing dutch barn will be approximately £12 per ton capacity, a total capital expenditure of £3,600.

Cost of drying and storing grain on the farm.				Costs incurred in having grain dried and stored by Contractor.	
		£.	s.		£. s.
Fixed costs	£			Contract drying by Re-commissioned Mills Ltd. 300 tons @ 43s. per ton for grain @ 22% moisture content.	645. 0.
Depreciation	240				
Interest @ 5%	180				
Insurance	30	450.	0.		
Variable Costs of drying 300 tons grain from 22% to 14% moisture content				Storage of wheat @ 6d. per ton per week (91¼* tons for 30 weeks)	68. 8.
	£. s.			Transport of grain to drier at 10s. per ton	150. 0.
Electricity 8s.2d. per ton	122.10.				
Repairs 10d. per ton	12.10.				
Labour 2s.5d. per ton	36. 5.	171.	5.		
		621.	5.		
Net Savings in Costs		242.	3.		
		863.	8.		863. 8.

* 100 tons of wet wheat delivered for drying. Deduction for loss of weight in drying, handling and storage = 8¾% for grain of 22% moisture content, therefore leaving 91¼ tons of wheat for sale.

The budget shows a net saving of £242 by installing a plant for drying and storing grain on the farm, rather than getting the grain dried and stored by contractors. From the above, it can be seen that the capital expenditure

can produce a genuine saving and a probable increase in revenue which covers the annual cost by a substantial margin.

The increase in receipts by storing the wheat until the following May will be £5 per ton, i.e., 91¼ tons at £5 = £456. 5s. in each case. Also the farmer may be fortunate in obtaining an increase in price for the rest of the grain if he stores it, and in the above budget we have not charged for storing the other cereals by the contractor.

If the grain is fed to livestock on the farm, there is the convenience of having it suitably stored to be considered. If the grain stored by the contractors is required for feeding purposes on the farm, the cost of transporting the grain from the drier to the farm will have to be borne by the farmer himself, thus involving the farmer in additional costs.

From the above it is seen that it is an economic proposition for the larger farmer to invest his capital in a grain drying and storing plant. For the smaller farmer, improvisation of existing buildings to store grain, and the installation of an in-sack drier may solve his problems.

The farmer who is about to embark on the purchase of a combine must also consider purchasing a drier as well, and it is useless to install a drier unless storage is available for the grain. It is for this reason that the ventilated bin type of drier now seems to be gaining in popularity for the larger farms; for this is essentially a storage plant with relatively inexpensive drying equipment.

COSTING METHODS.

1. Fixed Costs.

Interest

In a number of cases the cost of new drying and storage equipment is paid for by the farmer himself. In such cases no interest will be actually paid on the capital so invested, but by purchasing this equipment the farmer is foregoing the interest it would have earned for him if invested elsewhere. Therefore, in calculating the costs involved in capital investment it is convenient to treat them as if they were financed by borrowed money on which interest was paid. In this investigation interest at 5% has been charged.

Depreciation.

The depreciation of grain drying and storage equipment will arise through use and deterioration when not in use. The process may be rapid or may be slow but eventually the installation and equipment will be worn out and valueless. Depreciation will also arise through

obsolescence. A new design may render the old plant obsolete, so that it is no longer an economic proposition to use it. Though it may be reasonable to assume that obsolescence is a relatively unimportant consideration with grain drying and storage plants, especially the storage part, it may be of considerable importance if less grain is grown in the future.

It is difficult to assess a reasonable charge for the cost of depreciation. This is due to the variation in the use made of the plant from year to year. If the same amount of depreciation is charged every year, the cost per ton of grain dried will be comparatively low when throughput is large but in a dry season the cost per ton will appear excessive, due to the fact that a smaller tonnage of grain has been dried.

In this investigation a life of 15 years is assumed. To calculate the working life of a drier is difficult, as few have been in use long enough to provide a basis for assessing it. The charge is calculated by the following formula.

$$\frac{\text{Capital cost}}{15} = \text{annual cost of depreciation.}$$

Rent.

Where tenant farmers had drying and storage facilities installed by the landlord, the actual rent charged was used in the costings. On some farms where the tenant installed the equipment and the landlord did any structual alterations that were needed, depreciation and interest was charged for the equipment and the actual rent charged by the landlord for the alterations was included.

Insurance.

Only a very small proportion of the farmers insured their drying and storing plants. The annual premiums on these farms were included in the costs.

2. Variable Costs.

Manual Labour.

The variable costs consist of labour, fuel and repairs. Labour was charged as follows, unless the farmer paid more than the standard rate, when the full amount was charged.

Per hour.	s. d.
Men	3. 0.
Youths	2. 0.

Tractor Labour.

Tractor work performed was charged at one of the following rates, according to the classification of the tractor (inclusive of fuel).

	s.	d.	
Small petrol tractor	3.	8.	)
Small T.V.O. "	2.	5.	)
Small diesel "	1.	7.	)
Medium T.V.O. "	2.	9.	) Per hour
Medium diesel "	1.	9.	)
Large T.V.O. "	3.	1.	)
Tracklayer "	3.	5.	)

Fuel)
) charged at actual cost to the farmer.
Repairs)

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