THE FERTILISER ASSOCIATION OF IRELAND

"Fertiliser Handling and Distribution"

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FERTILIZER ASSOCIATION OF IRELAND

MANUFACTURERS POINT OF VIEW

(By J.E. Leonard, Grassland Fertilizers Limited)

INTRODUCTION

The fertilizer industry is essentially a distribution industry — from the extraction of the necessary elements from some source on the earth, their intermediate processing, and eventually to the end user, the farmer.

In common with all industry, the fertilizer manufacturer is faced with enormous annual cost increases, which, when combined with falling prices and, in consequence, declining profits, naturally encourages one to look for savings in areas which are initially within the indivuals control. The distribution function which, as already mentioned, cuts right across every level of our industry is one area where fertilizer manufacturers must pay particular attention to new developments and trends in the increasing need to reduce costs and, at the same time, maintain and improve service to their customers — the wholesalers and farmers.

This paper takes a broad look at current methods of fertilizer handling, with emphasis on solid fertilizers, and endeavours to evaluate the main methods of solid fertilizer handling and relate these to the needs and aspirations of the Irish Fertilizer Industry.

Handling of solid fertilizer

A recent survey (1978) of fertilizer handling in industrial countries carried out by the Agricultural Committee of I.S.M.A. showed that the greater portion of fertilizer handled on farm was in 50 kg 'free bags.' However, in addition to indicating increasing use of liquid fertilizer, particularly in U.S.A., the survey showed that there is a trend (more prevalent in certain countries) towards farmer handling of solid fertilizers in bulk and in large disposable bags.

It should be remembered that, when comparing methods of fertilizer handling in various countries regard must be taken of the reasons which historically have led to the adoption of different methods. For instance, climatic conditions, methods of transport, type of agriculture, farm size, crops, political, economic and commercial conditions, etc., all play their part in the eventual trend(s).

Different methods of fertilizer handling

The farmer has to apply the necessary nutrients to the soil. By far the most common method in the world to-day is to broadcast the fertilizer in solid (pelletised) form. Alternative methods of application are in the liquid form, e.g., liquid ammonia (NH_3), Solutions / NH_3 (Urea Ammonium Nitrate), clear solutions, and suspensions (liquid mixes of P.K.'s and N.P.K.'s). Indeed it is in the general area of 'liquid fertilizers' and their application that most technological advances has been made in recent times. However, the use of liquid fertilizers is considered less suitable for use on grassland and its development, if any, should occur in arable farming. This subject is in itself far ranging and outside the scope of this paper. Suffice to say it has been mentioned and apart from a nominal — almost experimental — quantity of Urea/ Ammonium Nitrate used in recent years all chemical fertilizer used in Ireland to-day is in solid form.

Bagged material on pallets, shrink wrapped

The use of pelletized fertilizer in Ireland had its origin during the 1960's, synonomous with the emergence of Granular and Concentrated Compound Fertilizers and the consequent decline of powder fertilizer. In this context the plastic bag replacing the paper and 2 cwt. Jute bags was a revolutionary factor.

The modern sophisticated plants could chemically stabilise and dry the finished product to a very low moisture content, thus preventing further conditioning and caking in storage. The manufacturer found that the finished product could be stored out-of-doors in plastic bags with a minimum of cover (in this case also plastic) without impairing its shelf-life. bagged product could also be moved to customer's premises (yards) and/or to farm headlands during the low season thus reducing logistical and supply problems previously encountered during the peak season.

One particular problem with plastic bags is in their handling when wet. This led to concern for employee safety when stacking on site and load stability on lorries. Furthermore, in the early 1970's the cost of labour in Ireland rose significantly, and the palletized load with its attendant mechanisation became the standard method of handling bagged fertilizer. Later on the shrink-wrap hood was an added factor to safety and load stability in addition to facilitating storage out of doors.

To-day although blended fertilizer products are a feature of the Irish Fertilizer scene, owing to advances in research and technology, the blended product when properly treated can be confidently stored in plastic bags for long periods. However, it is advisable to store fertilizer under cover owing to risk of decomposition due to ultra violet rays or temperature from sun's rays. Most shrink wrap hoods contain an ultra violet inhibitor to obviate this danger.

Republic of Ireland

There are nine fertilizer manufacturers in the Republic of Ireland. Two have C.C.F. plants, two have Granulation and Blending Plants, the remaining five have blending plants only.

Except for Straight Nitrogen all our fertilizer raw materials have to be imported from abroad in one form or another, and 'assembled' into the required formulations.

The manufacturer has to plan raw material intake, production, storage, and offtake over an entire season to cope with the farmer demand in Spring. The ideal would be to produce the Finished Product as near as possible to the time of use thus eliminating or reducing cost of storage and working capital.

However, apart from the unavoidable costs of working capital and physical storage, other factors such as conditions of storage, handling, compatability of various materials, moisture uptake, physical characteristics and chemical stability require the manufacturers attention.

The less handling bulk fertilizer product receives the less exposure it will have to atmosphere and the less moisture will be absorbed — in Irish climatic conditions of high relative humidity this is particularly true. In recent years compound fertilizers are becoming more and more concentrated. In many cases — particularly in High Nitrogen Compounds — they contain Ammonium Nitrate, which, in certain conditions, is highly susceptible to moisture uptake. In N.P.K. Compounds, moisture can trigger off chemical reactions which lead to formation of crystals and hence, 'setting' or 'caking' of the product.

Three main methods of solid fertilizer storage, distribution and transport will be considered with particular reference to the scene in Ireland, namely:

- Bagged material or pallets, shrink wrapped.
- Bulk material delivered to the farmer.
- Disposable big bags or 'Intermediate Bulk Containers' (I.B.C's).

Bagged material on pallets, shrink wrapped

At present virtually all fertilizer manufactured in Ireland is packed in 50 kilo heat sealed plastic bags, which are handled by the manufacturer on two tonne pallets, shrink wrapped to customers (Merchants and Co-Operatives) who like the manufacturer, invariably have fork-lift equipment to handle palletized goods.

Approximately 80% of fertilizer is dispatched to the farm on pallets where the bags are usually removed from the pallet on arrival. Thus it can be assumed that some 95% of fertilizer used in Ireland is handled on the farm in 50 kilo 'free bags.'

Advantages

1) The manufacturer can 'convert' solid raw materials almost directly from the process plant to the 'bagged state' without incurring the expense of intermediate bulk storage.
2) The system of handling and distribution can be 'streamlined'. We can achieve greater capacity with less labour thus improving overall productivity and efficiency.
3) The conventional heat sealed plastic bag offers sufficient protection from the atmosphere to obviate moisture pick-up by the material — thus prolonging the shelf-life of the product.
4) The product can be packed two tonnes per pallet which can be safely stacked 3 (in some cases 4) pallets high. Pallets measure 5'x4', thus 6 to 8

tonnes can be stored in an uncovered area of 20 square feet.

5) Storing the bagged product in the open saves the expense of covered storage. The product can also be moved to Merchant's/Co-Operative's premises and possibly onto farm headlands outside the peak season.
6) This method facilitates transport by road and rail.
7) As far as the retailer and farmer are concerned, the 50 kilo bag, pallet, and mechanical handling equipment are largely 'conventional' when other types of farm supplies and product are considered.

Disadvantages

1) The manufacturer has to invest in pallets, and maintain specialised equipment for palletizing and handling.
2) The pallet is returnable and problems associated with its consignment and eventual return to the manufacturer must be faced. Thus cost of administration is high.
3) The modern pallet is heavy for the farmer to handle and the cost of specialised equipment for handling bags on pallets is prohibitive to most farmers.
4) The human (physical) and time (cost) factors in handling 50 kg. bags on the farm and into the spreader.

Bulk material delivered to farm

In Ireland at present only a very small quantity of fertilizer is delivered to farms in bulk — approximately 3 to 4% of total. This is accounted for mainly by one Merchant, who, in addition to having a bulk blend facility, offers bulk delivery and a spreading service to farmers. A large Co-operative Society has also tried to introduce bulk delivery to farms, also some farmers and sprading contractors who live close to manufacturing points choose to collect in bulk, e.g., some growers of Sugar Beet.

It can be concluded, therefore, that there is a slight trend towards an increase of the handling of fertilizer in bulk in Ireland.

It is interesting to look at the development of bulk fertilizer usage on farms in other European countries, notably Denmark, Western Germany, Netherlands, and Sweden where bulk usage now accounts for 75%, 50%, 30%, and 25% respectively and is showing signs of steadily increasing. It is important to note that in all these countries where bulk fertilizer is gaining in popularity the predominance of a major manufacturer is evident who is adding an important additional impetus to this particular method. On the other hand, bulk handling to farms in the U.K. is static at only 2% of the total — mainly contractor application.

The main constituent of bulk handling in W. Germany is the fertilizer warehouse, owned by the retailer (Merchant or Co-operative), where profitability has three essential pre-requisites,

i) Very careful planning,
ii) Low cost construction of premises,
iii) 1½ to 2 transits per year.

As far as Ireland is concerned it would appear that, should there be an increasing trend in bulk fertilizer delivery to farms, it will eminate from two basic methods of agriculture.

Firstly, on arable crops, where the retailer/blender is also likely to provide a spreading service.

Secondly, on intensive grassland farms where P.K. Compounds and Straight Nitrogen will be stored in a bulk silo on the farm for application as required. This trend is the more likely on larger farms where fertilizer usage exceeds 80 KgN (or 6 bags C.A.N. 27½ % N) per acre.

Reasons given for the general increase in popularity of bulk fertilizer include:

— Lower prices for bulk product,
— Labour saving aspect/convenience,
— Improved physical quality of fertilizer,
— Development of equipment and techniques adapted to bulk materials.

The principal disadvantages of bulk handling include:

1) Additional cost of investment in storage facilities and bulk handling equipment by the manufacturer, by the retail trade, and by the farmer.
2) The large number of formulations that complicates the bulk conditions and the danger of deterioration due to excessive handling and/or poor storage conditions.
3) The susceptibility of certain compounds to atmospheric conditions and the danger of deterioration due to excessive handling and/or poor storage conditions.
4) The relatively large number of farmers who cannot afford to fully mechanise fertilizer handling. (In many cases it may not be economically justified).
5) the disadvantage to a farmer, who has not got bulk storage facilities on the farm, to carry out fertilizer application immediately on receipt of bulk delivery.

A transition from the present method of bagged, palletized product to bulk deliveries ex-manufacturing points would not be possible to any great extent without substantial investment in intermediate storage (premises and equipment) at central distribution locations.

Disposable big bags or intermediate bulk containers (IBC's)

The use of I.B.C.'s has been advocated as a preliminary step in the transition from the conventional 50 kg bag toward bulk distribution. This form of package was known in the early 1970's but so far has gained little or no acceptance in Europe, except on a small scale in France and to some extent in Norway and Sweden where it was under commercial introduction by the major fertilizer manufacturers themselves. It has also found use for transport of fertilizer by ship, for subsequent delivery by bulk or bagging at the port of destination. This mainly applies to shipments to developing countries where labour costs are relatively low. It has also been experimented with by the Irish Sugar Company, who handled approximately 500 tonnes in this manner last season.

The capacity of the I.B.C. is usually 500 kg or 1000 kg. The 500 kg are mainly one-way (non-returnable) bags of woven polypropylene with an inner polythene bag. Handles for mechanical lifting are attached. Some 1,000 kg bags can be recycled, there is a valve type opening in the base of the bag to control the flow of the material. In this context the term 'disposable bag' is a misnomer. However, it appears that the 500 kg size is the more popular.

Advantages

1) This method outweights some of the disadvantages of the palletized system, as far as the returnable pallet itself is concerned.
2) It also has some merit compared to bulk handling systems which are more suited to the larger type of farms.
3) It is claimed that economically this system can compete with palletised material and bulk material where small farms are concerned and practice has shown that most farmers can handle the I.B.C. with their existing equipment.
4) It would appeal to the human factor at farm level by eliminating the 'drudgery' of physically handling 50 kg bags.

Disadvantages

1) As far as a manufacturer is concerned, the handling of I.B.C.'s at the factory has definite disadvantages compared with palletized material. For instance, they are slower to fill and require more storage space.
2) A very high level safety factor has to be built into the container which makes it expensive. The cost of a 500 kg bag is approximately £3.50 or £7.00/tonne compared to £5/tonne for cost of 50 kg plastic bags, shrink wrapped and palletized.
3) Like bulk handling, the I.B.C. system would require investment in intermediate storage depots with specialised filling and handling equipment.
4) It would appear that if any saving accrues from this method it would not occur at the manufacturing point. Rather it would likely accrue at farm level where a time saving may be effected in the area of loading the spreader.
5) It would also be important that store and farm personnel receive adequate instruction and training in measures and precautions required in the handling of bulk fertilizers with particular reference to hygroscopic fertilizers and relatively large volumes such as contained in I.B.C.'s.

Summary and Conclusions

1) There is at present only one major system of handling fertilizer *on the farm* in Ireland, namely in 50 kg free bags.
2) There is a slight trend towards bulk usage and there is little evidence of a trend towards the big bulk container, the latter more of an experimental nature.
3) Palletized handling of bags (50 kg) by the manufacturer to the retailer and *to the farm* continues to be the standard method presently adopted by the fertilizer industry in Europe, except in certain countries where a definite trend towards bulk usage has been largely influenced by the manufacturer.
4) Any major change from the present system of 50 kg bags to either bulk or large bags would require considerable investment in intermediate storage and handling equipment.
5) If application by the farmer in bulk or from large bags were to develop in Ireland the large range of compound formulae presently on the market would have to be reduced to avoid complications in intermediate stores.
6) Farm size and activity are important factors in determining the economics of type of fertilizer handling at farm level. In Ireland the average size farm would not seem to warrant such investment.
7) Apart from the human and cost aspects of changing to alternative systems of fertilizer handling other factors such as, type of fertilizer used and climatic conditions should have consideration.

Today, the Irish Fertilizer Industry has developed the most advanced and sophisticated method of handling bagged fertilizer in the world. It is quite an advance from the 2 cwt. (190 kilo) bags of the early 1960's!

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FERTILISER HANDLING & DISTRIBUTION

THE FARMERS' VIEWPOINT

(By Ken Price, Irish Farmers' Association)

INTRODUCTION

Employed labour on farms can be expected to continue to decline and as such farmers will become owner occupiers, and will seek for themselves higher standards of safety and also a more comfortable and convenient working environment. Technology will continue to develop and materials handling will play a crucial role in the development of agriculture. Increased profit can only come from increased productivity and this in turn implies increased mechanisation. Many of the old chores on farms, such as work surrounding sugar beet, has long since been overtaken by mechanisation and in the recent past milk collection has gone over to bulk on a widespread scale. More recently the big bale for both hay and straw has been introduced and has been a great success.

All these developments have taken place in the materials handling area, and it is quite clear that there is a very substantial market for methods which can reduce onorous and tiresome tasks on a farm.

Indeed, it could be said that if the fertiliser manufacturer did not distribute their product in a manner that was attractive and convenient to farmers, there must at the margin be an overall loss of sales as a result of this.

Increased mechanisation and automation generally require a very consistent and usually high standard of raw material in order for the scheme to operate satisfactorily. It has been a problem up to now that different brands of fertiliser can vary enormously in physical quality and some brands can vary in quality from year to year. Currently, there are no specific regulations governing the physical quality of fertiliser offered for sale, although there are very detailed and comprehensive regulations governing the chemical composition of fertilisers. Clearly any proposals to further mechanise fertiliser handling and distribution will place a great strain on the quality control aspect of fertilisers.

The fertiliser manufacturing companies in Ireland introduced quite some time a standardised two ton shrink wrapped pallet for the distribution of their product. Certainly it was a very progressive idea to introduce this scheme

which now dominates the distribution pattern of fertilisers in Ireland. However, the two two pallet whilst it may well be highly suitable for the factory environment and the road and rail distribution network and facilities, it is not at all an attractive scheme so far as the farmer is concerned, as the farmer does not have facilities to handle two ton pallet on a farm. With regard to development it should I feel be borne in mind that farms in Ireland have a rather unique structure and any developments in this field should be along the lines of an Irish solution to an Irish problem, rather than an attempt to import a solution from some other country where farming conditions may well be fundamentally different.

The main differences in agriculture in Ireland are the pattern of mixed farming which requires a considerable number of different types of fertiliser to be used throughout the year, the problem of fragmented holdings and outfarms, which inevitably pose problems for a highly automated mechanised scheme. Lastly the fact that the average farm size here is relatively low which would seem to render unfeasable some of the more sophisticated solutions which have been adopted elsewhere and which would only be suitable for very large farms.

Alternative handling techniques

With regard to the big bag or two ton bag, this would appear to have very little application in Ireland. Firstly, there would be virtually no existing equipment on Irish farms capable of lifting it and it could not be envisaged that this equipment would be in widespread use in the foreseeable future. It would imply that fertiliser would have to be bought in units of two tons and there would be an off loading problem, as the two ton bag on being opened would not fit into any combined drill or spreader. It would have to be put into some form of intermediate hopper from which it could be drawn off into the combine drill or spreader as required. In any event any farmer who had equipment capable of handling a two ton big bag would probably be quite happy with the present regime of having his fertiliser on two ton pallets.

With regard to the small bag or half ton bag, this is certainly very much more attractive to the farmer than the two ton bag. However, only something around 25% of the existing combine drills would be capable of taking the full contents of the half ton bag in one lot at the time the bag would be punctured. Even at that it would seem to be quite difficult to off-load the bag evenly into a 3 metre wide drill.

Thus the half ton bag would not seem to be very attractive to the tillage farmer, although they may well have an application for the grassland farmer. There may also be problems with on-farm storage of these small bags with regard to stacking them and it would appear that a larger surface area may be required to store a given quantity.

With regard to bulk fertiliser in the context of on-farm storage bins, there would be a relatively sizeable capital cost which would not appear attractive to a farmer at the present time to purchase and locate satisfactory storage facilities which would be weather proof. In addition there may well be problems with corrosion of bins and a problem of logistics of handling fertiliser in respect of a farmer who perhaps already had feed bins which he

proposed to use for fertiliser during the appropriate season as the seasons would in fact overlap. Also in the context of mixed farming, there might be a problem of compounds left over from a previous operation being left in a storage bin which it was required to take delivery of a different compound. On-farm storage would also put great pressure on the storage properties of the material particularly the anti caking properties and further research might need to be done to identify coating materials and techniques, which would be suitable for use with bulk fertilisers stored in on-farm storage bins. In addition the bulk fertiliser would have the disadvantage of not being suitable for small farmers, or farmers with outfarms or awkwardly shaped holdings, where the yard in which the storage bin could be located would not be adjacent to the land on which it was required to spread the fertiliser.

In so far as the tillage man is concerned, seed would still have to be handled in bags anyway so that bulk fertiliser would not be a universal solution to his material handling problem.

On the positive side however, bulk is probably more attractive than either the small or big bag and the most obvious possibilities for development of bulk fertiliser ae in situations of medium to larger sized farms which are very intensively farmed. This would seem to imply nitrogenous fertilisers and the sugar beet sector because of the intensiveness of the latter.

50 kg bags

The 50 kg bag is the most flexible system in that an infinite range of quantities can be handled under this scheme, and it suits the pattern of mixed farming, fragmented holdings, outfarms and small farms etc. Clearly there will always be a substantial market in Ireland for bagged fertilisers because of these features which will not be overcome in medium term. However, the existing 50 kg bag is really a very unattractive item to handle. The philosophy of palletisation on two ton pallets tends to break down at farm level in that the fertiliser although delivered by the merchant on two tons pallets is off loaded on to the floor of a farmers shed. It then has to be handled numerous times from that point onwards. It is really a two man operation to load bags off the floor of a storage shed on to the trailer which will take them out to the field where they will be used. As has already been pointed out there is less and less labour now available now available on Irish farms and the second man to assist with this task is just not there. This particular problem is overcome by some farmers by the farmer collecting the fertiliser direct from the merchant with his tractor and trailer on the pallets and then bringing them straight out to the field where they will be loaded directly into the spreader or corn drill etc. This however cuts down the possible range of suppliers which a farmer using this device would have, and also waste a considerable amount of time going to the local distributor each day during the season when the farmer would wish to use fertiliser.

It should be borne in mind the farmer has to handle these 50 kg bags twice and even this is assuming that they have been off loaded from the distributors lorry into the farmers' storage shed by staff of the distributor. The solution to this problem of the very unattractive weight of a 50 kg bag would appear to be to introduce a lighter bag, perhaps of either 35 kg to 40 kg. While there would

in the short term be a disruption in the standard unit of measurement which is now so well established, it is considered that this measure will be necessary and notwithstanding the increased cost of packaging materials in order to make it attractive for fertiliser to be utilised by farmers.

Summary

There will always be a substantial demand for bagged fertiliser in Ireland, but there is an urgent need to reduce the weight of the bag in the short term. With regard to long term developments, bulk fertiliser seems to offer the best possibilities but it might require considerable capital investment at farm level, which investment might not be well utilised. One possibility for overcoming the extremely low utilisation of on-farm fertiliser bins would be to introduce demountable bins similar to those used by the various waste disposal firms. In this case the bins would of course have lids and be watertight and would have legs which could be set up in a field by the vehicle delivering the bin. A farmer would then be in a position to reverse his corn drill or spreader under the shoot of the bin and fill it up as and when he required it.

When the bin was empty the fertiliser company could send the truck to remove the empty bin and the logistics of this scheme would seem to settle down along similar lines to the way waste disposal firms in the city organise their business.

It would appear to be timely that the fertiliser manufacturers should do some basic market research in this area of the materials handling of fertiliser at farm level and come up with an integrated system which could be offered. It would seem to be beyond doubt that if it was made more attractive for farmers to use fertiliser, they would in fact do so, which would be not only to the benefit of the fertiliser companies themselves and the farmers but also very much to the national economy.

THE HANDLING AND APPLICATION OF FERTILISER IN ENGLAND AND WALES

(By D. A. Bull, Mechanisation Advisory Officer, Agricultural Development and Advisory Service, Silsoe, Bedford)

Since 1970 the volume of gross agricultural product per person engaged in British agriculture has increased by 3½% annually. Reasons for this high level of productivity are the uptake of new technology and the efficient use of machinery. When considering materials handling tasks, for example, farmers are keen to reduce the work load which was once associated with handling crops and commodities and at the same time by using machines they can gain the advantages of precision and timeliness of operation.

This paper is about one aspect of farm mechanisation, the handling and application of fertilisers.

Some 3.8 million tonnes of fertiliser are used in England and Wales each year, costing the farmer about £100 per tonne and responsible for between 40 and 50% of variable costs. Its production is a major consumer of primary energy, Table 1. Consequently it is now widely recognised that fertiliser should be used effectively.

Table 1
Primary energy used in agriculture 1978

	(Petajoules)
Fertiliser manufacture	102
Petroleum	70
Feedstuff manufacture	53
Electricity	33

Source: Dr. D. J. White, MAFF.

Most of the fertiliser used in England and Wales is manufactured by three companies, namely Fisons Fertiliser Co Ltd, ICI Ltd, and UKF Fertilisers Ltd.

These companies have invested large sums of money in manufacturing and distribution facilities.

Fertiliser is dispatched from their factories in 50 kg polythene bags, palletised in units of 30 bags (1.5 tonnes). The pallets are transported by road and rail to depots located throughout the country and the fertiliser is dispatched from these depots to farms during twelve months of the year. In this way the fertiliser manufacturers are able to maintain steady production, the keeping quality of the fertiliser is not at risk and the problems of storing large quantities of this material are shared.

50 kg bags

Handling fertiliser in 50 kg bags has advantages for the farmer as well as for the manufacturer: a wide range of grades is available in this bag; the contents are clearly identified; and the declared weight is ideal for calibration and stock-taking purposes. Storage is straightforward and the system offers flexibility in forward buying. The main disadvantage is that a 50 kg bag of fertiliser is heavy and the package is not particularly convenient for a man to handle.

Palletisation

Although the exact number is not known, many farms in England and Wales are equipped to receive fertiliser on pallets. It has been suggested by a leading authority on this subject that palletisation is worthwhile when a farmer uses more than 30 tonnes of fertiliser annually, but as with most decisions associated with farm mechanisation, individual circumstances must be taken into account. Many self-employed farmers and farms with a limited number of workers have opted for palletisation and the cost of equipment for handling pallets of fertiliser is shared with other handling activities on the farm.

Most farmers have adopted the 1.5 tonne unit load. For this the pallet is dimensioned 1525 × 1225 mm. It is reversible with 2-way entry and costs about £13. An alternative to purchasing pallets outright is for the farmer to hire or lease them from the merchant.

A trend in recent years has been for suppliers to shrink wrap a cover of polythene over the palletised unit of 30 bags. This helps to stabilise the load and makes it more weatherproof.

The benefits of handling fertiliser on pallets are evident when the fertiliser is delivered, when it is stacked into store and when it is loaded out of store onto trailers. Handling rates, using fork-lift equipment, average about 30 tonnes per hour.

Handling Equipment

Equipment used on farms to handle 1.5 tonne pallets includes fork attachments on heavy duty tractor front loaders, tractor fork-lift mast attachments, rough terrain fork-lift trucks and factory fork trucks. Typical specifications for pallet handling equipment are shown in Table 2. Where the equipment is tractor mounted, a secondhand tractor can be used.

Table 2
Pallet handling equipment used on farms

	Lift capacity and lift height	Typical engine power	Approximate price 1980	Comment
Heavy duty front end loader	1500 kg to 20 m	55 kW	£3,000 plus tractor	Poor view of the forks. Not good for precise stacking.
Fork lift mast supported on its own wheels attached to tractor 3-point linkage	1500 kg to 2.4 m	46 kW	£1,000 plus tractor	Lift ram extends beyond top of mast.
Fork lift mast permanently attached to tractor	1500 kg to 3.2 m	50 kW	£2,500 plus tractor	Useful over soft terrain.
Rough terrain fork-lift truck	2500 kg to 3.6 m	46 kW	£11,500	Attachments available for most tasks.
Factory fork truck	2500 kg to 3.0 m	30 kW	£10,500	Uses limited to travel on level 'concrete'.

Flexible intermediate bulk containers (FIBCs)

There has been a steady increase in the use of FIBCs for handling fertiliser since they were introduced in the early 1970s. In addition to the three major manufacturers there are at least 30 smaller suppliers of fertiliser in England and Wales and about ten of these offer fertiliser in FIBCs. They have their own trade names to describe the FIBC handling system, for example Big Bags, Agrobags, Portabulk, Maxipacks and Minibulk. Typical weights being carried in intermediate bulk containers are ½, ¾ and 1 tonne.

FIBCs consist of an outer bag, woven from polypropylene, and an inner liner of polyethylene film which protects the fertiliser from contamination and dampness. The bags are handled with a crane hook and some have lifting loops at each corner, whereas others use the bag itself as the lifting medium.

A typical bag dimension is 1,100 × 1,000 mm high, which elongates to 1,700 mm when it is raised. Bags which are dimensioned to have a dumpy appearance are less likely to fall over, although this shape is less economical on floor space.

Lorries used to deliver 'big bags' are equipped with a crane so that the driver can off-load them without assistance, at a rate of about 1 bag per minute. Care must be taken not to damage the fabric when the bags are handled and if the fertiliser is to be stored more than just a few weeks, the bags should be placed under cover.

Most 'big bags' used on farms are non-returnable and are destroyed after once used. The cost for disposable bags is about £5 for 1 tonne and £3.20 for ½ tonne capacity, that is they cost more than the equivalent number of 50 kg bags, shrink wrapped on a pallet. However, any difference in price is usually shared between the fertiliser supplier, the merchant and the farmer, since there are potential time savings at all stages.

To empty a 'big bag' it is raised above the spreader hopper and the bottom panel and the inner liner are cut to allow the contents to run out. It is an advantage if the capacity of the spreader hopper is greater than that of the bag.

The types of handling equipment used to lift 'big bags' include: Hook attachments on tractors or industrial loaders; and cranes mounted on spreaders or on the tractors used to tow the spreaders. One engineering company now offers a mobile gantry for this purpose. Little physical effort is required when handling fertiliser in 'big bags' and this feature is particularly attractive when the fertiliser is being spread at high application rates.

The time taken to fill a spreader hopper from a 'big bag' depends on how well the job is organised, and times ranging from between 80 kg/minute and 375 kg/minute have been recorded.

This work rate compares with an average of 100 kg/minute when spreader hoppers are filled from 50 kg bags, handled manually.

The 'big bag' system is proving worthwhile for contractors who operate a deliver and spread service, and the fertiliser is delivered a head of the spreading team.

Loose bulk

Some contractors who spread fertiliser in Eastern areas of England, use self-propelled spreaders which have hopper capacities of 5-7 tonnes. These machines are capable of spreading 30 tonnes of fertiliser in a day.

In those cases where the contractor is co-operating with the fertiliser supplier, the material is often supplied in loose bulk, on a day to day basis. Shovel loaders are used to fill the spreader hopper at rates of about 800 kg/minute.

Most farms now have a front loader with a bucket attachment which would enable fertiliser to be handled in loose bulk if it were not for the problems associated with storing these highly concentrated materials.

No progress has been made following attempts to copy the Dutch system of storing fertiliser on farms in fibre-glass over-head hoppers. This has been due to the high capital expenditure involved and the reluctance of merchants to co-operate in setting up a delivery service.

The fertiliser handling system used on a farm will depend to some extent on the scale of the operation and the type of spreader used.

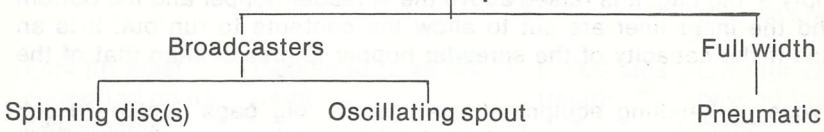
Fertiliser spreaders

In England and Wales granular fertiliser is applied by some 100,000 farmers

with equipment which is straightforward to operate, and capable of applying the fertiliser evenly at a chosen application rate. There is a wide choice of fertiliser spreaders available, both tractor mounted and trailed with prices ranging from £300 to more than £5,000. Many are imported.

It is convenient to classify fertiliser spreaders either as broadcasters or full width machines. Broadcasters use a spreading mechanism which is either a spinning disc or an oscillating spout, whereas most full width spreaders are pneumatic. (Fig. 1)

Figure 1
Fertiliser Spreader



Spinning disc broadcasters

Broadcasters which use either one or two spinning discs rely on centrifugal action to spread the fertiliser. The granules are fed onto the rotating disc causing them to be thrown outwards. Effective spreading depends on the disc being in good mechanical condition, rotating at the recommended speed at the correct operating height above the crop.

Oscillating spout broadcasters

The other spreading mechanism widely used on broadcasters is an oscillating spout. In this case the granules are spread by the action of the spout as it changes direction. An even distribution depends on the spout being in good condition, including the stirrup which is attached at the end of the spout, also the machine should be operated at the correct power take off speed and operating height.

Each pass of a broadcaster leaves a triangular shaped fertiliser distribution patterns and careful selection of the bout width and accurate matching of each bout are essential to achieve an even distribution across the field.

Full width — pneumatic spreaders

Full width — pneumatic machines depend on a different spreading action. Fertiliser granules metered from the hopper are carried along tubes in a high velocity air stream to outlets, which are spaced at regular intervals across a boom. At each outlet the granules come into contact with a spreading plate which causes them to be scattered.

Full width machines produce a rectangular shaped distribution pattern and accurate bout matching is important to avoid the effects of under- and over-lapping. Uneven distribution can be due to misaligned or damaged spreading plates, leaking air tubes and sagging booms. Full width machines are usually 9 or 12 m wide and to aid bout matching they are often equipped with foam blob markers or are used in tramlines.

ADAS Study

In the spring of 1980 the Mechanisation Department of ADAS undertook a study of fertiliser application, by observing 177 machines at work. The results of this study showed that the evenness of fertiliser distribution was outside normally accepted limits in half the cases observed. The accepted limit was taken as C of V = 20% or less.

The information collected in the study indicated that the standard of accuracy would be improved if operators paid more attention to details of operation, such as:

1. Maintaining the spreading mechanism in good condition.
2. Setting the machine at the correct operating height and power take off speed.
3. Selecting the correct bout width and accurately matching the bouts.

Fertiliser quality has an important bearing on the evenness of distribution and the study concluded that the physical quality of the fertiliser was of a good standard. Samples of fertiliser taken at the time the spreaders were assessed were analysed for density and mean particle size. The results of the analysis are shown in Table 3.

Table 3
Fertiliser bulk density (g/litre) and mean particle size (mm)

	Granular (50)	Prilled (97)	Blend (23)
Density (g/litre)	**Mean** 939	**Mean** 971	**Mean** 924
	Range 787-1056	**Range** 859-1023	**Range** 871-1052
Mean particle size (mm)	**Mean** 2.56	**Mean** 2.31	**Mean** 2.56
	Range 2.02-3.29	**Range** 1.80-3.00	**Range** 1.86-2.93

Source: ADAS Farm Mechanisation Study No. 35.

The analysis for size grading was carried out using the quality standard that '90% of the fertiliser shall be greater than 1.4 mm and less than 4.0 mm'. 166 of the 170 samples met this standard.

Liquid fertiliser

About 5% of th nitrogen used in England and Wales is applied in liquid form — non-pressure solutions of solid fertiliser dissolved in water. Factories producing liquid fertiliser are located in the arable areas of England and although liquid fertilisers are less concentrated than the equivalent granular materials, they do have advantages such as simplicity and all movements are made by pumping.

A farm using liquid fertiliser usually has at least one storage tank capable of holding about one-third of the season's requirements. Typical tank capacity is 65 tonnes and the tank may be compartmented to hold different grades. One supplier offers at least 12 grades of liquid fertiliser and the composition of 4 typical grades are shown in Table 4.

Liquid fertilisers are applied with applicators made from corrosion resistant materials. The applicators are often hired from the liquid fertiliser supplier and operating costs can be shared with herbicide application. Tractor mounted, trailed and self-propelled applicators are in use and the liquid is pumped through jets mounted on booms, usually 10-12 m wide. The jets are colour coded to provide a range of application rates. At a typical application of 550 litres/ha a work rate of about 3.5 hectares/hour can be expected. (ADAS Farm Mechanisation Study No. 31).

Table 4. Four typical liquid fertiliser grades

	Kg per 100 litres			Weight %		
Plant nutrient ratio	N	P_2O_5	K_2O	N	P_2O_5	K_2O
1-0-0	33	0	0	26.1	0	0
1-3-0	10	30	0	7.8	23.4	0
2-0-1	20	0	10	16.7	0	8.3
2-1-3	8	4	12	6.8	3.4	10.1

(Source: J W Chafer Ltd)

Stream jets and dribble bars have been developed for conditions where crop scorching may be a problem and their use also helps to reduce the harmful effects of cross winds. The liquid can be placed relative to seeds for some applications for example on potato planters.

Estimation of costs

It is sometimes useful in the Advisory Service to estimate the cost of carrying out mechanised operations and in conclusion examples of costs for spreading granular and liquid fertilisers on a 162 ha farm are shown. The costs are based on the prices of new equipment purchased in 1980.

System 1

A 400 acre (162 ha) mainly arable farm using 60 tonne of granular fertiliser per annum. The fertiliser is in 1 cwt (50 kg) bags, handled 30 bags at a time on pallets,

spread with a trailed broadcaster, hopper capacity 1¼ tonne, which travels back to the farm store to refil. On average, each field receives 2 applications of fertiliser during the year, equivalent to covering 800 acres (324 ha).

Costs:

Labour	£2.20 per hour
Tractor	75 hp (55 kW), price: £10,255. Costed at £5.10 per hour.
Spreader	Price £1,400, depreciated over 6 years @ 20% interest and 5% maintenance charges. Annual Cost: £443.
Tractor fork lift mast attachment	Price £2,000, depreciated over 7 years @ 20% interest and 3% maintenance charges. Annual cost: £546 of which £200 is charged to handling the fertiliser pallets.

Tractor to which the fork lift is attached is charged @ £3.50 per hour.

Pallets	20% interest on the average capital cost of 40 pallets @ £13 each is £52 per year.
Farm storage	The building is charged @ £7 per m^2 per annum and the fertiliser occupies 30 m^2, totalling £210 per year.

Rate of work

The fertiliser spreader has an overall work rate of 8.5 acres/hour (3.5 ha/h) and in addition to the time taken to spread the fertiliser, a worker spends 2½ hours stacking the palletised fertiliser in the farm store.

Annual cost

	£	
Spreader	443	
Tractor for spreader	479	. . . (94 hours x £5.10)
Forklift attachment	200	
Tractor for folklift	70	. . . (20 hours x £3.50)
Operator	212	. . . (96.5 x £2.20)
Pallets	52	
Farm store	210	
	1,666	

That is: £2.08/acre or £5.14/ha

System 2

A 400 acre (162 ha) mainly arable farm using 85 tonne of granular fertiliser per annum. The liquid fertiliser is stored in a twin compartment tank on the farm and it is applied with a trailed sprayer which is hired from the liquid fertiliser supplier. On average, each field receives 2 applications of fertiliser during the year, equivalent to covering 800 acres (324 ha).

Costs:

Labour	£2.20 per hour
Tractor	75 hp (55 kW), price: £10,255. Costed at £5.10 per hour.
Trailed sprayer	Hired for £600 and the cost is shared equally with spraying herbicides
Farm storage tank	65 tonne capacity, price installed: £3,150 Depreciated over 10 years @ 20% interest and 5% maintenace charges. Annual cost: £788.

Rate of work

The trailed sprayer has an overall work rate of 8.5 acres/hour (3.5 ha/h).

Annual cost

	£	
Farm storage tank	788	
Trailed spreader	300	
Tractor	479	. . . (94 hours x £5.10)
Operator	207	. . . (94 x £2.20)
	1,774	

That is: £2.21/acre or £5.48/ha

Note:

Contractors' charges — £2.75/acre for granular
£2.86/acre for liquid

(Farm Contractor, September 1980).