

Mechanical Fertiliser Spreaders for oil palm conditions - Types and costs with emphasis on the TURBO-SPIN air-assisted fertiliser spreader.

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Abstract:

Mechanical spreaders have been used to apply fertilisers under oil palm conditions in Malaysia since the 70s. Through the years, various methods and types of machine designs have been used. These various designs were discussed with particular emphasis on the Turbo-spin air assisted spreader together with different application methods in different conditions. Some costing analysis were indicated.

Keywords: Mechanical spreaders, productivity, spread patterns, cost analysis, spreading systems .

Overview

Fertilisers alone constitutes about 24% of the total production cost of oil palm in Malaysia. The depreciation of the Malaysian Ringgit has drastically increased the costs of production through increases in the cost of fertilisers. It is thus more important that fertilisers are applied properly and in accurate quantities to optimise the up take by palms. Further faced by the shortage of labour in the plantation sector in the country, the job of applying fertilisers in estates has become a very important issue. Not only labour shortage is an issue, the method and quality

of application which affect the final yield and the resultant profitability are prime considerations. It is now no longer a consideration of “will you mechanise”, but rather, “when will you mechanise”.

Some years ago, when estate managers looked at fertiliser application, all they have to decide is whether to go manual, aerial or mechanical. If the decision is to go mechanical, they just call up a few companies and choose the machine with the best value for money - that means the choices were limited. Today, the scenario is different, suppliers have actually gone out and developed machines to suit local requirements rather than the old “You-buy-what-we-have” situation. Today, the planter has a choice of a number of systems, where he can start comparing the cost advantages, pros and cons of one system over another in performance.

This paper will attempt to bring some insights on the various types of tractor mounted mechanical fertiliser spreaders that are used in oil palm plantations in Malaysia. How each of them work and the benefits one can achieve. Individual design characteristics of these machines are discussed and finally we look at some costs experienced by local plantations. The paper will also concentrate into greater detail, the usage of the Turbo-spin fertiliser spreader, that currently, being the most popular spreader in the market.

Methods of fertiliser spreading used in oil palm:

No fertiliser application In the long past, no fertilisers were applied at all, but that is not possible now because plantations need to increase yields, and plants must be fed to get increased yields. It is believed some very steep areas are still not fertilised due to poor accessibility.

Manual labour Manual labour application is still common, this is used in areas where the “justification” of using labour exceeds that of using other means e.g. small areas, undulating areas, areas that are ‘not conducive’ to using mechanical spreaders due to age of palms, accessibility of tractors. Application costs are high when using labour and slow in comparison to mechanical means in flat conditions or wherever it is accessible to tractors.

In the event of labour availability, this is slowly becoming scarce as owners are pressured by both the shortage of labour and having to reduce application costs.

Some companies are placing slow release fertilisers into the ground. While some are placing fertilisers at the bottom of mats or plastic sheets laid at the base of palms. Studies on the viability of these methods are being conducted. Due to the lack of suitable machines to perform these tasks, manual labour is still used.

Aerial Some plantations use aerial spreading, especially in areas inaccessible to tractors and road equipment. Some have gone into it and some have gone out of it. Factors such as high spreading costs/ton using aircraft, wastage of fertilisers falling on tree tops, roads, drains, car roofs and other people’s estate, requirement to prepare landing strips, difficulties in adhering to schedules because of weather, frond scorching etc. are deterrents. However, aerial spreader where possible is faster and definitely the only alternative where field conditions are inaccessible to tractor and any other mechanical means.

Irrigation Some have tried to incorporate fertilisers into their irrigation systems. However it is believed this method has not taken off as a popular means in oil palm due to various other

costs factors such as construction of drains or laying of piping, installation of filtration systems and very expensive fertilisers .

Semi-Mechanical There has been many “semi-mechanical” systems developed by planters themselves to cope with various ‘unique’ conditions . A popular one is to have a trailer drawn by a tractor loaded with fertilisers and carrying a number of workers manually throwing fertilisers onto the sides.

Mechanical Tractor mounted fertiliser spreaders have proven to be the best alternative due to the following advantages:

- Spreading time flexibility, although dependent on weather, but much more flexible than aerial.
- Uniformity in spread
- So far, the lowest cost method
- Minimised labour requirement
- Minimal fertiliser wastage

But in order to get the above benefits, the following are necessary:

- Have trained operators
- Have proper machine maintenance schedules
- Have field conditions conducive to allow tractors enter the field such as clean tractor paths, good headland for turning, etc.
- Have other requirements to complement this system e.g. transport systems, suitable tractors, cranes etc.

It is to be accepted that not all areas in every estate can use mechanical fertiliser spreaders. There are machines developed to go into terraces as well.

Types of Tractor mounted Fertiliser Spreaders

Currently, there are several main types of mechanical spreaders used in oil palm plantations:

Fertiliser drills

Single disc Broadcasters – Centrifugal system

Pendulum or Oscillating Spout Spreaders

Twin disc Broadcasters - Centrifugal system

Turbo-Spin Air-Assisted centrifugal disc Spreader

Fertiliser drills

Tractor mounted fertiliser drills (Pic. 1) has been tried by several plantation groups in Malaysia in the past. The objective is to have the fertiliser drilled into the ground close to the palm base. This will prevent losses and the fertilisers will be discharged slowly into the soil for plant uptake.



Pic. 1 - Drill

In the past, this method has proven to be slow and suitable equipment was not readily available. However, lately several companies have again adopted this method and found it successful agronomically.

Interest in the development of this method is continuing with the availability of slow release fertilisers. Present method of incorporating fertilisers into the ground is done manually, it is hoped that in due course, suitable machines will be designed for its use to suit specific customer requirements.

The Pendulum or Oscillating spout spreaders

Pendulum or “Oscillating spout” spreaders (Pic. 2) use either a “dry” oscillating mechanism or an “oil bath” oscillating gearbox to give the left-to-right swing of the spout. Spread is achieved by the oscillating force of the spout. The harder the spout swings to



(Pic. 2) – Pendulum spreader

one side, the further the fertiliser is thrown from the spout. This is aided by the length of the spout, the longer the spout, the greater the swinging force. With the maximum Spout length of 497mm of an average spreader, the maximum swath is 7.5-8 Metres (24.6-26 ft) - Slightly more with granular form of fertilisers.

It is the common requirement of most estates that no fertiliser are to be dropped onto the tractor path, this is because the tractor paths are compacted and takes a lot longer for fertilisers to become available to the palm roots. Furthermore, fertilisers are also picked up by tractor wheels, human and animal feet, etc. and taken to areas where they are not needed e.g. to the mill or tractor yard. Washout also occurs during rain on compacted ground. Reports have come from estates that as much as 30% of fertilisers still drop onto tractor path using the pendulum system.

It is inherent in the design that the oscillating gearbox suffers from over loading and frequent breakage once the spout is clogged up with moist fertilisers.

Spinning Disc type broadcasters

In Europe, the spinning disc “broadcaster” has been the most cost effective and simplest machine used to spread fertilisers. Usually, it is a single disc but to get a wider spread area, twin discs with the same principle, were introduced. Popularly used in rice crops, golf courses, grass land and areas where a blanket cover of spreading is desired.

Two basic types of spinner disc spreaders are available:

Single disc spreaders

Single disc spreaders (Pic. 3) are the cheapest and of the simplest construction. It consists of a single spinning disc with a number of spreading vanes. The disc spins in one direction and fertiliser is thrown out as a result.



(Pic. 3) – Single disc spreader

Fertiliser is thrown to give a blanket cover, not only palms on the right and left of the machine gets the fertilisers, the tractor path will also get the same quantity of fertiliser thrown. Without proper deflectors to direct the fertilisers towards the ground, powder fertilisers generate a high level of drift before they land on the ground.

Twin disc spreaders

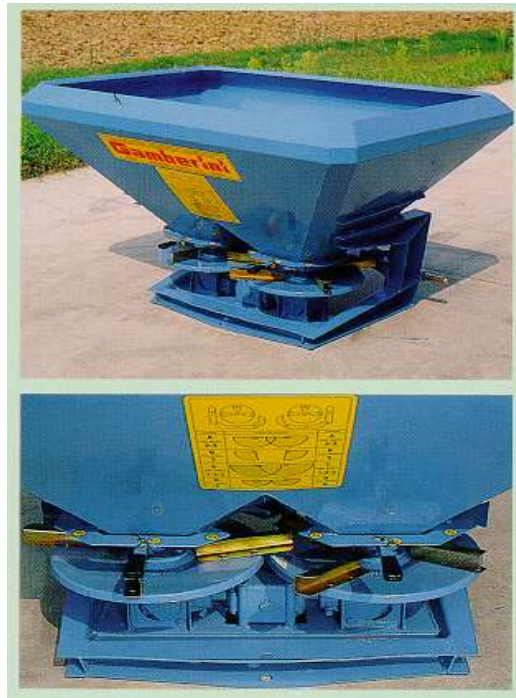
Twin discs spreaders (Pic. 4) are more complicated in the design. The construction of the unit usually requires the use of 3 gearboxes – one central gearbox to drive two more gearboxes on the left and right, each with a spinning disc synchronised to spin in opposite directions.

Since the twin disc design essentially works similarly as the single disc spinner design, it is able to cover a wider swath, but fertiliser is still distributed to give an even blanket cover.

However, the quantity of fertiliser discharged to the left and right hand side can also vary by controlling separate levers.

Some manufacturers have designed chutes at the rear of the spinning discs to direct fertilisers to the sides instead of dropping onto the tractor path and

these were much more successful. Essentially, this type of spinners achieve the throwing distance through high speed spinning discs.



(Pic. 4) – Twin disc spreader

Turbo-Spin air-assisted spreader

Turbo-Spin air-assisted spreaders (Pic. 5) were introduced into the market some 7 years ago, it was developed entirely in Malaysia specifically for oil palm conditions.



(Pic. 5) – Air assisted spinning disc spreader

It is a spreader with single disc spinning within a chute chamber. The difference from the single disc spinners mentioned above is that the discs have vanes specially designed with air suction fins to generate a powerful air flow. Spreading is thus through centrifugal force assisted by air blast to give a much further throw. A swath of 5M to 25M is possible depending on the type of fertiliser used through the incorporation of fertiliser deflectors. One can adjust the deflectors on the chute to vary the direction of throw. The specially designed spinning disc uses both short and long vanes to give an even spread throughout the distance covered. Because a chute chamber is used, no fertiliser is dropped onto the tractor path.

Due to the high air flow, fertilisers in powder form tend to drift to greater distances. In this case, the side deflectors have to be reversed such that the powder fertilisers can be directed downwards towards the ground.

The Turbo-Spin may be used in 2 ways:

- Conventional 2-row system – one palm row on each side of the tractor
- 4 row system – 2 palm rows on each side of the tractor

2-row system

This is the conventional way of spreading fertilisers to achieve results similar to the pendulum and single/twin disc machines. Fertiliser is placed at the base of the palm row by using deflectors on the spreader to limit its throw. The advantage is that the tractor need to run at a very low engine speed to achieve this.

Some agronomists still do insist on spreading fertilisers this way for the following main reasons:

- Height of frond piles or interior vegetation such as nephrolepis .
- That they do not wish to have fertilisers landing onto the trunk of the palm.

4-row system

The concept of a 4 row spread must not be mistaken that ALL fertiliser can be thrown to cover the palm base of 4 rows of palms. As mentioned, only certain large grained fertilisers can be applied this way. This method of spread was conceived by planters that should fertilisers be thrown far enough into the frond row to give an even spread inside the middle of the frond path, fertilisers can then become available to 4 rows of palms instead of 2 because of the wide-spread fibrous root system of oil palm.

If this is acceptable to the estate, then one pass in every two can be skipped thereby creating tremendous savings in the number of passes per hectare. This is achieved if alternative paths are used in different rounds of spreading to even up.

The plantation manager can use either the 2-row system or 4-row system, he is given the choice.

For soft ground conditions and single terraces

Smaller turbo-spin spreaders have been developed for use with 20-45 HP mini tractors with different configurations for use in different field conditions.

Twin side spreading (Pic. 6) :

Small tractors fitted with suitable high floatation wheel equipment can be used to access peat or soft soil conditions where the larger tractors cannot go.

These are used to spread fertilisers on both sides.



(Pic. 6)–Two side spreading using a mini tractor

Rear or one side discharge only (Pic. 7) :

Small tractors can be used to access single terraces where the terraces have been made to at least 12-16ft wide. The unit will discharge fertilisers towards a single side or when rotated towards the rear, fertiliser is thrown towards the base of the single palm



(Pic. 7) – Rear discharge for single terraces

rows. The rear discharge chute is fitted with deflectors to deflect fertilisers horizontally towards the left or right hand sides of the terraces depending on the direction of travel.

Mechanical spreader accessories that can improve productivity :

Some plantation groups have devised various attachments to enhance their mechanical spreading costs, one of such is the crane attachment (Pic. 8). The crane is specially designed to mount onto the back of the tractor 3-point linkage, then the spreader is attached to the rear of the crane.



Pic. 8-Using a crane with a spreader

This combination will necessitate the fitting of an auxiliary hydraulic services control valve to the tractor hydraulics to enable both the crane and the 3-point linkage to function properly.

These cranes will lift a specially supplied 500 kg bag and fill the spreader hopper in one go. By doing this, the complete operation will require only one person i.e. The tractor operator. Considerable costs savings are achieved.

Bunch Ash spreader

The bunch ash spreader (Pic. 9) was developed to handle bunch ash that will be difficult to be used with a normal fertiliser spreader due to its poor-flowing characteristics and bulk. Normal inorganic fertilisers are about double the weight of bunch ash, as such



Pic. 9-Spreader for bunch ash and decanter cake

a much larger container is required to contain the ash to save turn-round time .

Although bunch ash is a very cheap source for K and has high pH neutralising properties for acidic coastal soils, its use may be limited due to the difficulty in sourcing bunch ash.

Spread pattern of various types of spreaders:

In summary, the simulated chart (Chart. 1) below shows the approximate pattern generated by the various machines described above.

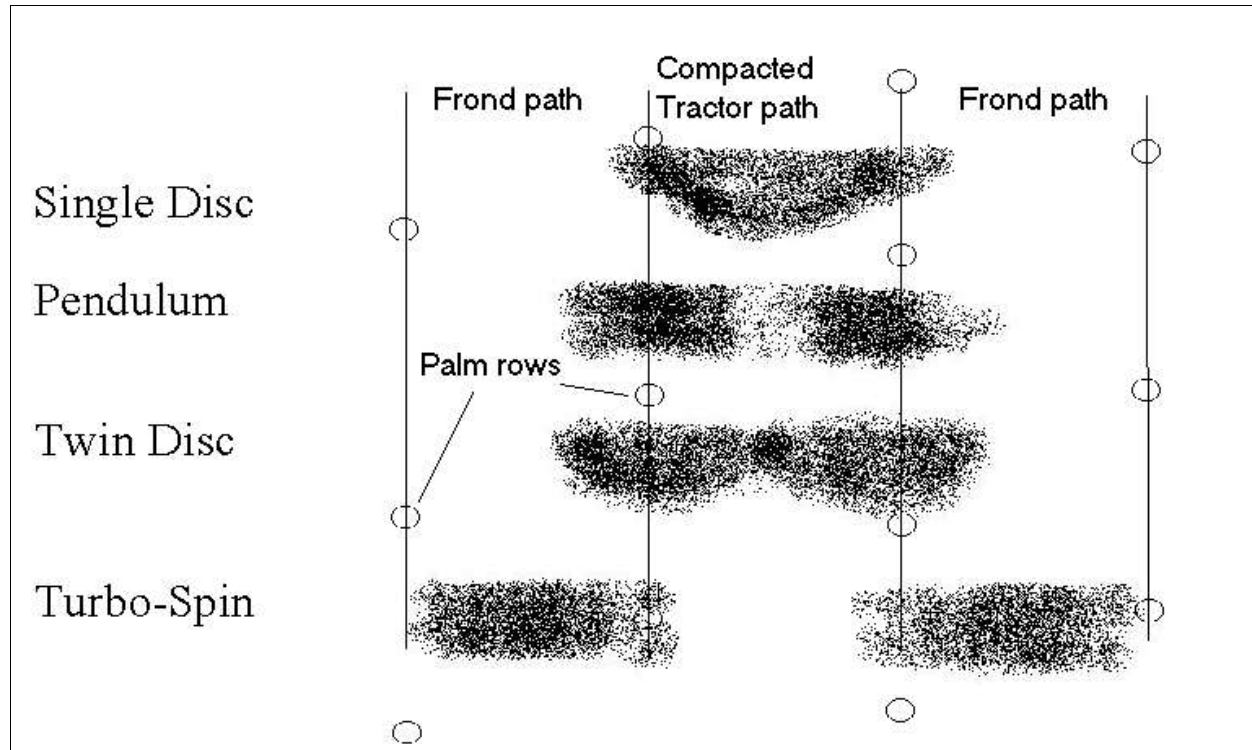


Chart 1 – Simulated spread patterns of various types of spreader machines.

Requirements for mechanical fertiliser application:

Performance of the mechanical fertiliser spreaders depends on the following conditions

- Dryness of the fertiliser used
- Type of fertiliser used , the grain size, density etc. e.g. powders, granules, crystalline etc.
- Quantity of fertiliser thrown (Rate per palm)
- Field conditions - density and height of frond pilings and inter-row vegetation.
- Height of implement mounted on the tractor during work
- Tractor PTO speed
- Operator skill

Cost Analysis

Data from various estates have been collected over the years in Malaysia, these costing cover the use of all the methods mentioned above viz. Manual labour, the single disc, Twin disc, pendulum and Turbo-spin models doing 2-row or 4-row systems wherever possible.

A general range of figures have been derived but only average figures are presented in Table 1. We have used a range of figures rather than single average figures because of differences in field conditions, fertiliser types, methods used in costing, and varying labour rates from estate to estate. Those figures for tractors used with cranes are strictly with 500kg bags while those without cranes used 50kg bags.

Factors considered :

Tractor and implement running and repair costs only, capital costs not included

- Cost of skilled tractor driver on 8 hour normal work day full time spreading
- Cost of labour to load and unload fertilisers
- Cost of transport of fertiliser to field from store
- Rates of work based on an average of 6 km radius
- Areas relatively flat, very suitable for mechanisation
- Fertilisers used include AC, MOP, AN, Urea, AS etc
- Normal rates per palm at 1.5 - 3.25 - Averaged 1.7 kg/palm

(Table 1) Comparison of average cost and productivity

	Manual method	2-row system		4-row system	
		W/O Crane	W/Crane	W/O Crane	W/Crane
Capacity per day (Hectare/day)	Approx. 3.25	31	to 45	42	to 54
Cost/hectare	RM5.38-9.80	RM4.26	to RM3.39	RM 3.20	to RM2.00

As can be seen from the average figures derived above, substantial savings may be achieved with mechanical system over the manual system, and with the use of crane and suitable large grain fertilisers, the 4 row system can further reduce spreading costs over the 2 row system. Since the 4 row system will require large grain sized fertilisers, its use may be limited.

Some agronomists agree to its use and some do not - we leave it to the user to determine if they want to adopt a 2 row or 4 row spreading system.

Conclusion

No one single mechanical spreader system described above can meet all the needs of the oil palm plantation industry because of the different terrain and field conditions available, but by careful consideration over the set of field conditions an estate has, a suitable system(s) can be selected that will not only be cost efficient but also able to achieve optimum performance. The plantation manager may need to select a large machine with a high horsepower tractor for optimum efficiency on the flatter areas and a small, narrow machine with mini tractors to work on the terraces, or a light weight unit with a small tractor with special high floatation tyres to work in soft conditions.

Currently available mechanical spreaders are used mainly for matured palms or at least palms that have sufficient frond clearance to allow fertilisers reaching close to the palm base. However, in immature areas, the fronds still close to ground level will prevent proper fertiliser

placement near to the base of the palm. Also, the young root system has not grown sufficiently to take up fertilisers that are thrown in between the palms and are thus wasted. Further development in this area is still required.

It can be seen that compared to the manual labour, the mechanical spreader is more productive. It can spread fertilisers more evenly and at a consistent speed, the time taken to complete the entire spreading programme is shorter.

Mechanisation demands that planning for its involvement must start right from land clearing, field preparation, infra-structure design to the final stages of production. Paths and terraces must be ready for tractors to go in and work at comfortable speeds. Careful considerations must be given to equipment selection, maintenance, their proper use and trained operators and mechanics must be at hand to perform these tasks.