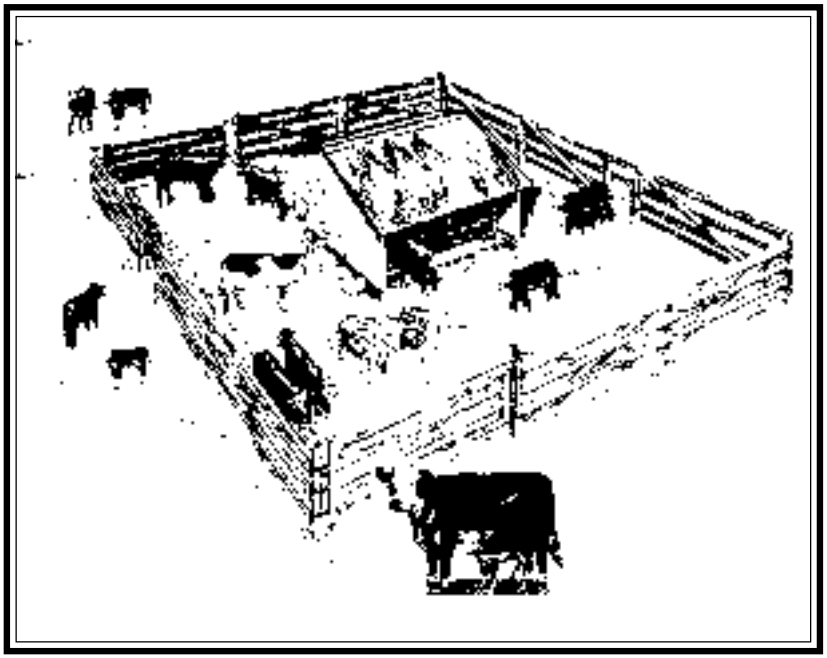
Department of Agriculture and the
Agricultural and Rural Development
Research Institute, Fort Hare

USING KRAAL MANURE AS A FERTILISER



W. van Averbeke and S. Yoganathan

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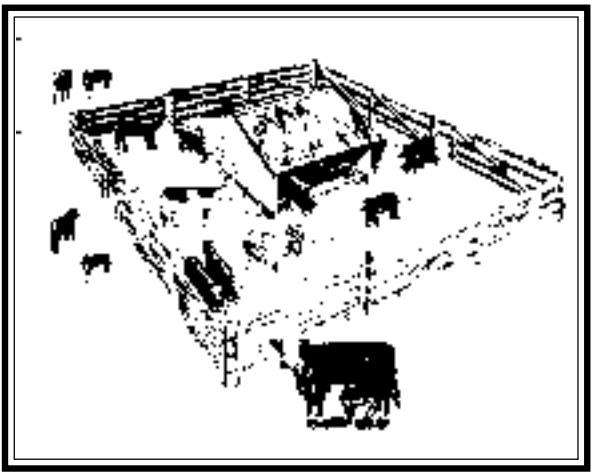

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Contents

Kraal manure as fertiliser

Plants need water and nutrients to grow well

- All plants need water and nutrients to grow well.
- Water and nutrients are extracted from the soil by the roots of plants.
- Soil water removed by plants is regularly replaced by rain or by means of irrigation.
- In forests and grasslands nutrients taken up by plants are returned to the soil mainly through a process of decaying litter.
- Dead plant material such as leaves and stems accumulate on the soil surface, where it decays or decomposes. The nutrients contained in this plant litter is returned to the soil.
- On cropped land most plant material and the nutrients contained in it is removed from the land in the form of grain (eg maize and sorghum), leaves (cabbage and spinach) or other plant parts (potato, pumpkin).
- In order to maintain healthy growth of crops it is necessary to replace the nutrients that have been removed by the crops. Replacement of nutrients is achieved by means of fertilising the soil.

Chemical fertilisers versus manure

In South Africa most large-scale farmers use chemical fertilisers on their soils. These fertilisers are bought in bags from fertiliser suppliers.
In the rural areas chemical fertilisers are not easy to come by. One often has to travel to town to find a supplier. Chemical fertilisers are bulky and heavy. Getting these from town to your village or farm is cumbersome and you may have to pay for the transport.

Chemical fertilisers are also too expensive for many households. Yet, without fertilising your garden or field soil, the crops you plant will not grow very well and you will most probably be disappointed with the yields, especially considering the amount of work you have invested in tending your crops.

There are, however, alternatives to the use of chemical fertilisers. One alternative is kraal manure. Before the introduction of chemical fertilisers, farmers all over the world, including those in South Africa, made use of manure to restore the fertility of their lands. Many farmers turned to chemical fertilisers because these fertilisers are more concentrated than manure and easier to handle with mechanised planting equipment (labour saving). Another reason is that the quantity of manure available on large farms is usually insufficient to fertilise all the land that is being planted to crops. However, when cropping a small area only, the available supply of manure may be quite adequate and the work involved with transporting manure to the lands not too difficult to handle.

The kraal as a source of manure

- In rural areas the most common source of manure is the kraal.
- The kraal is an enclosure in which livestock are kept during the night, providing protection against theft and wild animals.
- The excrement and urine of livestock in the kraal accumulate on the floor of the kraal forming a layer of manure.

- Manure is essentially organic material consisting of the residues of plants that were digested by the animals housed in the kraal.

Which nutrients are the most important?

The main nutrients a plant needs are nitrogen, phosphorus and potassium.

Phosphorus

In most South African soils phosphorus is the most deficient nutrient. This means that if you would have to choose between the application of either nitrogen, phosphorus or potassium, your crop yields would show the largest increase when phosphorus is applied to the soil.

Nitrogen

Nitrogen is usually the second most deficient nutrient and once you have taken care of the phosphorus needs of your crops, you can expect an additional increase in yield by applying nitrogen.

Potassium

In many parts of the country the amount of potassium stored in the soil is considerable and applying potassium may not always result in higher yields. Over time, however, continuous cropping will also deplete the potassium reserve in the soil, making it necessary to fertilise the soil with this nutrient in order to maintain high yields. In high-rainfall areas or where the soils are sandy, the quantity of potassium stored in the soil is usually low and fertilising with potassium may be necessary from the start.

Does manure contain all the important nutrients?

In this booklet the focus is on the use of manure only. The strategy of combining manure with mineral fertiliser will therefore not be discussed.

- Manure contains all the nutrients a plant needs, but not always in the desired proportions.

- Chemical analysis of kraal manure shows it to be quite high in potassium and relatively low in phosphorus and nitrogen. That is unfortunate, because phosphorus and nitrogen are the two nutrients soils are most deficient in.
- There are two ways of addressing this problem.
  - One can apply enough manure to meet the nitrogen and phosphorus needs of the crops. This will result in the supply of more potassium to the soil than is needed, but it is not really harmful.
  - The alternative is to combine the use of manure with mineral fertilisers. By doing so the rates at which manure needs to be applied (amount of manure per unit area of land), is much reduced. However, most mineral fertilisers have to be purchased, requiring you to spend money.
- As was indicated earlier, the supply of phosphorus is most crucial. Some of the most common sources of mineral phosphorus are chemical phosphates, such as superphosphates, bonemeal and rock phosphate.
- Bonemeal and rock phosphates release phosphorus very slowly. The beneficial effects are not as immediate as those of chemical phosphates, but are longer lasting, therefore reducing the need for regular addition.
- Manure is an organic fertiliser and unlike in chemical fertilisers, the nutrients that are present in manure are not immediately available to plants.
- In order to release these nutrients and make them available to plants, the manure needs to be decomposed or broken down.
- In the soil manure is decomposed by very small organisms. These organisms are usually too small to be seen with the naked eye, but they are always present in the soil. The application of manure and other organic matter increases their numbers.
- The soil organisms break down manure rapidly when the soil is warm and moist.

- When the soil is dry, cold, or both, decomposition takes place at a much slower rate. Therefore, if you apply manure to your soil in winter, when the soil is cold and dry, little may happen to the manure. But as soon as the weather warms up and rain adds water to the soil, the manure will be broken down rapidly and within a few days nutrients are released to the soil, where they can be reached and absorbed by plant roots.
- The release of nutrients occurs over quite a long time and during this period increasing quantities of plant nutrients become available to your crop.

Are soil tests necessary?

Many commercial farmers send their soils for testing to a laboratory. The technicians then determine the nutrient content of soils.

When sending samples to a soil test laboratory farmers are asked which crops they intend to grow on the lands from which the samples were taken. This information and the results of the soil tests are used by expert advisors to formulate a fertilisation programme.

Farmers will receive a letter informing them which fertilisers to apply and the rates at which the fertilisers need to be applied to ensure optimum growth of the crops and high yields.

Having your soil tested is a good idea, but it does not come cheaply. A complete analysis of one soil sample may cost you more than R100 and many of you may not have that kind of money to spare. We will therefore assume that you will not send your soil to a laboratory for testing.

What is the nutrient content of manure?

At the University of Fort Hare manure samples from many different kraals in central Eastern Cape were analysed.

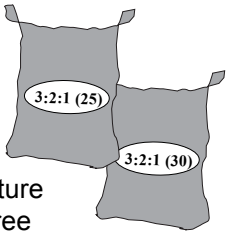
On average a fully heaped modestly compacted wheelbarrow load of kraal manure was found to contain 0,6 kg nitrogen, 0,2 kg phosphorus and 0,8 kg of potassium. The manure contained in the wheelbarrow had a mass of about 75 kg, comprising about 15 kg of water and 55 kg of dry manure.

The wheelbarrow that was used, was the one commonly used by builders to mix cement. It is the type with the high sides, not the gardener's wheelbarrow with the low sides.

Understanding the formulas used in describing chemical fertiliser mixtures

In South Africa chemical fertiliser mixtures are described by means of a formula. This formula is printed in bold on the bag containing the fertiliser mixture. An example of a formula of a fertiliser mixture is 3:2:1 (25). The (25) component of the formula indicates the concentration of the combination of pure nitrogen, phosphorus and potassium present in the fertiliser expressed as a percentage. Practically, it means that in every 100 kg of 3:2:1 (25) fertiliser mixture there is 25 kg of pure nutrients consisting of a combination of nitrogen, phosphorus and potassium.

The higher the number in brackets, the more concentrated the fertiliser mixture will be. A 50 kg bag of 3:2:1 (30) fertiliser will contain more nutrients than a 50 kg bag of 3:2:1 (25) fertiliser and will, as a result, also cost more. The 3:2:1 component of the formula indicates the proportion of nitrogen, phosphorus and potassium in the fertiliser.



In the case of fertiliser mixture 3:2:1 (25) the mixture contains 25 % pure nutrients in the proportion three parts nitrogen, two parts phosphorus and one part potassium.

A useful chemical formula for kraal manure

Kraal manure can be described by the same formula used to describe chemical fertiliser mixtures. In the central areas of the Eastern Cape the average formula for kraal manure was found to be 3:1:4 (3). The (3) indicates that in every 100 kg of manure there is a total of 3 kg of pure nutrients, consisting of a combination of nitrogen, phosphorus and potassium. The 3:1:4 component of the formula indicates that in manure these nutrients occur in the ratio three parts nitrogen, one part phosphorus and four parts potassium. From the (3) in the formula of kraal manure it is obvious that the concentration of nutrients in kraal manure is not very high.

For example, when compared to the chemical fertiliser mixture 3:2:1 (30) the nutrients in kraal manure are ten times less concentrated. This means that you would have to apply 1 000 kg of kraal manure to supply the same amount of nutrients found in 100 kg of the chemical fertiliser mixture 3:2:1 (30).

Is the nutrient content of kraal manure always the same?

The concentration of nutrients in kraal manure depends on a number of factors, but the most important one is soil content of the manure. The more soil the manure contains, the lower its nutrient concentration and the more you have to apply to supply the same amount of nutrients. In the central areas of the Eastern Cape, kraal manure was found to contain between 20 and 80 % soil by mass, causing the formula to range between 3:1:4 (7) where the soil content was low and 3:1:2 (2) where more soil was present.

For practical purposes all the recommendations in this booklet are based on kraal manure containing about 60 % of soil by mass for which the formula 3:1:4 (3) applies. When your manure contains little soil you can reduce the amount of manure recommended here, but there would be absolutely no harm in following the application rates recommended. After all, to increase the nutrient content of your soil to levels harmful to crops would require very large applications of manure, of which there is no danger when following the recommendations in this booklet. If the soil content of your kraal manure is high (visibly much more soil than organic matter) the rates recommended in Tables 1 and 2 should be increased for optimum results.

Estimating the size of your field or garden or plot

- In order to be able to supply manure at the recommended rates (amount of manure per unit area of land), you need to know the area of your plot or field.
- You can estimate the size of your plot or field fairly accurately by pacing the length and width of your field. One pace is about the same length as a metre.
- Determine the length of your field by counting the number of paces it takes you to walk from one side of the field to the other along the length of the field (the longest side of the field).
- Do not forget to record the number of paces, so take along a piece of paper and a pen or pencil.
- The same procedure is followed to determine the width of the field (the shortest side of the field). You count the number of paces while walking from one corner of the field to the opposite corner along the short side of the field and record the number of paces it took you to get there.
- To determine the area of the field, you multiply the number of paces obtained for the length of the field with the number of paces counted for the width of the field. This will give you the approximate area of your field in square metre (m^2).
- The procedure to be followed when determining the area of a square or rectangular plot or field is illustrated in Fig. 1.

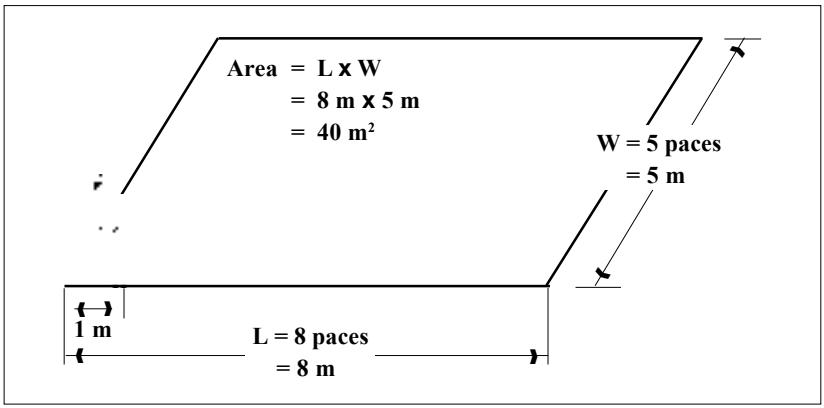


FIG. 1. Estimating the area of a rectangular or square plot

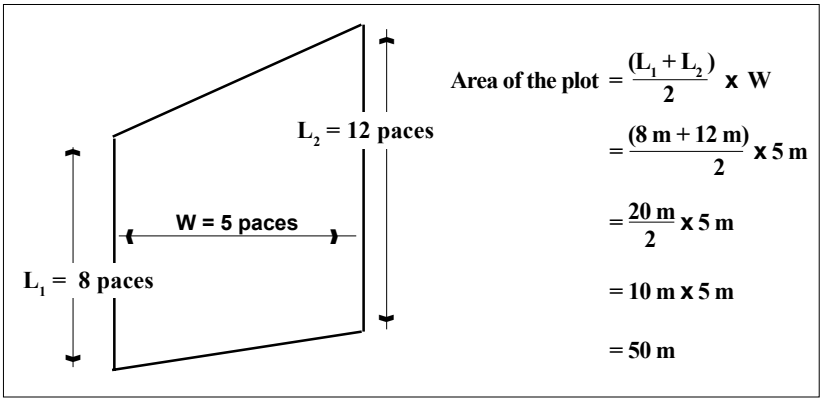


FIG. 2. Estimating the area of a plot with constant width but varying lengths

- If the shape of the land is not rectangular or square you can still determine its area. In Fig. 2 the procedure to be followed for plots with constant width but differing length is shown. The same procedure applies for plots with constant length but differing width.
- Determine the width (W) of your plot by pacing across the plot at right angle to the field edges.
- Determine the length (L) of your plot by pacing along the length of the plot on both sides.
- This will give you two estimates of plot length namely L_1 and L_2 (Fig. 2).
- Calculate the average length of the plot by dividing the total of L_1 and L_2 by 2
- The area of the plot is then obtained by multiplying the average length of the plot $\frac{(L_1 + L_2)}{2}$ by the width of the plot (W)
- Area $= \frac{(L_1 + L_2)}{2}$ x W

If you have problems with the calculations, ask some of the highschool students in your village to do it for you, but do not ask them to do the pacing, because the legs of children are shorter than those of grown-ups and their paces may be less than 1 m. To convert the area of your field to hectare, you divide the area in square metres (m^2) by 10 000.

Curing your soil after years of nutrient depletion

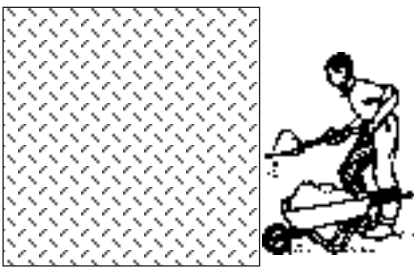
In case you have been mining your soil (taking crops off the land without returning nutrients to the soil by means of fertilising) your soil will now be depleted of nutrients. You will know this is the case when your crops do not grow well. Crops starved of nutrients grow slowly, have a stunted appearance (small plants with thin stems and small leaves), have pale green or yellowish leaves and give a poor yield. If this is your situation, your soil needs nutrients such as a broadcast application of manure. Broadcasting manure means that the manure is spread evenly over the soil surface. In order to restore your soil to a healthy and productive condition, we recommend that you apply 250 wheelbarrow loads of manure per hectare or one wheelbarrow load for every 40 m^2 of land. An area of 40 m^2 is more or less equivalent to a square area six large paces wide and six large paces long. A hectare is roughly the size of a soccer field. It covers an area of 10 000 m^2.

In order to determine the number of wheelbarrow loads of kraal manure that need to be applied to your field, divide the area of your field expressed in m^2 by 40.

For example: Assume you have a plot of 70 m x 70 m. Its area will be 70 m x 70 m = 4 900 m^2 .

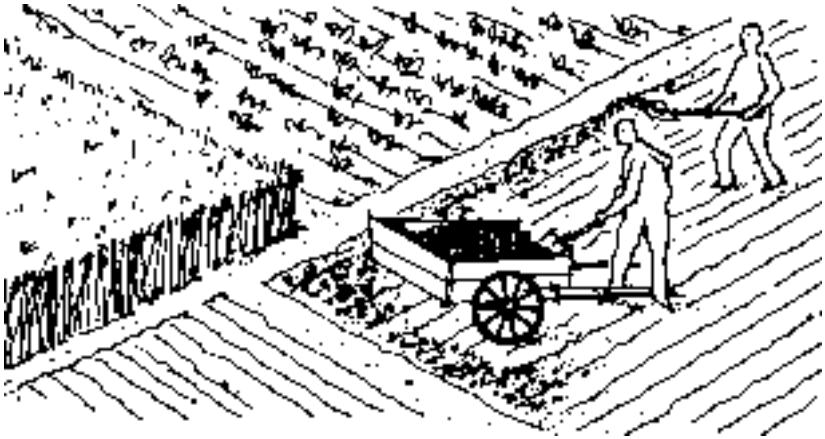
To determine the number of wheelbarrow loads of kraal manure required to cure your soil from nutrient depletion the area in m^2 is divided by 40.

Number of wheelbarrow loads of kraal manure $= \frac{\text{Area of plot } (m^2)}{40\ m^2/\text{wheelbarrow}}$



$= \frac{4\ 900\ m^2}{40\ m^2/\text{wheelbarrow}}$

= 122,5 wheelbarrow loads



Fertilising your crop with kraal manure

Once your soil is cured, you should keep it in a healthy and productive state. This is best achieved by supplying the field soil with the nutrients that will be removed by your next crop. Do this before you plant the crop. Crops differ in the amount of nutrients they remove. Some crops remove nutrients in large amounts while others do not. Furthermore, the higher the yield of the crop, the more nutrients the crop removes from the soil.

Recommended application rates

In Table 1 and 2 the recommended application rates for manure are presented for some garden and field crops which are planted frequently. Table 1 is most useful when you intend producing a crop on a field scale and Table 2 is designed for use in home gardens.

For each crop or group of crops two target yields are presented, namely a low and a high target yield. You should use the application rates of manure recommended for the low target yield when farming in an area where the rainfall tends to be low and unreliable. When farming in areas with high rainfall, or when irrigation water is available, you should use the application rates of kraal manure recommended for high target yields.

TABLE 1. Application rates of kraal manure recommended for low and high target yields of some garden and field crops

Crop	Target yield	t/ha	Application rate of kraal manure wheelbarrows/ha
Maize and sorghum	Low	2	100
	High	5	200
Potatoes and cabbage	Low	30	300
	High	40	400
Peas	Low	2	150
	High	3	200
Dry beans	Low	1	100
	High	2	150
Cucurbits, beetroot and onion	Low	20	200
	High	30	300
Tomatoes	Low	30	225
	High	40	300
Spinach	Low	10	550
	High	15	850

TABLE 2. Recommended area of land to be fertilised with one wheelbarrow load of kraal manure

Crop	Area to be fertilised with one wheelbarrow load of kraal manure (m^2)	
	Low target yield	High target yield
Maize, sorghum and peas	100	50
Dry beans	30	60
Cucurbits, beetroot, tomato and onion	50	30
Potato and cabbage	33	25
Spinach	15	10

CAUTION

Do not use manure when growing carrots. This causes carrots to split and reduces their quality.

The use of Table 2 is explained by means of two examples.

Example 1: Garden production of cabbage

Assume you wish to grow cabbage in a plot with a length of 20 m and a width of 10 m. The area of the plot is 20 m x 10 m = 200 m^2. You are able to irrigate the plot and, therefore you aim for the high target yield. High target yield in cabbage requires manure to be applied at a rate of one wheelbarrow load per 25 m^2 (Table 2).

To fertilise the 200 m^2 plot you will require

$$\frac{200\ m^2}{25\ m^2/\text{wheelbarrow}} = \textbf{8 wheelbarrow loads of kraal manure}$$

In case you do not have irrigation and conditions demand you to aim for the low target yield you would require only

$$\frac{200\ m^2}{33\ m^2/\text{wheelbarrow}} = \textbf{6 wheelbarrow loads of kraal manure to fertilise the 200 } \textbf{m}^2 \textbf{ plot}$$

Example 2: Field production of maize under irrigation

Assume that your field has a width of 40 m and a length of 50 m. Assume also that the field is to be planted to maize under irrigation. The area of the field (m^2) is obtained by multiplying the length of the field (50 m) by the width of the field (40 m) giving you an area of 2 000 m^2 (Fig. 3).

Irrigation being available you should aim for the high target yield of 5 tons per ha or 100 bags of 50 kg grain per ha. Table 2 shows that in order to obtain this high target yield, you should apply one wheelbarrow load of kraal manure per 50 m^2 of land.

The number of wheelbarrow loads needed to fertilise the plot is obtained by dividing the total area of the field in m^2 (2 000 m^2 in this case) by the area to be covered by one wheelbarrow load of manure (50 m^2 in this case).

The number of wheelbarrow loads needed

$$= \frac{2\ 000\ m^2}{50\ m^2/\text{wheelbarrow}}$$

= 40 wheelbarrow loads

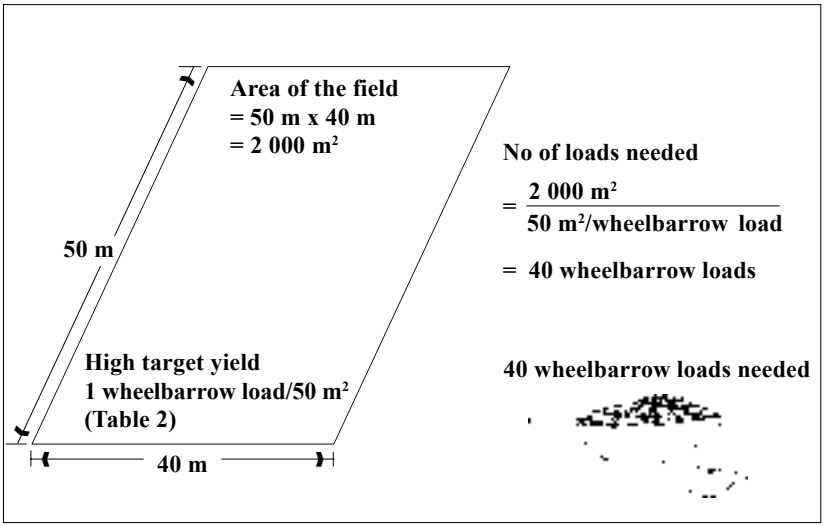


FIG. 3. Estimating the number of wheelbarrow loads of kraal manure needed to apply to a known area or field

Using a cart or sledge, how do I determine the application rate?

- In case you transport kraal manure with a cart or sledge, you will need to determine how many wheelbarrow loads it takes to fill the cart or sledge.
- To do this you empty wheelbarrows of kraal manure into the cart or sledge until it is full while counting the number of wheelbarrows it takes to fill it.
- Then determine the number of wheelbarrow loads of kraal manure you need to fertilise your field using the information in Table 2.
- To obtain the number of cart or sledge loads required to fertilise your land, you have to divide the number of wheelbarrow loads of kraal manure needed by the number of wheelbarrows required to fill your cart.
- This procedure can be illustrated by means of an example using the data presented in Example 2 and Fig. 3.

Assume your cart requires five wheelbarrow loads of kraal manure to get filled. From Table 1 you can see that for high yields one wheelbarrow load of manure is sufficient to cover 50 m^2.

For a field of 2 000 m^2 it will take

$$\frac{2\ 000\ m^2}{50\ m^2} = \textbf{40 wheelbarrow loads to fertilise the land}$$

Each cart load contains five wheelbarrows. Therefore the number of cart loads needed is

$$\frac{40\ \text{wheelbarrows}}{5\ \text{wheelbarrows/cart load}} = \textbf{8 cart loads to fertilise the 2 000 m}^2\textbf{ maize field}$$

What if I have a cart but no wheelbarrow?

In case you have a cart or sledge, but no wheelbarrow, you could borrow a wheelbarrow from a neighbour or friend. If that is not possible, you can use a 10-ℓ bucket to determine the volume of kraal manure that can be loaded in your cart or sledge (Fig. 4). Fill the bucket with manure and empty it into the cart. Repeat this until the cart is full, while counting the number of buckets it takes to fill the cart.

To fill one fully heaped modestly compacted wheelbarrow with kraal manure it takes about 11 full buckets. To obtain the number of wheelbarrow loads it would take to fill up your cart, divide the number of buckets it took you to fill your cart by 11.

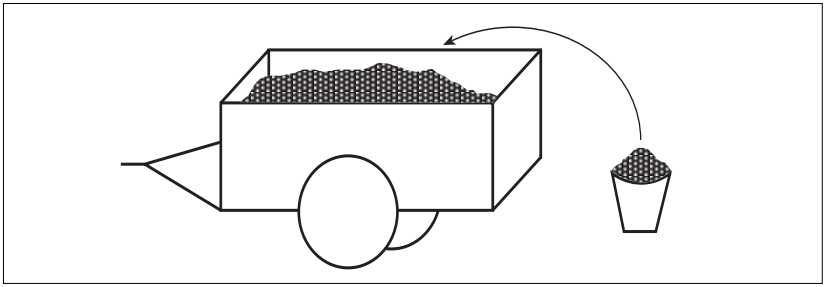


FIG. 4. Estimating the number of wheelbarrow loads in a cart load of manure using a 10-ℓ bucket

Let us again use the data in Example 2 and illustrated in Fig. 3 to explain this procedure by means of an example.

Let us assume that your cart takes 55 buckets of manure to get filled.

We know that each wheelbarrow requires 11 buckets of manure to get filled. A cart that requires 55 buckets to get filled will require

$$\frac{\text{55 buckets}}{\text{11 buckets/wheelbarrow}} = \textbf{5 wheelbarrow loads to fill the cart}$$

From Table 1 we obtained that one wheelbarrow load of kraal manure is sufficient to cover an area of 50 m^2 of land if the high target yield of 5 tons maize grain per ha is to be obtained. For a field area of 2 000 m^2 it will take

$$\frac{\text{2 000 m}^2}{\text{50 m}^2} = \textbf{40 wheelbarrow loads to fertilise the 2 000 m}^2 \textbf{ field}$$

Each cart load contains five wheelbarrow loads, therefore it will require

$$\frac{\text{40 wheelbarrows}}{\text{5 wheelbarrows/cart load}} = \textbf{8 cart loads of manure}$$

How and when should manure be applied?

- Kraal manure is usually applied during winter, which is the fallow period for most crops.
- The recommended quantity of manure is spread evenly over the plot and worked into the soil to a depth of 5 to 10 cm soon after application.
- Working manure into the soil can be done with a spade in small gardens or by plough in large fields.
- Applying manure during winter provides enough time for it to decompose before the crop is planted during spring or summer.
- In areas where crops are grown in winter, manure can be applied during late spring, at least one month before planting the crop.

Do I have to apply manure every year?

People who have access to large quantities of manure can apply up to four times the recommended amounts of manure to the land and postpone the next application by up to four years without much loss of yield. The application of manure every second, third or fourth year reduces labour and transport.

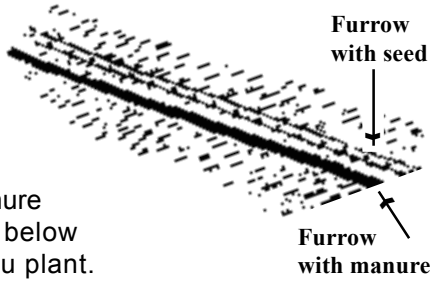
What should I do if I do not have enough manure to fertilise my entire field?

Many farmers try to plant all their land to crops. Often the available labour for weeding and the manure for fertilising the land is insufficient for optimum results. Weeds are not controlled in time and the manure is applied at a rate well below the recommended rate (Tables 1 and 2). If you experience these problems, you should seriously consider planting part of your land only. Concentrate on that piece of land and apply all available manure to it. This will enable you to keep weeds under control effectively and allow you to apply manure at the recommended rate. You may find that your total crop yield exceeds the yield you obtained previously when planting the entire area to crops, while putting in less effort!

When the need to plant your entire land is urgent, and the quantity of manure insufficient to fertilise the land at the recommended rate, you can resort to band placing or spot placing manure.

Band placing or spot placing results in higher yields than would be the case when the same quantity of manure is broadcast, especially when the quantity of manure available is less than what is recommended.

When band placing manure, a line of manure is placed in a furrow below or to the side of the seed, but never in contact with the seed. When spot placing manure, a little manure is positioned in a shallow hole below or to the side of every seed you plant.

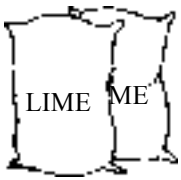


Band placing and spot placing concentrates the manure, and therefore the nutrients, in soil positioned closely to the plants. This enables the plants to get to nutrients easily while reducing the quantity of manure needed.

Because band and spot placing fertilise the soil in parts of the field only, the fertility of the rest of the field is not improved. As a result, it is necessary to fertilise every planting.

Lime and ash improves the effect of kraal manure on acid soils

When farming in an area where the rainfall is relatively high, it is most likely that your soil is acid. In acid soils nutrients are rendered unavailable, meaning that they are present in the soil, but plants are not able to extract them from the soil. Therefore, when you apply manure to an acid soil, the yield of your crop may not increase much, because the nutrients released from the manure are not available to your crop and remain fixed in the soil.



This problem can be addressed by applying lime to the soil. Large quantities of lime are required to reduce soil acidity effectively and you may have to apply 2 to 3 tons (2 000–3 000 kg) of lime per ha to neutralise soil acidity. This does not come cheaply, especially when you live in a remote area.

In case you cannot get hold of lime, or are unable to afford lime, you could make use of wood ash to improve the quality of your manure. Save the ash from cooking fires and mix it with the kraal manure before applying the manure to the plot or field. The wood ash will help in keeping the nutrients which are released from the manure available to your crop, at least for a short time. Mixing wood ash with your manure will improve the effectiveness of manure applications on acid soils and will give higher yields.

Weeds also grow better when fertilised: control them regularly!

- Crop yield does not only depend on the quantity of nutrients in the soil.
- In order to produce high yields crops need an adequate supply of water and should be kept free of weeds.
- Weeds are also plants and like crops they remove water and nutrients from the soil.
- When you allow weeds to grow among your crops, they will use most of the water and nutrients intended for your crops.
- Remember, weeds will also grow better when the soil has been made fertile by manure applications.
- Allowing weeds to grow among your crop will largely remove the benefit you expect to derive from fertilising your soil with kraal manure.
- The results obtained from growing a crop on fertilised soil where weeds are not eradicated will be very disappointing, because instead of harvesting food you will produce a beautiful crop of weeds and very little to feed your family or to sell on the market.

Diseases and pests

Even when you have supplied the required nutrients to your crop, made sure the plants are never short of water and kept the weeds in your plot under control, it is still possible that your crop could be destroyed by pests or diseases. The control of pests and diseases in crop production is a complex matter and a number of pest control strategies can be followed.

We intend to publish information on appropriate plant pest control strategies for small-scale farmers, paying special attention to some of the most commonly grown crops.