

USE OF ORGANIC AND INORGANIC FERTILIZERS



**FOR MAIZE, VEGETABLES
AND FINGER MILLET
PRODUCTION**

PREAMBLE

The Soil Management Project (SMP) was initiated in 1994/95 as an adaptive research project in Kenya Agricultural Research Institute (KARI) with financial and technical support from the Rockefeller Foundation. The main objectives of the project were, a) to improve smallholder agriculture by developing low-cost and sustainable technologies for increasing soil fertility and crop production, and b) to strengthen the scientists capacity for conducting on-farm research, analyzing of on-farm data and reporting.

The SMP was implemented in two Centers; KARI Kitale and KARI Kisii. The project adopted the Farmer Participatory Research (FPR) approach to implement research activities so that farmers and other stakeholders could participate actively in all stages of technology development and transfer. Collaborators included staff of the Ministry of Agriculture and NGOs; including Environmental Action Team, Vi- Agroforestry Project and Manor House in Kitale, and CARE-Kenya and Community Mobilization Against Desertification(CMAD) in Kisii. Most of the research work was implemented on-farm with active farmer participation. The first phase of the project ended in December 2000.

In Kitale the research was conducted in five sites; Cheptuya (West Pokot district), Matunda and Weonia farms (Trans Nzoia district), Chobosta (Uasin Gishu district) and Anin (Keiyo district). The research work addressed decline in soil fertility, lack of suitable crop varieties and inadequate livestock feeding as the main constraints limiting smallholder agricultural production. This booklet/bulletin has been prepared with the support from the SMP and is prepared in a language and format that would be easily understood by the extension workers and farmers. It is anticipated that this booklet/bulletin will promote wide scale dissemination of the **Use of organic and inorganic fertilizers** for maize vegetables and finger millet production in neighboring villages to the study sites and other regions in Kenya having similar agro-ecological characteristics.

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Coordinator, SMP

INTRODUCTION

There has been a decline in soil fertility as a result of continued cultivation and inadequate use of recommended rates of fertilizers in the North Rift Kenya. Inorganic fertilizers are costly while organic fertilizers are affordable but available in insufficient quantities. Combinations of inorganic and organic fertilizers can improve soil fertility and crop yields. The choice of the combination is mainly determined by cost of inorganic fertilizer, availability of the organic fertilizer and/or the market value of the crop.

The use of organic and inorganic fertilisers on maize, vegetables and finger millets were tried on farmers fields by KARI Kitale. After five years of on-farm experimentation with a number of treatment combinations, some promising options were jointly identified by KARI scientists, extension staff and farmers. During that period, farmers identified options that were suitable for their social economic conditions. Recommended organic and inorganic fertilizer rates together with their combinations were identified for maize, kales, cabbages, local vegetables and finger millet. The following is a description of available organic sources of nutrients and recommendations of organic/inorganic fertilizer combinations for several crops.

ANIMAL MANURE MANAGEMENT

a) Manure with litter

Farmers should be encouraged to use litter such as bean and maize stover and grass as bedding in the boma or huts used for keeping livestock. The litter will also increase the quantity of manure. In order to get high quality manure:

- remove the mixture from the boma at intervals of 1 - 2 months (depending on the number of animals, size of boma and rainfall amount).
- ensure the litter is well mixed with the dung and urine.
This mixture is heaped in a shade and covered with grass or leaves for decomposition and to reduce loss of nutrients due to direct sunlight and rain. Farmers in low rainfall areas can handle the mixture as described above or in pits.

b) Manure without litter

Farmers who cannot use boma bedding should collect and heap the manure more often (preferably once every week) to prevent over-exposure of manure to the sun and rain. Those who practice zero grazing should dig slurry pits near the sheds and cover them to reduce loss of nitrogen as the slurry decomposes.

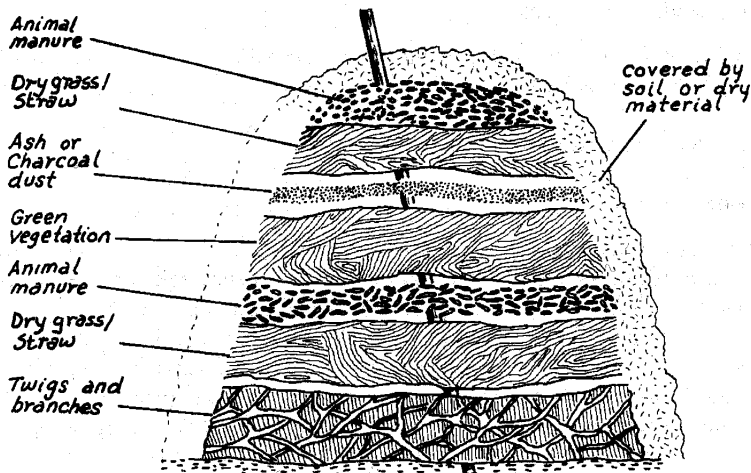
c) Treatment

The heaped manure (with or without litter) should be turned once a month for at least 2 months. This however does not apply to slurry that is applied immediately on crops or used for biogas production.

MAKING COMPOST

- An area of about 1 m x 1 m should be cleared and the soil loosened
- Lay down a foundation of twigs and small branches to allow drainage and ventilation.
- Sprinkle with a little amount of water.
- Arrange alternative layers of dry materials such as grass/straw, green plant materials (weeds, tithonia, banana leaves, lantana etc), kitchen waste, ash or charcoal waste and top soil or animal manure (if available).
- Each of these layers should be 5 -20 cm thick. They should be added to the foundation in that order until the heap is 1.5 m high.
- Sprinkle water on the heap after each layer of material.
- Cover the heap with a layer of topsoil about 10 cm thick and dry grass or leaves and allow the heap to decompose.
- Check progress of composting regularly using a stick inserted in the centre of the heap. When the stick is whitish apply water and when warm decomposition is taking place. However when it is cold turn the compost heap.
- Turn the heap twice at 3 weeks interval.

The compost will be ready for use or storage after 1-2 months when the mixture is friable.



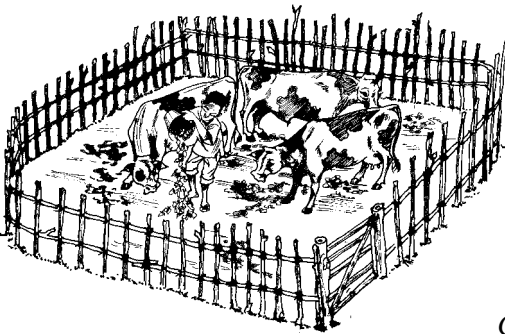
MAKE YOUR OWN FERTILIZER FROM FARMYARD MANURE (FYM)



Scattered manure in the open

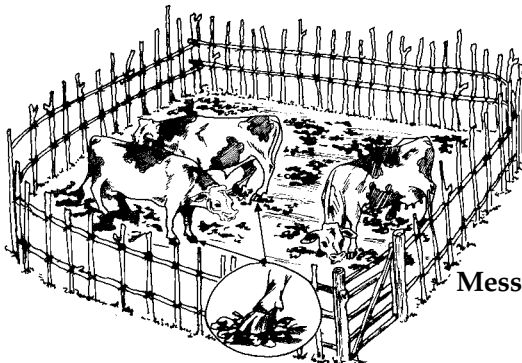
Message:

Badly stored manure loses plant nutrients to the air during sunny days. When it rains, some plant nutrients are either washed away or seep deep in the soil.



Cattle boma with crop residues

Message: Add crop residues



Message: Let the animals mix crop residues with dung



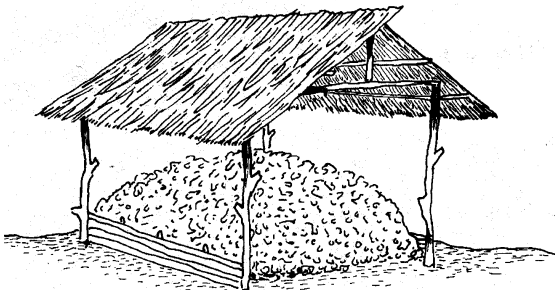
Freshly removed FYM placed under shade

Message: Remove and heap under the shade to conserve nutrients for crops



Turning the FYM

Message: Turn your manure twice to fasten decomposition



Storage under shade

Message: Store under a shade



Healthy crop

Message:

Use of good quality FYM increases crop yields immediately and long afterwards. Poorly decomposed manure has a large Carbon:Nitrogen (C:N) ratio, hence the nitrogen is not immediately available for plant use. It takes more than one season before nitrogen becomes available to the crops.

COMPOST AND MANURE STORAGE

The compost or manure should be stored using one of the following methods:

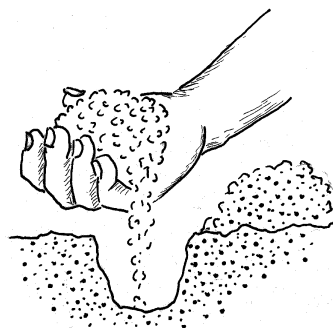
- Heap under a shade
- Cover with grass
- Put in a pit
- Heap inside a hut
- Put in bags and keep in a shelter till application on the farms

RECOMMENDED METHODS OF APPLICATION OF COMPOST AND MANURE

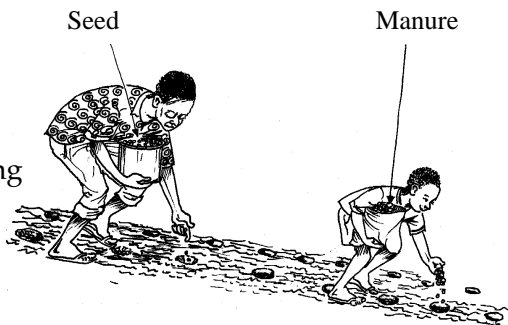
- Broadcasting followed by immediate incorporation into the soil to reduce nutrient loss



- Application in holes at planting



- Application in furrows at planting



BENEFITS OF ORGANIC AND INORGANIC FERTILIZERS

a) Compost and animal manure

Use of compost and manure can lead to increased crop productivity.

The use of organic fertilizers is advantageous to the farmer because:

- They are friendly to the environment.
- They are locally available.
- Have lasting effects with less immediate dramatic effect on soil productivity are realized.
- They add plant nutrients to the soil
- They increase soil water holding capacity
- They improve soil structure
- They increase microbial activity by supporting soil micro-organisms
- They enhance soils cation exchange capacity
- They act as a buffer for soil acidity

(b) Inorganic fertilizers

Fertilizers contain plant nutrients that become available to the plant when it dissolves in soil water. The soils in the North Rift Valley region are normally deficient in nitrogen and phosphorous but in some cases potassium is also deficient. Every fertilizer has a guaranteed nutrient content. For example, a compound fertilizer has a guaranteed content of nitrogen, phosphorous and potassium (N-P-K).

Most fertilizers are packed in bags of 50 kg but some are in some instances packed in 25 and 10 kg bags. It is important to note that nylon linings are put to prevent absorption of water by the fertilizer. Once the fertilizer absorbs water, it dissolves and some nutrients are lost. It is therefore important to tie the bags firmly with a rope after use if the fertilizer remains in the bag. It is also not advisable to buy fertilizers that are sold in small quantities at the open air market because they absorb water and deteriorate in quality.

Several fertilizer types are available from stockists that farmers can choose from. It is important to make the right choice depending on the limiting nutrients in the soil. An agricultural officer can be consulted when the farmer is not sure of the fertilizers to use. In case crops do not respond to fertilizer application, the farmer should take soil samples for analysis. After analysing soil, the farmers are advised on the amount and type of fertilizers to apply.

The following are the advantages and disadvantages of using inorganic fertilizers

Advantages	Disadvantages
Gives a rapid increase in yields within a short time after application	Their effect on soil productivity is short-lived, especially for nitrogenous fertilizers, larger doses of fertilizer are needed in each succeeding season to get the same results
Dissolves quickly in the soil	When used over a long time without combining or alternating with organic fertilizers, the soil physical, chemical and microbial properties deteriorate leading to decline in crop yields

RESPONSE TO USE OF ORGANIC AND INORGANIC FERTILIZERS FOR SELECTED CROPS

1. Maize

Maize is an important food and cash crop. It is grown from the sea level to above 2500m. Optimum yields can only be realized when certain agronomic practices are fulfilled. One of the most important practices in maize production is use of correct rates of appropriate fertilizers. Farmers should choose from any of the following recommended rates per hectare:

Fertilizer Application Rates per hectare

- i) 5 tons FYM or compost (100 wheelbarrows 50 kg each) together with 30 kg P_2O_5 (1 $\frac{1}{4}$ bags DAP of 50 kg each) and 30 kg N (1 $\frac{1}{2}$ bags CAN of 50 kg each)
- ii) 10 tons FYM or compost (200 wheelbarrows 50 kg each)
- iii) 60 kg P_2O_5 (2 $\frac{1}{2}$ bags(50kg bag) DAP and 60 kg N (3(50kg) bags CAN

The other recommended maize agronomic practices include:

- i) Early land preparation and early planting at the onset of rains
- ii) Use of recommended and certified maize variety seed for the area
- iii) Correct plant population: 75 cm between rows and 60 cm between plants, 2 seeds per hill or 75 cm between rows and 30 cm between plants one seed per hill.
- iv) Where beans are intercropped there will be one single row of beans to be planted at a spacing of 30 cm from hole to hole, 2 seeds per hill in between maize rows.
- v) Two weeding: The first at 3-4 weeks after germination and the second at 6-8 weeks after germination
- vi) Pest control by use of permethrin dust at 2.5 kg per hectare 4-5 weeks after germination, Dipterex at 4 kg per hectare or recommended local technical knowledge (LTK).

If recommended fertilizer rates and agronomic practices are followed, yields of between 5 and 7 tons per hectare (between 56 bags and 78 bags per hectare or between 22 bags and 32 bags per acre) can be achieved.

Table 1. The cost and benefits of different maize fertilizer recommendations realised at Cheptuya village, West Pokot District in the year 2000

A	B	C	D
Type and quality of fertilizer used in an acre	Fertilizer used in Column A converted to equivalent number of bags of maize	Harvest (90 kg) bag / acre	Benefit (90kg) bags/acre
No fertilizer (control)	Nil	1	1
4 tons FYM	1	12	11
2 tons FYM + 1 (50) kg bag of 23:23:0	4	20	16
2 (50 kg) bags of 23:23:0	8.5	24	15.5

2. Vegetables

Vegetables are nutritious and are important components of the farming system. They are grown for food and income generation. They can be planted throughout the year provided there is reliable water.

(a) Exotic vegetables: cabbages and kales

These are the most commonly grown vegetables for home consumption. They grow well under cool conditions at 700 m above sea level and above. They require fertile soils to give high yields. Farmers can choose fertilizer application rates per hectare from the following options:

- (i) 5 tons FYM or compost (100 wheelbarrows, 50 kg each) together with 30 kg P_2O_5 (1 $\frac{1}{2}$ bags DAP 50 kg each) and 30 kg N (1 $\frac{1}{2}$ bags CAN 50 kg each)
- ii) 10 tons FYM or compost (200 wheelbarrows, 50 kg each)
- iii) 60 kg P_2O_5 (2 $\frac{1}{2}$ bags DAP, 50 kg each) and 60 kg N (3 bags CAN, 50 kg each)

The expected yield of cabbages is 44-78 tons per hectare (11,100 and 15,000 heads per acre) while that of kales is 36-54 tons per hectare (15-22 tons per acre). In order to realise high yields, the following agronomic practices should be carried out.

- i) Use of certified seed
- ii) Correct plant population: cabbages should be planted at 60 cm x 45 cm in wet areas or 60 cm x 60 cm in drier areas. Kales should be planted at 45cm x 45 cm in wet area or 60 cm x 45 cm in drier areas
- iii) Keep the crops weed-free
- iv) Control pests using either market insecticides or LTK.

(b) Local vegetables

Indigenous vegetables are an important source of nutrients. Of late they have gained popularity and farmers are now cultivating them for both home consumption and for sale.

Table 2:**Some recommended agronomic practices for different vegetables**

Crop	Fertilizer rate per ha	Spacing (cm)	Expected yield (kg per ha)
Spider flower: Saka, saget, akeyo (dek) <i>Gynandrosis gynandra</i>	4-8 tons FYM or compost (80 to 160 wheelbarrows)	30 by 15	300-500
Crotalaria: Miro, mitek mito <i>Crotalaria brevidens</i>	4-8 tons FYM or compost (80 to 160 wheelbarrows)	30 by 15	300-500
Jute mallow: Murere, ndrerre, apoth <i>Corchorus sp</i>	4-8 tons FYM or compost (80 to 160 wheelbarrows)	30 by 15	300-500
* Black nightshade: Sucha, suchot, osuga <i>Solanum olitorius</i>	4-8 tons FYM or compost (80 to 160 wheelbarrows)	30 by 15	1,500-2,000
* Cowpeas: Shkhubi, Kunde, alot booX alot boo	4 tons FYM or compost (80 wheelbarrows) or 7.2 kg N and 19kg P O (about one 50kg bag ² D ⁵ AP)	45 by 15	500-1,000

* denotes certified seed available

The expected yields can only be achieved if other recommended agronomic practices are followed. These include:-

- i) Use of certified seed (where available)
- ii) Correct plant population
- iii) Keeping the crops free of weeds
- iv) Controlling pests using either commercial insecticides or recommended LTK

4 Finger millet

Finger millet is an important traditional cereal crop in the North Rift Valley region. It is a source of iron especially for infants. It also has low insoluble sugar and hence is suitable for diabetics. Farmers grow finger millet in small acreages and on poor soils. The yields are low since no fertilizer is used. Applying fertilizer increases yields from 12.5 to 40 bags per hectare. To get high yields from finger millet, apply one of the following fertilizer options.

- i) 12.5 kg P₂O₅ together with 12.5 kg N (1 bag 23:23:0, 50 kg each) and 2.5 tons compost/ FYM per ha (50 wheelbarrows, 50 kg each)
- ii) 25 kg P₂O₅ and 25 kg N per hectare (2 bags 23:23:0, 50 kg each)
- iii) 5 tons compost or FYM per hectare (100 wheelbarrows, 50 kg each)

To arrive at the recommended fertilizer rates shown above, apply as follows:

- i) 150 gms compound NPK 23:23:0 together with 7 1/2 kg FYM/ compost per 100 m length furrow.
- ii) 300 gms compound NPK 23:23:0 per 100 m length furrow.
- iii) 15 kg FYM/ compost per 100 m length furrow.

Fertilizer alone will not improve the yields of finger millet. Other recommended agronomic practices should be followed including:

- i) Use of recommended varieties; P224; P283; GULU-E
- ii) Dry planting (at the onset of rains)
- iii) Drill the seed in rows 30cm apart and thin at first weeding to 10 cm between the plants.
- iv) First weeding should be done after 4 weeks and the second after 6 weeks
- v) Control stalk borer by dusting with Thiodan at the rate of 2.5 litres per hectare
- vi) Harvest when seeds are mature and spread on mat for drying
- vii) Thresh by beating with sticks to remove grains
- viii) Winnow to remove chaff
- ix) Store seed in a cool dry place.

Conversion of inorganic fertilizers into bags per unit area

In most cases, inorganic fertilizer recommendations are deliberately given in terms of Kg P₂O₅ and N per unit area. For example the recommended fertilizer rate of maize in the North Rift is 60 kg P₂O₅ and 60 kg N per hectare. This translates to 24 kg P₂O₅ and 24 kg N per acre. It is important to note that the P₂O₅ and N supplied by all good quality fertilizers are the same and can be obtained in bags per acre from either a combination of two different types of available fertilizers or one type that is in the market through calculation.

Examples of calculation of bags of fertilizer to apply in an acre in order to achieve the recommended 60kg P₂O₅ and 60kg N per hectare

60kg P₂O₅ and 60kg N per hectare equals 24kg P₂O₅ and 24kg N per acre

1. Using TSP and CAN

The content of P₂O₅ in TSP is equal to 46%. Thus 46 kg P₂O₅ are contained in 100 kg TSP.

Therefore 24 kg P₂O₅/acre are contained in $\frac{100 \times 24 \text{ kg TSP}}{46} = 52 \text{ kg TSP}$

That is about 1 (50 kg) bag of TSP

Similarly, the content of N in CAN is 26%. Thus 26 kg N are contained in 100 kg CAN

Therefore, 24 kg N/acre are contained in $\frac{100 \times 24 \text{ kg}}{26} = 92 \text{ kg CAN}$

That is about 2 (50 kg) bags of CAN.

Hence the recommendation is 1(50kg) bag of TSP and 2 (50 kg) bags of CAN.

2. Using 23:23:0

23 kg P₂O₅ is contained in 100 kg 23:23:0

Therefore, 24 kg P₂O₅ (recommended per acre) will be provided by

$\frac{100 \times 24}{23} = 104 \text{ kg 23:23:0}$

That is about 2 (50 kg) bags of 23:23:0

Similarly 24 kg N (recommended per acre) will also be provided by 2 (50 kg) bags of 23:23:0.

Hence, a farmer using 23:23:0 fertilizer to grow maize will apply only 2 (50 kg) bags per acre.



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