Tumbukiza technology: an alternative method of Napier grass production

by

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Posted in April 2006

SUMMARY
This short paper describes the "Tumbukiza" method of planting Napier grass and presents initial results of a comparison of this method of planting in holes with the conventional method of growing it. A survey of some farmers from Western Kenya documented the technology and adaptive research was undertaken to evaluate and compare the productivity of Napier grass planted using either the Tumbukiza technology or the conventional method with organic and inorganic fertilizers, with different kinds of manure (cow dung manure, goat manure and slurry), with different sizes of pits (40 x 60 x 90 cm, 60 x 60 x 60 cm, 90 x 60 x 40 cm in depth, length and width respectively) and with different planting densities of (3, 6, 9 and 12) plants per hole. An initial economic evaluation of "Tumbukiza technology" as an alternative method of increasing Napier grass productivity onsmallholder farms was also carried out.

INTRODUCTION
Many of the poor in Kenya are smallholder dairy farmers who live in areas with a high potential for agriculture and forest production by virtue of favourable rainfall, temperatures and in many areas appropriate soils (Smith *et al*., 2000). Dairy farming is an important enterprise for income generation, food security and manure production in medium and high rainfall areas (Otieno *et al*., 1995; Rees *et al*., 1998a; Staal *et al*., 1998). The crossbred dairy cows kept by most smallholders have a potential to produce ten litres or more of milk per cow per day. However, because of inadequate quantity and quality of feed, most dairy cows produce an average of 6 litres per cow per day during the wet season and 3 litres or less in the dry season (Rees *et al*., 1998a; Nyambati, 1997; Staal *et al.*, 1998). Most smallholders therefore do not get adequate income from their dairy cows to meet their household needs. Participatory Rural Appraisals (PRAs) in various parts of Kenya show that smallholding size is a key limiting factor to the production of forage (Rees *et al.,* 1998b; Staal *et al.*, 1998). The human population in Kenya has grown rapidly, exerting considerable pressure on arable land, which has undergone drastic subdivision, fragmentation and intensive cultivation. Since most smallholders are resource poor and are unable to afford commercial fertilizers, increased production per unit land area depends on improving soil fertility. Increasing livestock feed on smallholder farms therefore requires the use of high yielding forages and appropriate but cheap agronomic practices that can maximize productivity per unit area.

Napier grass (*Pennisetum purpureum*) is one of the most important forages producing high herbage yield per unit area of land and is thus the most popular and widely grown forage by smallholders in East Africa (Orodho, 1990; Lukuyu *et al*., 1990). Orodho (2005) indicates that Napier grass forms up to 40 percent of the dry matter in the diet of smallholder dairy cattle (the rest coming from other cultivated grasses, fodders, crop by-products, crop residues and purchased concentrates). Napier is a tall, predominantly vegetatively propagated, perennial indigenous to sub-Saharan Africa which can produce biomass of 20-30 tons of dry matter/ha/year with good agronomic and management practices. Productivity of Napier grass using conventional methods however, starts declining after a number of years, especially if proper management is not used. In conventional methods Napier grass stem cuttings or root splits are planted 15-20 cm deep in well prepared land, using organic or inorganic fertilizers, at a spacing of 60 cm x 60 cm, 90 cm x 60 cm or 90 cm x 90 cm depending on the amount of rainfall received. The higher the rainfall the closer the spacing.

Smallholders from Western Kenya visited Central Kenya and saw how smallholders there use their small parcels of land intensively to produce high value crops. Bananas and coffee planted in pits, with heavy doses of dung, performed very well and were high yielding. The Western Kenya farmers wanted to use the same technology to plant their Napier grass. They started planting Napier grass in pits which they fertilized heavily with cow dung , a technology they called "Tumbukiza" (a Kiswahili word meaning "to put into a hole or pit"). Farmers in Western Kenya claim that Napier grass planted using Tumbukiza technology is higher yielding (than when conventionally planted) especially where soil moisture is low. This paper presents some initial results of surveys and trials.

[**N.B.** A recent paper by the same author (Orodho, 2005), as well as various communications from other scientists, have indicated that Napier grass, having been grown as the main fodder in western Kenya for decades, always with the same few ecotypes, is now seriously at risk from disease. While a new Napier grass variety Kakamega 1 has been identified as high yielding and resistant to Napier grass head smut (causative organism *Ustilago kamerunensis*) the most serious disease, presently found in western Kenya and also reported from Uganda is Napier grass stunting disease thought to be caused by a mycoplasma.

This disease is spreading fast and is causing serious economic loss to the smallholder dairy industry; most Napier grass varieties appear to be susceptible and many smallholders have lost all their Napier crop and have been forced to de-stock. While the adoption of the Tumbukiza method to increase Napier grass yields is presented in this paper it should be appreciated that although increasing Napier grass yields is a basic agronomic issue, the major problem facing many smallholder dairy farmers, particularly in areas of Western Kenya, is Napier grass stunting disease].

SURVEY

A Participatory Rural Appraisal (PRA) was carried out on Tumbukiza Technology of Napier grass in several smallholder dairy farms in various agro-ecological zones in Western Kenya. Survey sites were in the Lower Midland zones (LM_{2-3}) and in the Upper Midland zones (UM_{3-4}) [zones according to Jaetzold and Schmidt (1983)]. The lower midland zones had a lower annual rainfall (800 – 1,200 mm), relatively poorer soils and longer dry seasons (4 – 6 months) while the upper midland zones had higher annual rainfall (1,100 – 1,800 mm), better soils and a shorter dry season (3- 4 months). Soils in both the zones are deficient in available phosphorus and nitrogen.

Its objective was to study and document the Tumbukiza technology for Napier grass establishment and management, and thereafter to refine and standardize the technology.

Planning meetings were held with the divisional Livestock extension officers of the Ministry of Agriculture Livestock Development and Marketing in the survey areas. The survey was carried out, in 1997, by researchers and extension staff interviewing farmers in the field using open ended questionnaires as a guideline.

Survey results

It was evident that the Tumbukiza technology haddeveloped after smallholders visited Central Province and saw the performance of coffee and bananas plated in fertilized pits. Most farmers interviewed had only practiced this technology for 3 years or less, so plots under Tumbukiza were far fewer than those using conventional methods. Farmers interviewed said that they were gradually expanding their Napier grass plots using Tumbukiza technology and some farmers were replacing Napier grass plots previously planted using the conventional method. Most farmers using Tumbukiza technology had dairy animals and had a great demand for fodder. Herd size varied in the various divisions and districts surveyed. Larger farms kept larger herds while smaller farms kept smaller herds and most practiced zero-grazing. Most farmers who used Tumbukiza technology zero-grazed their animals and only a few let cattle graze natural pasture; even then Napier grass was used as supplementary feed.

Types of Tumbukiza

Three types of Tumbukiza holes were identified:

- **Round pits.** Most farmers established their Napier grass in round pits similar to the ones used when establishing bananas. Pits were on average 60 cm in diameter and 60 cm deep, spaced about 60 cm apart in rows 60 cm apart. In some divisions, particularly where land was not a major constraint, farmers used wider pits of 120 cm but shallower, about 45 cm.
- **Rectangular pits.** These pits were not so common but were seen in somedivisions. In general they were 120 cm long but occasionally they were longer. Their width and depth were 60 cm in both cases.
- **Round in trench type.** This was a modification of the two types described above. They were a combination of either round or rectangular pits within wide trenches or between banks. The sizes of the pit or trenches were similar to those described above. In some cases sweet potatoes (*Ipomoea batatas*) were established on the banks.

How farmers established Tumbukiza

There were minor variations from farmer to farmer; the major steps can be summarised as follows: farmers clear their fields and do normal ploughing and harrowing. They peg the position of the pits according to the type of holes intended, then dig their pits as measured, separating top soil from sub-soil. The top soil is mixed with manure and the mixture returned to the pits ensuring that the pits are not filled to the brim; leaving 15-20 cm of unfilled space. Sub-soil is spread between the pits to form soil erosion barriers. The topsoil-manure mixture is usually allowed to settle, without compacting, for a week before planting. Cuttings or single root splits of preferred Napier grass varieties are used from their own farms, from neighbouring farms or from Government institutions (Orodho, 1990). The number of plants per pit varied with uniform stocking the main aim. Any weed inside the pit is weeded out or hand pulled. The areas between the pits are either slashed or weeded and used for growing forage legumes such as *Desmodium* or food crops such as sweet potatoes.

Advantages and disadvantages of Tumbukiza Technology

The advantages of Tumbukiza technology were enumerated by farmers as follows:

- It requires less land, produces high yields per unit area of land, ensures efficient use of manure because the manure is confined at a spot and is not subject to run off.
- Napier grass regrows faster and needs less weeding and is easy to irrigate during the dry season.
- Because of the lush growth under Tumbukiza, the Napier grass is preferred by livestock and farmers claim to get more milk compared to Napier grown by conventional methods.

- Napier grass under Tumbukiza has a longer lifespan and is not subject to damage by moles [*Editors note*: however, as most farmers had only tried the new system for 3 years or less, this needs to be studied further].
- Napier grass under Tumbukiza is resistant to drought.
- Most farmers indicated that a major disadvantage of Tumbukiza technology is the high initial cost of labour for digging the pits. Farmers, however, appreciated that despite the initial labour cost, the advantages in the subsequent seasons or years outweigh the initial higher cost.

From the PRA survey it was clear that farmers using Tumbukiza technology were convinced that this is a better way of Napier establishment than the conventional method.

Conclusion of PRA Survey
In conclusion, from the PRA survey on 'Tumbukiza technology' of planting and managing Napier grass, it is suggested that regardless of the ways smallholder farmers make pits, the strength of this technology lies in better moisture retention, better manure utilization at the point of requirement, less demand for land, reduced weeding and the ability to intercrop.

ADAPTIVE RESEARCH ON TUMBUKIZA TECHNOLOGY
Since many smallholders have been seeking information and standard recommendations on "Tumbukiza technology" and as no research work had been carried out, both on-station and on-farm adaptive research wereneeded to verify the information found by the survey. The main objective of the research was to develop standard recommendations on this technology. Agronomic trials were carried out to evaluate and compare the productivity of Napier grass using both the Tumbukiza technology and the conventional method with organic and inorganic fertilizers, with different kinds of manure (cow dung manure, goat manure and slurry), with different sizes of pits (40 x 60 x 90 cm, 60 x 60 x 60 cm, 90 x 60 x 40 cm in depth, length and width respectively) and with different planting densities of (3, 6, 9 and 12) plants per hole (Otieno *et al*., 1997, 1998, Muyekho *et al.,* 2000). An initial economic evaluation of "Tumbukiza technology" as an alternative method for increasing Napier grass productivity in smallholder farms was also carried out.

The Tumbukiza method of planting three canes per pit measuring 60 x 90 x 40 cm and with topsoil-cow dung was compared for its economic merits with the conventional method of planting one cane per hole 15-20 cm deep at a spacing of 1 x 1 metre and applying either Diammonium Phosphate (DAP) or cow dung. Trial sites were in both the lower and the upper midland zones and both in farmers' fields and research centres in the same agro-ecological zones of the survey area.

Economic data collected by semi-structured interviews with farmers at a time when each activity was being carried out and consisted of farm gate prices of the inputs and labour during planting and maintenance for 1997 and 1998. Output price of Napier grass was based on sales of green Napier grass. Partial budgeting was used to compare benefits and cost accruing from each treatment. However, because the income stream from Napier grass is for a productive life cycle of 5 years, net present value approach was used to calculate the benefits which include the benefit cost ratio (BCR) and returns to labour (ROL). For the purpose of these trials, yields of the third and fifth year were assumed to be equal to the second year since the trial had not been carried out for the full life cycle [*Editors note*: this may not be a valid assumption] and to test the stability of the technologies, sensitivity analysis was done based on changes that are likely to occur in Napier grass yields, labour costs and interest rates.

Varying the size of Tumbukiza holes and planting densities of Napier grass
Varying the sizes of holes from 40 cm to 90 cm in depth and width did not affect herbage dry matter yield (**Table 1**). Farmers' evaluation concentrated on the depth of "Tumbukiza" holes. The length and width of holes was not of major concern to them. A depth of 60 cm was preferred to those of 40 cm and 90 cm. Farmers dismissed 40 cm deep holes because the Napier grass fills the hole quickly and reverts to the conventional method thereby reducing production per unit area. Depths of 90 cm were appreciated for better water collection and moisture retention and hence better yields of Napier grass during the dry season. However, the main disadvantage was its high cost of labour for digging and preparation. This was particularly of concern to female headed households, elderly farmers (aged over 60 years) and poor farmers who could not hire labour. Farmers generally agreed that the high labour could be compensated by the higher yields produced over time.

Increasing the number of planting canes or root splits from 3 to 12 per hole did not increase or decrease the dry matter yields of Napier grass significantly (P=0.05), although 5-10 cuttings per pit are usually recommended.

The amount of manure applied increased with the number of canes per hole and this removed competition for the nutrient resources. The study suggest that farmers can use any density from three plants per hole to twelve plants per hole and any size of hole for Napier grass production provided the amount of nutrient applied matches the plant density and provided that nutrients (and water) are not limiting. Farmers observed that planting fewer canes per hole means that the Napier grass takes longer to establish and fill the hole and planting many canes increases the cost of the planting material and causes earlier competition for space.

Table 1. The effect of the size of "Tumbukiza" holes on dry matter yields of Napier grass and the ranking by farmers			
Size of Tumbukiza hole	Dry matter yields (t/ha)		
	1997 (6 cuts)	1998(7 cuts)	Farmers ranking (10 farmers)
40 x 60 x 90 cm deep, long and wide	37.6[a]	41.4[a]	2.1
60 x 60 x 60 cm deep, long and wide	37.3[a]	38.7[a]	2.3
90 x 60 x 40 cm deep, long and wide	38.4[a]	41.3[a]	1.7

Means within the same column followed by similar superscripts are not significantly ($P<0.05$) different. Farmers ranking: 2.3 = most preferred, 2.1 moderately preferred and 1.7 least preferred.

Adapted from Muyekho *et al*. (2000)

Napier grass production under different sources of fertilizer

In Kenya, sources of manure vary according to ecological zones. In semi-arid areas both goat and cow manure are common but in the medium and high rainfall areas with intensive smallholder dairying and where cattle are kept under zero or semi-zero grazing systems, cow dung and slurry are the commonest types. The nitrogen and phosphorus contents of small ruminants' dung, especially goats, is higher than cattle manure (Powell & William, 1993).

The dry matter production of Napier grass plots planted by both the Tumbukiza and conventional methods in lower midland zones was calculated. Results show consistently higher DM yield of Napier grass for Tumbukiza technology at every month of harvest compared to the conventional method at all sites. The mean total DM yield after eleven months of harvest was 30 t DM and 7 t DM per hectare for Tumbukiza and conventional method respectively (Orodho *et al.* 1999). [*Editors note*: these differences are considerable and possibly reflect low soil moisture status]. An average DM yield per Tumbukiza pit per hectare per harvest was 0.4 kg.

Using the Tumbukiza technology in similar areas, it is suggested that to feed one mature dairy cow would require well managed Napier grass from some 960 pits in approx. 0.2 ha. To feed the same cow with well managed Napier grass from conventional methods would require at least double the area and possibly up 0.8 or 0.9ha. In general results of experiments carried out confirm that Napier grass produces higher herbage and dry matter yields under Tumbukiza technology when compared to conventional method using both manure and DAP. The Tumbukiza technology was ranked higher than the conventional method by farmers on the basis of its higher Napier grass production most probably because the Tumbukiza technology enabled Napier grass to be more efficient in utilizing the plant nutrients by providing better moisture collection and retention environment as expressed through faster regrowth, and production of more green herbage material per unit area especially during the prolonged season of drought. The dry matter yield of Napier grass produced when an application of goat manure, cow dung (manure) and slurry were used were not significantly different from the Napier grass dry matter produced when the application of 60 kg of P_2O_5 phosphatic fertilizer (DAP) was used at planting and an annual application of 60 kg of nitrogenous fertilizer is used to top dress Napier grass (**Table 2**).

In the farmers' evaluation, goat manure was ranked highest because of the ease in collecting it and transporting it to the fields compared to cow dung manure or slurry. Trials suggest that any of the organic manures could be used for Napier grass production under Tumbukiza technology depending on whichever is available. However, more research is needed to determine the most economic rates of application.

Table 2. Napier yields using various manures and DAP and farmer rankings of manure type				
Treatment	Number of tillers/ha	Dry matter yields/ha	Farmers Ranking[1]	
			male	female
1997 Cow dung	1751[a2]	30.3[a2]	- -	- -
Goat manure	1591[a]	30.4[a]	-	-
Slurry	1596[a]	30.0[a]	-	-
DAP	1522[a]	29.0[a]	-	-

1998 Cow dung	4154[a]	34.6[a]	1.9	1.7
Goat manure	3881[a]	34.2[a]	2.8	3.0
Slurry	3864[a]	32.4[a]	1.5	1.2
D.A.P	3586[a]	32.4[a]	-	-

[1]Ten male farmers and one female farmer participated in the ranking. The rankings are means of farmers scores across the replicates (3.0 = most preferred, 1.7 = moderately preferred and 1.2 = lest preferred)
[2]Means within a column with similar letters are not statistically significantly different at $P<0.05$ according to the Duncan Multiple Range Test
Adapted from Muyekho *et al*. 2000.

Economic evaluation of Tumbukiza
Studies on the economic evaluation of "Tumbukiza" as an alternative method for increasing forage production shows that all the three methods of planting Napier grass namely: by Tumbukiza technology and by conventional methods using DAP and using cow dung manure are all economically viable. They all have positive Net Present Values (NPV)s with Benefit Cost Ratios (BCR) and Return to Labour (ROL) that are greater than 2.0, the minimum acceptable for most smallholder farming activities (**Table 3**). However, in terms of absolute ranking, Tumbukiza with FYM had the highest NPV and BCR. Relatively, 'Tumbukiza' with FYM had a NPV greater than 100%, and almost 40% higher than conventional with farmyard and conventional with DAP, respectively. In terms of return to labour, the less intensive labour treatment "conventional method with DAP" had the higher return to labour.

Table 3. Economic evaluation of Tumbukiza as an alternative method of Napier grass production at Moiben, Uasin Gishu, Kenya - average scenario.

Method of planting Napier grass	Net present value	Benefit cost Ratio	Return to labour
Conventional with DAP fertilizer	80,268	4.83	7.23
Conventional with FYM	53,251	3.03	2.32
Tumbukiza method with FYM	111,421	5.27	4.85

CONCLUSIONS AND RECOMMENDATIONS
Although only an initial investigation, the work appears to confirm the farmers' findings that the Tumbukiza technology of planting Napier grass is superior to the conventional methods in terms of herbage dry matter yield. This implies that farmers using the Tumbukiza technology will obtain more dry matter to feed their livestock per unit area of land. As well fed livestock produce more manure, farmers using the 'Tumbukiza technology' should obtain more manure from the same unit of land than those using conventional methods of planting Napier grass. Farmers can use any size of 'Tumbukiza' hole provided that the nutrient applied matches with the plant density. Farmers can also use any source of manure available for growing Napier grass using the Tumbukiza technology.

The economic evaluation suggests that under present economic circumstances, both Tumbukiza and conventional methods of Napier grass production are cost effective. If labour is a major limiting constraint, it is recommended that farmers use the conventional method with DAP fertilizer. However where labour is not the major limiting factor then farmers are advised to use 'Tumbukiza' technology because it gives the highest Net Present Value (NPV). Intercropping Napier grass with other food crops such as beans and sweet potatoes especially during the first year of Napier grass establishment will maximize returns to labour and make 'Tumbukiza' a more preferred technology during the subsequent years of Napier grass production.

OTHER LESSONS LEARNED from "Tumbukiza technology" development
In the past, all research centres in Kenya carried out mainly on-station research to develop applied technologies for farmers. In the present research set up, most research centres in Kenya are adopting a Farming Systems Development (FSD) approach which on the other hand concentrates mainly on carrying out adaptive research that involves helping to adjust the applied technologies developed to specific environmental conditions. In carrying out adaptive research, researchers work very closely with farmers and extension personnel in the entire process of problem identification, technology development and adoption. The FSD approach also helps to give feedback information about the future priorities of the applied research to research centres.

The development of the conventional method and Tumbukiza technologies of planting and managing Napier grass illustrate the two technology development approaches which can be compared. The one developed by conventional method of on-station based research and the 'Tumbukiza' technology developed using the Farming System Development (FSD) approach. It may be suggested that they are substitutes for each other. However, both the on-station based research and farm level (FSD) approaches are needed. This is because they focus on different things that are complementary to each other.

Table 4 illustrates some major difference between station based research (conventional) and Tumbukiza technology which is a Farming System Development (FSD) approach, and help to indicate why both are necessary. Whereas the on-station farm based research develops applied technologies, the FSD approach on the other hand does the following:

- It improves a systematic way of trying to understand both the technical and human environment of farmers. In doing so, it provides a method of highlighting the discussion in terms of the suitability of the developed technologies.
- As a result of identifying important issues, it provides a way in which relevant research priorities can be fed back to the experimental station.
- Additionally, it enables research and extension staff personnel working on farmers' fields to select appropriate technologies to address the problems that have been identified.
- It also provides a practical way of evaluating technologies within a systems context, using criteria that are relevant to the farmer.

Table 4. Some differences between station-based research and FSD

Characteristic	**Station-based Research**	**FSD**
Location of trials	Usually experimental station	Usually on farms
Disciplines involved	Often single, mostly technical	Usually several, technical and social
Priority setting for trials:		
Researcher	More involved	Less involved
Farmers	Less involved	More involved
Experimental designs:		
Complexity	Usually more	Usually less
Management	Researcher	Researcher or/farmers
Implementation	Researcher	Researcher or/and/farmer
Degree of experimental control	More	Usually Less
Evaluation of trails - factors taken into account:		
System perspective	Less likely	Less likely
Technical feasibility	Yes	Yes
Economic viability/reliability	Less likely	More likely
Social acceptability	Less likely	More likely
Farmer opinion	Not likely	More likely
Expense of experimental programme:		
Fixed (overhead) costs	Likely to be higher	Likely to be lower
Variable (recurrent) costs	Likely to be lower	Likely to be higher

Adapted from: Norman *et al.* (1995).

See Annex for a summary of Tumbukiza technology

REFERENCES

Jaetzold, R. & H. Schmidt (1983) Farm management handbook in Kenya, Vol. II Part B, Central Kenya.

Lukuyu, B. Njubi, D., Owango M., Tanner, J., Thorpe, W. & Y.S. Valk (1990) Review report of the DEAF survey during 1989 NDDP/M41/200 Ministry of Livestock Development, Nairobi, Kenya.

Muyekho, F.N., Cheruiyot, D.T. & G. Kapkusum (2000) Effects of the "Tumbukiza" method of planting napier grass (*Pennisetum purpureum*) on the quantity and quality of forage on smallholder farms in Kenya. In: Murethi, Gachene, Muyekho, Onyengo, Mose & Magenya (eds). Participatory Technology Development for soil management by smallholders in Kenya. Proceedings of the 2nd Scientific Conference of the Soil Management and Legume Research Network Projects June 2000. Mombasa, Kenya 551 pp.

Norman, D.W., Worman, F.D., Siebest, J.D, & E. Modiakgotta (1995) Rationale and philosophy of the farming systems development approach. In: Norman, Worman, Siebert &

Modiakgotta (eds). The farming systems approach to development and appropriate technology generation. Food and Agriculture Organization of the United Nations (FAO) Rome, 1995. Farming System Management Series No. 10.

Nyambati, E.M. (1997) Dairy cattle research achievements, feeding practices, constraints and strategies for future research. In: Rees, Mkonge & Wandera (eds.) A review of agricultural practices and constraints in the North of Rift valley Province, Kenya.

Orodho, A.B. (1990) Dissemination and utilization of research technology on forages and agricultural by-products in Kenya. In: Utilization of research results on forage and agricultural by-product materials as animal feed resources in Africa. Proceedings of the first joint workshop held in Lilongwe, Malawi 5-9 December 1988. PANESA/ARNAB, Addis Ababa, Ethiopia, 833 pp.

Orodho, A. B. (2005) Intensive forage production for smallholder dairying in East Africa. In Reynolds & Frame (eds.) Grasslands: Developments Opportunities Perspectives, FAO and Science Publishers Inc., 433-459 pp.

Orodho, A. B., Otieno, K., Wansmbacha, J. W. & P.O. Mudavadi (1999) Pasture and Fodder Research within the Regional Research Centre - Kakamega mandate region: A review of the last ten years 1990-1999. A paper presented to the National Workshop for Pasture Research Scientists at National Agricultural Research Centre. Kitale.

Otieno, K.,Wanambacha, J. & A.B. Orodho (1995). Appraisal of manure availability and use in Busia, Siaya, Vihiga and Kakamega District Kenya, A report submitted to the African Highlands Institute (AHI) co-ordinating office, ICRAF Nairobi.

Otieno, K., Owamgo, R.S., Omudeck, I., Omolo I., Wekesa, A. & J. Makale (1997) Evaluation of the productivity of Tumbukiza method of Napier grass establishment/management as compared to the conventional method in Western Kenya. In de Jong and Mukisira (eds.) Proceedings of the (NDC PRP FSA-RET) National Dairy Cattle and Poultry Research, Extension and Training (FSA-RET) visits and seminars from July 29 to August 25, 1997. Part 1. visit notes, seminar papers and discussions. Kenya Agricultural Research, Institute, Nairobi. Document No. 9/1997.

Otieno, K., Wekesa, A.N., Makale, J., Owango,R.S., Omudeck, I. & J. Omolo (1998) On farm evaluation of the productivity of "Tumbukiza" methods of Napier grass establishment and management as compared to the conventional method. Paper presented to the mini workshop on pasture of the National dairy cattle and poultry research programme. Aug. 10-14, 1998 at NARC research compiled by De Jong and Mukisira (eds).

Powell, J.M. & T.D. William (1993) An overview of mixed farming systems in sub-Saharan Africa. In: Powell, Fernandez-Rivera, William & Renard (eds.) Livestock and sustainable nutrient cycling in mixed farming systems of sub-Saharan Africa. pp. 1 - 36.

Rees, D.J.C., Nkonge, C., Wandera, J.L., Mason, V.I. & F.N. Muyekho (1998a) Participatory rural appraisal of the farming systems of the north of rift valley province, Kenya, 1995- 1997.

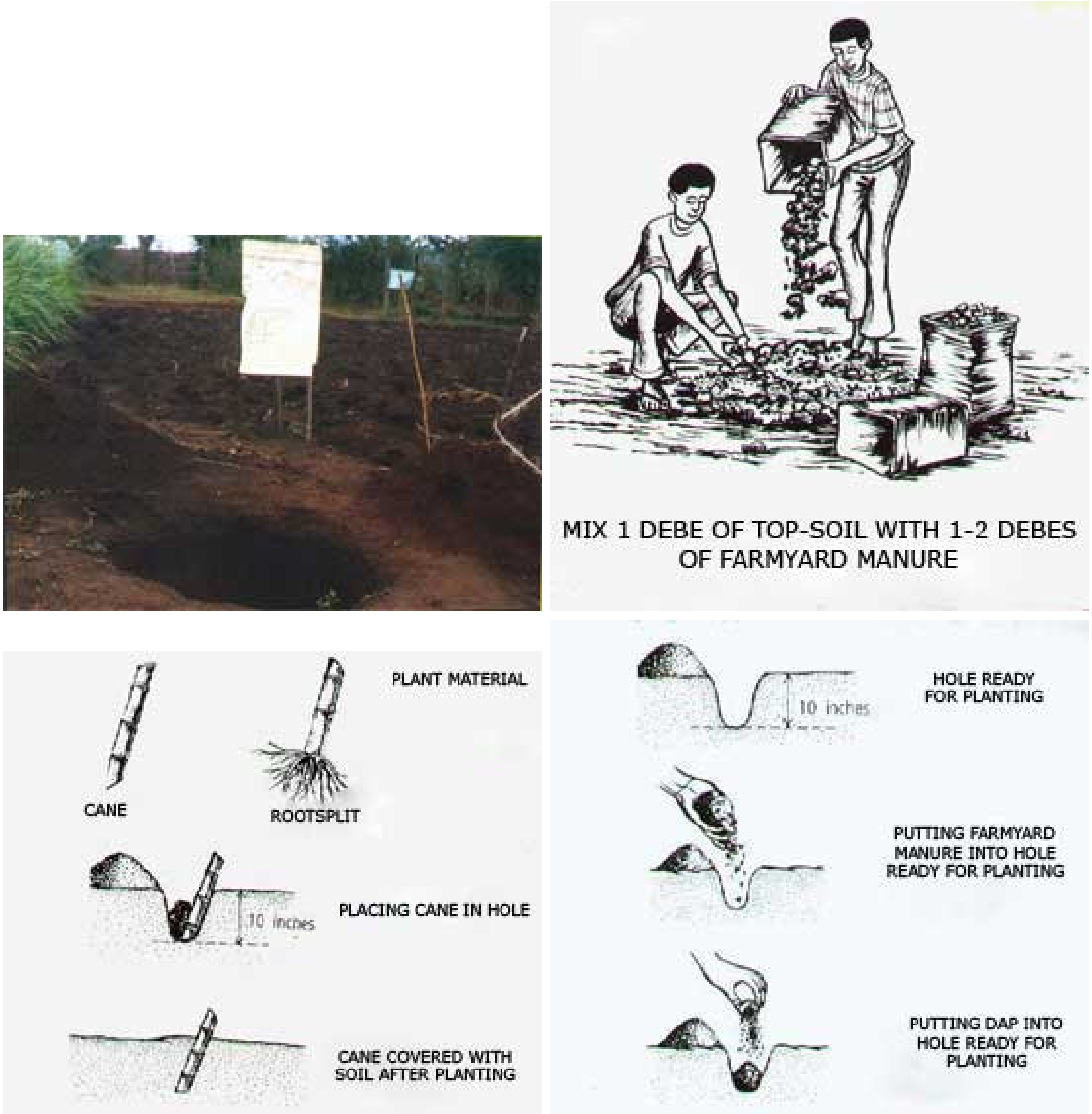
Rees, D.J.C., Njue E., Makini, F. & D.M. Mbugwa (1998b). Participatory rural appraisals of the Farming systems of South West Kenya, 1995 and 1996.

Smith, P.,D. Boase, M. & A.B. Orodho (2000) Assessment of current needs and researchable constraints of resource-poor households in some high potential production systems in Kenya. DFID (Department for International Development) Natural Resources Systems Programme Project R 7407 October 1999 - January 2000 study report.

Staal, S.J., Chege, L., Kinyanjui, M., Kimani, A., Lukuyu, B., Njubi, D., Owango, M., Tanner, J., Thorpe, W. & M. Wambugu (1998) Characterization of dairy systems supplying the Nairobi milk market. A pilot survey in Kiambu District for the identification of target groups of producers. Smallholder Dairy (R & D) Project. KARI, ILRI and Livestock Production Department (Ministry of Agriculture).

Tumbukiza technology summarized in figures 1-6 and conventional method compared

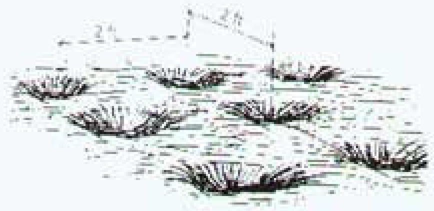
Figure 1. Tumbukiza technology



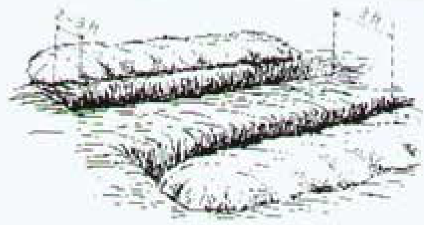
Conventional Method
- Plough and harrow the field well before planting
- Dig planting holes 15-12 cm deep, or spacing In each hole apply:
- Two handfuls of farmyard manure (FYM) or
- A soda bottle full of DAP or
- Both a handful of FYM and 1/2 soda bottle top of DAP
- Place 3 nodes piece of cane ensuring two nodes are covered or
- Place a root split of Napier planting material in the hole
- Cover the planted material with soil
- Intercrop with food crops or forage legumes.

Tumbukiza technology
- Plough and harrow the field well
- Dig pits with spacing of 60x 60 cm or 60 cm x 90 or 90 x 90 cm depending on moisture regime
- Mix 1 depe (20 liter tin) of top soil with 1 0r 2 depes of FYM
- Put the soil-farmyard manure into the pit leaving 1 cm space at the brim
- Plant 5-10 cuttings/canes/root splits per hole

Figure 2. Round and Rectangular Pits



ROUND PITS 2 FEET IN DIAMETER, 2 FEET DEEP AND 2 FEET APART



RECTANGULAR PITS 2-3 FEET WIDE AND 3 FEET APART

PLANT 5-10 CUTTINGS PER PIT

For Round Pits

Where land pressure and rainfall are both high

- Dig pits 60 cm in diameter and 60 cm deep
- The rows of pits should be 60 cm apart

Where land pressure and rainfall are both low

- Dig pits 60-90 cm in diameter and 60-90 cm deep
- The rows of pits should be 1 meter apart

Thus wider pit spacing where moisture is low

Rectangular Pits

Where land pressure and rainfall are both high

- Dig pits 60 cm deep, 60-90 cm wide

-Length of the pit can vary depending on the available of land

- The pit should be 1 m apart

Where land pressure and rainfall are both low

- Dig pits 60-90 cm wide or in diameter and 60-90 cm deep
- The rows of pits should be 1 meter apart
- Separate top soil from sub-soil
- Plant 5-10 cuttings/canes or single root splits for every 1 meter length

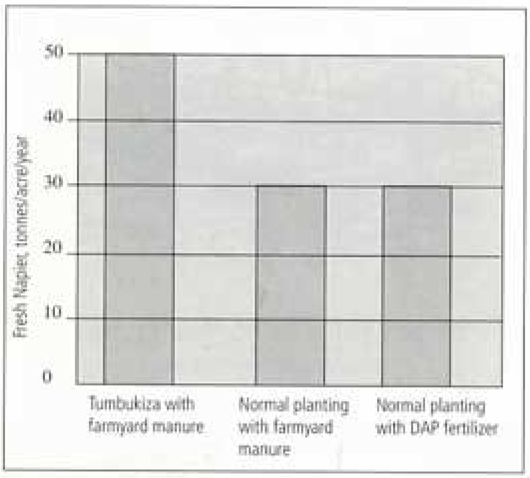
Use top-soil-manure mixture or fertilizer

Figure 3. Napier Management and Utilization

Hand weed if there are any weeds.
Use space between the pits to grow other crops such as beans, potatoes or forage legumes like Desmodium. Apply farmyard manure or slurry after every 4-6 harvests.

WHY TUMBUKIZA IS BETTER

- Better growth in the dry season.
- Feed available even during the dry season.
- More milk.
- More money from increased milk sales.



Harvesting

- Harvest napier grass and Desmodium at 2-3 feet (60-90 cm) high.
- Leave a stem length of 4 inches (10 cm) from the ground at harvesting.
- Chop the harvested Napier grass and Desmodium to reduce wastage while feeding it to the animals.
- Regrowth can be harvested when it reaches 2-3 feet (60-90 cm) high which means a period of 6-8 weeks between cuts

Benefits

- More fodder of better quality
- More milk
- Napier grass uses nitrogen supplied by Desmodium and therefore you can save on top dressing

Figure 4. Farmers field school on tumbukiza technology

Tumbukiza technology

Conventional method

Small holder farmers who have been attending Mwangaza farmers field school compare Tumbukiza Technology with Conventional method of planting and managing Napier grass during their graduation in the farmers field school.

During farmers' graduation, a farmers' field day is organized where the graduating farmers explain to other farmers what they have learned, during the entire school season which takes about 1 year. Here the technology learned was Tumbukiza. For the entire year the farmers here been meeting once a week going practically through the entire process of Napier grass planting, management, utilization and marketing, comparing napier grass production from Tumbukiza technology with production from the conventional method. This field day also serves as a way of disseminating the technology to other farmers.

Figure 5. Case study A

Mrs Soi of Motosieti farm in Kamplamai Division, Trans-Nzoia District, Rift Valley Province, Kenya, compares Conventional Method (Top) and Tumbukiza (Bottom) on her farm. She has intercropped Napier grass with sweet potatoes.
She learned Tumbukiza Technology from Mwangaza Farmers field school where she graduated. This is the peak of the long dry season. Mr and Mrs. Joel Soi's farm has had 3-4 months of drought. She says that the napier grass they established by conventional method dried up during the initial period of the dry season and remained unproductive. She says that while the napier grass established by conventional method remained unproductive, the napier grass established by Tumbukiza technology has enabled their dairy animals to remain productive. Tumbukiza technology has enabled the family to earn higher milk payments from milk produced during the dry season. Napier grass established and managed using Tumbukiza remained green and kept on growing even during the dry season because of the moisture conserved in the pits and high fertility. Mr. Soi is also happy that she is able to harvest sweet potatoes that she planted between the pits. She uses sweet potatoes for food and feeds potato vines to the calves.

Figure 5. Case study B

Douglas Nabwaya is seen standing with his mother. His parents have only 1.0 ha. of land in Saboti Division of Trans Nzoia District and they keep two dairy cows under zero-grazing and they mainly feed them on Napier grass planted and managed by conventional method. The parents have used their dairy income to educate Douglas to secondary school level. Douglas has just graduated from Mawazo farmers field school and he is increasing their Napier grass production on their farm using Tumbukiza Technology he learned from the farmers field school. He is confident that with this new technology, his parents will now raise enough funds to educate him to college level.

Back to paper

Tumbukiza!

A Better Way To Grow Napier Grass For More Milk

PRODUCTIONAREAS
Low to medium altitude areas of Kenya

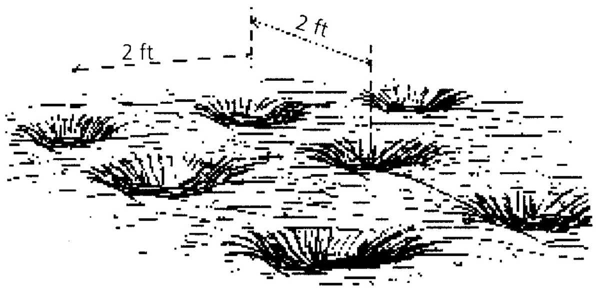
NAPIER GRASS VARIETIES
*Bana
*Clone 13
*French Cameroon
* Pakistan Hybrid

SOURCES OF NAPIER FOR PLANTING

* Research institutions
* Other farmers
* Ministry of Agriculture

TYPES OF TUMBUKIZA
1. The round pit type
2. The rectangular pit type

FOR ROUND PITS
Dig pits 2 feet in diameter by 2 feet deep.
The rows of pits should be 2 feet apart.

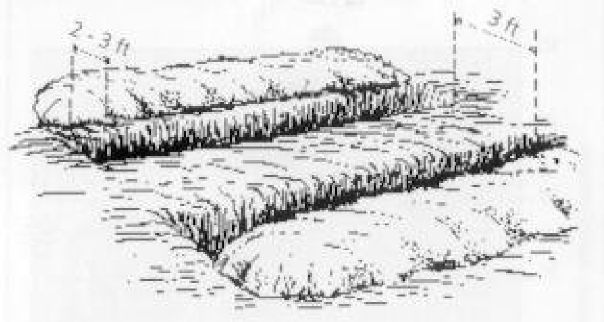


ROUND PITS 2 FEET APART

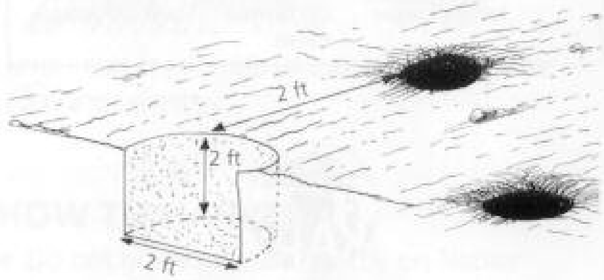
Round pits 2 fit apart

FOR RECTANGULAR PITS
* Dig pits 2 feet deep by 2 - 3 feet wide.
* The length of the pit can vary depending on available land.
* The pits should be 3 feet apart.
* Separate top-soil from sub-soil.

PLANTING
Mix 1 debe of top-soil with 1 to 2 debes of farmyard manure and put into the pits. For the rectangular pit put the top-soil/manure mixture for every 3 feet length.



RECTANGULAR PITS 2 - 3 FT FEET WIDE AND 3 FEET APART



ROUND PITS 2 FEET IN DIAMETER, 2 FEET DEEP AND 2 FEET APART

- Leave about 6 inches unfilled space at the top of each pit.
- Plant 5 - IO cane cuttings or single root splits in round pits.
- In the rectangular pits, plant 5 - 1 0 cuttings or single root splits for every 3 feet length.

Mix 1 ded of top-soil with 1-2 debes of farmyard manure

or single root splits for every 3 feet length.

Plants 5-10 cuttings per pit

-

MANAGEMENT
* Hand weed, if there are any weeds
* Use spaces between the pits to grow other crops, especially sweet potatoes.
* Apply farmyard manure or slurry after every 4 to 6 harvests.

APPLY 1 DEBE OF FARMYARD MANURE IN EACH HOLE AFTER

APPLY 1 DEBE OF FARMYARD MANURE IN EACH HOLE AFTER
EVERY 4 TO 6 HARVESTS

HOW TO HARVEST

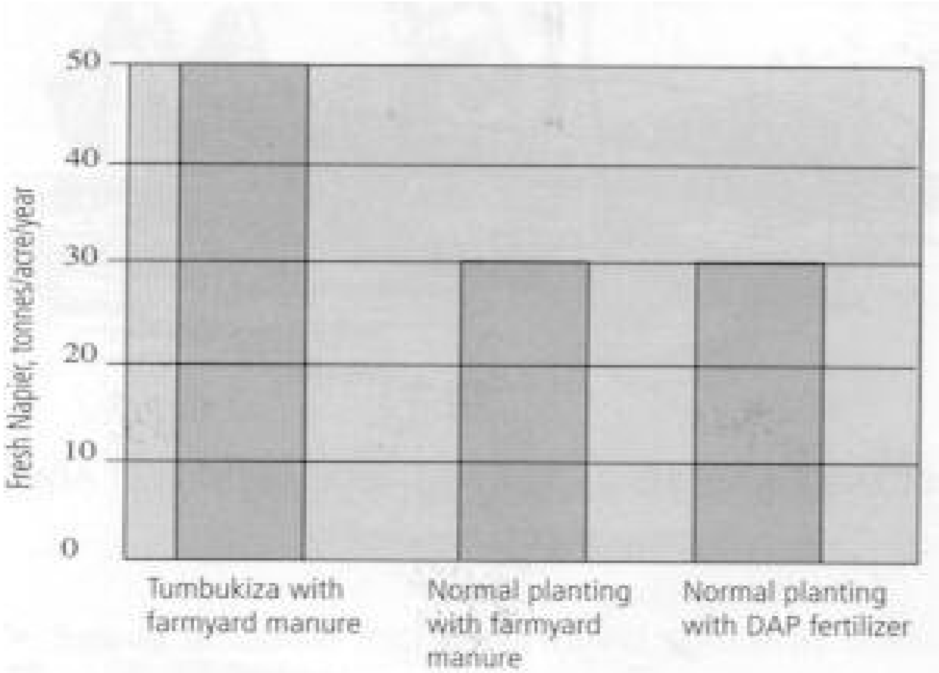
- Do not graze animals directly on Napier grass
- Cut Napier grass when 2 to 3 ft tall

FEEDING
Feed 70 kg or 7 headloads of fresh unchopped Napier grass to a dairy cow per day.

One acre of Tumbukiza Napier grass can give enough feed for 2 to 3 dairy cows for one year.

WHY TUMBUKIZA IS BETTER

- Better growth in the dry season.
- Feed avaiable even during the dry season.
- More milk.
- More money from increased milk sales.


Fresh Napier, tonnes/acre/year
50
40
30
20
10
0
Tumbukiza with farmyard manure
Normal planting with farmyard manure
Normal planting with DAP fertilizer