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REVIEW OF FORAGE RESEARCH IN THE MEDIUM TO HIGH POTENTIAL AREAS OF NORTH RIFT (2009-2010)

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INTRODUCTION

Livestock industry in Kenya has greatly expanded in last three decades. Apart from it's relevance as a direct source of food, livestock industry accounts for 7% of GDP. The sector is dominated by small scale producers who produce 80% of the milk consumed in the domestic market (GoK, 2003). The Dairy Industry has been reported to employ more labour per hectare than any other farm activity through processing of forage, routine management of animals, handling, processing and sale of dairy products (KARI, 1991). Cattle are predominant sources of red meat in Kenya. Fifty six percent (56%) of the cattle come from pastoralists in ASALs. Of these 35% are from Kenyan ASALs while the rest (21%) come from the neighbouring countries (Sudan, Ethiopia, Somalia, Tanzania).

The remaining 44% are found in high potential areas of Kenya. Beef contributes quite significantly to incomes of Livestock keepers and also earns foreign exchange through export of beef and beef products. Overall Kenya has an animal deficit of beef amounting to 40,000. Mt. Kenya is currently not a significant meat exporter.

Milk and beef are of great importance in the National development objective and research should focus on their production to meet the national deficit and development of the markets especially, meeting standards for international markets (KARI: Livestock sub-sector 1st Final document – 2010 unpublished).

Past research work (1960-1970) at NARC Kitale came up with three new cultivars of "Elmba", "Boma" and "Nasiwa" which were developed from Mbarara and Masaba Rhodes and Nandi setaria, respectively. Napier grass "Clone 13" which has higher dry matter and resistant to fungal mould, Beniowiskia sphoeroide was developed from the Napier Variety French Cameroon. Researchers also developed cultural practices for different regions of Kenya. These included intercropping of forage legumes with fodder grass/cereal crops. The seasonal productivity of fodders as compared to ley grasses, seed production potential of some forages, chemical compositions of forages, suitable stocking rates, grazing systems, calf rearing practices, levels of energy and protein supplements, grazing behaviour of different breeds of livestock and milk production potential when different breeds of livestock and milk production potential when different forages are fed to livestock were documented. Wandera (1997) and Nyambati (1997) observed that despite the development of recommendations on production and utilization of high yielding forages, inadequate feeds in terms of both quality and quantity remains the major constraint that limits livestock production in both meat and milk production particularly during the dry season.

This is mainly due to high cost of planting/establishing forages, laborious and expensive conservation techniques, lack of legume seeds and lack of technical know-how on the utilization of agricultural by-products. This was confirmed in participatory rural appraisals of the farming systems of the north rift province of Kenya (Rees et al. 1998) and also a report on Kenya Agricultural Research Priorities to the year 2000 (KARI,1991). The low adoption rates of the developed technologies made researchers in collaboration with extension staff and farmers to start on-farm verification and scaling up of the technologies. This paper discusses the solutions to the problems of inadequate feed for livestock production developed in the last 20 years.

Research Findings and Recommendations

Muyekho and Wandera (1997) carried out research work on effects of intercropping forage legumes with maize on grain and forage yield in the upper midland zone 4 of Trans Nzoia District. This work was done both on-station and on-farm. The results indicated that annual grain legumes (i) lupins (*Lupinus albus* cv. Ultra), dolichos (*Dolichos lablab*) and beans did not significantly ($P \leq 0.05$) reduce maize grain and maize stover dry matter yield (Table 1). However, the legumes resulted in low grain yields at both sites (Table 2).

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TABLE I-EFFECT OF INTERCOPPING ANNUAL GRAIN LEGUMES WITH MAIZE ON MAIZE GRAIN YIELD AND GROSS MARGIN

Maize/Legume intercropping	Maize grain Yield (t/ha)				Gross margin Ksh. (x100)	
	1994	1995	1996	1997	1994	1995
Sole maize + CAN	6.6	8.9	7.2	5.8	44.6	57.6
Maize + Beans	7.0	7.9	7.2	6.1	55.0	87.1
Maize + Lupins	6.7	9.1	6.6	5.2	42.2	76.4
Maize + Dolichos	6.4	8.0	7.1	5.9	56.3	75.1

TABLE II- LEGUMES GRAIN YIELD UNDER MAIZE INTERCROP AT NARC KITALE (T/HA)

	On-station		On-farm	
Maize legume intercropping system	1994	1995	1994	1995
Maize + Beans	0.26	0.56	-	-
Maize + Lupins	-	0.50	-	0.4
Maize + Dolichos	0.56	0.75	-	0.4

The same authors observed that perennial legumes (Silverleaf desmodium, Tropical Kudzu and Stylosanthes) did not have a significant effect on maize yield during the establishment year at the two sites but in subsequent seasons, maize grain yield was significantly reduced by Silverleaf desmodium but not the other legumes (Table 3). Stover dry matter yields were not significantly (P>0.05) affected by perennial legumes in the intercrops for all the three seasons.

Work was also initiated by Wandera et al (2000) on effect of intercropping herbaceous legumes and Napier grass on forage dry matter yields in the upper midland zone of Trans Nzoia district. The results in Table 4 revealed that;

(a) it is not possible to establish annual legumes in an already established Napier grass stand

TABLE III - EFFECT OF INTERCROPPING PERENNIAL FORAGE LEGUMES WITH MAIZE ON MAIZE GRAIN YIELD AT KITALE

Maize/Legume intercropping system	Maize Grain yield t/ha				
	On-farm		On-station		
	1994	1995	1994	1995	1996
Sole maize + CAN	8.23	6.70	8.18	7.36	7.50
Maize + Desmodium	7.99	6.81	8.61	5.97	6.34
Maize + Tropical Kudzu	7.48	7.51	8.04	7.63	7.32
Maize + Stylo	-	-	8.21	6.75	7.19
Maize + Beans	-	-	8.42	7.01	7.38

The gross margin analysis of the annual legume intercrop showed that lupin and Dolichos increased in gross margins relative to sole maize crop in 1995. Maize intercrop may be more profitable than the sole maize but not the bean-maize intercrop; however, the perennial legume maize intercrop showed marginal benefits.

(b) Silverleaf desmodium and Tropical Kudzu were the only legumes that persisted in Napier grass intercrop

(c) Dry matter yield of the legumes were drastically reduced when intercropped with Napier

TABLE IV - EFFECT OF INTERCROPPING ON LEGUMES AND NAPIER AT NARC KITALE

Napier grass/legume intercrop	Year			
	Dry yield (t/ha)	1994	1995	1994
Napier grass alone	Napier grass	16.0b	11.0b	12.8b
Napier grass + CAN	Napier grass	-	13.0b	12.8b
Napier grass + Desmodium	Napier grass	17.3b	11.2b	13.6b
	Legume	1.1	2.2	1.0
	Total	18.4a	13.4b	14.6a
Napier grass + Puereria	Napier grass	17.3b	12.7b	12.8b
	Legume	-	-	-
	Total	17.3b	12.7b	12.8b
Napier grass/Dolichos	Napier grass	15.0b	11.7b	13.0b
	Legume	0.5	-	-
	Total	16.0b	11.7b	13.0b
Napier grass/Lupins	Napier grass	14.4b	10.5b	13.9b
	Legume	0.8	-	-
	Total	15.2b	10.5	13.9b
Napier grass/beans	Napier grass	15.1b	12.2b	16.4a
	Legume	1.0	-	-
	Total	16.1b	12.2b	16.4a

Wandera et al. (1994) reported on factors limiting Lucerne herbage production in Western Kenya. In one of the experiments they looked at the effects of application of NPK on Lucerne herbage yield between 1992 to 1994. The results indicated that NPK application had no influence on Lucerne herbage yield (Table 5). The soil analysis before establishment of Lucerne were 1.17me%, 3.9me%, 2.65me%, 2.3me%, 13ppm for K, Ca, Mg, C and P, respectively. Except for phosphorus, the levels of other nutrients were in a range adequate to sustain high crop yield.

Wandera et al. (1994) carried out investigations on the effects of subsoil amendments on Lucerne herbage yield. The results indicated that breaking up the subsoil alone and breaking up the subsoil followed by addition of chopped maize stover (CMS) did not significantly influence Lucerne herbage yield (Table 6). By contrast breaking, the subsoil followed by addition of cowdung manure (CDM) doubled herbage yield while breaking the subsoil followed by addition of saw dust (SD) significantly reduced Lucerne yield. The author concluded that fertile sites where subsoils are rich in nutrients are the most suited for production of high

TABLE V - DRY MATTER YIELD (T/HA YEAR^{-1}) OF LUCERNE HERBAGE FOLLOWING APPLICATION OF N.P.K. IN 1992, 1993 AND 1994.

Fertilizer Treatment	Yield (t/ha)		
	1992	1993	1994
Control (No application of NPK)	6.7	8.1	8.9
60kg N/Ha/year	4.9	7.0	7.5
40kg P_20_5/ha/year	6.2	7.8	9.8
100kg K_20_5/ha/year	5.8	7.5	8.1
60kg N + 40kg P_20_5/ha/year	6.5	8.6	8.1
60kg N + 100kg K_20_5/ha/year	6.7	-	10.3
40kg P_20_5 + 100kg K_20_5/ha/year	6.9	-	11.3
60kg N + 40kg P_20_5 + 100kg K_20_5/ha/year	7.3	-	10.8
60kg N + 40kg P_20_5 + 100kg K_20_5 + Nitrogen/ha/year	6.9	-	11.5

TABLE VI -DRY MATTER YIELD OF LUCERNE AS INFLUENCED BY SUBSOIL AMENDMENTS

Treatment	Dry matter yield (t/ha/yr)		
	1992	1993	1994
No subsoil disturbance	8.6b	8.5b	6.7b
Subsoil broken	8.2b	8.9b	6.2b
Broken subsoil + CDM	15.4a	12.0a	11.9a
Broken subsoil + CMS	8.8b	8.3b	5.8b
Broken subsoil + SD	5.8c	6.4c	5.4b

Means followed by a similar letter are not significant at $P \leq 0.05$

Lucerne yields in Western Kenya. Such sites would include kitchen gardens and former night boma.

Investigations were carried out on management of Desmodium and Lucerne for seed production by Wandera et al. (1994). Phase one of this study focused on screening of selected Lucerne and Desmodium varieties at six sites. The tentative results indicated that:

a) Kitale and Elgon downs, were better sites for Lucerne and Desmodium seed production in 1994.
b) Among evaluated Lucerne varieties were Hunter River, CUF101, hairy Peruvian and Siriver. Hunter river, prodana resis and resis Lucerne and Siriver produced the highest amount of seed at Kitale, Elgon downs and Kisii sites, respectively.
c) Desmodium intortum 009618 exhibited best synchrony in seed production and it produced the highest seed yields at the Kitale site.
d) Diseases and pests reduced the potential of Lucerne and Desmodium varieties to produce seed at Alupe and Busia sites, respectively.

In the second phase of investigations on management of Desmodium and Lucerne for seed production Wandera et al. (1995) determined the influence of phosphorus and molybdenum on Lucerne and Desmodium seed yield. The results indicated that Desmodium seed production was generally low (Table 7) and unsynchronized. Silverleaf Desmodium produced more seed than the Greenleaf Desmodium irrespective of the treatments. Silverleaf desmodium responded significantly to application of phosphorus and molybdenum by producing more seed. By contrast, Greenleaf desmodium did not respond to phosphorus and molybdenum application. The heavy attack of fungal diseases led to the conclusion that variety CUF101 Lucerne variety was not suitable for seed production in the Kitale area.

TABLE VII - SEED YIELD OF SILVERLEAF AND GREENLEAF DESMODIUM AS INFLUENCED BY PHOSPHORUS AND MOLYBDENUM FERTILIZER

Fertilizer Treatment	Seed yield (Kg/ha)	
	Silverleaf Desmodium	Greenleaf Desmodium
Control (no fertilizer)	155^b	65^c
200kg P_205/ha	218^a	63^c
100g Mo/ha	208^a	60^c
100g Mo + 200kg P_205/ha	168^b	60^c

Means followed by the same letter in a row are not significantly different at $P \leq 0.05$

Lusweti et al. (1995) reported on performance of dual purpose sweet potatoes at Sigor (West Pokot) and Endebess (Trans Nzoia) Districts. Clones Mafuta, Kemb 10, Kemb 36, SPK004 and 440037 had the highest vine yields of 75.76, 66.41, 56.06, 59.34, 87.37 t/ha at Sigor and 60.40, 67.07, 59.53, 58.40 and 57.43 t/ha at Endebess, respectively.

Wandera et al. (1995) reported on the screening of multipurpose fodder trees for dry matter production at NARC Kitale with an objective of screening (different cultivars of Leucaena, Sesbania, Calliandra and Acacia). The highest yields were recorded from *Leucaena pallida* (0.81 t/ha/tree), a species which was found not to be attacked by psyllids. *Sesbania sesban* cv. Kwap produced (0.77 t/ha/tree), *Calliandra calothyrsus* (0.66 t/ha/tree) and *Acacia angustisima* (0.79 t/ha/tree) which were not significantly different from that of *Leucaena pallida*.

The effect of spacing and plant configuration on dry matter yield was studied for three fodder shrubs i.e. Leucaena leucocephala cv Hawaii, Sesbania sesban cv.15019 and Calliandra calothyrsus. Treatments were 0.5 x 0.5m within and between plants in a square pattern, a spacing of 0.5 x 0.5m with neighbouring plants forming a parallelogram and a 0.8 x 0.25m spacing between and within rows. The results indicated that Sesbania outyielded both leucaena and calliandra. Irrespective of the species, plant configuration had no influence on herbage yield. The third activity on screening of multipurpose fodder trees for dry matter production focused on the influence of different methods (i.e. cutting back using (a) sharp panga and (b) blunt panga on sesbania cultivars (i.e. 15019, 15036, 10865 and Kwap). Overall cultivar 15036 produced the highest dry matter yields for both two different methods of cutting back (i.e. 0.89 t/ha for sharp panga and 2.38 for a blunt panga). Sesbania cv Kwap produced the lowest yields for both methods of cutting back.

Among the ILCA shrub accessions, Sesbania sesban cv.15036 (0.5kg/plant), Acacia angustissima (0.6kg/ plant) Leucaena pallida (0.3kg/plant) were the top yielders during the fourth year of production. Low production levels were noted for *Flemingia macvophyla* (0.12kg/plant) and *Desmanthus vergatus* (0.03kg/plant) (Wandera et al. 1995). Muyekho and Orodho (2000) reported on effects of food crops and fodder shrubs as trellis on seed yields of desmodium species at NARC Kitale. The results indicated that *Desmodium uncinatum* produced significantly ($P \leq 0.086$) higher seed yields (58kg/ha) than *Desmodium intortum* (50kg/ha). Intercropping Desmodium (mean yield of 151.8kg /ha) with *Sesbania sesban* significantly ($P \leq 0.001$) increased seed yield by 33% compared to the control (108.3kg/ha). Use of maize, sorghum or cassava as trellis did not significantly affect seed yield.

Muyekho (2000) investigated on effects of cutting height and time of final defoliation on dry matter and seed yield of *Desmodium uncinatum* and *Desmodium intortum* forage legume species at NARC Kitale during 1998/99 season. The results showed that the effects of defoliation on herbage dry matter yields varied with the severity (height) of defoliation; time of final defoliation during the flowering stage and the legume species. *Desmodium uncinatum* had a significantly ($P \leq 0.05$) lower in DM yield when severe defoliation upto 3 weeks after flower appearance was imposed but when subjected to lenient defoliation significant reductions in DM yields only occurred beyond 3 weeks after flower appearance. *Desmodium intortum* was not affected by either defoliations. Defoliation did not improve flower synchronization. Seed yields were not significantly ($P \leq 0.05$) affected by defoliation treatments. The author concluded that:-

(a) Defoliation or grazing of *Desmodium uncinatum* and *Desmodium intortum* at certain times of the year before deferring for seed production reduces flower synchronization and, therefore, seed yield.
(b) Farmers **i**nterested in using *Desmodium uncinatum* for grazing or cut and carry feeds should defer the crop for seed production as soon as the first flowers appear in the field. For D. intortum grazing or cutting for herbage is not recommended for the seed crop in Kitale.

Mulaa and Muyekho (2000) carried out a survey in Bungoma and Trans Nzoia districts to identify the major pests of *Desmodium uncinatum* under different management systems, find out the farmers perceptions of damage caused by the pests and investigate the effects on seed production. The results from these studies have shown that the most destructive pests according to the farmers and scientists ranked in order were: the pollen beetles, African bollworm and ladybird beetles. The results also revealed that the aborted and damaged flowers and pods were more in Desmodium/maize intercrop (65%) and lowest in the sprayed Desmodium monocrop (14.2%), showing that chemical control reduces pest incidence.

Muyekho et al. 2000 reported work on promotion of forage legume seed production and processing on small holder farms in Uasin Gishu and Bungoma districts. In their on-farm trials, they set out to evaluate the seed production potential of *Desmodium uncinatum*, *Stylosanthes guyanesis, Stylosanthes scabra*, *Dolichos lablab* and *Macrotyloma axillare* and to encourage small scale farmers to start producing seeds for their own use and sale the surplus. A total of 832 farmers were exposed to legume seed production through formal trainings during the study period. In Bungoma 62% of the farmers obtained seed yields in the region of 50-137kg/ha for *Desmodium uncinatum*, 71% in the region of 300-750 kg/ha for S. guyanensis and 33% over 300kg/ha for S. scabra. Compared with local maize production, yields of 55kg/ha for *Desmodium* *uncinatum* and 115kg/ha for Stylosanthes were economically profitable.

Muyekho (1999) reported on oversowing and undersowing of different legumes and ley grasses in the lower highlands zones and upper midland zone 4 of Moiben (Uasin Gishu District) and at NARC Kitale, respectively. The results indicated that direct sowing as a method of pasture establishment is superior to undersowing or oversowing in terms of dry matter yields but farmers preferred undersowing because of reduced cost of establishment and benefits from the nurse crop (Maize or wheat) during the first year. No tillage seedbed preparation for oversowing may be cheaper for farmers than disc ploughing or harrowing of the natural grasslands. Congo signal was recommended as a better grass species for oversowing than Rhodes grass, setaria and coloured guinea.

Verification of the production and utilization potential of selected forages in the lower highlands (LH3) Uasin Gishu of Moiben division, was done by Muyekho et al. (1999). Based on yield economic indicators and farmer ranking, it was concluded that farmers interested in intensive dairy production system could adopt Bana Napier grass and Calliandra for high livestock productivity. The "Tumbukiza" method of Napier grass production was evaluated at NARC Kitale and Moiben Division of Uasin Gishu district. The "Tumbukiza" method of Napier grass production allows for intercropping of maize or forage legumes in Napier grass (Muyekho et al, 1999). The results have indicated that:

a) For farmers whose priority is to maximize productivity and profit per unit area "Tumbukiza" method would be the best choice, while for those where labour is a major limiting factor conventional method can be used in planting Napier grass
b) The "Tumbukiza" method is not superior to the conventional method in terms of yield of the maize intercrop. Thus maize may be intercropped in Napier grasses planted by either method in the year of establishing Napier grass.
c) The Tumbukiza" method does not enhance legume persistence in Napier grass/legume mixture.
d) Provided the amount of nutrient applied matches with the number of planting material per hole, the size of "Tumbukiza" hole or plant density would not affect Napier grass productivity.
e) Use of inorganic fertilizer gives the same Napier yields as applying goat manure, cow manure and cow slurry at planting.

On farm evaluation of some selected forage varieties was carried in semi-arid areas of West Pokot (Lusweti et al.1999). The three introduced grass varieties (Coloured guinea, Rhodes grass cv. Boma and Napier grass) and four legumes (*Dolichos lablab, Stylosanthes Secca, scabra* and verano) were tested by farmers under their own conditions. Results indicated that DM of Coloured guinea (6.8 t/ha) significantly ($P<0.05$) outyielded Napier grass (4.3 t/ha), but not Rhodes grass. The introduced legume forage yields did not differ significantly ($P>0.05$) amongst themselves. On the overall adoptability the farmers at Chepareria (West Pokot) preferred Napier grass, *Dolichos lablab* and *Stylosanthes scabra*.

In a collaborative project between ICIPE/KARI/MoA, an integrated strategy has been developed in which fodder plants are used to control stemborers and striga weed when planted in association with maize (ICIPE, 1997). Particularly promising are Napier grass, Sudan grass, *Silverleaf desmodium, Greenlead desmodium* and molasses grass. In addition to the benefits accruing from the control of stemborers, studies have demonstrated that farmers can get an additional 10 t/ha/year herbage dry matter yield from Napier grass from the same piece of land where maize is grown (Muyekho, 1998).

Lusweti et al (2007) evaluated Napier grass accessions for productivity in different agro-ecological zones of Western Kenya. The results indicated that at lower altitudes of lake region (i.e. Busia), the Napier accessions Kakamega 2, Machakos hairless, L12, Uganda hairless, Kakamega 9 produced the highest dry matter yields of: (29.5, 28.5, 26.3, 23.5, 22.4 t/ha respectively but were statistically ($P\leq0.05$) similar to the already recommended Bana grass (26.5 t/ha). However, at higher altitudes of Kimnai, the introduced Napier grass accessions namely R11, Kakamega 9, Kakamega I and L6 produced significantly ($P\leq0.05$) higher dry matter yields of 5.3, 4.8, 4,.5, 4.5 t/ha, respectively than the recommended varieties French cameroon (1.5 t/ha) and Pakistan hybrid (1.5 t/ha).

Kakamega I, Kakamega 9 and Kakamega 2 performed well at both lower and higher altitude zones.

Lusweti and Mulaa (2004) carried out a survey with an objective of establishing the prevalence and severity of the Napier stunting disease problem and also to collect the potential insect vectors for Napier grass stunting disease in Western Kenya. Survey findings indicated that the stunting disease incidence was high (roughly between 5% to 80%) and it was increasing. Bana grass which is high yielding and liked by farmers was highly susceptible to the disease. It was also noted that the higher frequency of cuttings, the higher the infection especially those crops that were not fertilized. Several insect species were collected (mostly leaf and plant hoppers). Lusweti et al (2005) evaluated the effects of fertilizer application on Napier grass affected with stunting disease in Western Kenya. The preliminary results suggested that using fertilizer particularly K and/or P may have positive effects in increasing yields from Napier stunt affected plots. Similarly, Lusweti (2009) evaluated the integration of crops and livestock for small scale farmers at KARI Kitale farm. The model farm was 0.36 ha of banana grown in alleys of alternating rows *Leucaena diversifolia* and *Calliandra calothyres* with *Panicum maximum* and *Desmodium uncinatum* as intercrops. Napier grass was planted under "Tumbukiza method of production in alleys as a pure stand on 0.08 ha. Napier grass, banana residues and leguminous trees trimmings were fed to a dairy cow and its follower.

The cow was expected to produce 3000kg of milk in 300 day lactation. The results from this study indicated that it was possible for a farm household of 6 members to make a living and then save some income from one acre of land provided no hired labour was used. Similarly this cropping system ensured positive balances for Nitrogen and phosphorous on the farm but potassium fertilizer application was required to compensate for heavy drains through sale of bananas.

Mulaa (2009) reported on management strategies for Napier stunting disease in Western Kenya. Napier grass cv. Bana plus uprooting infected plants and replanting with disease free materials had the lowest incidence of diseased plants followed by Napier clone R13 and Bana + Desmodium intercrop surrounded with molasses grass.

Dissemination of developed technologies

So far leaflets have been developed and produced and distributed in Kitale mandate region and beyond. The titles of these leaflets are as listed below:-

1. Seed productivity
2. How to get more milk in the dry season
3. Feed lupin seed with maize for cheaper dairy feed
4. Get more milk and meat from your farm
5. Tumbukiza! A better way to grow Napier grass for more milk
6. Grow Desmodium for seed and make more money
7. Sweet potato production in the North Rift Valley

Unfortunately no efforts have been made to make a follow-up and assess the impact of these developed technologies. Secondly there has been little response from extension officers on the same; the reasons being pegged on lack of funds. But there have been a lot of requests for leaflets from NGOs and individual farmers. Due to limited funding there has been no work on scaling-up of these technologies, though from the above review these technologies can be scaled-up.

On farm experiences

A good involvement of farmers, extension workers and researchers in technology verification was experienced in Uasin Gishu (Moiben), Chepareria (West Pokot) and Bungoma districts. Farmer Research Groups were formed who then elected a Farmer Research Committee. The most important activities of (FRC) were mobilizing farmers for visits and trial evaluations, encouraging members to implement their trails and relaying messages to research.

Working with farmer groups was not without problems; some of the problems experienced were:-

1. Appointment of a locally important person as Chairman, who had no further involvement in the research but could not be replaced.
2. Availability of transport for monitoring on-farm trials was a logistic constraint.
3. The farmer groups required some compensation from scientists for the time devoted to evaluations (i.e. lunch and sometimes cash payments)
4. Composition of the groups nominated by the communities to implement trials lacked representation of the disadvantaged groups (i.e. the most poor)

5. Request by farmers for farm inputs
6. Verification plots were too small for the farmers to assess the feeding potential of the pasture and fodder crops tested.

But on the other hand there were advantages to this approach because:-

1. Farmers selected the technologies they preferred during evaluations and thus the technologies were adopted immediately.
2. Dissemination of the suitable technologies was self propelling through farmer to farmer education.
3. Interaction with farmers enabled scientists from Research and Extension to learn farmers problems and their suggested solutions much faster.

Priorities for future work

a) Seed production research

1. Promote community based seed production through training of more farmers on the technologies developed in collaboration with farmers in Bungoma and Uasin Gishu.
2. Develop simple and affordable harvesting and threshing equipment/tools that small scale farmers can use to minimize drudgery and also save labour for other activities.
3. Carry out detailed surveys in different agro-ecological zones to find out the abundance of the major Desmodium insect pests and their seasonal fluctuations and also to identify peaks and develop appropriate intergrated pest management (IPM) practices that can reduce the cost of seed production.
4. Investigations of *D. intortum* for seed production under Kitale conditions (UM4) showed that farmers can get better yields if they avoid grazing or defoliating the sward when the crop is about to start flowering. This result needs to be verified in other agro-ecological zones.

b) Intercropping Research

1. Further research in identifying the critical stages of the maize crop at which Desmodium should be defoliated in order to minimize maize grain yield and optimize legume herbage production.
2. The results of the study on intercropping herbaceous legumes and Napier grass indicated clearly that for the Napier grass/perennial legumes intercropping technology to be sustainable on farmer's field, management packages that can reduce competition for soil nutrients between the 2 crops must be developed to sustain the species mixture in order. An understanding of the growth habits and the underlying competition mechanisms in the intercrops could assist in developing the management regimes.
3. Crop/Livestock integration studies should be encouraged since farmers' priority on land allocation for Pasture crops is low.

c) Management and utilization of forage research

1. Feeding studies to evaluate the milk production potential from the improved grasses.
2. Evaluation of the persistence of the pasture under farmer managed conditions.
3. Impact assessment studies on the technologies released from the Pasture/Fodder Research programme.
4. Validation of on-farm results in other agro-ecological zones different from where the trials were done and monitoring of the uptake of the technology.
5. Development of new proposals should focus on climate change and animal production value chain.
6. Pasture/Fodder Breeding work should be revived at KARI Kitale because:-

(i) with global climatic edaphic changes and also with new challenges in pest attack on our forages, breeding work is essential so as to come up with tolerant/resistant varieties

(ii) There is also need to look at possibilities of developing food crops that can also be a source of feed (dual purpose crops).

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