East Africa Dairy Development

In partnership with

SASHA: Animal feed proof of concept project - Rwanda and Kenya

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Why sweetpotato as animal feed?

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Why sweetpotato?

- Most forages are scarce in quantity and of are inadequate quality especially in dry season
- Sweetpotato vine provides more protein and dry matter per unit area than other staple feeds and requires less land to produce
- Can easily be incorporated in smallholder farming systems – abundant suitable niches

Advantages of sweet potatoes

- Can be used in fresh, dried form or silage
- Crop is grown with low inputs,
- Adapted to wide range of climatic conditions
- Produces high dry matter yield per unit area
- Short growing period
- SPR reduces over reliance on maize as ruminant feeds hence compliments maize as staple food and monogastric feeds

Project objectives

- Identify the appropriate adapted dual purpose and forage varieties for specific livestock production systems and specific agro ecologies
- Determine the most appropriate combination of sweetpotato vines/roots with other available feedstuffs that maximize livestock productivity
- Model and test novel feed and production and feeding strategies based on optimizing sweet potato legumes-other feed resources-pig and dairy interactions

Activities

- Activity 1: Screening sweet potato germplasm for biomass production under different cropping regimes and their potential as dual-purpose varieties
- Activity 2: Adapting simple, low-cost, silage-making techniques using sweet potato roots and vines, other feed resources and legumes
- Activity 3: Modeling and testing novel feed production and feeding strategies based on optimizing sweet potato-legumes-other feed resources-pig and dairy interactions

Activity 1

Screening sweetpotato germplasm for biomass production under different cropping regimes and their potential as dual-purpose varieties

Screening design and parameters

Design

Kenya:

- Comprised 6 sites x 6 varieties x 2 harvesting times.
- Harvesting regimes [75days (vines only) & 150 days (vines and roots)].

Rwanda:

- Comprised 6 sites x 8 varieties x 2 harvesting times.
- Harvesting regimes [80days (vines only) & 150 days (vines and roots)].

Parameters

- Total yield (forage and root)
- Nutritive value (proximate analysis)
- Climatic data (rainfall and temperature)
- Soils samples (N, P and K)
- Participatory farmer evaluation (150 days)

Results – Kenya

(On-farm trials)

R:V ratios across AEZs in Kenya

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AEZ	103001.15 2	Gweri	Kemb 23	Kemb 36	Naspot 1	Wagabolige
High altitude (wet)	0.8	0.2	0.4	0.4	0.5	0.4
Mid altitude (wet)	0.7	0.2	0.4	0.3	0.4	0.2
Mid altitude (dry)	0.6	0.2	0.3	0.3	0.5	0.4
High altitude (dry)	0.4	0.1	0.1	0.1	0.2	0.1
Mean	0.6	0.2	0.3	0.3	0.4	0.3
Classification	R	F	DPH	DPH	DPL	DPH

Classification	R:V ratio	Classification	R:V ratio
Forage (F)	≤ 0.2	Dual purpose -low (DPH)	0.31 > RV < 0.55
Root	RV > 0.55	Dual purpose -high (DPL)	0.2 1 > RV < 0.3

Biomass yield (t DM/ha) of SPV of day-150 ratooned (R) and unratooned (U) of six cultivars in different AEZs

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	High altitude		Medium altitude		Low altitude	
Cultivar	R	U	R	U	R	U
103001	0.76^{d}	0.10^{c}	1.04^{e}	0.72^{e}	2.30^{e}	3.17^{b}
Gweri	1.34^{a}	0.31^{b}	3.86^{a}	2.18^{d}	5.37^{a}	2.68^{d}
Kemb23	1.02^{c}	0.38^{b}	3.43^{b}	2.67^{b}	3.31^{b}	2.68^{d}
Kemb36	1.07^{b}	0.31^{b}	2.87^{c}	2.05^{d}	3.04^{d}	3.47^{a}
Naspot1	0.89^{d}	0.56^{a}	2.49^{d}	3.67^{a}	3.13^{c}	2.98^{c}
Wagabolige	1.02^{c}	0.17^{c}	3.49^{b}	2.49^{c}	2.44^{e}	1.63^{e}
Mean	1.02	0.31	2.86	2.30	3.27	2.77

Biomass yield (ton DM/ha) of SP storage roots for day-150 ratooned (R) and unratooned (U) of six cultivars in different AEZs

	High altitude		Medium altitude		Low altitude	
Cultivar	R	U	R	U	R	U
103001	1.41[a]	1.44[b]	1.48[a]	1.83[a]	1.56[a]	2.06[a]
Gweri	0.18[d]	0.19e	0.29[c]	0.42[d]	0.32[d]	0.41[d]
Kemb23	0.26[d]	0.89[c]	0.97[b]	0.63[c]	0.62[c]	0.67[c]
Kemb36	0.38[c]	2.08[a]	0.40[c]	0.70[c]	0.50[c]	0.77[c]
Naspot1	0.63[b]	1.30[b]	1.07[b]	1.92[a]	1.35[b]	1.63[b]
Wagabolige	0.24[d]	0.64[d]	0.45[c]	0.96[b]	0.51[c]	0.85[c]
Mean	0.52	1.09	0.78	1.08	0.81	1.07

CP (%) of SPV for day-75), 150 ratooned (R) and unratooned (U) of six cultivars in different locations

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	High altitude			Medium altitude			Low altitude		
Cultivar	75	150R	150U	75	150R	150U	75	150R	150U
103001	26	22	22	21	17	20	24	21	21
Gweri	25	21	23	21	20	21	22	14	17
Kemb23	26	23	21	20	17	19	21	16	21
Kemb36	22	21	22	21	17	20	22	19	19
Naspot1	24	22	20	22	17	23	26	20	21
Wagabolige	24	22	21	18	18	19	21	18	19
Mean	25	22	22	20	18	20	23	18	20

Ranking of preference of various attributes

	Farmers' preferred attributes					
Cultivar	Fibrousness	Sweetness	Forage	Flavor (DM)	Score	Ranking
103001	3	4	3	5	15	4
Gweri	5	4	1	5	15	4
Kemb23	2	1	2	3	8	2
Kemb36	2	3	2	4	11	3
Naspot1	1	2	2	2	7	1
Wagabolige	4	1	2	1	8	2

Key summary of findings

- In Kenya:
  - ✓ One variety (Gweri) was identified as most promising for forage
  - ✓ Four other varieties (Kemb-23, Naspot-1, Wagabolige, Kemb 37) were identified as “best bet” dual purpose varieties
  - ✓ Another (103001.152) was identified as mainly good for root
  - ✓ At least one varieties performed well in each different agro ecological zones, ensuring that farmers in each zone have at least one suitable option
  - ✓ All varieties performed poorly in high altitude cold areas suggesting the need to select/breed for cold tolerant varieties

Key summary of findings

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- Farmers will have to make tradeoffs in choosing between forage, dual purpose, and root varieties depending on feed needs on farms.
  - ✓ It is likely that farmers facing acute feed shortages will opt for forage or dual purpose varieties.

Activity 2

On station Screening of Sweetpotato Varieties and Silage Trial

Treatments (g)

(Vines: Root ratio on % basis)	Salt	Molasses	Cassava meal	Maize meal	Poultry manure
75:25	15				
75:25	15	60			
75:25	15		150		
75:25				150	
75:25	15				300

Silos opened after 90 days

Comparison of significance level between SPV and SPVR among additives (T-test)

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Additive	pH	NH3-N	DM	CP
Cassava meal	0.083	0.027*	0.468	0.027*
Poultry manure	0.038*	0.499	0.087	0.087
Maize meal	0.020*	0.398	0.367	0.367
Molasses	0.004*	0.483	0.004*	0.002*
Salt	0.029*	0.725	0.457	0.457

$P \leq 0.05$-Significantly different

Key findings

On-station silage trials demonstrated:

- The potential for silage additives like cassava meal, maize meal, and molasses as blends with sweetpotato silage using roots and vines
- Produced promising proportions of roots and vines for pig diets and also as a blend with other locally available feed resources

Activity 3

Testing sweetpotato based feed and feeding strategies in pig production systems in central Kenya

Activities accomplished

- Pig survey to understand the current sweetpotato and pig production practices in the study sites
- Evaluation of a new form of effluent drainage from silage by using a “modified plastic tank silo”
- Tested the appropriate level of combination of sweet potato vines and roots
- Determined the appropriate level of combination of Napier grass and sweet potato vines

Pig production survey

Surveyed 3 district; sampled 50 farmers per district

- 97% of pigs were reared on intensive production system
- 38% of pigs fed on kitchen and garden waste
- 32% fed on commercial concentrates and ingredients
- 15% on forages (including SPV)

- 58% of respondents were growing sweet potato as food as well as forage for livestock
- 85% of farmers ranked SP as the most important fodder

Pig feeding trial

Farms and feed

- Three farmers selected in each of the three districts (9 farms)
- Naspot 1 selected based on results of on farm trials
- The SP were multiplied farms; seed provided by CIP
- The vines and roots were harvested at 160 days of growth

Silage preparation

- Silage prepared 75% vines: 25% roots.
- Vines chopped (~ 3 inches) and roots sliced (~ 1 inch).
- Molasses water mixture (1:2 proportion) and salt included at 0.5%.

Experimental design

There were four treatment;

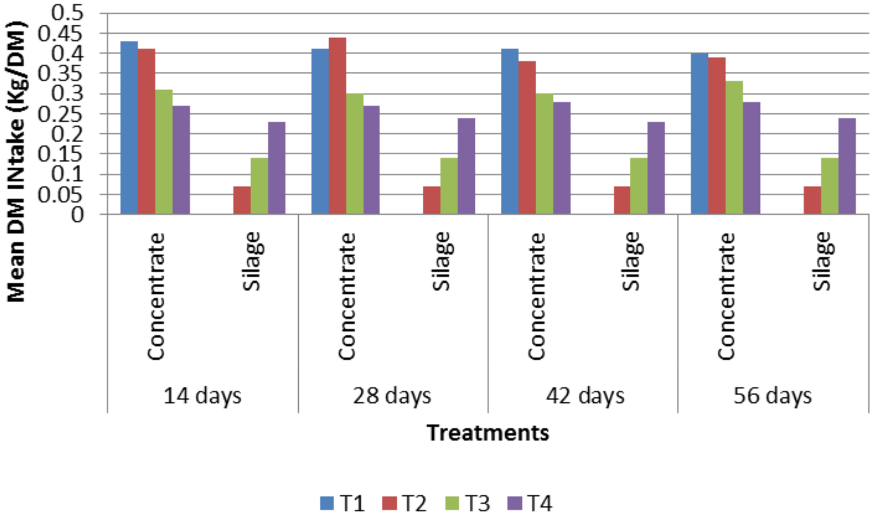
- T1-100% concentrate (control)
- T2- 85% concentrate: 15% silage,
- T3- 70% concentrate: 30% silage,
- T4- 55% concentrate: 45% silage

Each treatment was replicated 3 times i.e. twelve (12) pigs per farm

- Approx. 3 months of age with 20 - 30 Kg live weight.
- Animals randomly distributed to all the treatments based on sex and live weights

Mean intake (DM) and growth rates (Kg)

Fig 2: Mean dry matter intake (kg/d) of pigs fed different treatments

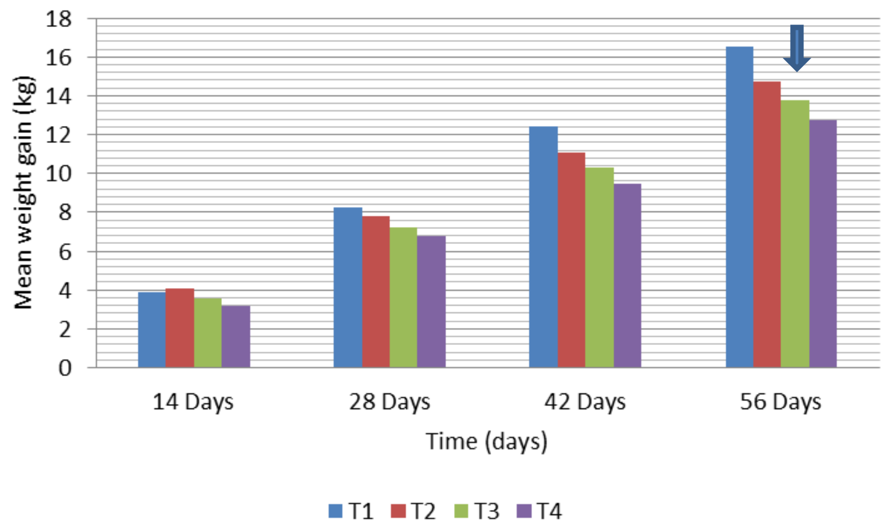


T1	- Concentrate only,
T2	- 85% conc+15% silage,
T3	- 70% conc + 30% silage,
T4	- 55% conc + 45% silage

Key point:

- The pigs on treatments with silage diet consumed more feed compared to the control
- The growth rate of two silage diets (T2 and T3) were not different from the concentrate.

Fig 2: Mean weight gains (kg) of weaner pigs fed different treatments

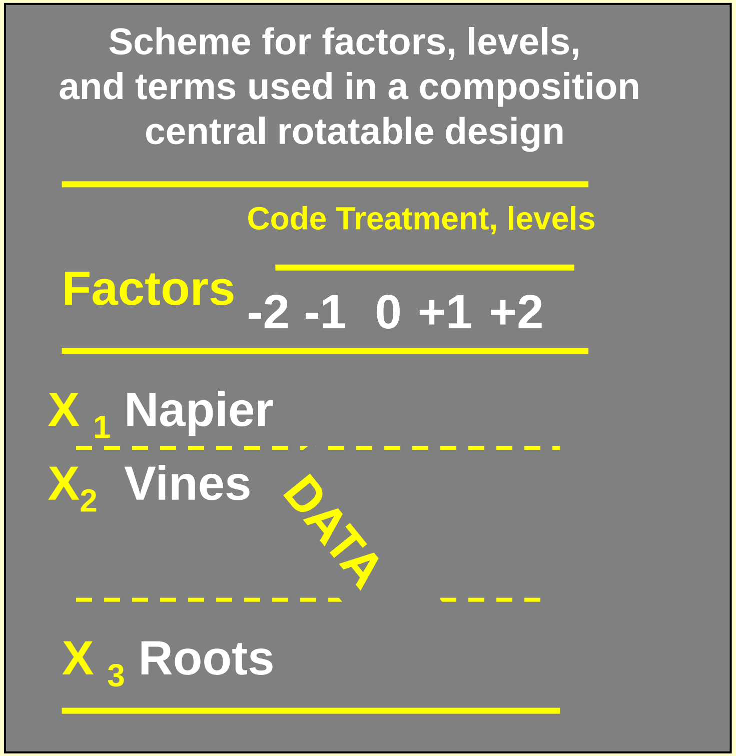


Cost (US$) of raising piglets fed on different diets

	14		28		42		56		Overall	
Treatment	Mean	se	Mean	se	Mean	se	Mean	se	Mean	se
T1	137	18	123	11	121	7	123^{a}	6	**126^{a}**	6
T2	143	24	124	8	135	7	137^{b}	6	**125^{a}**	7
T3	77	26	127	11	143	17	145^{b}	13	**135^{a}**	9
T4	110	24	139	22	161	29	156^{b}	21	**142^{a}**	12

Selecting optimum ranges of technological alternatives by using response surface design in Sweetpotato silage

Response surface



Response				
	Name	Unit		ID
Y1	Protein	%		Prot
Y2	Digestibility	%		DiG
Factors				
	Name	Unit		Id
X1	Napier	%		Napier
	Code (2) =	70.00	%	
	Code (1.682) =	66.82	%	
	Code (1) =	60.00	%	
	Code (0) =	50.00	%	
	Code (-1) =	40.00	%	
	Code (-1.682) =	33.18	%	
	Code (-2) =	30.00	%	
	Name	Unit		Id
X2	Vines	%		Vines
	Code (2) =	40.00	%	
	Code (1.682) =	38.41	%	
	Code (1) =	35.00	%	
	Code (0) =	30.00	%	
	Code (-1) =	25.00	%	
	Code (-1.682) =	21.59	%	
	Code (-2) =	20.00	%	
	Name	Unit		Id
X3	Roots	%		Roots
	Code (2) =	30.00	%	
	Code (1.682) =	28.41	%	
	Code (1) =	25.00	%	
	Code (0) =	20.00	%	
	Code (-1) =	15.00	%	
	Code (-1.682) =	11.59	%	
	Code (-2) =	10.00	%	

Equations ; y = f(x)

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon$$

Silage:

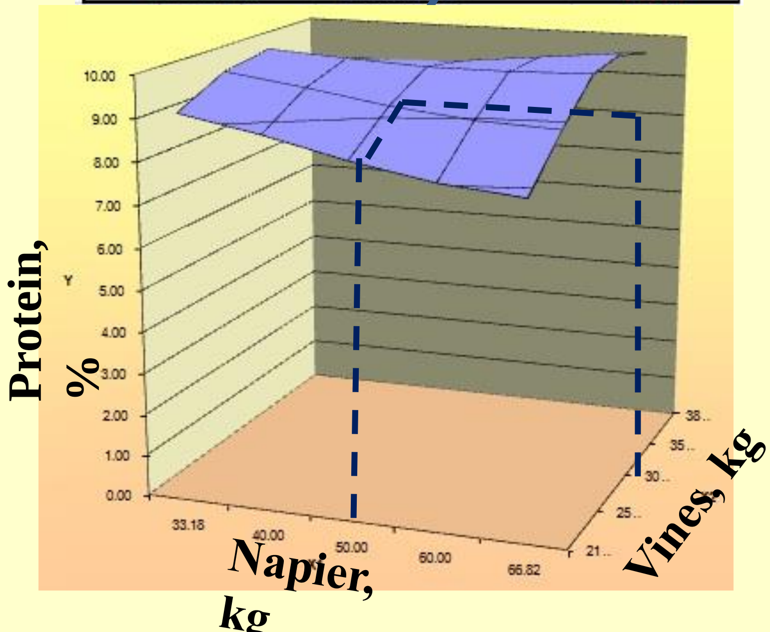
Vines ----- Roots
Vines ----- Napier
Vines ----- Napier ---- Roots
Vines ----- Napier ---- Stover

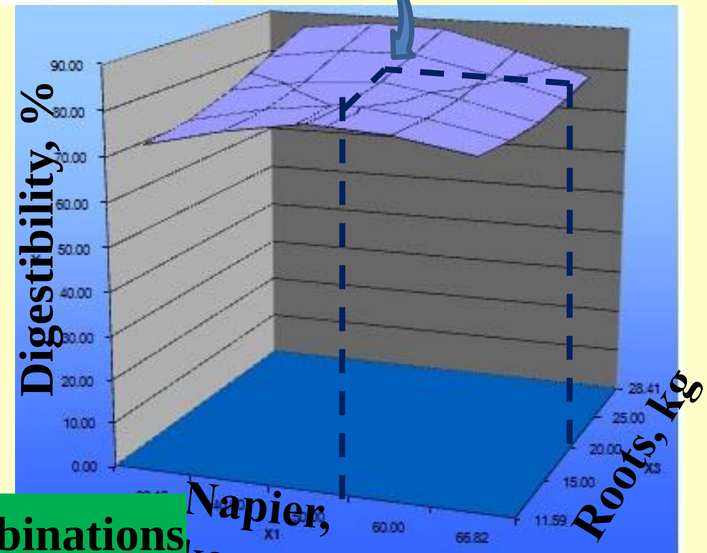
Dry matter; Nitrogen ; Crude protein; Organic matter; Neutral detergent fiber; Acid detergent fiber and lignin;
In vitro digestibility

CODED VARIABLES		REAL VARIABLES	STATIONARY POINT
$x_{1,0}$ =	-0.184	ε_1 = 48.164	
$x_{2,0}$ =	0.064	ε_2 = 30.318	$\hat{y}_0$ = 79.119
$x_{3,0}$ =	-1.260	ε_3 = 13.699	

Protein

CODED VARIABLES		REAL VARIABLES	STATIONARY POINT
$x_{1,0}$ =	0.064	ε_1 = 50.639	
$x_{2,0}$ =	0.220	ε_2 = 31.101	$\hat{y}_0$ = 9.717
$x_{3,0}$ =	-0.010	ε_3 = 19.948	





Results silage combinations

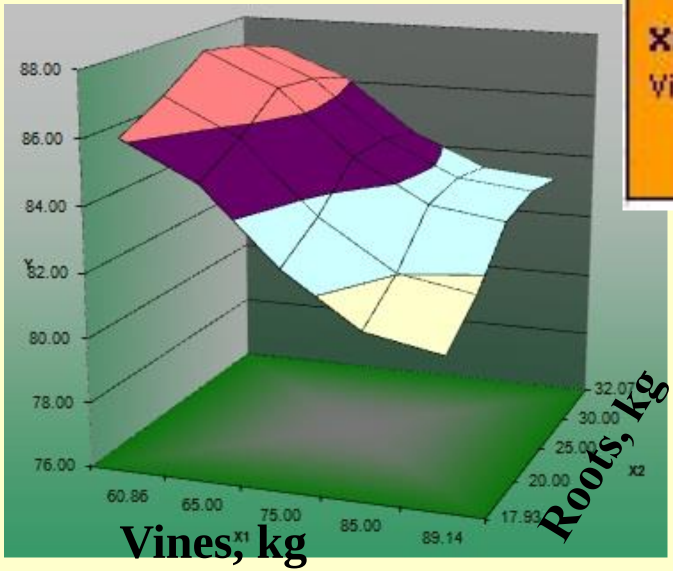
Napier	Vines	Roots
50	30	20
	80	20
75	25	

Recommendations

Considering roots fixed

Y= Prot		X1 = Napier 33.18	40.00	50.00	60.00	66.82
		9.18	8.82	8.38	8.04	7.86
		9.73	9.47	9.17	8.97	8.89
Vines	30.00	9.92	9.80	9.70	9.70	9.76
	35.00	9.35	9.37	9.48	9.69	9.89
	38.41	8.54	8.65	8.90	9.25	9.54

Vines - Roots



Y = DiG		X1 = Napier 33.18	40.00	50.00	60.00	66.82
X2 = Vines	21.59	83.27	84.13	82.13	76.23	69.97
	25.00	80.33	81.73	80.51	75.40	69.67
	30.00	77.91	80.09	80.02	76.05	71.11
	35.00	77.72	80.68	81.76	78.94	74.78
	38.41	78.86	82.36	84.22	82.19	78.56

Y= Digest		X1= Vines 60.86	65.00	75.00	85.00	89.14
X2 = Roots	17.93	86.11	84.97	80 [illegible].69	81.10	80.65
	20.00	86.84	85.73	83.53	82.03	81.61
	25.00	87.76	86.73	84.74	83.43	83.09
	30.00	87.51	86.56	84.76	83.65	83.39
	32.07	87.05	86.14	84.42	83.39	83.17

Thoughts on way forward

- On-farm trials to select appropriate cold tolerant sweetpotato dual purpose & forage varieties; multiply foundation material.
- The need to conducts fresh, chopped sweetpotato vine feeding trial to document impact on milk production.
- The need to test alternative sweetpotato silage recipes and packaging developed through the feed POCP.
  - Cow feeding trials based on sweetpotato silage
- Test two different systems for making & delivering silage: specialized large-scale silage producers vs home silage production

The SASHA feeds proof of concept team

Front row: Left to right

- Esther Karanja (EADD)
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- Prof. Charles Gachuiri (University of Nairobi

The End.

Thank you