



The Feed Study

2018-2022

Principal Investigator

- Dr. Adegbola Adesogan, University of Florida

Co-PI and Collaborators

- University of Florida: Co-PI, Dr. Geoff Dahl, Co-PI, Dr. Jose Dubeux, Dr. Esteban Rios, Dr. Ken Boote
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- ACDI/VOCA: Dr. Carl Birkelo
- Ethiopian Institute of Agricultural Research: Dr. Fekede Feyissa, Dr. Muluneh Minta, Dr. Getnet Assefa
- Hawassa University, Ethiopia: Professor Adugna Tolera

Objectives (subprojects)

- 1) Create an inventory of feed resources through a landscape analysis.
- 2) Increasing yield, quality and preservation of fodder with location-specific improved forages for different agro-ecologies.
- 3) Determine and meeting nutrient requirements of indigenous livestock with balanced rations.
- 4) Improve capacity to analyze the nutritional value of livestock feeds with near infrared reflectance spectroscopy.
- 5) Examine effects of synergizing feed, management and genetic interventions on milk production and health of dairy cows in Ethiopia.



Creating an inventory of feed resources through a landscape analysis: Ethiopia

2018 - 2022

Principal Investigators

- Prof. Adugna Tolera
- Ethiopia
- Dr. Augustine Ayantunde
- Burkina Faso

Objectives

- 1) Review and synthesize information from secondary data sources on the quantity and nutritional value of feeds.
- 2) Assess and map fodder, compound feed and by-product availability, variability, quality and prices.
- 3) Assess nutritional profile and cost per unit of nutrient in feeds
- 4) Calculate feed balance and compile feed databases.

Inventory of feed resources

A. Tolera, T. Feyissa, A. Nurfeta, M. Balehegn, M. Bedaso, M. Boneya, T. Tadesse, L. Tsega and A. Adesogan

Introduction

- Lack of reliable information on availability, dynamics and quality of feed resources in Ethiopia
- Need for systematic and countrywide assessments of feed resources

Methods

- Desk review and household survey
- Inventory and assessment of feed resources
- Assessed nutritional profile and cost of feeds
- Reviewed feed import-export data (10 years)

Results

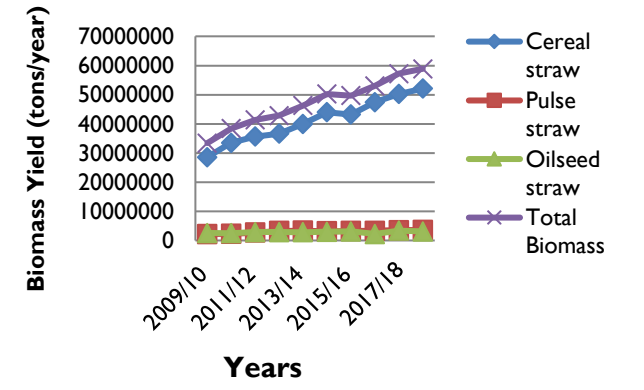
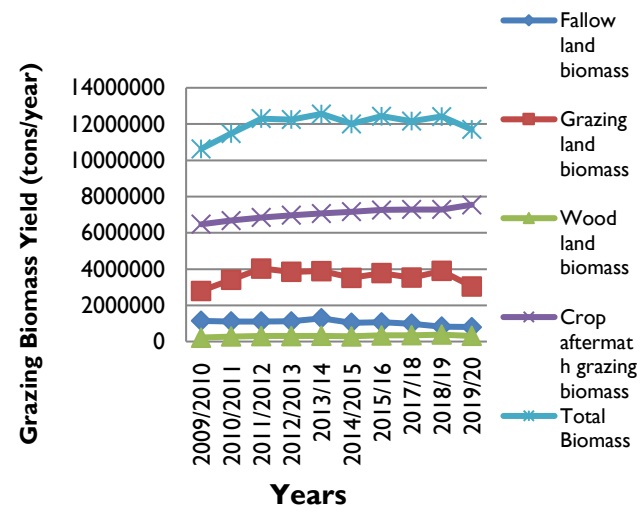
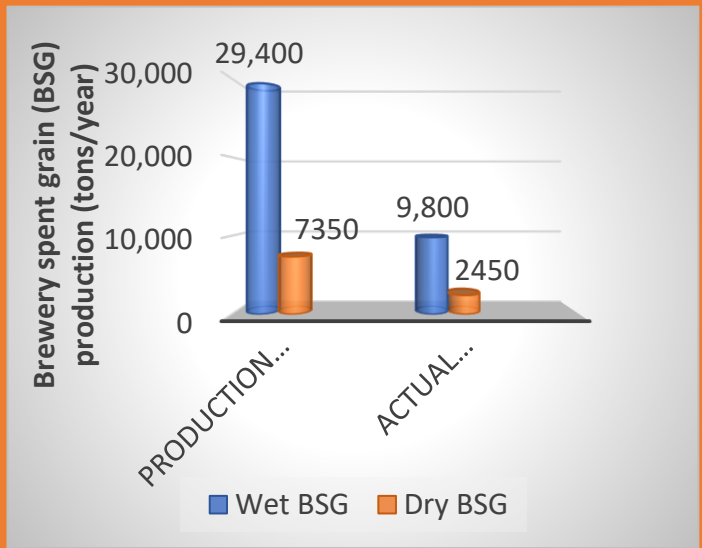
- Feed resource availability & nutritional quality reviewed
- 215 agro-industries, 24 abattoirs, 35 feed mills & different farms were assessed
- Nutritional value of 2442 entries of feeds collated (**database**) & 848 feed samples collected for analyses
- Interviews with 435 households and 34 focus group discussions

Crop residues and natural pastures are major feed resources

Limited availability of concentrate feeds and improved forages

The dominant cultivated forage crops are Elephant grass, Desho & Sesbania

Most agro-industries and feed mills are operating below capacity



Recommendations

- Compile feed database and profile
- Calculate feed balance

Research gaps

- Reliable quantification of feed resources obtainable from various browse species

Feed quality and price relationships in Burkina Faso

A. Ayantunde

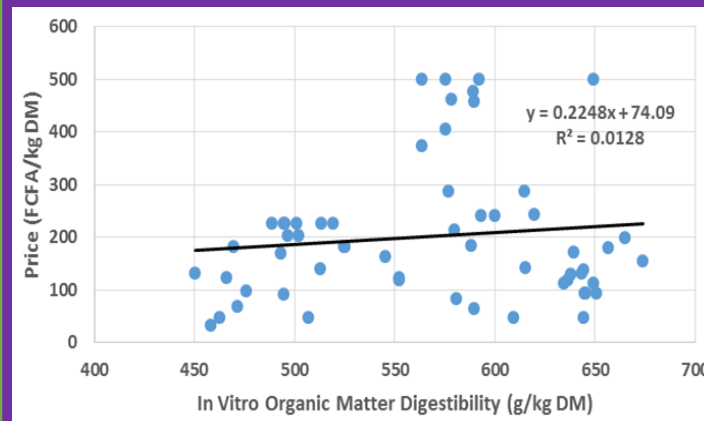
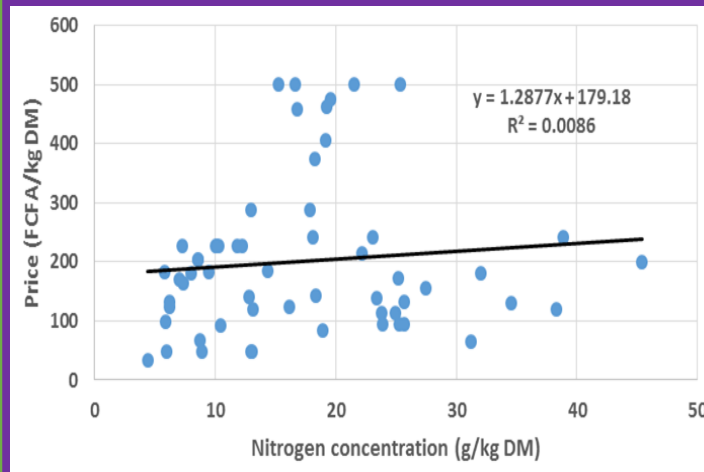
Introduction

- Limited access to adequate quantities of high-quality feed is a major constraint to livestock in West African Sahel. With increased demand for animal source foods, feed markets have sprung up in many Sahelian cities and towns.
- There is little information on price variations for different feed types across agro-ecological zones in Burkina Faso.
- Information on feed price and quality is essential to developing a strategy to match feed supply with demand.

Methods

- Surveys on price and quality of feeds at nine feed markets across the four agroecological zones in Burkina Faso were conducted in the late dry season (March– May) in 2019.
- In each location, at least 10 feed sellers were interviewed.
- Samples of major feeds collected from markets for laboratory analysis.
- Regression analysis was done to identify relationships between feed prices and quality

Price of feed was not dependent on quality, especially in urban areas where demand for feed is very high.



Preliminary analysis of the relationship between feed quality and price in BF



Local feed markets in Burkina Faso

Conclusion

- The lack of a relationship between price and quality suggests that there is lack of awareness and appreciation of the value of quality feed among farmers. Moreover, limited supply forces farmers to buy whatever is available.
- The project will further explore this issue and develop and compile a feed database and profile.
- Feed balances will also be calculated.



Increasing yield, quality and preservation of fodder with location-specific improved forages for different agroecologies

2018 - 2022

Principal Investigator

- Dr. Fekede Feyissa and Dr. Muluneh Minta- Ethiopia
- Dr. Nouhoun Zampaligre- Burkina Faso

Objectives

- 1) Evaluate the productivity and quality of forages in particular agroecologies and farming systems to determine the extent to which they can increase animal productivity and farm income.
- 2) Conduct on-farm livestock feeding trials with selected best bet forage species to demonstrate their potential for increasing livestock productivity and thus encourage their adoption by smallholder farmers.
- 3) Examine the most effective and profitable strategies to improve the preservation and quality of forages and crop residues for dry season feeding.

Improving access to quality seed/planting materials of improved forage crops

Muluneh Minta, Fekede Feyissa, Mulisa Faji

Introduction

- There is little production of seeds of improved forage crops and access to the few available is limited.
- Seed production is not a focus of traditional farmers and seed producing agencies focus only on crops.

Methods

- We produced seeds of major forage crops on station, and used these to produce fodder on smallholder farms

Results

- 7800 kg of seeds of high value forage crops produced
- Over one million root splits of Desho, Napier and Maralfalfa grasses multiplied.
- Over 300 t/yr hay production by 141 smallholder dairy farmers

Recommendations

- Develop options to improve access to quality seeds to support Ethiopian dairy sector at takeoff

Research gaps or future opportunities

- Lack of a forage crop seed producing agency
- Farmer level seed production

Our seed increase activity:

- Benefited 141 collaborating farmers and other stakeholders.
- Over 300 t of hay produced from oat-vetch mixture and perennial grasses in 2019.
- Increased awareness of the comparative advantages of improved forage production and use

Crop type	Seed produced (kg)	Root splits (number)
Oats	2,160	-
Vetch	480	-
Rhodes	120	-
Tree lucerne	40	-
Desho (grass)	-	>500,000
Napier grass	-	>145,000
Maralfalfa (grass)	-	>100,000

Legacies of increased seeds (Farmer fields)



On-farm productivity of Oat-vetch mixture in Addis Ababa milkshed areas

Muluneh Minta, Fekede Feyissa

Introduction

Production of hay from mixtures of oats and vetch is expanding in the central highlands of Ethiopia.

Methods

1. Seeds of oats and vetch (*Vicia dasycarpa*) were provided to farmers to produce hay on their farms. Herbage yield was measured.

Results

- An average DM yield of 8.1 t/ha was obtained under farmer management.

Recommendations

- Technical support is required to reduce the yield gap between research stations and smallholder farms.

Future opportunity

- Growing interest of producers

Feed shortage in terms of quantity and quality is one of the major bottlenecks for dairy development in Ethiopia.

A strategic shift towards intensive production of cultivated forages sustainably solves the problem.



Oat-vetch mixture on farmer field



Baled hay of oats-vetch mixture

Locations	Fresh Biomass Yield (t/ha)	Dry Matter Yield (t/ha)
Addis Alem	25.1 ^{ab}	6.0
Robgebeya	34.5 ^a	8.8
Welmera	32.0 ^{ab}	8.4
Sebeta	20.4 ^b	6.7
Sendafa	35.6 ^a	10.3
Mean	29.5	8.1

Performance evaluation of Introduced oats and ryegrass varieties in Ethiopian highlands

Author: *Muluneh Minta, Fekede Feyissa and Mulisa Faji*

Introduction

Forage genetic resources are essential for developing adapted, high yielding and high-quality livestock feed.

Methods

Two varieties of oats (Legend 567 & FL-720), ryegrass (Attain, Jumbo and FL-401) were evaluated against local controls for their herbage yield and nutritional quality.

Results

- Both oats varieties with their inherent merits and high yield found important for further evaluation.
- Attain and Jumbo varieties of ryegrass were selected for their better yield and tolerance to disease (rust).

Recommendations

- Advanced evaluation of selected varieties under diverse agro-ecologies for verification.

Research gaps or future opportunities

- Need for broad genetic bases for evaluation, particularly that of ryegrass

Selected varieties of oats and ryegrass have important attributes of yield, quality and tolerance to logging and diseases.

Oats Varieties	PH (cm)	FBY (t/ha)	DMY (t/ha)	STRY (t/ha)	GY (qt/ha)
Legend567	137.8 ^b	44.9 ^b	12.0 ^b	6.4 ^b	55.1
FL-720	158.3 ^a	70.7 ^a	16.4 ^a	10.2 ^a	64.5
CI-2806 (C)	167.0 ^a	63.7 ^a	15.1 ^a	10.3 ^a	53.5
Mean	154.3	59.8	14.5	9.0	57.7
CV (%)	3.9	11.9	11.0	15.8	11.0
LSD (p ≤ 0.05)	10.4	12.4	2.8	2.4	NS

Means with the same letters are not significantly different at p ≤ 0.05

PH= Plant height; FBY= Fresh biomass yield; DMY= Dry matter yield; STRY= Straw yield GY= Grain Yield; C=Control treatment

Ryegrass Varieties	PH (cm)	FBY (t/ha)	DMY (t/ha)	STRY (t/ha)	GY (qt/ha)
Jumbo	108.5 ^b	26.5 ^{ab}	5.2	7.8	1.8 ^b
Attain	110.8 ^b	44.1 ^a	7.0	8.0	2.4 ^b
FL-401	166.5 ^a	17.8 ^b	4.7	8.5	18.4 ^a
Mean	128.6	29.5	5.6	8.1	7.5
CV (%)	9.0	40.6	33.6	23.2	38.5
LSD (p ≤ 0.05)	20.1	20.7	NS	NS	5.0

Means with the same letters are not significantly different at p ≤ 0.05;

PH= Plant height, FBY= Fresh biomass yield, DMY= Dry matter yield, STRY= Straw yield, GY=Grain yield; FL-401= Logging problem



Oats



Oats



Ryegrass

Determination of appropriate planting density for *Desho* and *Maralfalfa* grasses production

Muluneh Minta, Fekede Feyissa

Introduction

- *Desho* (*Pennisetum pedicellatum*) and *Maralfa* (*Pennisetum purpureum* Schum) are recently developed high yielding varieties of perennial grasses adapted to various agro-ecologies in Ethiopia
- Agronomic packages for their husbandry have not been developed
- In this study investigated the effect of plant population density on growth, yield and nutritional factors of forage crops.

Methods

- Under respective experimental sets, root splits of *Desho* and *Maralfalfa* grasses were planted at varying spacing between rows and between plants within rows. Relevant agronomic data collected and analyzed.

Results

- *Desho*: At Holetta, high population density gave high herbage yield, while high yield was obtained from low population density at Kulumsa.
- *Maralfalfa*: High herbage yield at spacing of 75 cm x 50 cm between rows and plants respectively

Recommendations

- Use of location specific plant population densities

Research gaps

- Need further evaluation at multiple locations.

Desho and *Maralfalfa* are recently developed high yielding varieties of perennial grasses adapted to wide ranges of agro-ecologies in Ethiopia.

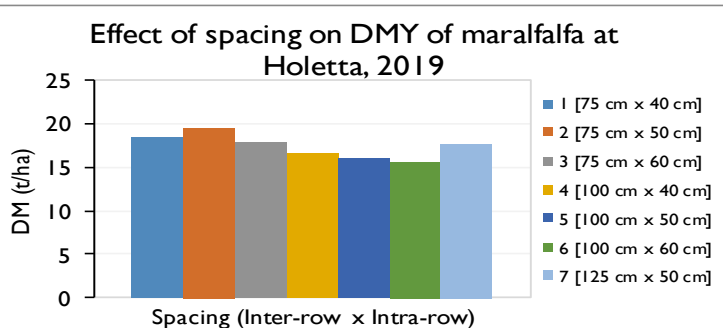
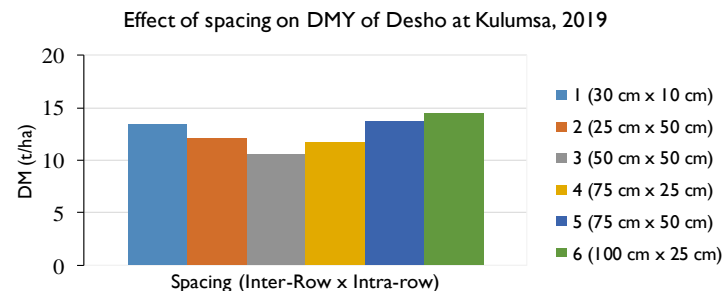
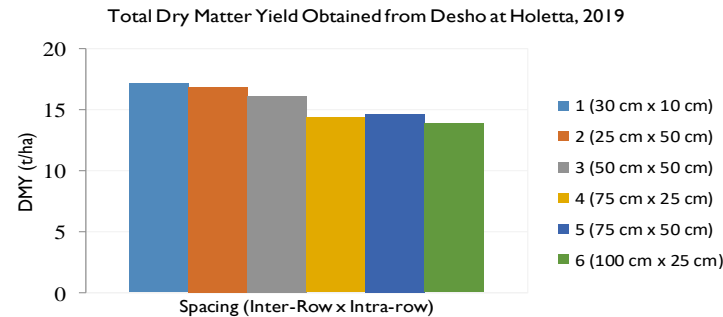
Optimization of the plant population density helps to exploit the benefits from these important genotypes.



Desho Grass



Desho Grass



Maralfalfa Grass

Enhancing Smallholder Dairy Productivity through Feeding Intervention

Aemiro Kehaliew, Muluneh Minta Mesfin
Dejene, Fekede Feyissa

Supplementation of improved forage and concentrate increased milk yield by 35% (compared to traditional practice), which in turn resulted in 345% marginal rate of return.

Training on Ration formulation



Introduction

Ration formulation of concentrate sources

Methods

Improved forage compared with traditional lactating cows in

Results

Incorporation of along with proper yield by 36% compared to the marginal rate of return group to intervene for ETB 1.0 investment obtained ETB 3.4

Recommendations

The adoption of improved feeding practices with sufficient training on balanced ration formulation has been observed to increase dairy productivity and food security through provision of sustainable economic opportunity for smallholder farmers.

Research gap and Future direction

Poor awareness creation and low adoption rate. Frequent training of smallholder farmers and development agents

Parameter	Treatments			SL (P value)
	Traditional diet	Intervention diet	Overall	
Milk Yield	7.52±0.81	11.67±1.03	9.60±0.77	0.005
Net profit	4.81±0.53	4.43±0.45	4.62±0.34	0.59
Milk CP %	3.18±0.11	3.08±0.03	3.13±0.06	0.38
Lactose (%)	4.74±0.15	4.64±0.07	4.69±0.08	0.55
SNF (%)	7.53±0.33	7.57±0.26	7.55±0.20	0.92
FCR	1.76±0.16	1.13±0.04	1.54±0.12	0.0001
Average daily milk yield (E)		16.50	16.50	
Farm get milk selling price (F)		16.50	16.50	
Gross return or Price of milk /cow/day, Eth. birr (G)= (E*F)		124.13±13.34	192.5±17.03	
Net profit /cow/day, Eth. Birr, H= (G-D)		45.42±10.34	95.12±12.78	
Change in total variable cost (TVC)		0.00	14.37	
Change in net profit (NP)		0.00	49.7	
Marginal rate of return (%)= (ΔNP/ΔTVC)*100		0.00	345.9	



Fodder biomass, nutritive value and grain yields of promising food-feed Millet and Sorghum varieties for Burkina Faso agro ecologies

Zampaligré Nouhoun, Yoda Gildas, Delma Jethro, Somé Sanyour, Mulubrhan Balehegn, Esteban F Rios, José Dubeux, Kenneth Boote and Adegbola T. Adesogan

Introduction

- The study examined the productivity and stover nutritive value of various improved food/feed sorghum and millet varieties.

Methods

- Five varieties of millet and nine varieties of sorghum were planted during two rainy seasons at three INERA research stations in the

- Sahelian zone (Dori, rainfall: 300-600mm),
- Northern Sudanian zone (Saria, rainfall: 600-900mm)
- Southern Sudanian zone (Bobo Dioulasso, rainfall: 900-1200mm).

- Planting densities were 80x40cm (sorghum) and 60x40cm (millet).
- Data were analyzed by ANOVA and means compared using the Tukey test with the R program.

Results

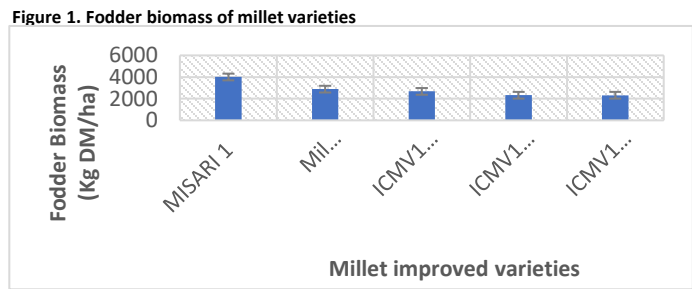
Grain and stover productivity

- MISARI 1 produced the highest millet grain yield (1.7 to 2.2t/ha) and fodder biomass.
- For grain yield, the best sorghum varieties were
 - Sariasso 15, Sariasso 16 and ICSV1049 in Northern Sudanian zone (1.5 to 1.6 t/ha)
 - Sariasso 14, ICSV1049 and Sariasso 16 in the Southern Sudanian zone (1.1 to 1.9t/ha).
- For fodder production, the best sorghum varieties were SF15, M67-M2 and Ponta Negra.

- MISARI 1 was the best millet variety and Sariasso 14, 15 and 16 as and ICSV1049 were the best sorghum varieties for improving grain and fodder production.
- This study identified best-bet food/feed millet and sorghum varieties for Burkina Faso agroecologies.

Table 1. Improved millet varieties fodder nutritive value

Sorghum varieties	Fodder biomass (Kg of DM/ha)
SF15	6822a
M67-M2	5867a
Ponta negra	5328a
Sepong 82	3122b
Sorgho 1011	2980b
Sariasso 16	2964b
ICSV1049	2524b
Sariasso 14	2090b
Sariasso 15	1958b



Fodder nutritive value

- The stover of the millet and sorghum varieties tested has high fiber and low crude protein concentrations and low digestibility.
- Most millet varieties have the required CP concentration (7%) to meet maintenance crude protein requirements of small ruminants

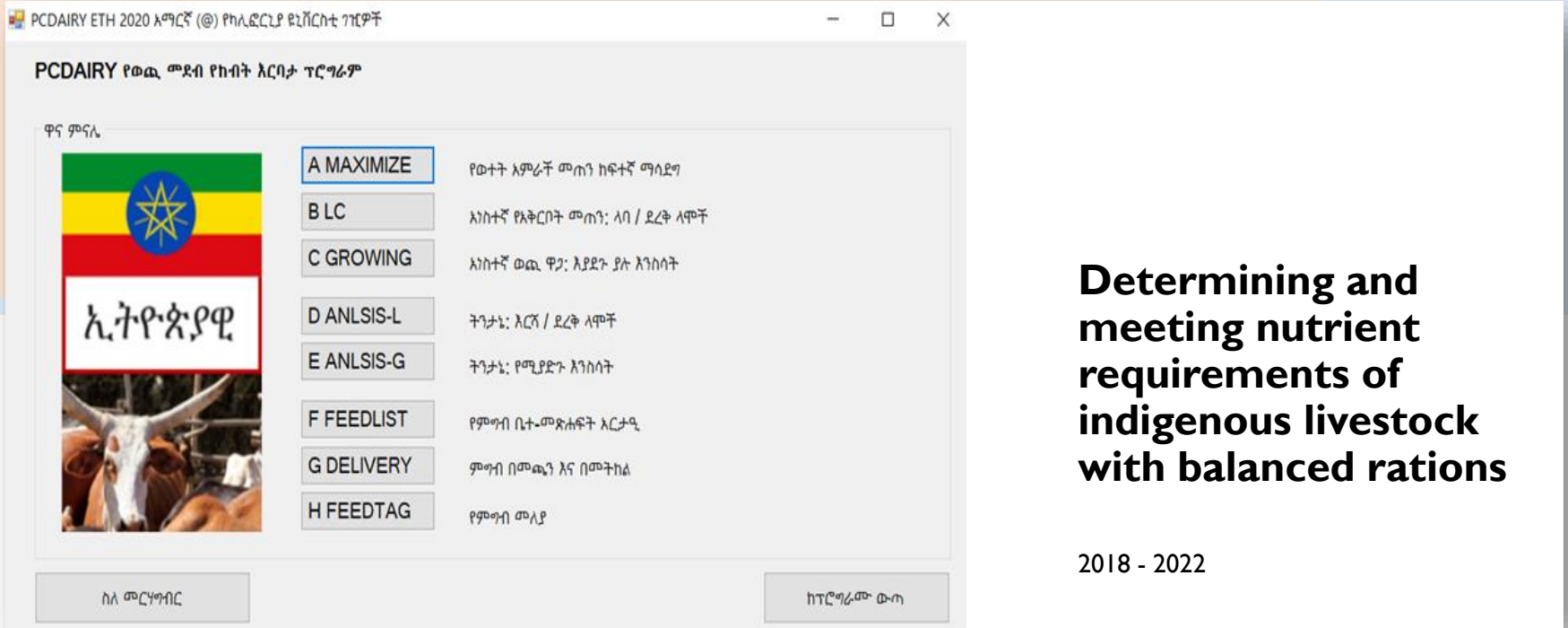
Table 2. Improved millet varieties fodder nutritive value

Millet Varieties	N	CP (%)		NDF (%)		IVOMD (%)	
		Mean	SE	Mean	SE	Mean	SE
ICMV16 7006	4	7	0.398	66	1	41	0.2
ICMV16 7001	4	8	0.407	62	1	42	1.5
ICMV16 7005	4	7	0.641	65	2	41	0.7
Mil fourrag er MISARI 1	4	7	0.222	65	1	41	0.9
MISARI 1	3	6	0.437	68	1	41	0.5



Table 3. Improved sorghum varieties fodder nutritive value

Sorghum Varieties	N	CP (%)		NDF (%)		IVOMD (%)	
		Mean	SE	Mean	SE	Mean	SE
Ponta negra	4	5	0.2	71	1.0	49	1.1
M67-M2	4	5	0.3	72	0.6	48	0.9
Sorgho 1011	4	5	0.4	67	0.8	51	1.1
SF15	4	6	0.4	69	0.8	51	0.9
Sariasso 14	4	5	0.5	69	0.7	50	0.5
Sariasso 15	4	5	0.5	71	1.7	49	1.9
Sariasso 16	4	4	0.5	68	2.1	49	1.9
Sepong 82	4	5	0.3	70	1.2	49	1.3
ICSV1049	4	4	0.2	69	2.2	50	1.7
DF		3		3		3	
F		1.93		1.11		0.59	
P-value		0.10		0.39		0.78	



Determining and meeting nutrient requirements of indigenous livestock with balanced rations

2018 - 2022

Principal Investigator

- Dr. Ermias Kebreab

Co-PI and Collaborators

- Dr. Abbas Ahmadi

Objectives

- 1) Undertake a review of the nutrient requirements of indigenous breeds of dairy cows and small ruminants in Ethiopia and Burkina Faso, respectively.
- 2) Develop software and a mobile app for formulating least-cost balanced, and environmentally sensitive rations with local ingredients.
- 3) Formulate least-cost balanced rations to enable accurate feeding of livestock using locally available feed resources .

Introduction

- Dairy consumption has the ability to provide nutrient dense food in low-income countries
- Objective was to determine the maintenance energy requirement of *Bos taurus* × *Bos indicus* crossbred dairy cows.

Methods

- Meta-analysis using 141 observations from 38 studies in tropical regions with crossbred dairy cows was conducted.

Results

- The net energy for lactation value at maintenance was 0.323 MJ/kg $BW^{0.75} \cdot \text{day}$.

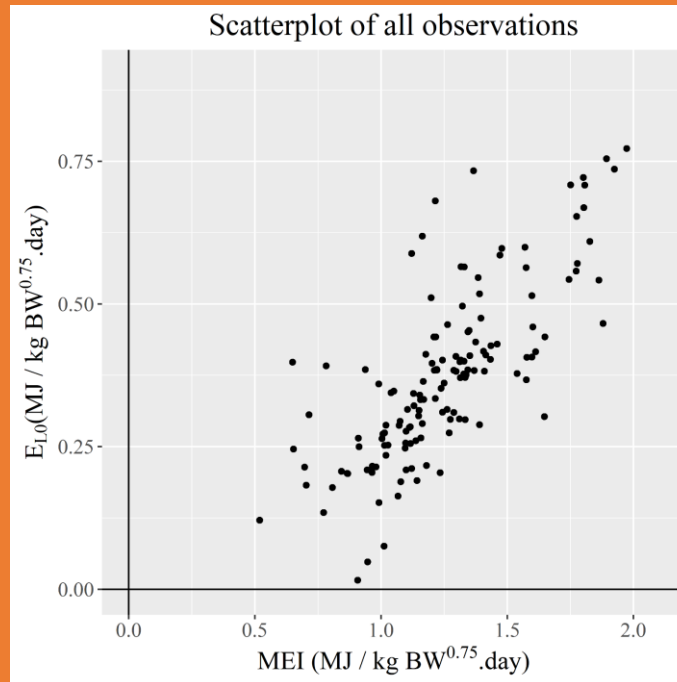
Recommendations

- Energy requirements in crossbred cattle differ from western cattle
- Adjusting energy requirement will improve nutrient formulation.

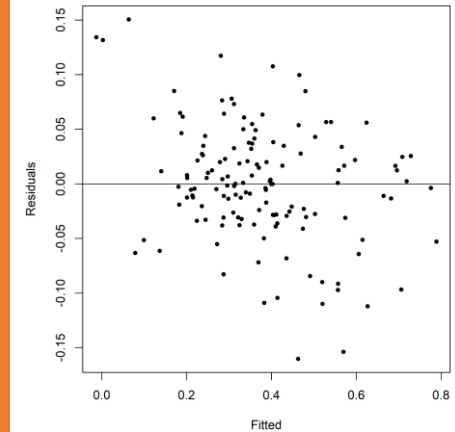
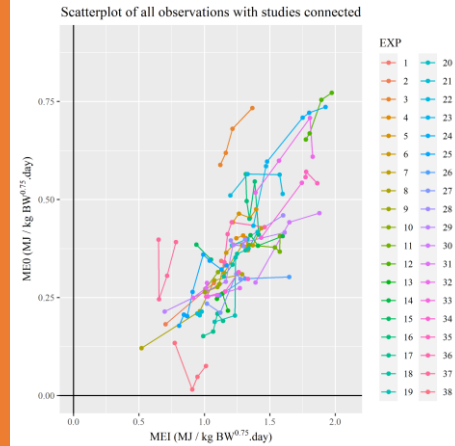
Research gaps or future opportunities

- The estimates need verification through experimentation.

Estimates of energy requirement for tropical dairy cows was **3.6% lower** and **efficiency of using energy was 10.6% lower** compared to *Bos Taurus* (western cattle).



Extra Figures





Improving capacity to analyze the nutritional value of livestock feeds with near infrared reflectance spectroscopy

2018 - 2022

Principal Investigator

- Dr. Michael Blummel

Objectives

- 1) Develop NIRS equations for locally available feed resources in Ethiopia and Burkina Faso.
- 2) Map, link and create Communities of Practice around actual and potential NIRS providers and customers in Ethiopia and Burkina Faso.
- 3) Develop and employ low cost mobile NIRS devices with backward linkages to stationary NIRS systems.
- 4) Establish comprehensive feed price-quality relationships and explore technical and institutional mechanisms for feed quality control, feed ingredient labelling and ration balancing by advisory services.

Using Near Infrared Spectroscopy to assess feed quality

Michael Blummel

Introduction

- Feed quality assessment is essential
- Conventional techniques are too slow and expensive
- Near Infrared Spectroscopy (NIRS) can remove these constraints

Methods

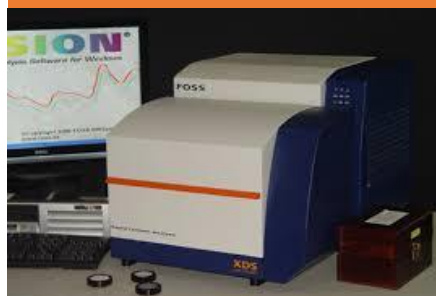
1. Stationary NIRS connected for equation exchanges
2. Low cost mobile NIRS tested process
3. Tested a new low-cost field-suitable method for presenting feeds for scanning (i.e. plastic bags)

Results

- Widely available stationary NIRS can be formed into hubs after spectra standardization
- Low cost mobile NIRS (<2 000 US \$) can yield similar results to high cost (c. 70 000 US \$ stationary NIRS)
- Sample presentation in plastic bags gave similar results to expensive crystal cups.

NIRS offers quicker and more affordable feed quality assessments than conventional laboratory techniques.

Some newer low cost mobile NIRS are as accurate as expensive static systems



FOSS XDS



TellSpec

Nitrogen and digestibility (IVOMD) estimates obtained using FOSS XDS NIR System

Quality	Plastic bag	Cup
N (%)	2.08 (0.44 – 6.7)	2.05 (0.48 – 6.9)
IVOMD (%)	54.9 (41.4 – 70.9)	55.0 (41.1 – 70.9)

Nitrogen and digestibility (IVOMD) estimates obtained using TellSpec NIR System

Quality	Plastic bag	Cup
N (%)	2.0 (0.17 – 6.3)	2.1 (0.59 – 6.0)
IVOMD (%)	54.7 (39.3 – 72.3)	55.0 (42.4 – 70.7)

Recommendations

- Make better use of widely available stationary NIRS by country and regional hub formation
- Comprehensively test new mobile NIRS coming onto the market



Examining Effects of Synergizing Feed, Management and Genetic Interventions on Milk Production and Health of Dairy Cows in Ethiopia

2018 - 2022

Principal Investigator

- Dr. Bayissa Hatew and Dr. Carl Birkelo

Objectives

- To conduct a baseline study to understand the available feeds, feeding and management practices and genetics of animals on smallholder farms
- To conduct a study that examines if combining improved feeding with management training and improved genetic improves milk production by dairy cows

Synergism of feed, management and genetic interventions of dairy cows in Ethiopia

Bayissa Hatew, Carl Birkelo, Geoff Dahl, Francisco Penagaricano, Mulu Gebremikael

Introduction

- Increasing the productivity of smallholder dairy farms is a high priority of Ethiopian government through its GTP and Livestock Master Plan
- Development partners (PAID, ADGG) & government extension services have introduced improved dairy genetic material to Ethiopia mainly through AI
- To fully optimize the gains of the genetic potential of cows for milk production, its interaction with feeding and management need to be explored.

Methods

- 96 smallholder dairy farmers across 4 regions were selected (2 woredas per region, 2 kebeles per woreda and 6 households per kebele) and grouped into:
 - Untrained (control) group
 - PAID trained alone (PAID) group
 - Feed-management group (received training and improved feeds)
- Training was given to smallholder farmers on feeds and feeding, milking, management of cows, health, heifer, housing, role of gender and record keeping
- Training conducted at two levels: Training of trainers (TOT) and training of farmers by TOT.
- After training the feed-mgt group received supplementary feed necessary compliment on-farm feed resources and forage planting materials

Results

- On average a 20% increase in milk yield due to the feeding and management intervention from the baseline was recorded (Table I)
- A general decline in milk yield was evident in both the control and the PAID training group relative to the baseline
- Overall comparison of the change in milk yield relative to the baseline for the three-treatment groups is shown in Figure I

Table I. Change in milk yield of cows from different regions in the three treatment groups relative to the baseline

Region	Treatment		
	Control	PAID	Feed-management
Oromia	1.8	3.3	11.3
Amhara	-8.9	-13.2	18.3
SNNP	-1.1	10	14.3
Tigray	-23.4	-21.6	36.9
Mean	-7.9	-5.4	20.2
SE	9.77	12.61	9.96

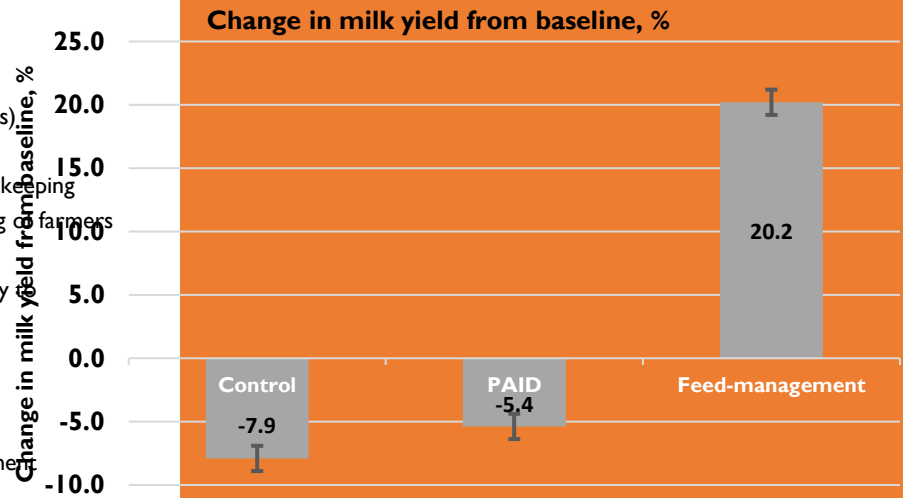


Figure I. Comparison of percentage change of milk yield for cows in the three different treatment groups

Recommendations

- Develop market access for smallholders
- Create linkages with feed input suppliers and service providers

Research gaps or future opportunities

- Increase efficiency and competitiveness of the small-scale dairy value chain