
FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative
Forage Seed Systems and Feed Reserves:
Business Propositions, Case for Ethiopia
January 21, 2021
Tony Rodd

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FEED THE FUTURE GLOBAL SUPPORTING SEED SYSTEMS FOR DEVELOPMENT – S34D

January 2021

Forage Seed Systems and Feed Reserves: Business Propositions, Case for Ethiopia

Authors:
Dey, B*; Notenbaert, A; Makkar, H; Mwendia, S; Peters, M; Sahlu, Y.

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January 21, 2021

** Corresponding Author (bhramar.dey@crs.org)*

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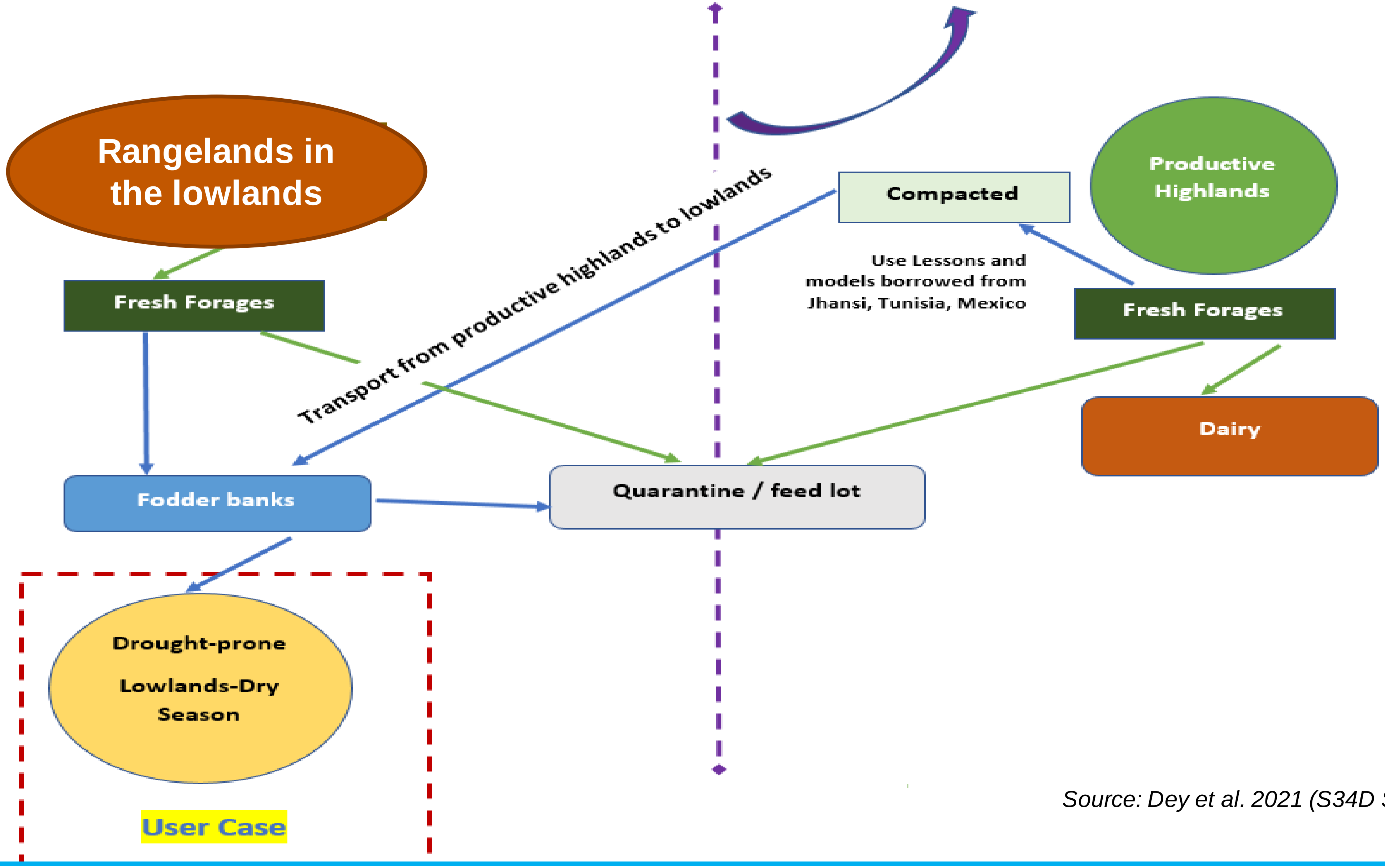
Activity Objectives

- Build stronger interface between formal, informal, and emergency forage feed and seed systems (bridge between productive highlands and drought-prone lowlands in Ethiopia)
- Identify role of cultivated forages to develop sustainable business models (using economic analyses) in an inclusive manner
- Learn from global case studies to apply novel (cultivated forage-based) feed preservation technologies in Ethiopia

Introduction

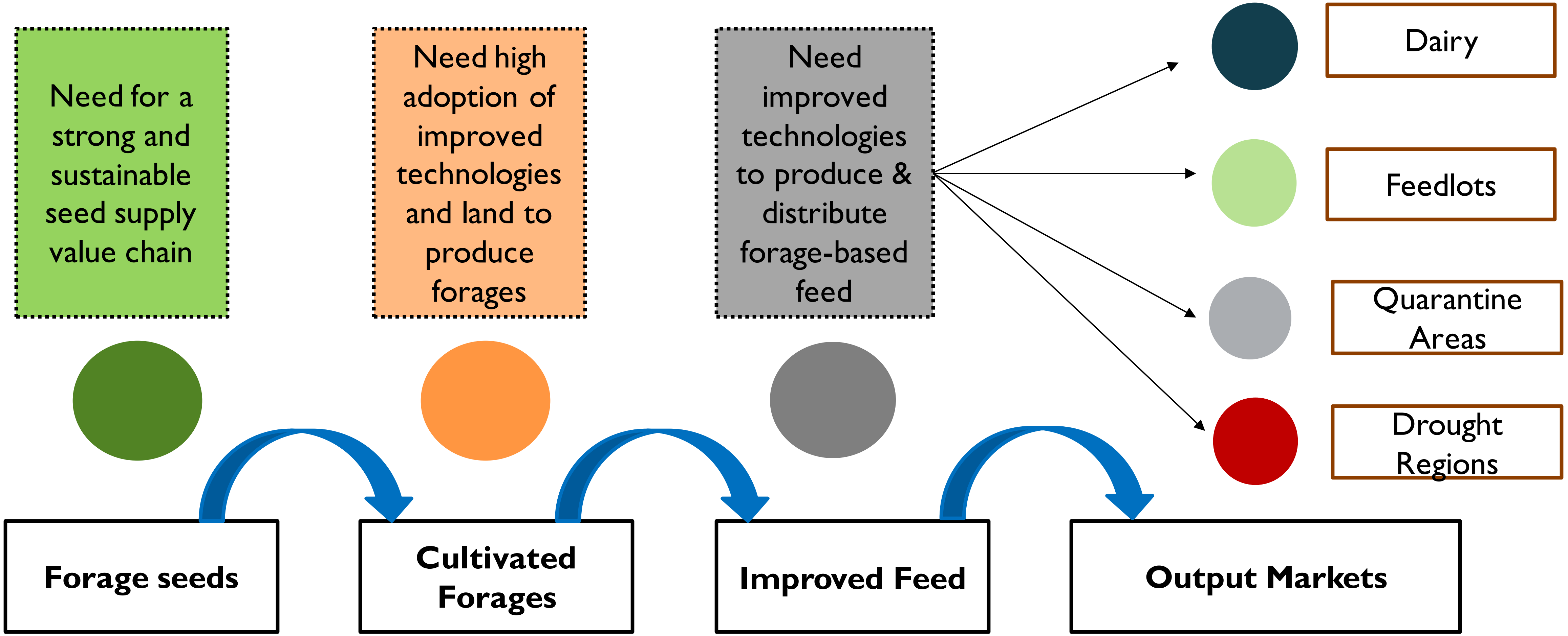
- Ethiopian livestock sector contributes to 35% - 47% of agricultural GDP. Regionally, Ethiopia could potentially also export feed to Eastern and Northern African countries (Ethiopian MoA, 2020)
- One of the reasons for low productivity of the livestock sector in Ethiopia is shortage of feed and low quality of available feeds, particularly in the dry seasons. Low adoption and promotion of cultivated forages. (Tolera et al, 2019)
- As of 2007, conservative estimates suggested $15M of emergency seed aid in Ethiopia per year – delivered by governmental and non-governmental organizations. As of 2007, this translates to a cumulative total of $0.5B USD (Sperling et al. 2007). It is safe to say that that figure has risen in the last 12 years or so to $0.75B
- Lot of work has been done on seeds and feeds, but linkages with the output markets in an economically viable fashion is not common. Also not common is building bridges / interface between development and ECR seed systems.

Interface between development and emergency-chronic seed systems



Source: Dey et al. 2021 (S34D Study)

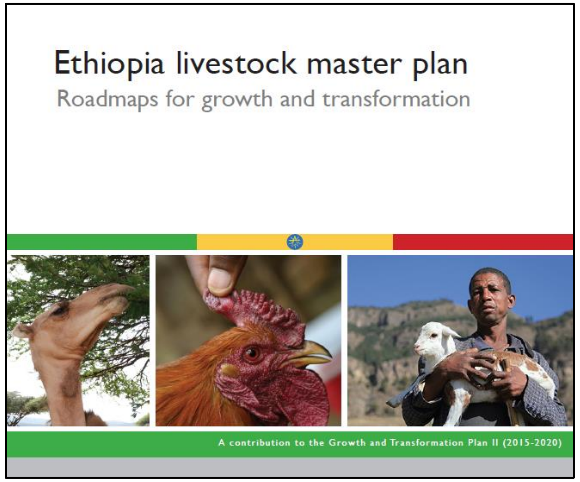
Forage seed value chain, market for cultivated forages as improved feed, and output market for the livestock feed cannot be compartmentalized



Mobilize high-quality feed preservation technology to generate a new avenue of demand for forages

Alignment with national strategies in Ethiopia – GTP II, LMP, Feed Strategy

Production type / sub-sector	Units	Baseline year target (2014/15)	GTP II target for 2019/20
Milk from cow, goat and camel	million litres	5,304	9,609
Meat from cattle, goat, camel	thousand tons	1274.9	1932.8



- “Lack of compelling evidence and knowledge on the comparative economic benefit and role of cultivated forages”
- “increase in public investment in rehabilitating range and pasture lands to improve feeding management and enhancing the promotion by the GoE extension services of improved feeding..”
- “Introduce and utilize technologies that enhances better utilization of cultivated forages”

Presentation Outline

- Study Approach and Partnership Landscape
- Demand estimation for forage seeds – an illustration
- Forage seed value chain in Ethiopia – stakeholders' perspective
- Global case studies on forages and feed reserves
- Cost-benefit analysis and business model propositions
- Key takeaways – next steps and concluding remarks

Principles used in our research

- Assess and leverage ongoing activities by implementing partners on the ground to coordinate, collocate and collaborate
- Align with Ethiopian national strategies (*GTP-II, LMP, Feed Strategy*)
- Use released forage seed varieties to target business models in the short term as releasing new varieties is a lengthy process in Ethiopia (*MOA, 2018. Plant Variety Release, Protection and Seed Quality Control Directorate – Crop Variety Register No 21*)
- Use an array of data sources: literature, structured surveys to collect data from other countries, case studies, surveys to conduct key stakeholder interviews in Ethiopia, and semi-structured discussions with other partners and stakeholders
- Keeping our analyses simple yet rigorous; feasible yet comprehensive, given we cannot do site visits in person (due to Covid)

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Partnership Landscape & Information Gathering

Study Approach

Step 1

- **Partnership Landscape**
- Conducted key stakeholder interviews to learn about the forage sector activities in Ethiopia

Step 2

- **Information Gathering**
- Collected and mapped information of demand sinks and infrastructure facilities: quarantine facilities, feedlots, dairy centers, ware houses, national agricultural research centers

Step 3

- **Global Case studies**
- Conducted structured interviews with stakeholders in India, Mexico, and Tunisia to determine costs and benefits of forage-based densification
- Identify cases from Mongolia, Thailand, and India on role for feed reserves and cultivated forages for dairy

Step 4

- **Demand Estimation**
- Conduct a rough assessment of the need for cultivated forages in Ethiopia (proxy market demand)

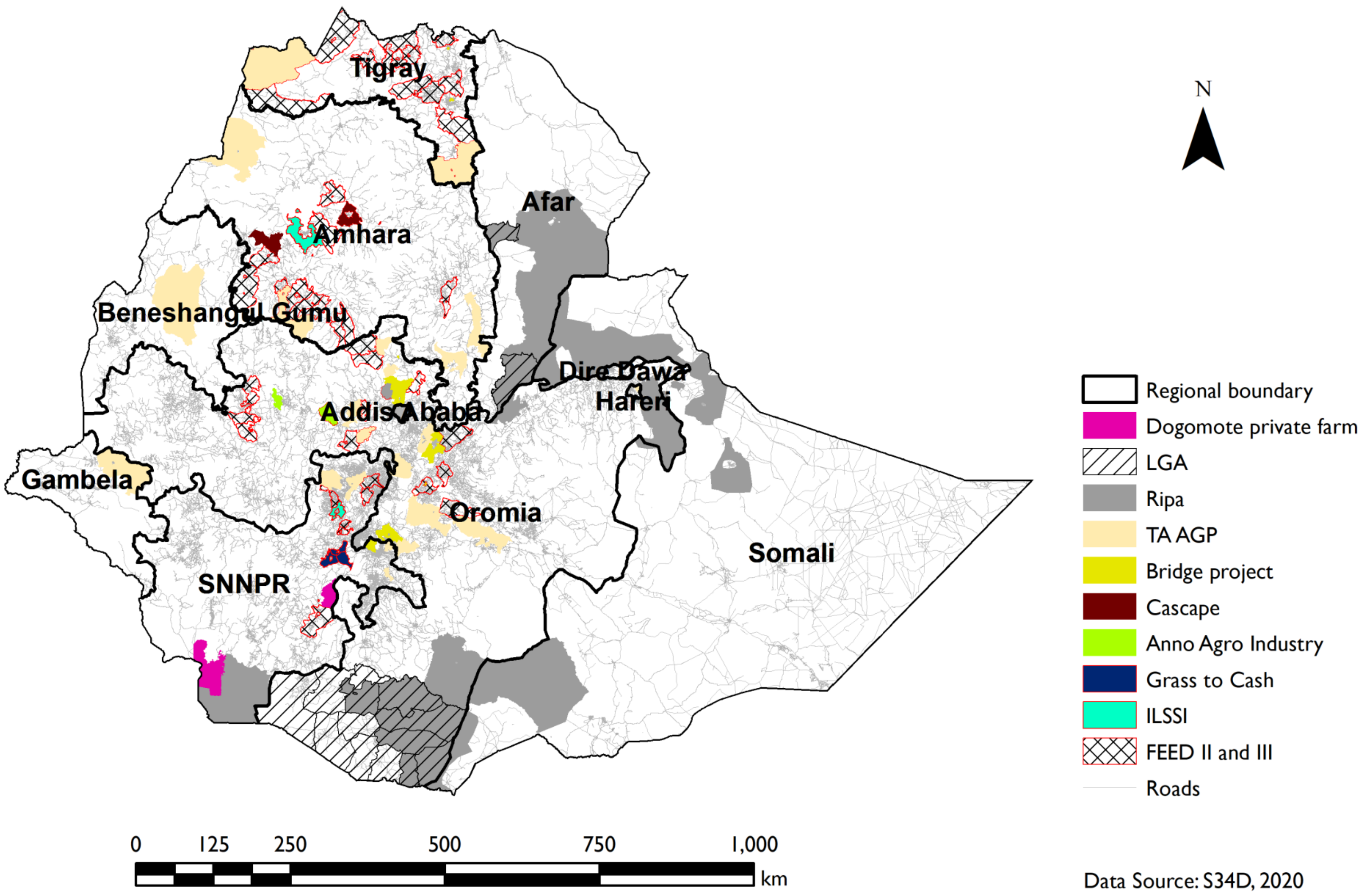
Step 5

- **Conduct Economic Analyses**
- Calculate cost per nutrient analyses for cultivated forages to supply to identified demand sinks in Ethiopia

Step 6

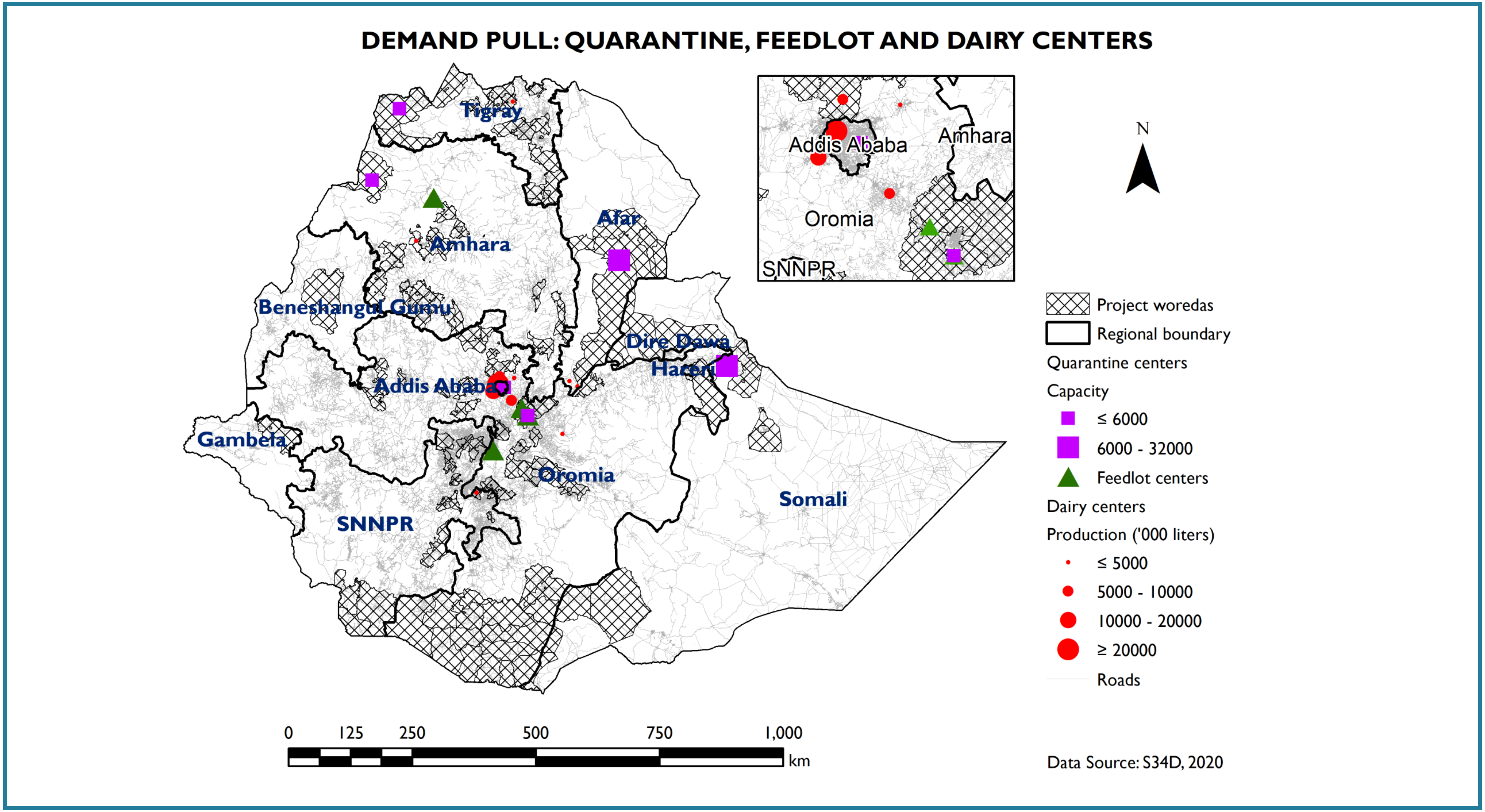
- **Business Model Propositions – Way Forward Illustration**
- Conduct a survey to determine the forage-seed value chain in Ethiopia
- Arrive at business model propositions that are inclusive

WOREDAS WITH ONGOING FORAGE ACTIVITIES BY PARTNERS

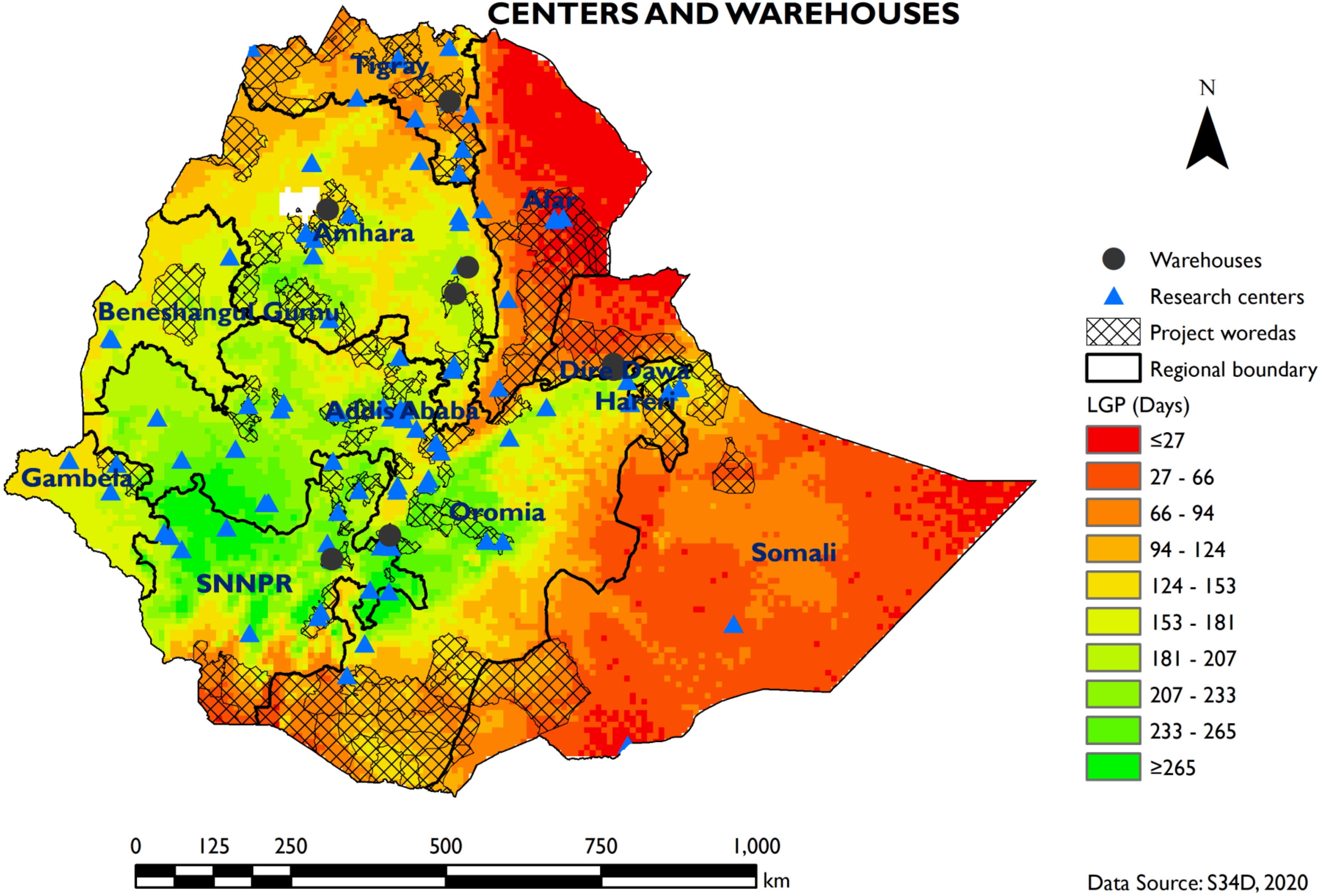


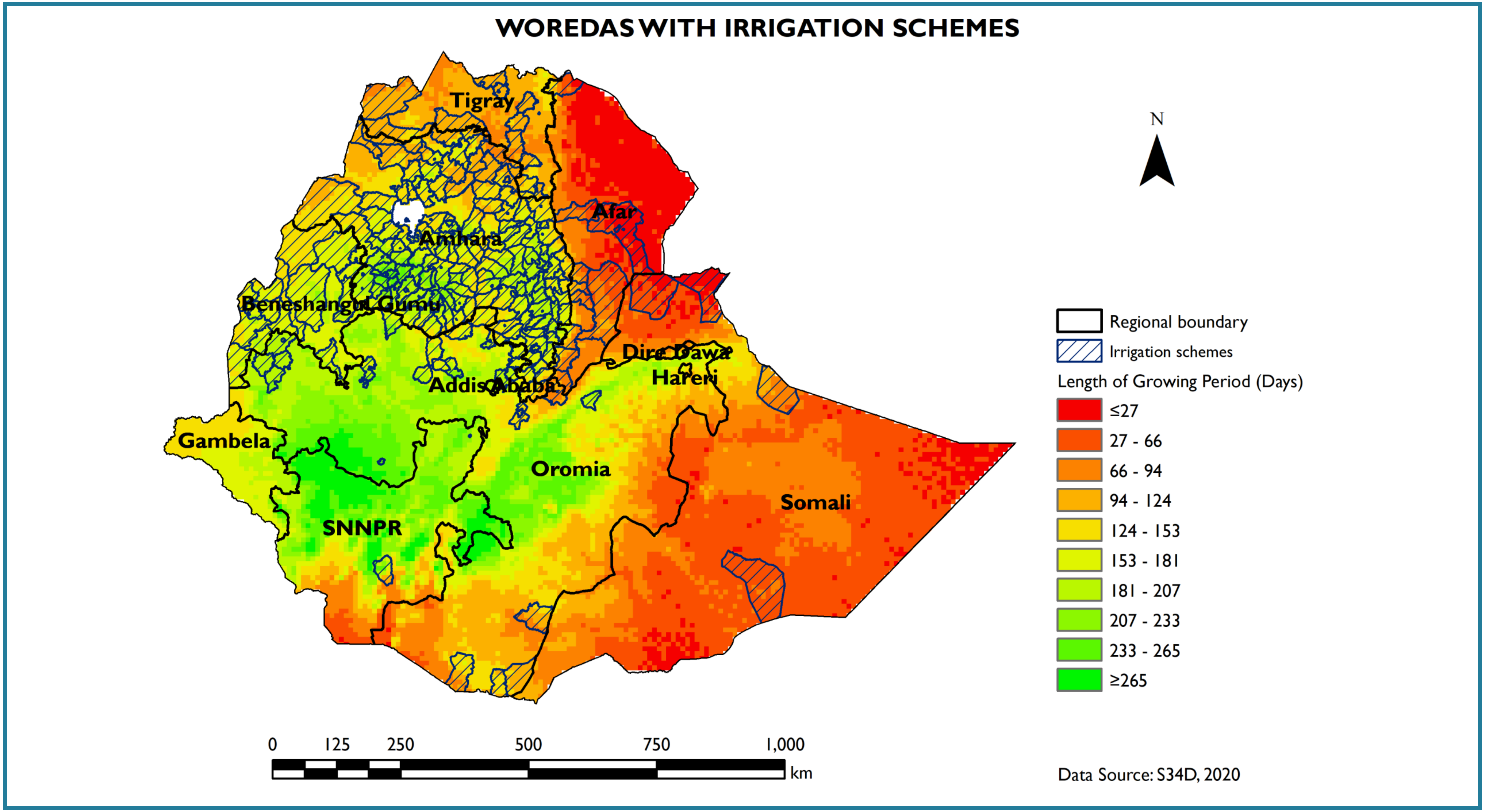
Data Source: S34D, 2020

Region	Number of Zones	Number of Woredas
Oromia	8	31
SNNP	8	19
Amhara	6	24
Tigray	5	18
Gambella	1	1
Benishangul Gumz	1	1
Harrar	1	1
Dire Dawa		1
Total	**30**	**96**


DEMAND PULL: QUARANTINE, FEEDLOT AND DAIRY CENTERS
Tigray
Afar
Amhara
Beneshangul Gumu
Dire Dawa
Hareri
Addis Ababa
Gambela
Oromia
Somali
SNNPR
Addis Ababa
Amhara
Oromia
SNNPR
N
Project woredas
Regional boundary
Quarantine centers
Capacity
≤ 6000
6000 - 32000
Feedlot centers
Dairy centers
Production ('000 liters)
≤ 5000
5000 - 10000
10000 - 20000
≥ 20000
Roads
0
125
250
500
750
1,000
km
Data Source: S34D, 2020

ONGOING FORAGE ACTIVITIES, LENGTH OF GROWING PERIOD (LGP), RESEARCH CENTERS AND WAREHOUSES




WOREDAS WITH IRRIGATION SCHEMES
Tigray
Afar
Amhara
Beneshangul Gumu
Dire Dawa
Hareri
Addis Ababa
Gambela
Oromia
Somali
SNNPR
N
Regional boundary
Irrigation schemes
Length of Growing Period (Days)
≤27
27 - 66
66 - 94
94 - 124
124 - 153
153 - 181
181 - 207
207 - 233
233 - 265
≥265
0
125
250
500
750
1,000
km
Data Source: S34D, 2020

Data Sources

Data Variable	Information Source
Dairy Processing Centers	IFPRI (2020)
Quarantine Facilities	MoA (2020)
Feedlots	Makkar (2020)
Length of Growing Period (LGP)	ABC-CIAT
Partners' Landscape & KIIs	S34D Study (2020)
Warehouse Facilities	CRS Ethiopia; NDRMC
Agricultural Research Institutes	ABC-CIAT; EIAR
Overlaps/ Alignment with ATA ACCCs	ATA (2020)
Road network	Open Street Map (OSM)
Global Case studies; Forage Seed Value Chain	S34D Study (2020)

Demand Estimation – Forage Seed

An Illustration

Feed quantity, quality and seasonal flows in Ethiopia

- In Ethiopia, the main sources of animal feed are natural pastures, crop residues and agro-industrial by -products.
- The *feed deficiency* in Ethiopia is 21.6% as dry matter (DM), ME - 51.7% and CP 48.2%
- *Seasonal* feed shortages and the inefficient feed utilization are the major challenges affecting livestock productivity (Gelayenew *et al*., 2016).
- A large *geographic* difference exists in feed surpluses and deficits. Eight out of ten regions are deficit in feed resources.
- Drought epidodes- six 2000 – 2017. Last two (in 2011 and 2016/17) had devastating effects on pastoral and agro-pastoral livelihoods.

Role of improved cultivated forages in feed quality

- Generally, cultivated forages have higher quality than roughages crop residues.
    - Crop residues is between CP 3 and 5 %
    - Cultivated forages is between 8 and 18% on DM basis.
- Native grasses in Ethiopia are of low quality (CP of about 6%) and cannot support good daily body weight gain.
- Cultivated forages as a mix with other feed ingredients, especially agro-industrial by-products, also form a good feed for high yielding dairy animals.
- Increase in use of feed quality from cultivated forages contribute to *decrease in methane emission* (a greenhouse gas) per unit of milk or meat production from ruminants (Peters *et al.*, 2013).

Annual forage seed requirement (AFSR) in tonnes (illustrative)

Forages	AFSR forages grown simultaneously deficit[a]	Annual FSR for the first 10 years[b] (tonnes)									
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Panicum	168	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
Rhodes	225	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Fodder oat	4010	401	802	1203	1604	2005	2406	2807	3208	3609	4010
Lablab	1404	140	280	420	560	700	840	980	1120	1260	1400
Cowpea	1404	140	280	420	560	700	840	980	1120	1260	1400
Brachiaria	528	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8
Regeneration seed[c] (perennials)	-	-	-	-	-	-	-	-	102	102	102
TOTAL	**7739**	**773**	**1454**	**2135**	**2816**	**3497**	**4178**	**4859**	**5652**	**6323**	**7004**

[a], when 100% of annual cultivated forage deficit met in the first year by growing simultaneously the four grasses @ 20% each and two legumes (leaving aside alfalfa); [b], 10% increase per annum (a life span of 10 years was taken for the perennial grasses); [c], for the three perennial grasses.

Case Study: Kenya & some E. Africa forage seed consumption

- Meru Dairy Union(Central Kenya), an umbrella that houses 55 farmer owed dairy societies,
- Meru Union processes 200,000 liters /day
- Under good weather conditions a certain society delivers 1200 liters of milk daily
  - but due to the animal deaths coupled with forage scarcity in 2020 dry spell the daily delivery dropped to 200 liter /day
  - During the dry spell in that area, use of gathered grass from forest increased
  - Such grass also carries vectors causing disease that led to loss of dairy animals.
- The union now to sensitizing the societies through their respective management to expand forage cultivation to curtail going forward

✓ In E. Africa, use of improved seed is gaining momentum 2020 (Fig 1)

✓ The figure present quantity of seed sold by Advantage Crops Limited, a seed company in Kenya

✓ There are other companies in east Africa and our field observations suggest cultivation of improved forages is gaining momentum

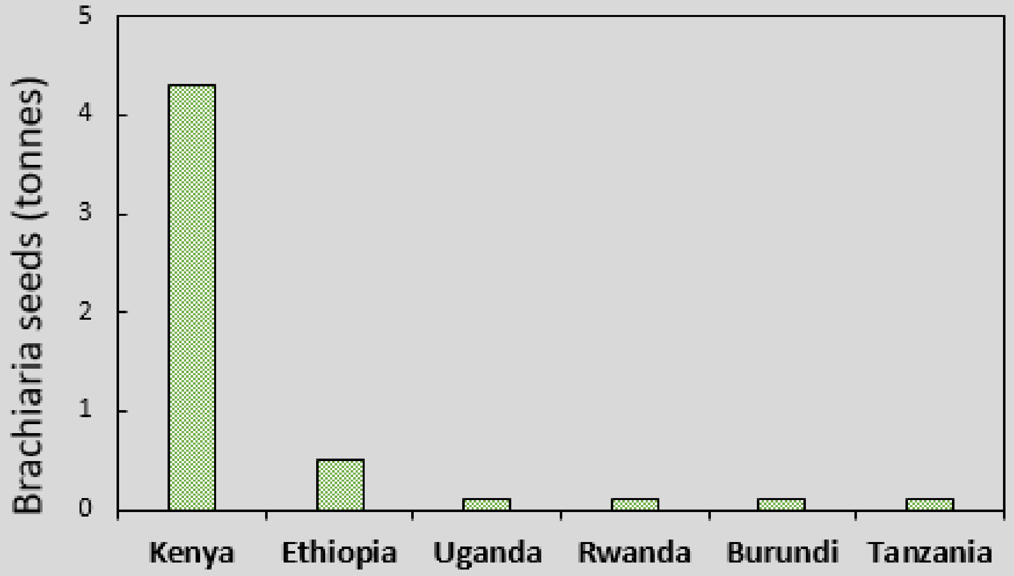


Fig. 1. *Brachiaria* seed (tonnes) sold across eastern African countries (2017-April 2018) from Advantage Crops Limited. (Data obtained from Advantage Crops Limited).

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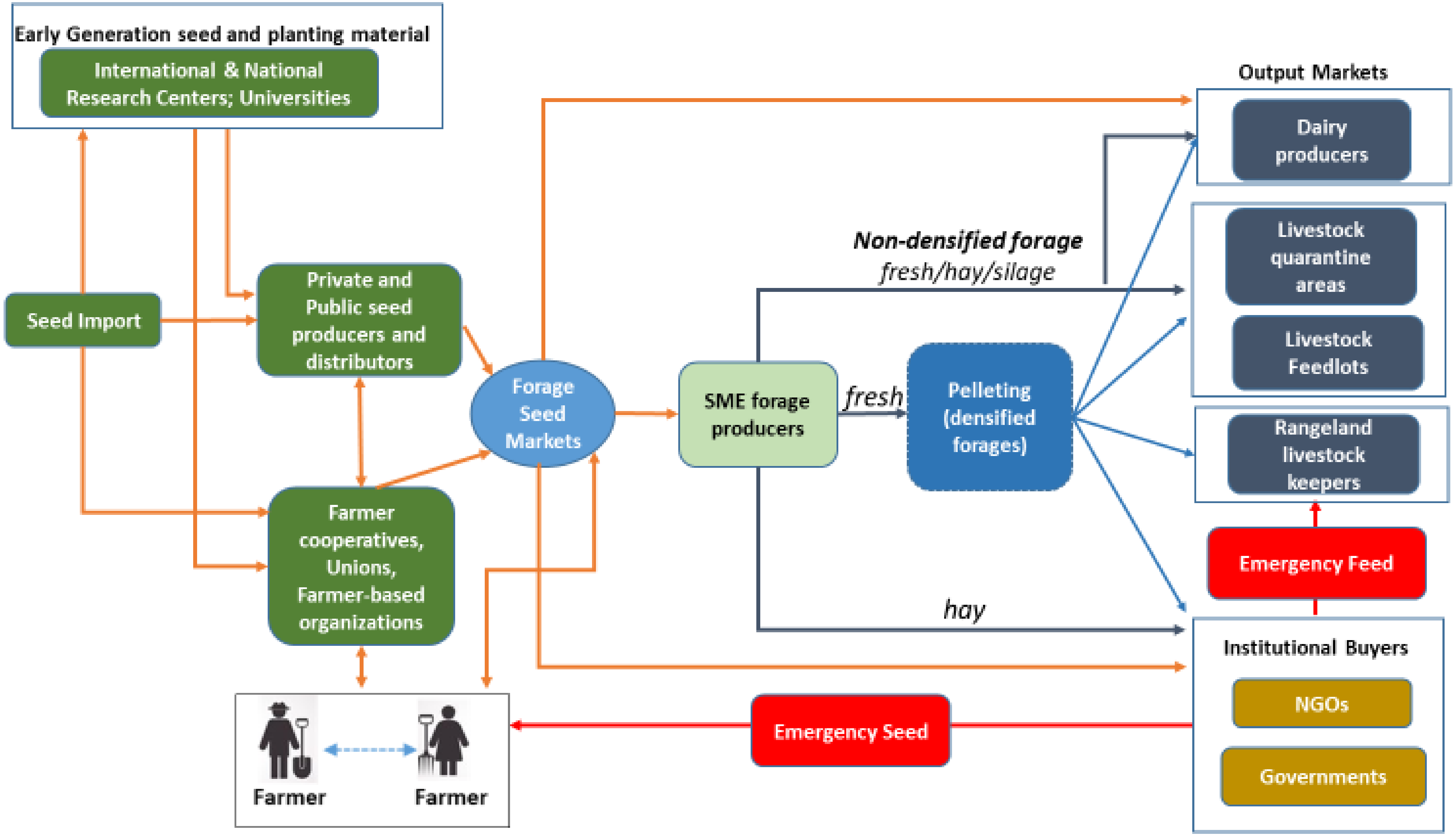
Forage Seed Value Chain

A perspective from stakeholder interviews

Forage Seed Value Chain - Illustration



SWOT

STRENGTHS	**WEAKNESSES**
- Various interests and enthusiastic partners - Several improved varieties are released and garnering interest among smallholders - Several improved varieties are highly suitable in Ethiopia - Demand for forages is on the rise through increased animal production	- Shortage of quality forage seed supply, including Early Generation Seeds (EGS) - Limited technical capacities - Lack of market linkages - Shortage of high-quality feed; seasonality - Land and extension services - High transport and storage costs
OPPORTUNITIES	**THREATS**
- Strengthen forage seed system starting with supply of EGS - Develop training material (traditional and digital) to increase capacity on the ground to provide tailored extension services; raise awareness - Develop new and strengthen existing market linkages - Introduce high-quality feed preservation techniques	- Droughts - Internal conflicts - High fluctuations in cost elements - Pests (alien weed prosopis)

Perception from stakeholders (stratification of regions)

High / *Medium* / *Low*	Cluster	Region	Level of current forage cultivation (area/importance)	Competition with food/ cash crops	Commercial fattening (%) (range 1-30%)	Commercial dairy (%) (range 1-85%)
	Central Highlands	*Amhara*				
		Oromia				
		SNNPR				
	Northern Zone	*Amhara*				
		Tigray				
	Southern Zone	*SNNPR*				

What did we hear about specific forage species?

- Perennials are more preferred than annuals, however annuals or semi-perennials could be options to produce biomass with a growing period of 8 to 12 weeks. Some farmers may prefer shorter crop rotations
- Desho and Alfalfa are most popular at present
- Other species include: Vetch, Pigeon pea, Napier

Forage Species	Suitability
Panicum maximum	
Rhodes grass	
Oat	
Lablab	
Cowpea	
Brachiaria-(hybrid)	

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Case Studies – Forages, Densification, Feed Reserves

Thailand, India, Tunisia, Mexico, Mongolia

What happens to feed during droughts?

- **The cost of manufactured feed increases during droughts** (by 20%) due to high competition for feed ingredients in the market, resulting in their shortages. The cost of transport of hay in the form bales is much more expensive compared with that of grains or manufactured feed.
- **The region around Adama is the hub for the supply of emergency feeds to Somali (Jijiga) and Afar (Semara) regions**. As for the manufactured feed, the cost of hay almost doubles during the dry season.
- Market distortion also takes place due to purchase of feed ingredients, particularly of hay, grains, brans and oilseed cakes in high amounts for distribution into the drought affected areas. Their free distributions by NGOs and international organizations pose marketing challenges for the private sector.
- To the best of the knowledge of the stakeholders contacted, feed has not been imported from the adjoining countries during droughts.

Densification of forages – a global perspective

- Forages in loose form have low bulk density and hence are difficult to handle, transport and store. **Densification technologies** provide opportunities to increase the bulk density and **decrease the cost of transport and storage,** the latter also ensuring the continuity of feed supplies and reduction of waste **contributing to resilience**. The density of pellets is highest, followed by blocks and then bales.
- **Cultivated forages** are generally soft and **easier to densify**, while crop residue such as rice straw is very hard, requires more power to cut and hence needs specialized chopping machine.
- In most developing countries the livestock management - including feeding of animals - is undertaken by **women**. The densified feeds are easier for farmers to feed and **reduction in feeding time by 75% and in labor cost by 30-40%** has been observed when compared with feeding with loose ingredients (FAO, 2012).

Case Study: Business approach to fodder cultivation enhanced income, Thailand

Napier Pakchong I grass cultivation as a business enterprise

Source and credit: CFC – OFID - FAO Funded Project FIGMDP 19

- Through a technical cooperation project implemented by Department of Livestock Production of Thailand with the technical support of FAO, an innovative approach was used to promote grass cultivation as a business enterprise.
- The farmers who had some surplus land and the unemployed **youth** who could lease land at reasonable rental rates were trained in the **business** of production and sale of **high yielding high nutrient grass varieties**.
- ***The annual earnings of the grass business farms were 62,500 Thai Baht /ha/year, approximately twice the earnings from rice from the same area. A total of 20 such grass business farm grew under the project.***
- The productivity improvement also stimulated private investment by dairy farmers, resulting in larger herd sizes.

Case Study: Mongolia

Fodder (hay) storage for winter in Mongolia (photo credits: Harinder Makkar)

- Mongolia has a very harsh long winter with temperatures reaching as low as minus 40 °C to minus 50 °C. Mongolia has around 75 million livestock heads and approx. 74% of all families that own livestock earn their living from livestock herding. Livestock is the only source of livelihood for pastoralists, comprising of 35% households.
- In Mongolia, public and private stakeholders including federal, provincial and district level governments take part in storage of feeds for the severe winter period.
- By issuing resolutions the **Government sets the targets of feed supplies for the winter, including volumes of emergency feed reserves** to be prepared at aimag (province) and soums (district) level and by herders.
- To support herders, the Government of Mongolia also import hay and fodder from the Russian Federation.
- Increased Investments in i**mproving feed availability and strategic feed reserves for the winter periods** is one of the important points **in the action program of the Government of Mongolia for 2016-2020.**

Case Study: India

Photos: Biomass bunkers for storing dry fodder at Mulkanoor Milk Union, left; and a village level, right (photo credit: NDDB, India)

- In arid areas the prices of crop residues nearly double during the dry season
- **National Dairy Development Board (NDDB) of India implemented a holistic 'Crop Residue Management Model' under the National Diary Plan (NDP) Phase I.**
- Pick-up' devices for securing crop residues from the fields and **balers for enhancing their bulk density were provided; and 'Biomass bunkers'** for long-term storage of the crop residues were established in the Cooperative Institutions.
- A total of 119 such bunkers have been established under NDP Phase I and cost of each of these bunkers is approx. Rs 1 million (1 US$ = Rs 73). These are **managed by Milk Unions and village based Dairy Cooperatives.** In the dry season, these storage facilities result in saving of 30 to 50% in the cost of purchase crop residues, which form almost 50% of the diet .

	India	Mexico	Tunisia	Kenya
Benefits of densified feeds	**Less wastag**e, higher animal productivity, **ease of feeding, smaller storage space requirement, lower transpor**t cost and non-selection of feed ingredients by animals and as a result better utilization of poorer quality ingredients, prevention of fire which could result on storage of forages in loose form	**Ease of handling, no wastag**e because all is consumption by animals, lesser storage space required and increase in animal productivity.	**Ease of storage and feeding**, and efficient use of locally available feed resources.	**Ease of storage and/or transportation** while maintaining good quality. Lesser **time required for feeding**.
Role of women & Youth	Currently women are involved in forage harvesting, collecting, drying, feeding and dissemination of the technology. **Feeding of pellets and blocks takes less time, which is attractive to both the youth and women.** Innovative nature of the technology is attractive for youth. Enhancing skills to produce formulations, operate and maintain the machines, and run the densified forage production as a small business would attract youth in this innovative technology. It is also expected to **stop the migration of youth** which is of particular importance during the COVID-19 situation.	**Increased opportunities for the youth** in the densification business are anticipated. The reasons being: the products are innovative, youth are more open to new technologies, and they have recent knowledge and aptitude of rearing animals on scientific basis	**Women** are exclusively in charge of feeding and their role in feeding of pellets or blocks would be vital. **Youth** could participate in operation and repair of the machines after undergoing vocational training. They can also participate in the transport of densified feeds, from the factory to the livestock farmers.	**Women** play key role in feeding livestock and would benefit from easy access and storage of forage pellets and from lesser time required for feeding. For **youth**, opportunities exist in production of forages and processing.

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Economic Analyses & Business Model Propositions

Densification of improved cultivated forages into pellets

Why pellets?

- Easy handling, transportation, storage and feeding
- Lower cost of transport and storage.
- Good nutritional quality
- Higher shelf-life than loose forages and baled hay
- Offer an attractive possibility of setting up of feed banks near to the feed deficit areas.

Improved forages provide key nutrients at a much lower cost compared to conventionally used feed ingredients*

Feed resources	Cost US$/ton dry matter	Cost US$/kg Crude Protein	Cost US$/1000 MJ Metabolizable energy
Cultivated forages	10.91 – 61.46 (**Av. 36.19**)	0.097 – 0.340 (**Av. 0.219**)	1.299 – 6.681 (**Av. 3.990**)
Protein sources: Oilseed cakes	182.42 – 446.14 (**Av. 314.28**)	0.470 – 1.030 (**Av. 0.750**)	14.910 – 42.490 (**Av. 28.700**)
	Normal time		
Hay at production site	88.0	**1.38**	**12.57**
Concentrate feed at production site	279.2	**1.99**	**25.15**
	Drought time		
Hay at production site	135.0	**2.11**	**19.29**
Concentrate feed at production site	349.0	**2.49**	**31.44**
Hay in drought areas*	224.0	**3.50**	32.0
Concentrate feed in drought areas*	374.0	**2.67**	33.69

**Drought areas approx. 600 km away from the production site*

Feed Demand Scenario

Quarantine centers

- Ethiopia established two new stations – Mille and Jigjiga
- Mille in Afar region – facilitate export of live animals via Djibouti
- Jigjiga in Somali region – export via Berbera in Somaliland
- Assuming same requirement for both Mille and Jigjiga, the annual feed requirement would be 189,000 tonnes / year (AKLDP, 2017)

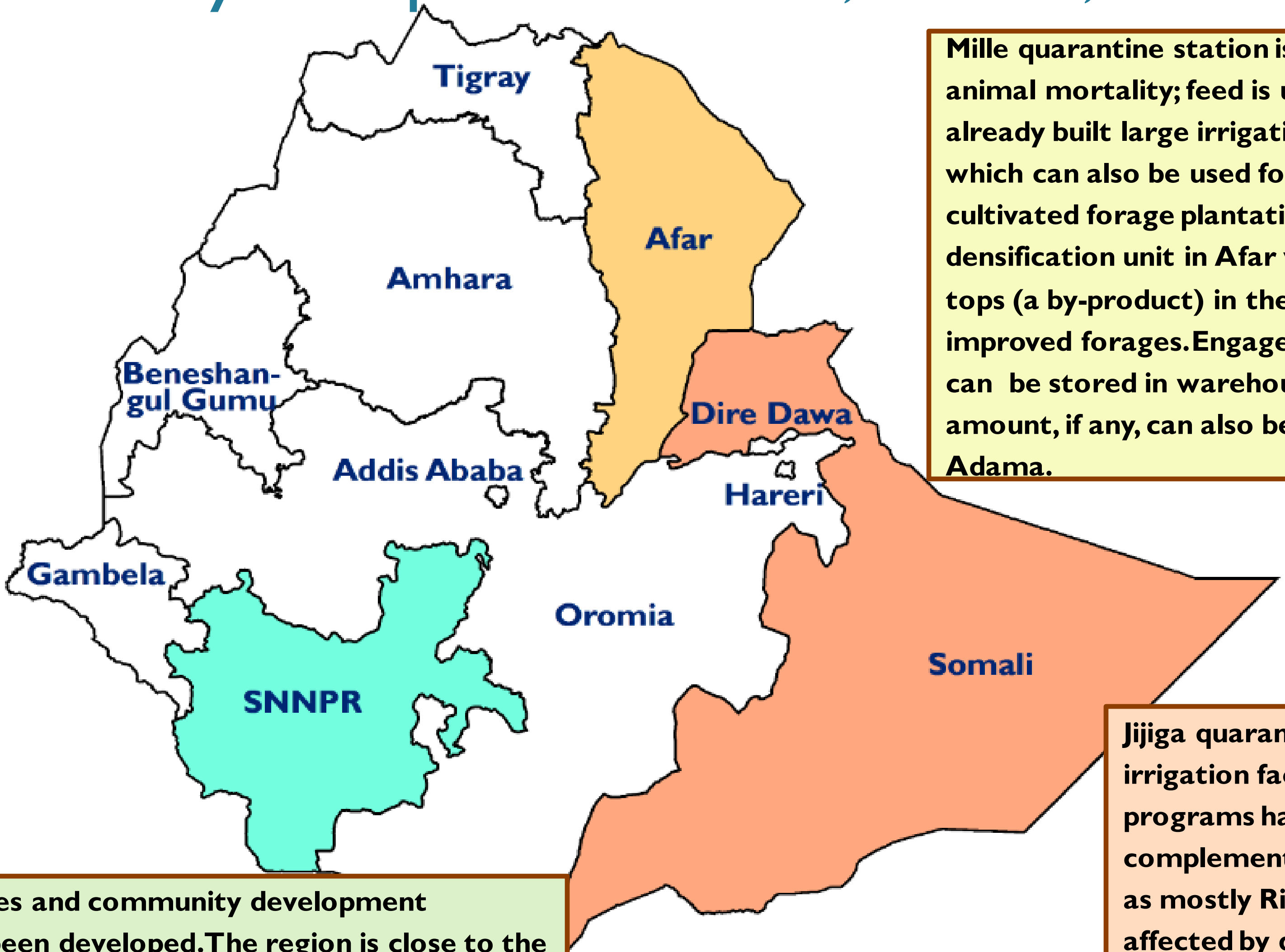
Feedlots

- There are around 300 farms that fatten animals in and around the Adama region. Each farm has capacity between 100 – 1500 animals (FAO, 2018)
- Analysis indicates the total amount of feed requirement would be around 203,000 tonnes / year

Droughts

- Severely affected regions – Afar, Somali, lowlands of Oromia, SNNPR
- About 2.25 million households need livestock support including animal feed (OCHA, 2017)
- During 2002-2003 drought, Ethiopia lost 1.4 million animals (ICRC, 2005)
- In 2017 drought, increased malnutrition affected 458,000 children. About 2.5 million children and women suffered from acute malnutrition (OCHA, 2017)

Approach for the business model: Cultivate improved forages and densify into pellets in Afar, Somali, and SNNPR



Mille quarantine station is located in Afar. Afar is a dry region; high animal mortality; feed is unavailable. The regional government has already built large irrigation facilities for sugarcane cultivation, which can also be used for cultivation of improved forages; 700-ha cultivated forage plantation (Panicum and Rhodes grasses). The densification unit in Afar would also allow inclusion of sugarcane tops (a by-product) in the pellets along with the cultivated improved forages. Engagement with pastoralist community. Pellets can be stored in warehouses, for use during droughts. The surplus amount, if any, can also be transported to feedlot areas near Adama.

Jijiga quarantine station is located in this region. The irrigation facilities and community development programs have been developed. The work would complement the activities of the ongoing project such as mostly RiPA and LGA in these regions. The region is affected by droughts. Feed banks can also be established in this region, for providing pelleted feed during droughts.

Irrigation facilities and community development programs have been developed. The region is close to the commercial feedlot areas near Adama. The region is also close to the drought-affected areas.

Plantation size and densification units

- The cultivation of improved forages could be in large plantation areas, for example 500-ha farm, as has been established in Afar by the regional government or it could be in smaller farms of 50 to 150 ha.
- A large farm of 500-ha plantation has potential to produce approximately 10,000 tonnes of dry forage in a year.
- To convert such an amount of biomass into pellets, a fixed high-pressure pelleting machine of capacity 20-25 tonnes pelleted feed production per 8-h shift is proposed.
- For the smaller plantations (50-150 ha), mobile high-pressure pelleted machine of 5-8 tonnes pelleted feed production per 8-h shift could be used.
- The forage cultivation and densification sites must be close to each other, to avoid transport of loose forages to the densification unit.

A mobile pellet making machine (photo credit: A.K. Verma, NDDB, India)

Model – Assumptions

- Feed demand calculated using assumptions and literature data represent the true picture.
- The quarantine facilities would eventually function at its optimal values in the near future.
- Outreach services would be able to demonstrate the economic and environment benefits of using the diets based on cultivated forages to the commercial feedlot farmers and managers of the quarantine areas.
- Quarantine areas and commercial feedlots would procure pelleted feed from the densification units or traders.
- The fixed and operational costs generated from the global case studies (India, Tunisia, and Mexico) surveyed under S34D would be valid in Ethiopia

Densification costs

Fixed costs		
Machinery – stationary Capacity: 20-25 tons/8-h shift	80 –110 K	• Initially high-pressure and high-capacity stationary forage densification units to form pellets would be available through import because these are not manufactured in Ethiopia. • Local production of such units will follow. • Provision of policy support by the Government to the agricultural mechanization sector that provides impetus to the local manufacturing of the high-pressure forage densification units to form pellets from forages.
Machinery – Mobile Capacity: 5-8 tons/8-h shift	25 – 30 K	• Same as above for the stationary high-pressure densification units
Operational costs		
Cost of densification (pelleting) – operational costs/ton*	**17.76**	• Densification units are co-located around the plantation sites, and there is enough sunlight near the densification units.
• **Running cost (labor, electricity, additives)/ton**	16.35	• Assuming 300 working days in a year and 8-h shift per day; production of 20 tons/8-h shift).
• **Maintenance cost/ton**	0.58	• Same as above
• **Depreciation cost of machinery/ton**	0.83	• Assuming working life of 20 years; 300 working days in a year and 8-h shift per day; production of 20 tons/8-h shift.
Cultivation cost		
Planting and harvesting cost/ton	**10.9 – 61.5**	• Large pieces of lands and irrigation facilities would be available for the plantations. • Production levels of the cultivated forages taken for the cost estimation would be realised at the sites selected for the cultivation. Costs of inputs including labour taken for the calculation represent the true picture.
Transport cost		
Pelleted feed or concentrate feed/ ton/100 km	**4.9**	• The costs of transport collected from the feed companies represents the true value and remain valid for the near future.
Hay/ton/100 km	7.6	• The costs would not change for the short or long transport distances.

Costs of cultivated forage-based pelleted feed/ton, prepared through the proposed model	
Diets	Cost estimate (US$)
Production site	
• Cultivated forage-based pelleted feed for fattening animals, Feed-A	35 **(44)**
• Cultivated forage-based pelleted feed for dairy animals, Feed-B	57 **(71)**
Feedlot, quarantine or drought areas*	
• Cultivated forage-based pelleted feed for fattening animals, Feed-A	64 **(80)**
• Cultivated forage-based pelleted feed for dairy animals 600 km from production site, Feed-B	86 **(108)**
Cost of cultivated forage-based pelleted feed vis-à-vis that of conventional diet for fattening animals, to produce daily body weight gain of one kg, in feedlot or quarantine areas*	
• Using cultivated forage-based pelleted diet	0.64
• Using conventional diet	1.46
Feeding diet based on the proposed model is ca 2.3-times lower	
Cost of cultivated forage-based pelleted feed vis-à-vis that of conventional diet for one litre of milk production in areas 600 km away from the pellet production site	
• Using cultivated forage-based pelleted diet	0.097
• Using conventional diet	0.39
Feeding diet prepared using the proposed model is ca 4-times lower	
Daily cost of cultivated forage-based pelleted feed vis-à-vis that of conventional diet for feeding during droughts (to meet maintenance requirement)	
• Using cultivated forage-based pelleted diet	0.32
• Using conventional diet	1.143
Feeding diet prepared using the proposed model is ca 4-times lower	

Feed-A:
10% CP & 9.3 MJ/kg ME

Feed-B:
14% CP & 9.3 MJ/kg ME

Costs (US$) of currently used feeds, equiv. Feed-A

Production site,
Normal time: 179
Drought time: 236

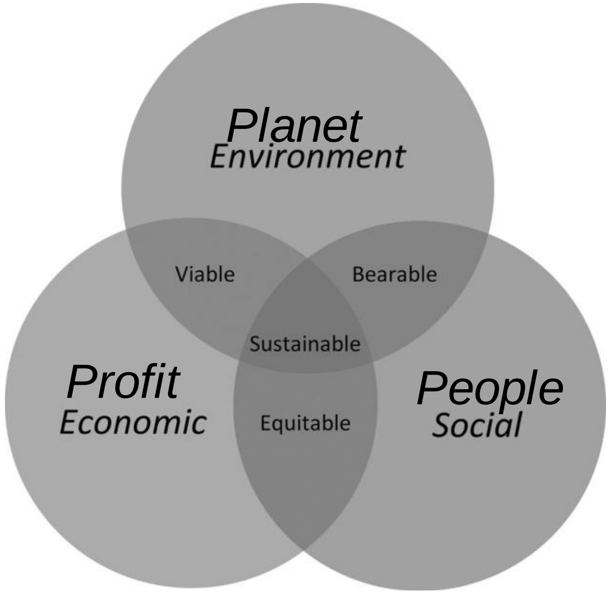
Feedlot, quarantine and drought areas, 600-km away
Normal time: 183
Drought time: 295

Assumption for the analysis: 25% profit (values in parentheses are with profit)

Model – Benefit Analyses

The implementation of the model would contribute to achieving Sustainable Development **Goals 1 (Poverty alleviation)**, **2 (Zero hunger)**, and **13 (Climate action)** of the United Nations

3-P Dimensions – Profit, People, Planet (IUCN, 2005)
Decrease in feed cost and increase in farmers' income *(Profit dimension)*
Decrease in greenhouse gas emissions from the livestock sector *(Planet dimension)*
Decrease in food-feed competition and in feeding cost *(Ethical (People) and Profit dimensions)*
Decrease in regional feed disparities, feed costs and volatility in feed costs *(Profit dimension)*
Increase in soil health *(Planet dimension)*
Economic opportunities for women and youth *(People and Profit dimensions)*
Decrease in malnutrition, especially in growing children and pregnant women, and *(People and Profit dimensions)*
Increase in profitability and ***natural resource use*** through increased feed efficiency (*Planet and Profit dimensions*)
Increase in availability of foreign currency with the government *(Profit dimension)*
Increased resilience in the drought-prone lowland livestock production zones (People dimension)



Potential next steps for the densification model

- Zero-in on the sites for cultivation of improved forages and in the choice of area-specific forages (including participatory land use planning, involving pastoral communities to get their buy-in)
- Selection of different components of the densification units based on the type of forages and other biomass to be converted to feed pellets
- Strengthen capacity of agricultural equipment manufacturers involved in serving the livestock sector (*Global S-S learnings*)
- Collaborate with GoE on the policies to strengthen agricultural equipment manufacturers
- Zero-in on the warehouse sites for establishing feed banks, and garner government support for such a system.
- Strengthen policies with regard to agricultural equipment manufacturers

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Key Takeaways

Way forward…additional thoughts

- ***Develop PPP*** with seed companies, EIARs, and regional research centers (within Ethiopia) to strengthen the supply of EGS for forages
- Support ***business models*** that produce and distribute cultivated forages to smallholder dairy farmers in the highlands
- ***Technical capacity building and awareness creation*** through tailored extension services; developing content focused on forage seed multiplication and forage crop cultivation.
- ***Develop market linkages*** through greater coordination and collaboration leveraging existing platforms (examples – forage seed consortium, national associations); develop and disseminate market intelligence; create transparency; efficiently align with the existing implementers on the ground
- ***Partnerships*** with MoA; RBoA; ATA; Implementing partners; Digital Green; Seed companies, QDS producers, Cooperatives, emerging seed businesses

Policy implications

- Reframe the outlook of the chain from a holistic viewpoint (see "seed" as a business)
- Increasing operational efficiencies of the quarantine facilities (AKLDP, 2017)
- Streamlining roles and responsibilities in the EGS production
- Expanding QDS production of forage seeds
- Focus on informal seed channels – such as traders who moves seeds and "potential planting materials" from one region to another
- Expand sale and seller categories to embrace traders and local markets
- Increase transparency: direct information, digital systems, inclusive feedback
- Policies on requirements for feed reserves

Concluding Remarks

- Costs of nutrients from cultivated forages are **up to 15 folds lower** than those from the conventional feed resources
- Densification of cultivated forages **decreases the costs** of: a) saving animals during a 100-day drought period by 4 times, b) fattening animals by 2.3 times, and c) cost of feed for milk production by 4 times.
- It is **cheaper to produce** meat from animals of good genetic potential (for example those growing at 1 kg/day) than those from animals of poorer genetic potential (for example those growing at 0.5 kg/day. Likewise, it is cheaper to produce milk from dairy animals of high genetic potential.
- The **greenhouse gas emissions** per unit of animal source food production are lower from healthy animals of higher genetic potential fed with high-quality balanced diets.

Concluding Remarks (cont.)

- When we think of seed systems – especially those of forages, we need to think about the **interconnectivity** with the livestock sub-sector and thus the output markets
- Through our research, we have developed a **new avenue for demand creation** of cultivated forages – feed preservation technology using cultivated forages – that in turn will **decouple the spatial dependence**
- Our analyses show opportunities to strengthen the **demand-led growth** for the forage sub-sector
- The proposed business model(s) suggest PPPs that will **provide solution** to long dry seasons and recurrent droughts in Ethiopia leading to increased animal productivity, reduced human malnutrition, and **increased livelihood resiliency**
- Solutions proposed here **create economic opportunities** for smallholders, women, youth, and mitigates climate change
- Solutions that **transform** an emergency focused feed issue into one centered on long-term sustainability.

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Speakers

Brief Introduction

About the Speakers (in alphabetical order)

An Maria Omer Notenbaert

Africa Team Leader Tropical Forages at the Alliance of Bioversity International and CIAT; Cluster Leader on Environmental Assessments of Livestock in the Livestock CRP

Ms. Notenbaert started her career as a GIS analyst. After moving to Africa, where she –mostly through her work for the International Livestock Research Institute - became passionate about livestock production systems. An's work focused on supporting the transition towards sustainable food systems and the role of livestock production therein. As Africa Team lead of the tropical forages team, she zooms in on the multiple roles forages can play in environmentally-sound development of integrated crop-tree-livestock systems. An leads the design, implementation and documentation of multiple agricultural research projects across Sub-Saharan Africa. Ms. Notenbaert graduated in 1994 as Bio-engineer in Land and Forest Management with a specialization in Land Use Planning from the Catholic University of Leuven, Belgium.

Bhramar Dey, Ph.D

Senior Technical Advisor, Catholic Relief Services; Senior Management Team, S34D

As an Economist, Dey leads Monitoring, Evaluation, Learning, Seed Policy, Data, and Strategy for Supporting Seed Systems for Development (S34D). As part of the S34D senior management team, Dey brings a unique blend of project design, management, and analytical skills focusing on country-led interventions (often through negotiations with governments) in data, policy, monitoring and evaluation, and agricultural input systems. She has over 16 years of experience in data systems, policy, and regulatory reform analyses, designing, managing large client and stakeholder-oriented projects. Prior to joining CRS, Dr. Dey worked at the Bill and Melinda Gates Foundation (BMGF) - Agriculture initiative in Seattle, USA. Born and raised in India, Dey holds a Ph.D. in Applied Economics from Clark University.

Prof. Dr. Harinder P.S. Makkar

International Consultant (Sustainable Bioeconomy); Adjunct Professor of the University of Hohenheim, Stuttgart, Germany.

Prof. Makkar worked as Senior Animal Production Officer at FAO, Rome, Italy. Before joining FAO, he was Mercator Professor at University of Hohenheim. He also worked at the International Atomic Energy Agency (IAEA). Dr. Makkar worked as a consultant with IGAD, VSF-G, CIFA, ILRI, ICARDA, EFSA, DFID, GIZ, IFS, and IAEA, among others. He obtained PhD in Agriculture Biochemistry from the University of Nottingham, U.K. and Dr. Habilitation in Tropical Animal Production from the University of Hohenheim. He has been awardee of Honorary Professorships by Universities in China and Mongolia. Dr. Makkar has been a Fellow of Commonwealth Association, UK; Humboldt Foundation, Germany; and Japanese Society for the promotion of Science, Japan.

Solomon Mwendia, Ph.D.

Scientist, Forage Agronomy (Alliance of Bioversity International and CIAT)

Dr. Solomon is a career scientist on forage agronomy with 19 years' experience in R4D. His training entails BSc in Animal Production, MSc in Livestock Production Systems, and PhD in Forage Agronomy from University of New England, Australia. He started working for the National Research System in Kenya before Alliance of Bioversity International and CIAT. Dr. Solomon has contributed to livestock projects in various sub-Saharan countries including Ethiopia, Kenya, Uganda, Rwanda, Tanzania, Mozambique and Zambia. He has worked directly with livestock producers characterizing challenges and seeking feeding solutions together. Dr. Solomon has authored and contributed to various peer reviewed journal articles, working papers, and presented in various conferences.

Michael Peters, Ph.D.
Tropical Forages Program Leader, Alliance of Bioversity International and CIAT; Flagship Leader on Feeds and Forages of the Livestock CRP
Dr. Michael worked for more than 30 years in the area of Tropical Forages and Livestock-Crop-Tree Systems. Michael worked in Latin America, in West (with ILCA/ILRI), Eastern, and Southern Africa and in a coordinating function in Southeast Asia. His research focusses on the development of tropical forages and their integration in tropical systems for ecosystem and livelihood benefits. He has ample experience in working in multidisciplinary and multicultural teams, contributing to or leading fund raising, design, execution, management and documentation of multiple agricultural research projects in Latin America and Caribbean, Sub-Saharan Africa and Southeast Asia. Dr. Michael is on the Management committee of the Tropical Grasslands-Forrajes Tropicales journal, and on the Management committee of the Livestock CRP. Michael was awarded his PhD (Dr.agr.) by the University of Giessen (Justus-Liebig-Universität Gießen) in 1992.

Yonas Sahlu Woldeselassie
S34D Consultant, Ethiopia
Yonas has been working at various capacities in the Ethiopian seed sector after he graduated with a BSc degree in Plant Sciences from Addis Ababa University in 1984. His career started with the Ethiopian Seed Enterprise (ESE) when he started working as seed production agronomist and continued with heading the seed quality assurance services until he was promoted to lead the whole seed production, polarization and quality assurance activities of the enterprises.. Yonas served the Agricultural Transformation Agency (ATA) as acting director of the seed program before he joined the Alliance for a Green Revolution in Africa (AGRA) in the USAID funded Scaling Seeds and Technologies Partnership (SSTP) in Ethiopia. Yonas obtained his MSc. degree in Agricultural Resources and Environment (Agronomy), from the University of Jordan, Amman, Jordan in 1999

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