Experiment on cattle feed with women farmers in central and southern Ethiopia

This paper summarizes findings from an experiment conducted by Inter Aide and AVSF on cattle productivity in small dairy farms in the Central and South Ethiopia Regional States between 2023 and 2025.

1. Context

Region	Woreda	Altitude	Nb of cows
Central Ethiopia Regional State	Kacha Bira (Kembata)	highland	27
	Tembaro (Tembaro)	midland	26
	Begedamo (Kembata)	highland	32
	Misha (Hadiya)	highland	26
South Ethiopia Regional State	Wareza (Wolayita)	midland	32

Note: midland is between 1600m and 1900m ; highland means above 1900 m.

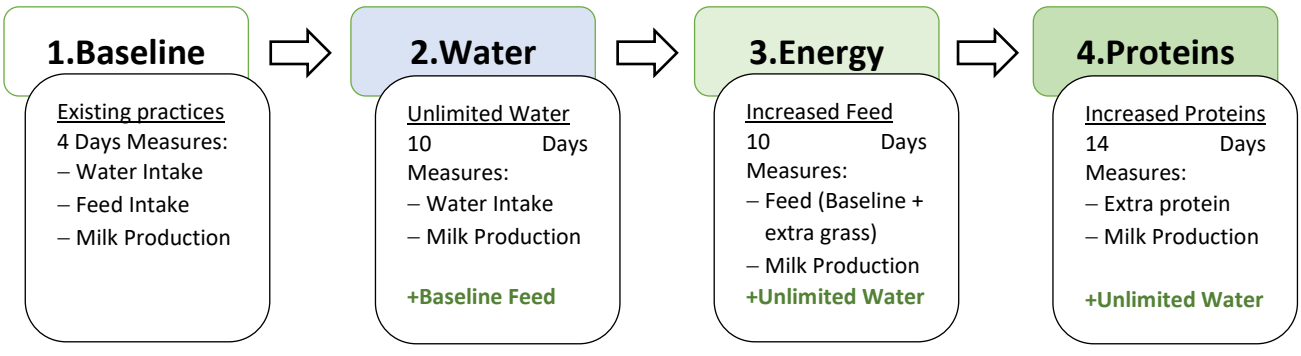
2. Objective

AVSF and Inter Aide tried to determine how farmers could improve the milk production of their cows, by changing what they are giving in terms of water and food.

3. Experimental protocol

This experiment was conducted during the dry season in all woredas except Begedamo (in the dry season, farmers usually have more difficulties to adequately feed their animals). In Begedamo, the experiment took place in the rainy season.

A total of 131 women smallholder dairy farmers were involved with a total of 143 dairy cows (57 crossbred[1] and 86 local cows). All cattle involved were fed according to the protocol below:



The water and feed given to the cows were measured on a daily basis. Each type of food was analysed to evaluate its content in terms of water, energy and proteins[2]. These computations were then

[1] The level of cross breeding could not be precisely known: crossbred cows in this study covers a wide variety of situations

[2] Standard values for each type of forage extracted from www.feedipedia.org ; See table in annex

compared against cow estimated daily needs[3].

Regarding the feed intake in Step 3, the average fresh feed given to the cows (grass of Pennisetum type) went up 44%, from 28,3kg to 40,9kg.
In step 4, cows were fed 4 kg of legume shrubs[4] or frushka (wheat bran) for extra proteins.

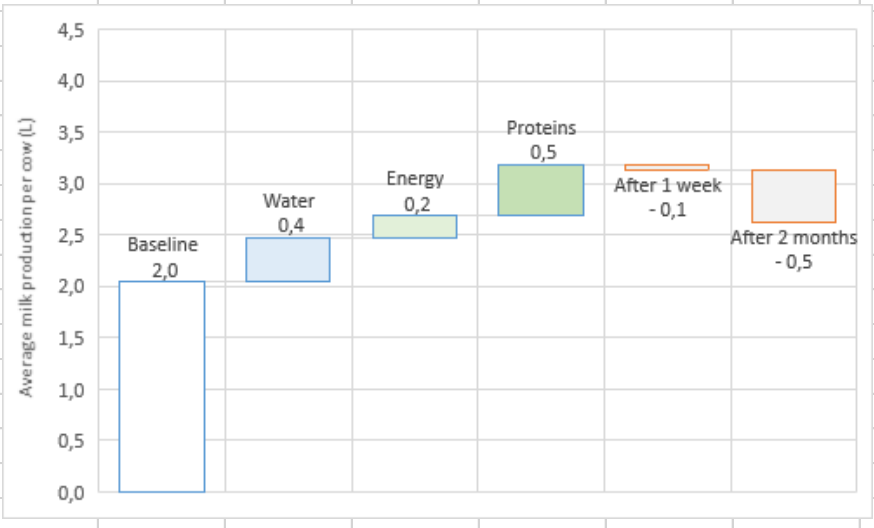
During this protocol, famers did not have to pay for additional feed and water (beyond the baseline).

Additional measurements also took place 1 week (Step 5) and 2 months (Step 6) after the completion of the protein phase. So all in all the experiment lasted about 90 days.

4. Results

All following figures are an average for all cows in the study, unless otherwise mentioned:

	Step 1	**Step 2**	**Step 3**	**Step 4**	**Step 5**	**Step 6**
Daily ration / needs	**Baseline**	**Water**	**Energy**	**Proteins**	**After 1 week**	**After 2 months**
Water intake (L)	6,3	17,8	18,6	27,6	26,0	21,6
Total Water (L)	65% (29/44)	90% (40/45)	110% (52/47)	127% (58/45)	111% (53/48)	97% (47/48)
Energy (MJ)	92% (47/51)	88% (47/53)	114% (62/55)	112% (65/58)	109% (61/56)	118% (63/53)
CP (g)	57% (266/464)	53% (270/508)	79% (425/534)	95% (558/586)	85% (474/559)	79% (401/509)
Milk production (L)	**2,0**	**2,5**	**2,7**	**3,2**	**3,1**	**2,6**
variation vs n-1		*21%*	*9%*	*19%*	*-2%*	*-16%*
variation vs Baseline		*21%*	*31%*	*56%*	*53%*	*28%*



[3] The cattle nutrition needs where defined according to: Dairy Cattle Feeding and Nutrition management, Training Package for Dairy Extension Workers, SNV, 2017
Their water need were taken from: Nutrient Requirements of Dairy Cattle,7th Edition, 2001, Board on Agriculture and Natural Resources National Research Council, Washington D.C.
[4] Sesbania Sesban, Tree lucern – Citysus proliferus (Fabaceae shrub also known as Tagasaste), Gliricidia sepium, Korch - Erythrina abyssinica, wheat bran ("frushka")

Comments on steps 1 to 4

Step 1. Baseline: The average intake per day per cow was 6.3 L of water and 28,3 kg of fresh feed, essentially Enset pseudostems and leaves having a very high water content contributing largely to the total water intake (22.5 L from fresh feed). However, the average total water taken by the cows showed a significant gap compared to the estimated need (only 65% of the need covered). The water provided to the cattle did not vary significantly with the distance to the water points (some farms being at 5 minutes walking distance, others at 30 minutes walking distance). The other significant gap identified in the cows' nutrition was proteins (only 57% of estimated needs).
The average daily milk production was 2 L with an important variation between animals (from 0.3 L/day for the least productive cow to 5.9 L for the most productive one).

Step 2. Water: Providing permanent access to water, the cows' water consumption increased sharply (from average baseline of 6.3L to 17.8 L) corresponding to a total water intake increase of 38% (from 28.9 to 40.1 L), leading to a significant milk production increase of 21% (from 2.0 to 2.5 L).

Step 3. Energy: Cows provided with additional feed (+unlimited water) readily increased their fresh feed intake by 45% from 28.3 to 40.9 kg. This feed increase led to a more moderate increase in milk production of 8.6% compared to step 2 (2.5 to 2.7 L). Compared to the baseline situation, the milk production was 31% higher.

Step 4. Protein: Adding proteins to the ration generated another significant increase in the milk production.

- The milk production of cows having access to unlimited water and increased protein rations increased by 56% vs baseline situation (from 2.0 to 3.2 L).
- The protein sources having generated the biggest increase in milk production (compared to baseline) are the Gliricidia and Frushka. One should note that in order for the cattle to ingest 2 kg of wheat bran, it has to be mixed with 20 L of water thereby increasing the burden of water collection hassles and possible additional costs of an already expensive feed.

Variation in milk production at step 4, according to protein sources:

altitude	highland			altitude	midland	
Proteins	**Nb of cows**	**Step4 vs Baseline**		**Proteins**	**Nb of cows**	**Step4 vs Baseline**
Frushka	33	61%		Frushka	21	71%
Korch	4	40%		Gliricidia	15	66%
Sesbania	16	33%		Sesbania	22	65%
Tree Lucerne	32	48%		**Average**	**58**	**67%**
Average	**85**	**50%**				

Overall, as inferred by the main gaps identified in the baseline situation, acting on water and proteins generated the most significant improvements in milk production.

This improvement was stronger in the midlands (+67% at step 4) than in the highlands (+50% at step 4). But it is difficult to make further deductions at this stage because cohorts vary significantly between both, in number (85 cows in the highlands and 58 in the midlands) and in breed (52 crossbreeds in the highlands vs only 5 in the midlands): further study would be needed to confirm and identify the reasons for this difference.

Comments on steps 5 and 6: after the experiment

The team went back to measure the intake and milk production of the same cows 7 days and again 60 days after the end of the trial, to understand how farmers would feed their animals after this experiment and with no support from the project:

- **Water consumption**: The water quantity provided during the week after the trials remained high at 26 L/day, then it decreased after 2 months at 21.6 L/day, remaining however much higher than the baseline situation (6,3 L / day). This shows that farmers understood the positive impact of additional water supply on milk production, in spite of the burden to fetch important quantities of water.
- **Feed quantity and energy:** After one week, the feed quantity provided to cattle remained higher than the baseline situation with a ration of 34.5 kg of fresh feed, covering more than the theoretical energy need. After 2 months, the feed quantity of fresh feed decreased slightly (33.7 kg) while remaining above the baseline level, still exceeding the theoretical energy need. This is partly due to the fact that cows having a better access to water are capable to ingest more feed.
- **Protein:** The amount of crude proteins provided to the cows decreased gradually, going below the daily needs of the cows. However it remained above the level estimated at the start of the experiment, in line with the higher feed quantity ingested.
- **Milk production:** The milk production was at its highest just after the trials (the cows having had a generous diet the week before), and it decreased afterwards at 2.6 L/cow on average 2 months after the end of the trials. This level is still 28% above the baseline situation.

All in all, farmers participating to the experiment were clearly able to witness the benefit of increasing water and proteins given to their cows. This enabled their milk production to remain significantly above pre-experiment levels, whereas a decrease of lactation around 18% would have been expected at 90 days[5].

5. Conclusion and following steps

This experiment has shown that in areas where farmers cultivate improved grass and have large Enset fields, the limiting factor to increase milk production is not the feed quantity, but water provision and feed protein content.

Even for those farms located near water points, the amount of water provided to cows before this experiment was very low, providing only 65% of the cows' theoretical needs: this shows that there is a clear knowledge gap regarding watering. It means there is a strong opportunity to implement training modules on cattle watering, in parallel to water access programs: improving water access and farmers' awareness will lead to a clear benefit in terms of milk production and revenues for these farmers.

Access to proteins is also difficult: the cost of wheat bran is too high to be paid for by the milk increase[6]. But this experiment showed that farmers do not need to buy wheat bran: they can produce leguminous forage instead, to reach similar improvements in milk production. Promoting this alternative and supporting the production of significant amounts of protein-rich fodder in adequate areas of the farm would have a significant impact. For example, a 100m hedge of Tree Lucerne can provide 30% of the energy needs and 51% of protein needs of a milking cow[7].

---

[5] Peralta-Torres, Jorge Alonso & Izquierdo-Camacho, Yuliana & Ojeda-Robertos, Nadia & Severino-Lendechy, Víctor & Ek-Mex, Jesús & Segura-Correa, José. (2022). Lactation curves of Holstein x Gyr dual-purpose cows under humid tropical conditions. Revista de Investigaciones Veterinarias del Perú.

[6] In 2023, the cost of wheat bran was 25 ETB/kg ; 2 kg were given so the total cost was 50 ETB. This enabled an increase in milk production of 0,5 L (step 4), which translated into an added revenue of only 15 ETB (milk price at 30 ETB/L).

[7] Inter Aide has been integrating productive and perennial fodder grasses on soil and water anti-erosive structures in South Ethiopia since 2015. Numbers are taken from yearly reports, based on regular field experiments and measurements.

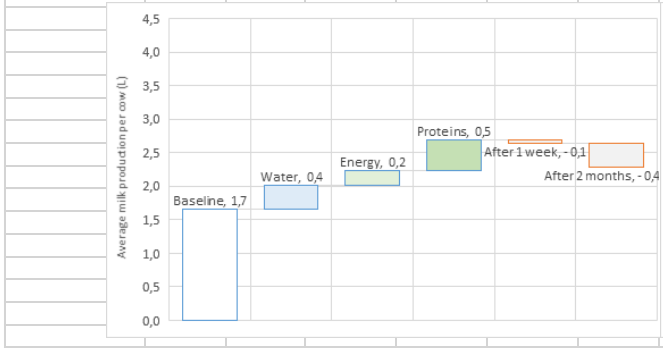
Having done this experiment in situ with woman dairy farmers had the immense advantage of converting these women into the most appropriate peer educators. They are now fully convinced and experienced, and are in the best position to convince other woman dairy farmers in the area to adopt such practices.

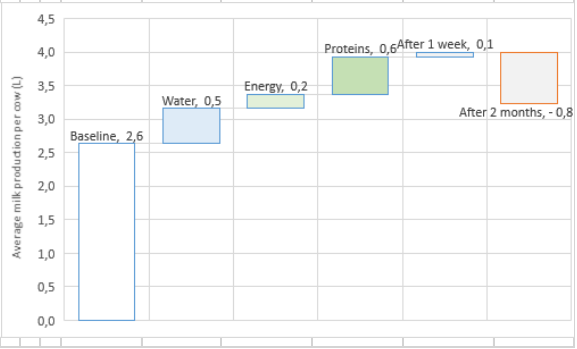
6. Annexes

Detailed results: local vs crossbred

	Local						Cross					
Ration	Step 1 Baseline	Step 2 Water	Step 3 Energy	Step 4 Proteins	Step 5 After 1 week	Step 6 After 2 months	Step 1 Baseline	Step 2 Water	Step 3 Energy	Step 4 Proteins	Step 5 After 1 week	Step 6 After 2 months
Total Water (L)	26,9	37,1	47,0	53,4	50,1	43,8	31,8	44,5	59,2	63,7	58,6	53,2
Water intake (L)	6,2	16,8	17,8	26,0	24,9	20,4	6,5	19,3	19,9	30,0	27,9	23,7
Fresh feed (kg)	25,9	25,7	36,0	34,4	32,1	30,8	32,1	31,9	48,3	42,4	38,9	39,0
var. vs Baseline			*39%*	*33%*	*24%*	*19%*			*51%*	*32%*	*22%*	*22%*
Energy (MJ)	41,6	42,8	54,8	59,7	57,3	57,7	54,4	53,8	73,6	73,2	69,0	74,0
CP (g)	239	244	389	530	446	370	307	310	478	599	524	459
Needs												
Total Water (L)	43,1	43,6	46,1	46,5	46,7	46,9	46,4	46,5	49,2	43,7	49,9	51,0
Energy (MJ)	48,6	50,8	52,3	55,2	53,5	51,5	54,2	57,3	58,8	62,0	61,5	57,2
CP (g)	424	463	489	538	508	474	524	578	604	660	651	575

Ration / Needs	Step 1 Baseline	Step 2 Water	Step 3 Energy	Step 4 Proteins	Step 5 After 1 week	Step 6 After 2 months	Step 1 Baseline	Step 2 Water	Step 3 Energy	Step 4 Proteins	Step 5 After 1 week	Step 6 After 2 months
Water intake (L)	6,2	16,8	17,8	26,0	24,9	20,4	6,5	19,3	19,9	30,0	27,9	23,7
Total Water (L)	62% (27/43)	85% (37/44)	102% (47/46)	115% (53/47)	107% (50/47)	93% (44/47)	69% (32/46)	96% (45/47)	120% (59/49)	146% (64/44)	117% (59/50)	104% (53/51)
Energy (MJ)	86% (42/49)	84% (43/51)	105% (55/52)	108% (60/55)	107% (57/53)	112% (58/51)	100% (54/54)	94% (54/57)	125% (74/59)	118% (73/62)	112% (69/61)	129% (74/57)
CP (g)	56% (239/424)	53% (244/463)	80% (389/489)	99% (530/538)	88% (446/508)	78% (370/474)	59% (307/524)	54% (310/578)	79% (478/604)	91% (599/660)	81% (524/651)	80% (459/575)
Milk production (L)	**1,7**	**2,0**	**2,2**	**2,7**	**2,6**	**2,3**	**2,6**	**3,2**	**3,4**	**3,9**	**4,0**	**3,2**
variation vs n-1		*22%*	*11%*	*21%*	*-2%*	*-14%*		*20%*	*7%*	*17%*	*2%*	*-19%*
variation vs Baseline		*22%*	*35%*	*63%*	*60%*	*38%*		*20%*	*28%*	*49%*	*52%*	*23%*





Breeds

Local breeds seemed to be less productive but experienced a stronger relative increase in milk production compared to cross breeds:

Cross vs local	Step 1 Baseline	Step 2	Step 3	Step 4	Step 4 vs Baseline
Cross	2,6	3,2	3,4	3,9	49%
Local	1,7	2,0	2,2	2,7	63%
Total	**2,0**	**2,5**	**2,7**	**3,2**	**56%**

Highlands vs midlands / breeds

The average milk production was higher in the highlands where the proportion of crossbred cows was higher (compared to the midlands). The production improvement was stronger in the midlands, probably due to the predominance of local breeds taken into account there:

highland vs midland	Cows	Step 1 Baseline	Step 2	Step 3	Step 4	Step 4 vs Baseline
highland	**85**	**2,2**	**2,7**	**2,9**	**3,4**	**50%**
Cross	52	2,6	3,1	3,3	3,8	48%
Local	33	1,7	2,1	2,2	2,6	53%
midland	**58**	**1,7**	**2,1**	**2,4**	**2,9**	**67%**
Cross	5	3,0	3,7	4,1	4,8	59%
Local	53	1,6	2,0	2,2	2,7	69%
Total	**143**	**2,0**	**2,5**	**2,7**	**3,2**	**56%**

Feed analysis

Standard values for each type of forage extracted from www.feedipedia.org

Short Name	Name of fodder	Dry Matter (%)	Energy (MJ/kg DM)	Crude Proteins (% DM)	Nitrogen digestibilty (%)	Adjusted CP (%)
Banana S.	Banana stem (Banana stalks, fresh)	7,2	9,9	5,1	54,7	2,8
Banana L.	Banana Leaves (areial parts)	16,0	9,9	16,6	54,7	9,1
Ens. C	Enset corm (fresh)	21,5	10,8	3,5	28,0	1,0
Ens. L	Enset leaves (Ensete ventricosum)	12,9	8,1	14,1	63,8	9,0
Ens. S	Enset pseudostem (fresh)	10,2	8,8	4,0	28,0	1,1
Maize S. Fresh	Maize stover (fresh)	29,6	8,4	6,8	45,3	3,1
Grass L. C&C	Natural grass (rainy season)	35,0	7,4	4,5	57,0	2,6
Weeds	Natural grass (rainy season)	35,0	7,4	4,5	57,0	2,6
Grass E.	Pennisetum purpureum (elephant/napier grass)	17,9	8,2	9,7	57,0	5,5
Desho	Desho (Pennisetum riparium)	17,9	8,2	11,8	57,0	6,7
Hay	Hay (cut fresh and dryed)	89,0	7,4	4,5	57,0	2,6
Dry Grass	Dry grass cut (cutted after drying)	89,0	4,44	3,2	57,0	1,8
Sesbania	Sesbania sesban (fresh)	26,0	11,5	24,4	83,0	20,3
TL	Tree lucerne	26,0	9,7	22,2	67,0	14,9
Gliricidia	Gliricidia (leaves and stems)	25,3	11	22,3	55,1	12,3
Cere. R	Wheat straw	91,0	6,8	4,2	63,0	2,6
Teff R.	Tef straw (Eragrostis tef)	91,6	7,9	4,1	59,2	2,4
Maize S. Dry	Maize stover (dry) & Shorgum	92,8	6,9	3,9	45,0	1,8
CowPea R.	Bean&Pea straw dry (Cowpea)	95,0	9	13,7	67,6	9,3
PP Dry	Pigeon pea (Cajanus cajan) Dry	90,3	8,7	14,5	64,5	9,4
PP Fresh	Pigeon pea (Cajanus cajan) Fresh	31,8	9,6	19,0	64,5	12,3
Haricot F.	Bean&Pea aerial fresh (Cowpea data)	38,6	9,8	18,1	70,0	12,7
Sugarcane L.	Sugar cane leaf	34,1	8,8	7,7	65,0	5,0
Sweet P. L.	Sweet potato, aerial part, fresh	13,0	8,8	16,5	33,0	5,4
Sweet P. T.	Sweet potato Tuber	20,6	11,9	10,8	69,0	7,5
Oat L.	Oat (Avena sativa), aerial part, fresh	20,6	11,1	14,8	73,3	10,8
Frushka	Wheat bran ('frushka')	92,0	10,33	17,3	80,0	13,8