Health benefits in contract farming and their impacts on production: evidence from the dairy sector in Senegal

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Introduction

Motivation

- Factors that may lead to irregular milk delivery to the factory
  - Seasonality
  - Side-selling: farmers are sometimes able to obtain more liquid cash and sometime at higher prices for their milk in local markets
  - Main effort providers – women - are many times not directly rewarded for their efforts

- Design an incentive to
  1. reward *regularity* of milk delivery
     - Incentives to increase effort are common in many fields such as education and labor
  2. improve health of farmers' families
     - Health benefits present worldwide in most labor contracts to attract and retain high quality workers
     - Somewhat present in agricultural in developing countries in the form of loans for family health shocks or dispensaries

Our study

- Health incentive intervention:
  - Free access to iron-fortified porridge “thiakry” for all children 2-5 years in household if fulfill contract
  - Contract: 0.5L (later 0.3L) of milk per cow per day, for 5 days in the week, weekly based
  - Targeted to women: “thiakry” is delivered at collection points easily accessible to women

Research questions

- Research questions
  - Can a nutrition incentive targeted at women and children be used to increase regularity of milk delivery?
  - How does the impact on milk delivery vary by **season** and by the **gender** of the individual in control of the contract?
  - What is the impact on children's health (companion paper)?

Potential pathways

- Three pathways through which the health incentive may increase regularity of milk deliveries.
  1. *Income effect:* value of thiakry on market is 200 FCFA/sachet
     - Value for household with 1 child = 1,400 FCFA for one week or 2,800 FCFA if have 2 children
     - nutrition incentive is similar to a cash-based incentive
  2. *Relational/social capital effect:* LDB signals that it cares about its farmers' well-being above and beyond the purchase of their milk.
  3. *Targeting effect:* By delivering at collection points, the incentive is targeting the main effort providers - women

Data and estimation strategy

Data

- 2 sources of data
  1. *Household data:* Baseline (January 2013) and endline (January 2014) questionnaires
     - *Household survey*: household wealth, demographics, milk production (monthly and seasonal)
     - *Mother survey*: Nutrition knowledge, child feeding practices, female status, milk production
     - *Child survey*: anthropometrics, hemoglobin, child development
     - *Sample Size*: 445 households, 529 mothers, 783 children at baseline, of which 437 households were resurveyed at follow-up
  2. *Administrative data*: Daily container-level milk delivery over 16 weeks pre-intervention and 50 weeks during intervention
     - 25,410 container-week observations
- We match household level data with administrative container level data
  - Households cluster into 385 containers

Outcomes

- Milk delivery outcomes (container level, weekly)
  - Fulfilled the contract: = 1 if container fulfilled contract in a given week
  - Delivered to LDB: = 1 if container delivered to LDB in a given week
  - Number of days container delivered to LDB in a given week
  - Total amount of milk delivered in a given week (liters)

- Household behavior outcomes (household level, monthly)
  - Number of lactating cows in the area (and not on transhumance) in a typical day
  - Number of lactating cows that are milked in a typical day
  - Amount of milk produced per lactating cow per day
  - Total amount of milk produced per day (liters)
  - Use of milk (own consumption, LDB, sold on market)

Estimation strategy

- Rely on randomization to estimate impact on milk delivery and household behavior
  - Comparing outcomes of treatment containers or households to outcomes of control containers or households.
  - Controlling for pre-treatment values of the outcome variable and other baseline controls (ANCOVA models)

- Heterogeneity of treatment effects
  - By week or month to account for seasonality
  - By gender of container head to account for intrahousehold dynamics

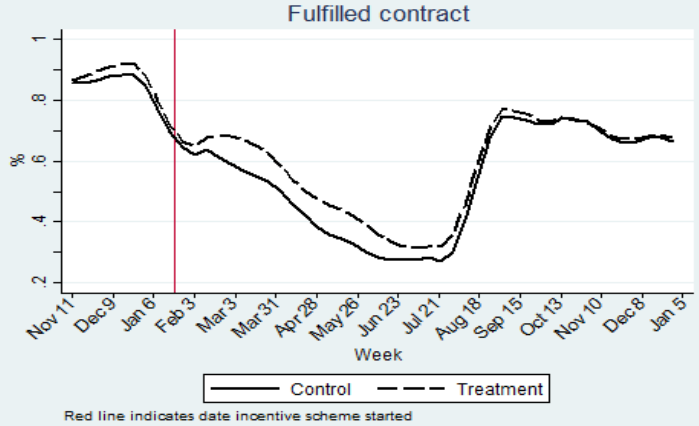
Balance of outcome variables

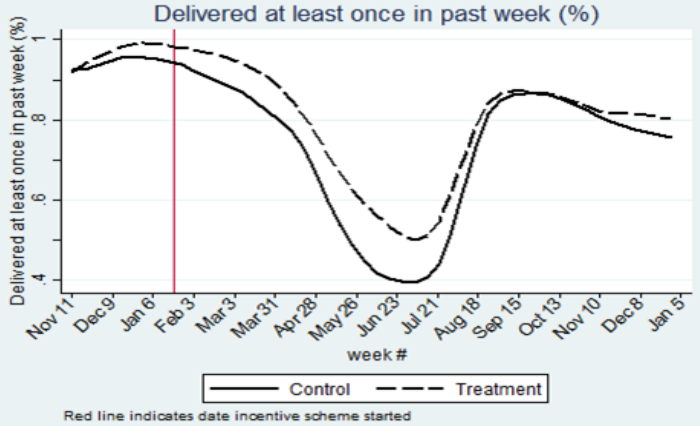
	N	All	Control	Treatment	P-value of diff.
Container level data					
Female container head	381	0.24	0.23	0.24	0.94
Number of children on contract	385	4.05	4.08	4.02	0.85
Number of cows listed in contract	385	3.77	4.01	3.53	0.08
Collective container	385	0.13	0.14	0.12	0.65
Milk production from December 9, 2012 (pre-study)					
Total weekly milk delivered to LDB (liters)	385	22.59	23.11	22.06	0.60
Container delivered at least once in the past week (%)	385	0.96	0.95	0.97	0.37
# of days delivered milk in the past week	385	6.29	6.22	6.37	0.40
P-value from joint F-test					0.47
Household level data					
Female household head	437	0.19	0.18	0.21	0.48
Age of household head	436	49.00	47.90	50.19	0.07
Household head has any schooling	437	0.04	0.03	0.05	0.23
Household size	437	8.73	8.56	8.91	0.39
Number of children 0-5 yrs	437	1.99	2.00	1.98	0.87
Owns or manages land	436	0.51	0.49	0.53	0.49
=1 if HH member is responsible for milk container	437	0.83	0.81	0.86	0.28
=1 if HH member fills other milk containers	437	0.16	0.19	0.12	0.11
Total number of milk containers HH is responsible for or fills	437	1.05	1.05	1.05	0.99
Number of lactating cows	436	6.53	6.29	6.80	0.13
Number of cows that were milked yesterday	435	6.38	6.12	6.67	0.16
Litres of milk collected yesterday	431	5.96	6.23	5.66	0.22
Liters of milk collected in a typical day (dry)	435	4.17	4.37	3.95	0.26
Liters of milk collected in a typical day (rainy)	435	12.69	12.50	12.91	0.62
Percent of income from - Milk (dry)	433	25.43	26.22	24.57	0.47
Percent of income from - Milk (rainy)	433	55.91	55.96	55.86	0.97
Percent of milk sold to LDB (dry)	407	55.72	55.41	56.08	0.83
Percent of milk sold to LDB (rainy)	434	64.03	62.88	65.27	0.22
Percent of milk sold to local market (dry)	407	3.55	4.21	2.80	0.24
Percent of milk sold to local market (rainy)	434	3.80	3.73	3.87	0.90
Number of years affiliated with LDB	437	4.75	4.86	4.63	0.28
P-value from joint F-test					0.18

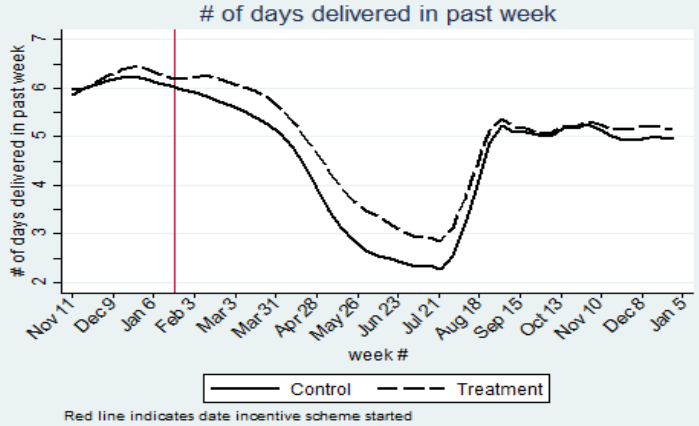
Results

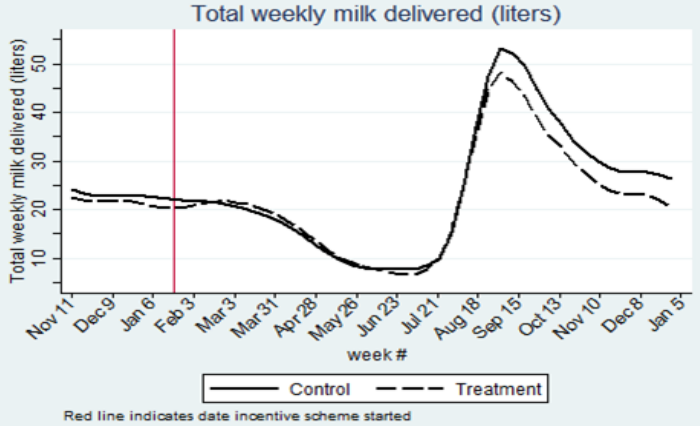
- Milk delivery outcomes – container level

Descriptive evidence

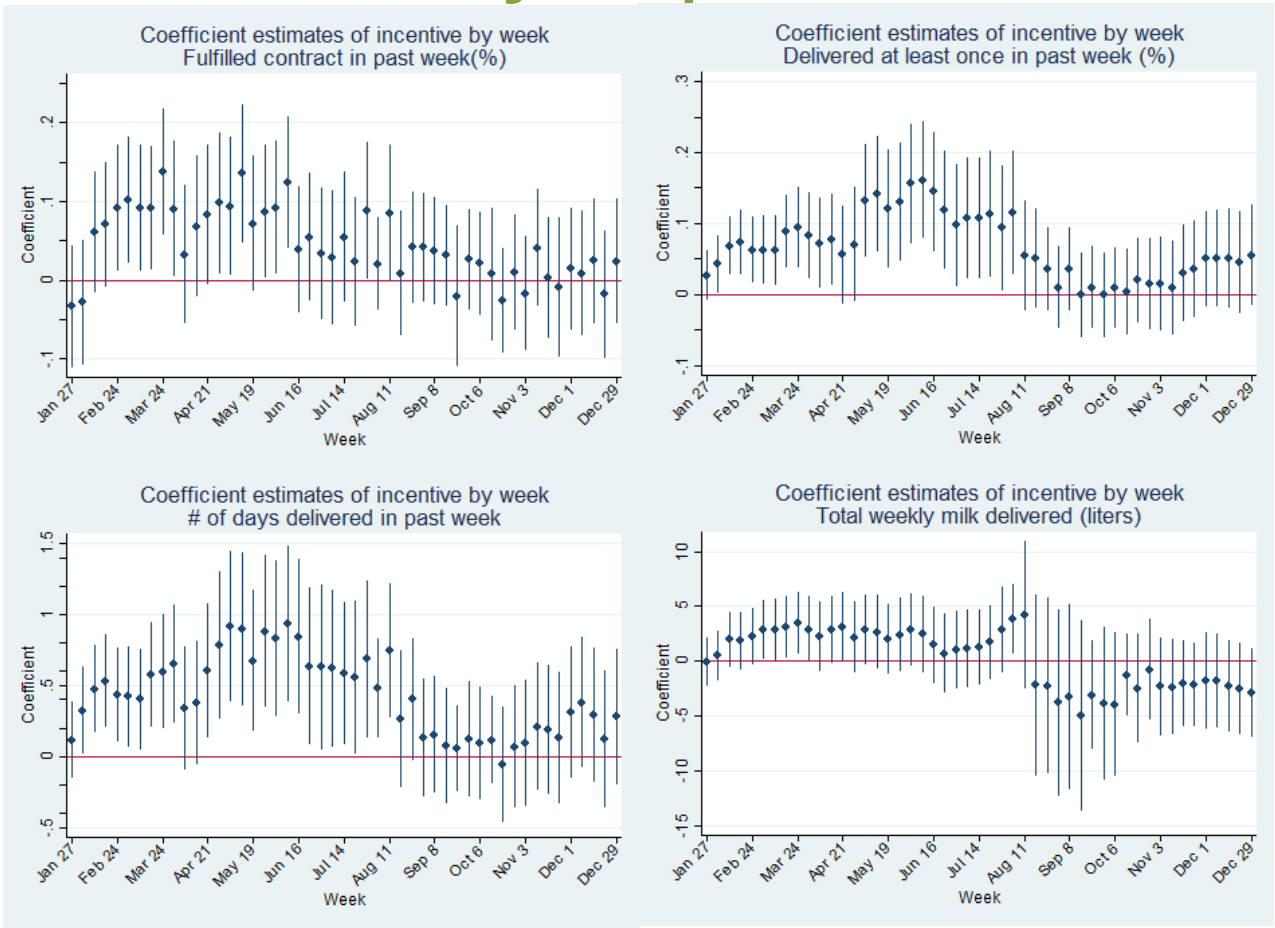




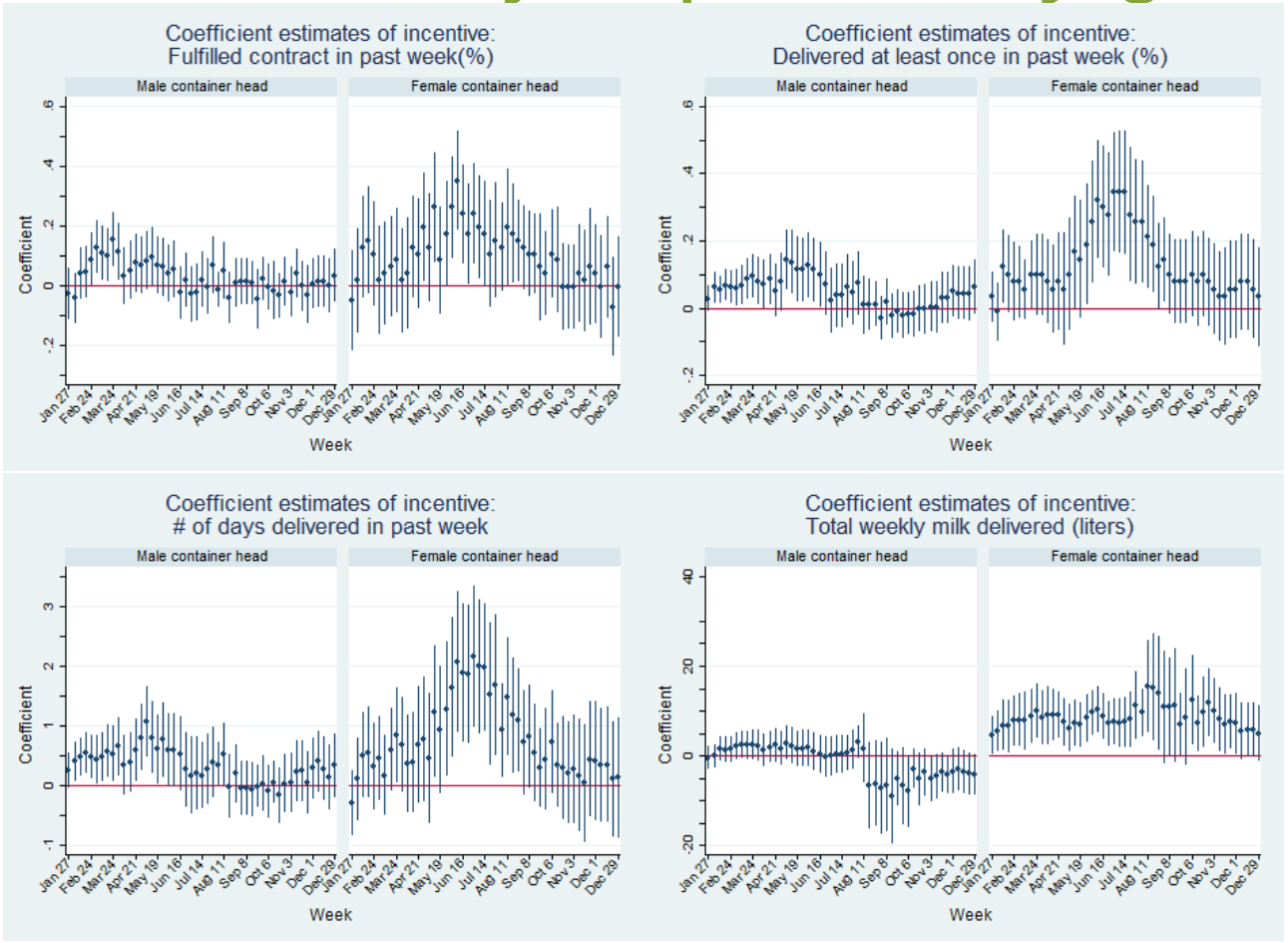




Milk delivery impacts



Milk delivery impacts– by gender



Total impacts throughout year

Table X: Impact of treatment on milk delivery, year-level

	# weeks satisfied contract, per container		# active weeks, per container		Total # days delivered, per container		Total # liters delivered, per container	
Treatment	2.66	1.56	3.48	2.53	23.89	18.26	55.91	-47.26
	(1.37)*	(1.49)	(1.20)***	(1.32)*	(8.29)***	(9.15)**	(90.93)	(107.23)
Female headed container		-3.04		-1.80		-6.84		-393.20
		(2.77)		(2.55)		(17.06)		(129.17)***
Treatment * Female headed container		4.70		4.06		24.04		440.21
		(3.34)		(2.96)		(20.07)		(182.45)**
Constant	12.81	13.26	29.69	30.08	130.92	133.22	-425.23	-383.07
	(2.52)***	(2.63)***	(2.54)***	(2.65)***	(16.22)***	(16.96)***	(163.12)***	(166.47)**
R^2	0.16	0.16	0.17	0.17	0.19	0.19	0.44	0.44
N	381	381	381	381	381	381	381	381
Mean of control group	26.37		35.24		215.58		1169.04	
Treatment+Treatment*female-headed containers		6.26		6.60		42.30		392.95
SE		3.03		2.67		18.06		151.76
Mean of control group, female-headed containers		25.36		34.67		217.29		922.04

- Household behavior – household level

Milk production behavior

Table: Impact of treatment on milk-related behavior

	# of lactating cows	# of lactating cows near concession	# of cows milked daily	# of liters collected per cow per day	Total # of liters collected per day
Treat X Month = 2	0.19	0.14	0.09	0.03	0.19
	(0.20)	(0.18)	(0.16)	(0.03)	(0.25)
Treat X Month = 3	0.32	0.35	0.38	-0.00	0.32
	(0.22)	(0.25)	(0.23)*	(0.04)	(0.31)
Treat X Month = 4	0.27	0.55	0.67	-0.02	0.47
	(0.26)	(0.28)*	(0.27)**	(0.04)	(0.34)
Treat X Month = 5	0.31	0.71	0.78	-0.04	0.53
	(0.28)	(0.35)**	(0.33)**	(0.05)	(0.38)
Treat X Month = 6	0.58	0.49	0.65	-0.03	0.83
	(0.34)*	(0.40)	(0.38)*	(0.06)	(0.45)*
Treat X Month = 7	0.41	0.80	0.92	0.04	1.42
	(0.39)	(0.46)*	(0.41)**	(0.08)	(0.66)**
Treat X Month = 8	0.17	-0.29	-0.16	-0.03	-0.41
	(0.40)	(0.45)	(0.41)	(0.08)	(0.70)
Treat X Month = 9	0.02	-0.43	-0.20	-0.03	-0.06
	(0.39)	(0.45)	(0.42)	(0.08)	(0.72)
Treat X Month = 10	0.13	-0.44	-0.24	0.02	0.13
	(0.37)	(0.41)	(0.39)	(0.08)	(0.64)
Treat X Month = 11	0.03	-0.35	-0.26	0.09	0.37
	(0.34)	(0.36)	(0.34)	(0.06)	(0.51)
Treat X Month = 12	0.27	-0.10	-0.11	0.05	0.33
	(0.33)	(0.34)	(0.33)	(0.05)	(0.40)
R^2	0.61	0.45	0.48	0.34	0.46
N	4,752	4,752	4,752	4,135	4,740

Milk production behavior

Table X: Impact of treatment on milk-related behavior

	% of milk for personal use	% of milk for LDB	% of milk for market	% of milk for other
Treat X Month = 2	-0.01	0.01	-0.00	0.00
	(0.01)	(0.01)	(0.00)	(0.00)
Treat X Month = 3	-0.01	0.01	-0.00	0.00
	(0.02)	(0.02)	(0.01)	(0.00)
Treat X Month = 4	-0.01	-0.00	0.01	0.00
	(0.02)	(0.02)	(0.01)	(0.00)
Treat X Month = 5	0.02	-0.01	-0.00	0.00
	(0.02)	(0.02)	(0.01)	(0.00)
Treat X Month = 6	-0.01	0.01	-0.00	0.01
	(0.02)	(0.03)	(0.01)	(0.00)
Treat X Month = 7	-0.02	0.01	0.00	0.01
	(0.02)	(0.03)	(0.01)	(0.00)*
Treat X Month = 8	0.00	-0.01	0.01	-0.00
	(0.02)	(0.02)	(0.01)	(0.00)
Treat X Month = 9	0.02	-0.02	0.00	0.00
	(0.02)	(0.02)	(0.01)	(0.00)
Treat X Month = 10	0.04	-0.03	-0.00	0.00
	(0.02)**	(0.02)*	(0.01)	(0.00)
Treat X Month = 11	0.02	-0.02	0.00	0.00
	(0.02)	(0.02)	(0.01)	(0.00)
Treat X Month = 12	0.03	-0.04	0.01	0.00
	(0.02)	(0.02)*	(0.01)	(0.00)
R^2	0.19	0.23	0.32	0.76
N	4,160	4,160	4,160	4,160

Milk production behavior, by gender

Table : Impact of treatment on milk-related behavior, by month and gender of container head

	# of lactating cows		# of lactating cows near concession		# of lactating cows milked		# of liters collected per cow per day		Total # of liters collected per day	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Treat X Month = 2	0.14	-0.29	0.14	-0.24	0.09	-0.31	0.03	0.07	0.22	0.05
	(0.23)	(0.35)	(0.21)	(0.48)	(0.18)	(0.50)	(0.04)	(0.09)	(0.29)	(0.70)
Treat X Month = 3	0.20	0.05	0.10	0.74	0.19	0.60	-0.00	0.06	0.11	1.03
	(0.26)	(0.42)	(0.28)	(0.72)	(0.25)	(0.74)	(0.04)	(0.09)	(0.35)	(0.88)
Treat X Month = 4	0.25	-0.37	0.38	0.55	0.52	0.57	-0.01	0.01	0.36	0.81
	(0.30)	(0.52)	(0.34)	(0.75)	(0.32)	(0.77)	(0.05)	(0.11)	(0.40)	(0.89)
Treat X Month = 5	0.30	-0.35	0.20	1.96	0.27	1.99	-0.03	-0.10	0.06	2.10
	(0.33)	(0.51)	(0.37)	(0.88)**	(0.35)	(0.89)**	(0.05)	(0.14)	(0.42)	(0.98)**
Treat X Month = 6	0.57	0.03	0.08	1.34	0.29	1.31	-0.04	0.02	0.48	2.23
	(0.38)	(0.72)	(0.44)	(0.95)	(0.41)	(0.95)	(0.06)	(0.15)	(0.51)	(1.04)**
Treat X Month = 7	0.37	-0.02	0.73	0.85	0.90	0.80	0.06	-0.03	1.52	1.35
	(0.46)	(0.71)	(0.56)	(0.97)	(0.49)*	(0.98)	(0.10)	(0.16)	(0.79)*	(1.36)
Treat X Month = 8	-0.01	-0.00	-0.21	-0.79	-0.05	-0.67	-0.02	-0.10	-0.12	-1.69
	(0.46)	(0.71)	(0.51)	(0.83)	(0.47)	(0.84)	(0.10)	(0.14)	(0.86)	(1.27)
Treat X Month = 9	-0.15	-0.19	-0.29	-1.04	-0.05	-0.79	-0.01	-0.03	0.21	-0.50
	(0.44)	(0.71)	(0.50)	(0.94)	(0.46)	(0.95)	(0.09)	(0.16)	(0.86)	(1.25)
Treat X Month = 10	-0.07	-0.05	-0.42	-0.77	-0.21	-0.56	0.00	0.15	0.17	0.30
	(0.43)	(0.72)	(0.45)	(0.86)	(0.43)	(0.88)	(0.08)	(0.17)	(0.76)	(1.15)
Treat X Month = 11	-0.09	-0.32	-0.31	-0.65	-0.26	-0.42	0.09	0.18	0.45	0.51
	(0.39)	(0.66)	(0.41)	(0.75)	(0.38)	(0.76)	(0.07)	(0.10)*	(0.56)	(1.14)
Treat X Month = 12	0.18	-0.02	-0.02	-0.42	0.01	-0.56	-0.00	0.30	0.35	0.80
	(0.39)	(0.62)	(0.39)	(0.72)	(0.37)	(0.73)	(0.06)	(0.11)***	(0.45)	(0.91)
R^2	0.56	0.78	0.44	0.53	0.48	0.52	0.34	0.47	0.45	0.57
N	3,498	1,023	3,498	1,023	3,498	1,023	3,042	888	3,488	1,021

Summary of results

- Incentive leads to more regular delivery of milk during the dry season
- Entire impact of incentive in terms of liters delivered is driven by female container heads.
- Regularity of delivery is most likely due to more cows being milked per day during the dry season

Pathways

Pathways

- *Income effect:* Likely, but don't have right data to measure increases in income/consumption
  - Explains seasonality of impact but not heterogeneity with respect to gender of container head.

- *Social capital:* No strong evidence supporting increases in loyalty
  - Side selling not a large problem, already "loyal"
  - Treatment households are not more willing to sell milk to LDB at lower price.

Pathways

- *Targeting effects:* Likely to explain heterogeneity in impact with respect to gender

- Targeting females leads to increases in female decisionmaking with respect to milk production, but mainly in households with female container heads

	Mean of control	All	Male container head	Female container head
=1 if female is primary decisionmaker for:				
Buy a cow	0.10	0.00	-0.01	0.04
		(0.02)	(0.02)	(0.07)
Sell a cow	0.09	0.02	0.00	0.09
		(0.02)	(0.02)	(0.07)
How to spend money from sale of cow	0.12	0.02	0.03	-0.02
		(0.03)	(0.03)	(0.07)
Type of feed to give cow	0.12	0.01	-0.01	0.10
		(0.03)	(0.03)	(0.09)
Vaccinate a cow	0.07	0.03	0.02	0.09
		(0.02)	(0.02)	(0.07)
Artificial insemination	0.07	0.04	0.03	0.09
		(0.02)*	(0.02)	(0.07)
Use of veterinary doctor	0.07	0.03	0.02	0.09
		(0.02)	(0.02)	(0.07)
How much milk to sell	0.71	-0.00	-0.01	-0.01
		(0.04)	(0.05)	(0.12)
Where to sell milk	0.71	0.01	0.01	0.01
		(0.04)	(0.05)	(0.11)
How to spend money from sale of milk	0.69	-0.02	-0.06	0.05
		(0.05)	(0.05)	(0.12)
How much milk to give children	0.78	-0.01	-0.02	0.03
		(0.04)	(0.05)	(0.11)
How much milk to give others	0.77	0.00	-0.02	0.04
		(0.04)	(0.05)	(0.11)
Which cows should go on migration	0.08	0.04	0.02	0.09
		(0.02)*	(0.03)	(0.07)
When cows should go on migration	0.06	0.04	0.03	0.09
		(0.02)*	(0.02)	(0.06)
Which household members accompany cows on migration	0.07	0.03	0.01	0.09
		(0.02)	(0.02)	(0.06)
N		437	323	93

Conclusions

Benefit to cost

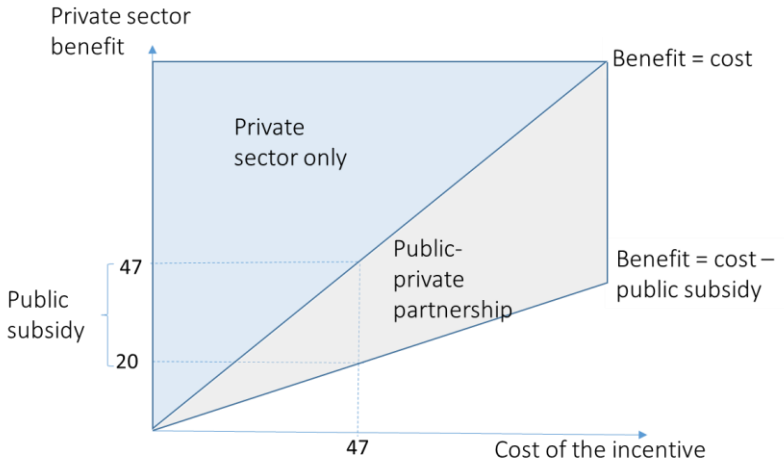
- Benefit over the year:
  - approximately 3.5 extra active weeks (or a **9% increase**)
  - 24 extra days delivered (or an **11 % increase**).
  - No significant impact on total milk delivered to LDB

- Costs
  - Production costs: 58.5 FCFA/sachet
  - Logistic costs: 8 FCFA/sachet
  - On average 812 sachet/container
  - **Total cost over the year: 54,404 FCFA/container or 47 FCFA/liter**

Benefit to cost

- If incentive is better targeted across seasons, production benefits could increase
- Benefits don't take into account health benefits or benefits to women
- Public policy perspective
  - Health benefits to remote population with 0 distributional costs, and only 8.5 FCFA of logistical costs

  →Room for public-private partnership



- Thank you!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