Title: Quality and safety improvements in informal milk markets and implications for food safety policy

Authors: Ma. Lucila A. Lapar[1], Ram Deka[2], Johanna Lindahl[3], and Delia Grace[4]

[1] International Livestock Research Institute, Hanoi, Vietnam; corresponding author, e-mail: l.lapar@cgiar.org

[2] International Livestock Research Institute, Guwahati, Assam, NE India; e-mail: r.deka@cgiar.org

[3] International Livestock Research Institute, Nairobi, Kenya; e-mail: j.lindahl@cgiar.org

[4] International Livestock Research Institute, Nairobi, Kenya; e-mail: d.grace@cgiar.org

Abstract

Milk marketing in Assam, NE India remains predominantly in the informal sector; there is also growing concern among consumers about the purity and quality of milk marketed by informal milk vendors and the possible health risk posed by it. ILRI's study on milk safety (ILRI 2008) indicates that most of the milk samples (including pasteurized and UHT) available in Assam do not meet quality standards from the standpoint of physical quality, adulterants and bacterial load (total bacterial count and coliform count). In 2009, a training and certification program was initiated to improve milk handling among milk traders who are the main conduits of milk being marketed in Assam. The impact of the program on milk value chain actors was assessed through a prospective matched cohort study using a double difference design. Data was collected from surveys of producers, milk vendors, and consumers. Rapid diagnostic tests on milk samples were conducted to assess levels of hazards from presence of pathogens in milk traded in informal milk markets. Estimates of economic benefits show positive effects in terms of increased average profit margins and value added. Sector level benefits as approximated from micro-level estimates of economic indicators show that traditional dairy value chain in Kamrup generates about 0.8 million rupees value added per day; this translates to an annual estimate of economic impact in Kamrup of at least US$ 5.6 million. Given the important economic contribution of traditional dairy value chain, public policy that affects informal milk markets and actors will need to be based on risk and not hazard, and improving capacity for risk assessment and incentives for better risk management will support the continued viability of the traditional dairy sector in Assam.

Keywords: smallholder dairy, informal milk markets, food safety policy

Introduction

Milk marketing in Assam, NE India remains predominantly in the informal sector; formal pasteurized milk and dairy product channels, both cooperative and private, account for at most 3% of total locally produced marketed milk, while traditional market channels, either for fresh liquid milk or importantly, for traditional products such as sweets, account for at least 97% of the market opportunities for farmers (Kumar et al. 2010). This limits alternative market options for smallholder producers located in hard to reach areas with poor access to markets. Developments in the traditional dairy market are critical to lift the economic status of actors in this sector, and a set of interventions that could facilitate improvements could complement the ongoing efforts to develop cooperative organized milk markets. Nevertheless, there is hardly any government or non-government initiative to improve the traditional dairy sector; all initiatives have been directed at the improvement of the organized sector (formed by cooperatives and dairy plants) despite its low level of contribution to total milk supply in the state. There is also growing concern among consumers about the purity and quality of milk marketed by informal milk vendors and the possible health risk posed by it. ILRI's study on milk safety (ILRI 2008) indicates that most of the milk samples (including pasteurized and UHT) available in Assam do not meet quality standards from the standpoint of physical quality, adulterants and bacterial load (total bacterial count and coliform count).

This study aims to assess the economic impact and cost-benefit of the ILRI model for improving the traditional dairy sector, and forms one component of the project on 'Generating evidence to support enhanced traditional dairying in India' funded by the OPEC Fund for International Development (OFID). The project has the broader objective of evaluating the impact of a model for improving the performance of traditional dairy through certification and training in order to generate evidence for scaling-up and scaling-out as well as to provide recommendations that will help continue to improve performance of the traditional dairy in Assam. The following sections will focus on the results of the economic impact assessment.

The research questions that drive the inquiry in this study are framed as follows:

1. How does training and certification of informal dairy chain actors change knowledge, behavior and milk quality/safety outcomes?

2. How does participation in the training and certification scheme translate into livelihood benefits for milk value chain actors and reduced health risks for dairy consumers?

3. How can sustainability be assured? What incentives are necessary to motivate participation in training and certification? How can the system be self-financing and credible?

4. What are the economy-wide impacts of these programs? What are the overall costs and benefits of the initiatives? Who gets the benefits and who pays the costs?

Study sites and sample selection

Study sites

The study was implemented in two districts of Assam: Kamrup and Jorhat (Figure 1). In Kamrup district (the intervention or exposed site), baseline survey was conducted in 2009 and training of milk producers and traders was implemented in 2010-11. In Jorhat district (the control or unexposed site), baseline survey was conducted in 2009 but no training was implemented in 2010-11. Guwahati City, the state capital of Assam and one of the fastest growing cosmopolitan cities in India, is located in Kamrup district. Based on human population census of 2011, Kamrup district has a population of about 1.26 million of which about 0.96 million are in Guwahati city. On the other hand, Jorhat district has about 1.09 million people, of which about 0.14 million live in Jorhat town, the third largest cosmopolitan town in the state. Jorhat is about 303 km away from Guwahati city.

Sample selection

A baseline study conducted through KAP survey and laboratory assessment of milk quality of all the actors involved in traditional milk value chain in 2009 was used for the sampling frame in this study. A comprehensive list of traders and producers was prepared from the names of traders and producers available with ILRI (especially, those who came into contact with ILRI during the baseline

survey or during the implementation of training). From the list, the traders and producers were classified in different sampling groups based on their past history of association with ILRI's dairy initiative. Accordingly, five different sampling groups of traders and producers were identified as stated below:

1. Traders/producers who were interviewed during baseline in 2009 and received training (Yes-Yes) in 2009-2011

2. Traders/producers who were interviewed during baseline in 2009 but did not receive training (Yes-No) in 2009-2011

3. Traders/producers who were not interviewed during baseline in 2009 but received training (No-Yes) in 2009-2011

4. Every third trader from the list of traders who were not considered in above 3 sampling

5. Traders who were not interviewed during baseline in 2009 nor participated in training in 2009-2011 and did not come into contact with other traders who were interviewed/trained. This group was called uncontaminated/ untouched group.

From each sampling group, traders and producers were interviewed using a random sampling method (if number of traders/ producers in a sampling group is more than the required sampling number). A questionnaire-cum-observation check list was prepared and used for conducting the survey. It had questions related to sales and business system, knowledge, attitude and practices, impact of training, credit and services availed, volume of business, cost associated of trading milk business, changes in business over a period of 3 years etc. The field survey was conducted by two enumerators after undergoing necessary training on survey implementation during the period from Feb to June, 2012. Enumerators were closely supervised and monitored by ILRI's local project coordinator. From each interviewed trader and producer, milk sample was collected aseptically using standard protocol and tested in the microbiological laboratory of the Department of Dairy

Development, Govt. of Assam by a Microbiologist recruited under the project. Apart from milk samples, hand wash samples were also collected from producers and traders and tested in the laboratory using standard protocol.

The same exercise was done in Jorhat district (mainly in Jorhat town) where no intervention was initiated during 2009-2011 but a baseline survey was conducted in 2009. This allows comparison of Kamrup district (with intervention) with Jorhat district (without intervention). As Jorhat town is smaller than Guwahati (Kamrup) city, the number of sampling groups and targeted respondents were much fewer in Jorhat. The study was conducted with the following two sampling groups of producers and traders.

1. Producers/ traders who were interviewed in 2009 but did not participate in training in 2009-2010 (Yes-No)

2. Producers/ traders who were not interviewed in 2009 and did not participate in training in 2009-2010 (No-No). This group of traders/ producers was in fact the nearest neighbor of the interviewed traders/ producers during baseline.

Apart from producers and traders, consumers of both Kamrup (Guwahati city) and Jorhat (Jorhat town) were interviewed using a short questionnaire enquiring about the family size and status, food (especially milk) consumption, food expenses, history of food borne diseases, treatment cost, other economic losses because of disease etc. From Guwahati city, randomly selected 60 consumers belonging to 6 wards (10 consumers from each) were interviewed and from Jorhat town 30 consumers belonging to 3 wards (10 consumers) were interviewed. The table below summarizes the distribution of sample respondents in the study.

The Dairy Sector in Assam

Milk marketing in Assam, NE India remains predominantly in the informal sector; formal pasteurized milk and dairy product channels, both cooperative and private, account for at most 3% of total

locally produced marketed milk, while traditional market channels, either for fresh liquid milk or importantly, for traditional products such as sweets, account for at least 97% of the market opportunities for farmers (Figure 2). Traditional market agents are dominant players in Assam's dairy sector. They are the key links between local milk producers and consumers, and focus nearly exclusively on local milk products.

Guwahati city has about 550 milk traders who mainly supply the daily requirements of fresh milk comprising about 75% of total milk marketed in the city per day. Both farming and trading business in and around Guwahati city are dominated by Nepali community people (originally from Nepal, a neighboring South Asian country). There is a small section of Bihari community people (originally from Bihar, a north Indian state of India) and they consider milk production and/or trading as a full time business activity. Because of the relatively bigger size of the city and higher requirement of milk, several types of traders, in terms of volume traded, right from wholesalers to middlemen to retailers, are involved in milk trade business. In case of Jorhat the size of traditional milk market is much lesser because of smaller population size and relatively lesser demand. There are about 40 milk traders in Jorhat town who handle the raw milk. Most of the traders in Jorhat town are from local Assamese community and majority of them are both producer-cum-trader and therefore the supply chain is much shorter in Jorhat.

There is a recurring perception among consumers that milk being traded in informal milk markets in Assam is adulterated at each level, resulting in very poor quality of milk. A previous study by ILRI (2007) did show widespread adulteration of milk by milk traders, with more cases observed among raw milk traders. Water was the most common adulterant, varying from 10-50% of the volume of milk. The most common reason for adulteration was to take advantage of increased milk prices (at the time of the survey in 2006) resulting from demand-supply gap in milk and milk products.

The Action Research Model for Improving Traditional Dairy Sector

In 2009, a training and certification program was initiated to improve milk handling among milk traders who are the main conduits of milk being marketed in Assam. The action research program was implemented in 4 stages (Figure 3): (a) training need assessment and manual development, (b) training implementation, (c) monitoring and certification and (d) impact evaluation. Bringing desired behavioral changes and policy facilitation were made integral part of each stage of our work through some cross cutting interventions.

A Hygienic Milk Monitoring Committee (HMMC) was formed by trained producers/ traders to monitor the degree of adoption of improved practices. A simple monitoring tool was developed to evaluate the adoption of improved practices at individual level by HMMC. The action research initiative engendered a new institution, the Joint Coordination & Monitoring Committee (JCMC). This committee is led by the Directorate of Dairy Development in Assam, and brings together organizations like the Dairy Development, Veterinary Department, public health departments in Assam, Guwahati Municipal Corporation, the Assam Rural Infrastructure & Agricultural Services Society and ILRI. Frequent field monitoring was done using monitoring tools to track qualitative and quantitative parameters. Qualitative parameters helped to have a sense of knowledge gained and utilized by the trainee while the quantitative parameters helped in inducing a sense of competition among the trainees. JCMC issues certificates signed by all JCMC member organizations to successful adopters of the practices.

Results

Economic impacts

Economic impact of food safety and quality in traditional dairy value chain is evaluated using the case of training in milk handling that was introduced in the action research model in a previous project led by ILRI in collaboration with Assamese collaborators. This preliminary impact evaluation is based on descriptive statistical analysis that compares economic indicators between milk traders

and producers who have undergone training with those who have not. Main hypotheses being tested is that training in milk handling will either have precipitated changes in milk handling practices that are then rewarded by consumers with higher prices or more quantity sold. Increased prices or higher volume of sales are hypothesized to have been engendered by the consumer recognition of improved milk quality and safety from better trained milk traders.

Comparison between 'with' and 'without' training

Traders and exposure to training

Economic impacts of training is evaluated by comparing relevant economic indicators of milk trading between sample of traders that have undergone training and sample of traders who have not undergone training. Table 2 shows the price, costs, and margins estimated using data from current survey in Kamrup, the exposed site (i.e., where training was implemented). Comparison between with and without training in exposed site shows that those who have undergone training are generating a positive margin from milk sales (2.04 rupees/liter); however, this margin is less than that among those without training (3.70 rupees/liter), on average. It appears that training may have engendered slightly higher prices on average per unit, but unit costs are also relatively higher among trained traders although this is not statistically significantly different than their non-trained counterparts (see Table 3). In general, the average margin that trained traders obtain is also still relatively higher than the average margin for all traders in the exposed site (i.e., 0.72 rupees/liter in Kamrup), as well as the margin of those in the control site (i.e., negative in Jorhat), on average.

An examination of data from baseline survey suggests, however, that the observed price differential between those with training and without training may be an artifact of market forces. It is shown that prices did increase over time (see Table 4), and across the control and exposed sites (see Table 5), based on data from matched sample (i.e., those respondents who have participated in both baseline and current surveys). In the absence of cost data from baseline survey, it is not possible to compare margins over time and across sites.

It is also interesting to note that over time (between baseline and current surveys for pooled sample of matched respondents), there has been a significant decline in average volume of sales sold by milk traders to various types of buyers, specifically sales to households and institutional users such as hotels and sweet makers. On the other hand, there has been significant increase in volume of sales to individual consumers at sale point outside households and also to other milk vendors. Comparison of baseline and current data by exposure, it is noted that sales to households and institutional users have also declined across both sites; however, marked increases in sales to individual consumers and other milk vendors in the exposed site (Kamrup) is also observed.

Producers and exposure to training

Economic impact of training on producers is evaluated based on similar indicators as the traders (see previous section). However, since cost of production data is not available from producer survey, it is not possible to estimate margins at producer level, i.e., the difference between farm gate price/liter (price at which producers sell) and their cost of milk/liter. Hence, comparison of producer prices between those with training and without training using information from current survey is all that is attempted. As shown in Table 6, prices received by producers who have undergone training is relatively lower than prices received by those who have not undergone training, on average. This figure is also relatively lower than the average farm-gate price for all producers in the exposed site (Kamrup); but relatively higher than average farm-gate price in the control site (Jorhat).

Among producers in exposed site, the volume of milk produced and sold appears not to differ significantly, on average, between those who have attended training and those who have not (see Table 7). Temporal effects that are observed when comparing baseline and current survey data suggest that all producers in both exposed and control sites have not significantly increased level of milk production and sales (Table 8). On the other hand, average farm-gate prices do appear to have increased over time in the exposed site (Table 9), suggesting that market forces could be the main driving force behind the observed price difference between producers who have been trained and those who have not been trained.

Economic benefits from milk production and sales

Estimates of some indicators of economic benefits generated in traditional dairy value chain are shown in Table 10 and comparison is made between control and exposed sites. Milk traders generate average profit margins of 0.62 rupees/liter of milk sold in control site and 1.25 rupees/liter of milk sold in exposed site. Value added estimates from traditional dairy value chain are 6.62 rupees/liter in control site, and 5.64 rupees/liter in exposed site. (Table 11). Relative shares of producer and trader prices in milk retail prices, on average, also suggest that the market for traditional dairy is efficient in sites that were covered by the study.

Sector level benefits may be approximated from micro-level estimates of economic indicators for traditional dairy. Using expert opinion on estimates of number of milk traders in Guwahati and their share in total milk traded, rough projection of economic benefits from traditional dairy value chain in Kamrup, the exposed site is illustrated in Table 10. At about 0.8 million rupees value added generated per day in traditional dairy value chain, annual estimate of economic impact in Kamrup is at least US$ 5.6 million.

Conclusions

With very few traditional milk market agents in Assam having received any type of training on milk handling; poor hygiene and milk adulteration are commonly encountered in the informal milk market. This study has shown that improvements in milk quality and safety in informal dairy markets could be engendered through a training and certification model in milk handling for informal traders and dairy producers. In addition to adoption of increased risk mitigation practices, those who have been exposed to the training also reported benefits that included personal satisfaction, customer satisfaction, sales and profits, acquired knowledge, increased number of customers, and milk quality improvements. Further work on exploring the sustainability of this model and its potential for scaling out will be worthwhile exploring for experimentation and documentation of learning to develop suitable and feasible quality assurance models in informal market settings. Given the important

economic contribution of the traditional dairy value chain in Assam, public policy that affects informal milk markets and actors will need to be based on risk and not hazard, and improving capacity for risk assessment and incentives for better risk management will support its continued viability. Training of milk market agents in proper hygiene, milk quality and best business practices should thus be an essential part of a dairy development plan, to be linked with a branding system that would be easily recognized by the consumers. Furthermore, any dairy development plan to address the needs of the producers, market agents and consumers should fully address the traditional sector, particularly if the aim is to increase the share of demand that is supplied by local production in Assam as opposed to imports from other states and regions in India.

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Table 1. Distribution of survey respondents in Assam.

Survey Respondents	Kamrup			Jorhat			All		
	Baseline	Current	Total	Baseline	Current	Total	Baseline	Current	Total
All respondents									
Producers	214	106	320	42	56	98	256	162	418
Traders	84	190	274	27	34	61	111	224	335
Consumers	-	60	60	-	30	30	-	90	90
Matched respondents (both in Baseline and Current surveys)									
Producers	-	53	53	-	28	28	-	81	81
Traders	-	122	122	-	17	17	-	139	139
Consumers	-	-	-	-	-	-	-	-	-
Unmatched respondents (not interviewed in both Baseline and Current surveys)									
Producers	-	53	53	-	28	28	-	81	81
Traders	-	68	68	-	17	17	-	85	85
Consumers	-	60	60	-	30	30	-	90	90

Source of data: ILRI-GET Dairy Survey, 2012.

Table 2: Comparison of prices, costs, and margins between exposed and non-exposed groups, and

with and without training in the exposed group.

	Exposed (Kamrup)			Control (Jorhat)
	With training	Without training	All Kamrup	
Price/liter	31.01	30.20	31.16	27.80
Cost/liter	28.97	26.51	30.44	27.86
Margin	2.04	3.70	0.72	-0.06

Source of data: ILRI GET Dairy survey, 2012.

Table 3: Comparison of quantity, costs, and prices of milk traded by milk traders between exposed and non-exposed groups, and with and without training in the exposed group.

| | Exposed (Kamrup) | | | | |
| | With training | | Without training | | P value |
	Mean	STD	Mean	STD	
1. Total milk procured per day (liter)	146.79	266.50	86.03	181.19	0.09
2. Total milk sold per day (liter)	151.56	266.43	90.15	186.74	0.09
3. Cost of milk procured per day (RS)	4129.70	8085.92	2236.20	5530.79	0.08
4. Cost of operations per day (RS)	260.47	325.29	153.68	139.81	0.00
5. Total costs/day (3+4) (RS)	4390.17	8375.34	2389.88	5661.26	0.07
Cost/liter milk sold (RS)	28.97	11.50	26.51	13.77	0.56

Source of data: ILRI GET Dairy survey, 2012.

Table 4: Traders - Comparison of sales and prices, baseline and current, pooled sample (Kamrup and

Jorhat)

	Baseline		Current		P value
	Mean	STD	Mean	STD	
1. Milk sales to:					
Consumer household (liter)	73.52	88.13	33.06	29.93	0.00
Consumer sale point (liter)	0.00	0.00	28.16	76.89	0.01
Vendors (liter)	0.00	0.00	9.59	41.68	0.10
Hotel/sweet market (liter)	170.80	238.50	74.08	156.91	0.02
Cottage processor (liter)	0.00	0.00	4.16	28.57	0.31
Other (liter)	1.20	8.49	1.37	3.64	0.90
2. Own household consumption (liter)	9.43	42.87	2.32	1.18	0.25
Quantity of milk traded per day (liter)	254.95	297.72	152.74	253.76	0.07
Total value of milk traded (RS)	5430.99	6313.61	4729.03	8056.61	0.63
Weighted price (RS/litter)	21.72	1.64	29.54	2.52	0.00

Source of data: ILRI GET Dairy survey, 2012.

Table 5: Traders - Comparison of sales and prices, baseline and current, exposed vs. control

	Control (Jorhat)					Exposed (Kamrup)				
	Baseline		Current		P value	Baseline		Current		P value
	Mean	STD	Mean	STD		Mean	STD	Mean	STD	
1. Milk Sales to:										
Consumer household (liter)	53.35	22.72	26.31	15.80	0.26	83.91	84.73	36.33	34.54	0.00
Consumer sale point (liter)	0.00	0.00	0.00	0.00	na	0.00	0.00	41.82	90.99	0.01
Vendors (liter)	0.00	0.00	4.38	13.15	0.18	0.00	0.00	12.12	50.04	0.17
Hotel/sweet market (liter)	95.00	109.91	19.06	29.79	0.01	209.84	276.47	100.76	185.11	0.06
Cottage processor (liter)	0.00	0.00	0.00	0.00		0.00	0.00	6.18	34.80	0.31
Other (liter)	0.00	0.00	0.31	1.25	0.31	1.81	10.44	1.88	4.28	0.98
2. Own household consumption (liter)	3.00	1.06	1.81	0.54	0.00	12.74	52.73	2.56	1.33	0.27
Quantity of milk traded per day	151.35	185.26	51.88	26.19	0.04	308.31	331.55	201.65	297.86	0.17
Total value of milk traded per day (RS)	3456.71	4522.38	1408.88	749.99	0.08	6448.05	6904.69	6338.80	9429.52	0.96
Weighted price (RS/liter)	22.21	1.60	26.61	1.83	0.00	21.46	1.62	30.95	1.26	0.00

Source of data: ILRI GET Dairy survey, 2012.

Table 6: Producers - Comparison of training effects on milk marketing indicators, exposed and control.

	Exposed (Kamrup)			Control (Jorhat)
	With training	Without training	All Kamrup	
Price/liter	27.18	29.20	28.88	23.20
Cost/liter	na	na	na	na
Margin	na	na	na	na

Source of data: ILRI GET Dairy survey, 2012.

Table 7: Producers - Comparison of training effects on milk production and sales indicators, exposed and control.

	Exposed (Kamrup)				
	With training		Without training		P value
	Mean	STD	Mean	STD	
Total milk produced/day (liter)	81.81	52.54	71.73	52.65	0.28
Total value of milk produced/day (RS)	2332.15	1532.44	2078.22	1576.92	0.39
Weighted price of milk produced/day (RS/liter)	28.28	2.01	28.60	1.29	0.09

Source of data: ILRI GET Dairy survey, 2012.

Table 8: Producers - Comparison of sales and prices, baseline and current, pooled sample

	Baseline		Current		P Value
	Mean	STD	Mean	STD	
1. Milk sales to:					
Vendor	52.00	83.84	52.00	41.75	0.98
Cooperative	5.10	19.14	5.40	16.55	0.94
Consumer household	6.00	19.86	3.00	10.82	0.20
Other	0.00	2.14	0.00	0.00	0.32
2. Farmer own household consumption	3.10	1.61	2.90	2.28	0.54
Total qty of milk produced/day (liter)	66.40	84.15	63.40	45.55	0.77
Total value of milk produced/day (RS)	1333.28	1770.53	1776.95	1361.83	0.07
Weighted price (RS/liter)	20.08	4.69	28.03	6.39	0.00

Source of data: ILRI GET Dairy survey, 2012.

Table 9: Producers - Comparison of sales and prices, baseline and current, exposed vs. control

| | Control (Jorhat) | | | | | | Exposed (Kamrup) | | | | | |
| | Baseline | | Current | | P value | | Baseline | | Current | | P value |
	Mean	STD	Mean	STD			Mean	STD	Mean	STD	
1. Milk Sales to:											
Vendor	50.13	146.21	29.41	29.97	0.50		52.51	42.64	60.76	42.54	0.28
Cooperative	2.89	7.36	2.56	9.54	0.89		6.03	22.02	6.46	18.49	0.90
Individual consumer	8.85	20.70	0.00	0.00	0.04		5.04	19.59	4.12	12.56	0.76
Other	0.83	4.08	0.00	0.00	0.32		0.00	0.00	0.00	0.00	na
2. Farmer own household consumption	2.46	1.47	1.88	2.92	0.38		3.29	1.61	3.26	1.87	0.91
Total quantity of milk produced/day	65.17	143.62	33.85	29.23	0.30		66.88	46.56	74.61	45.77	0.35
Total value of milk produced/day (RS)	1448.81	3060.21	786.50	768.96	0.30		1289.26	931.15	2154.27	1352.29	0.00
Weighted price (RS/liter)	21.31	8.67	19.98	9.61	0.62		18.99	1.07	28.64	1.21	0.00

Source of data: ILRI GET Dairy survey, 2012.

Table 10: Estimates of economic benefits from milk production and sales, exposed vs. control

|	Control (Jorhat)			Exposed (Kamrup)		
	Producer	Trader	Consumer	Producer	Trader	Consumer
Number of observations	50	34	27	112	192	45
1. Buying price	-	27.18	30	-	29.91	33
2. Selling price	24	27.8	-	28.61	31.16	-
3. Profit margin (2-1)		0.62			1.25	
4. Value added	3.8	2.82		2.55	3.09	
6. % share of retail price	80	93		87	94	

Source of data: ILRI GET Dairy survey, 2012.

Table 11: Estimates of sector level economic benefits from traditional dairy value chain

| Estimate of milk sold traders in Guwahati	
Total no. of traders (expert opinion)	550
Ave. qty /day (from survey data)	202
Total liters/day (accounting for 75% of total milk traded)	111,100
Projected to 100% (liters)	148,133
Value added (rupees)/day	835,472
Annual VA (USD at 54 USD = 1 INR)	5,647,172

Source of data: ILRI GET Dairy survey, 2012.

Figure 1. Map of Assam showing the project districts.
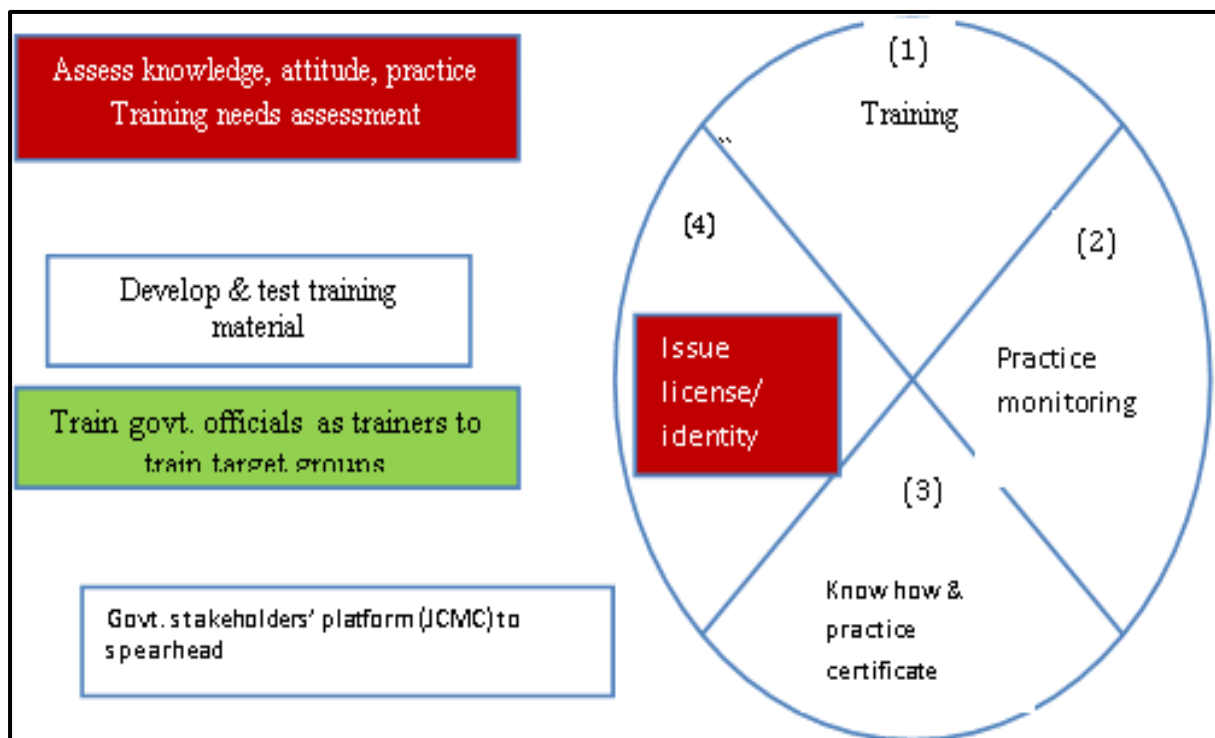

Fig: Map of Assam
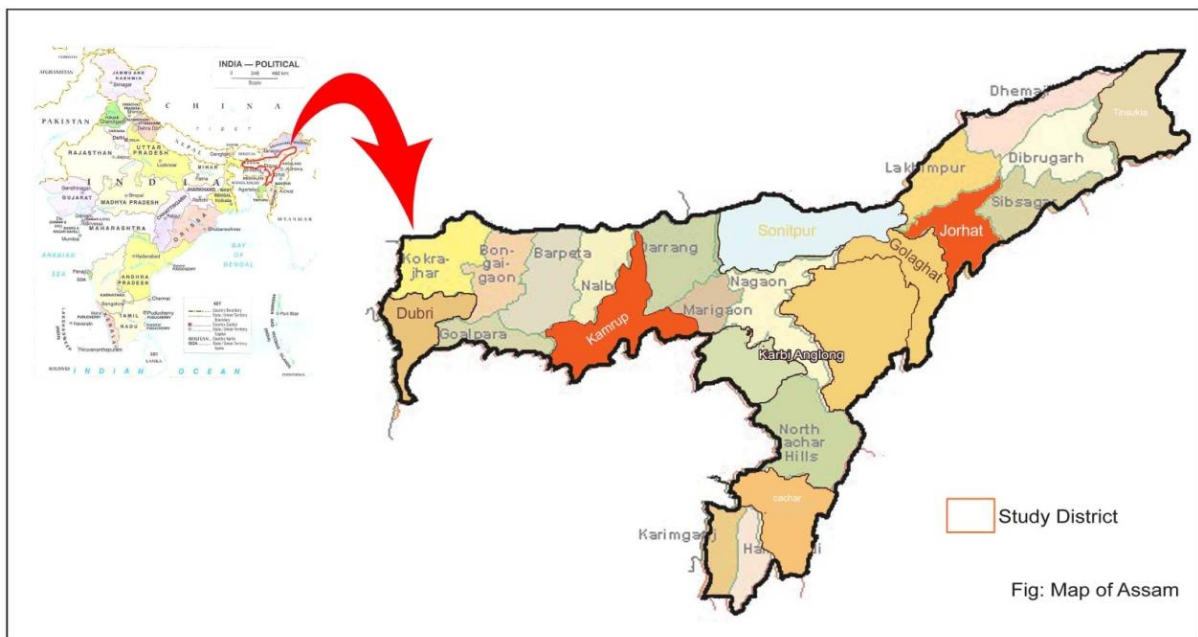
Source: ILRI, 2013.

Figure 2. Milk and dairy product flow in Assam
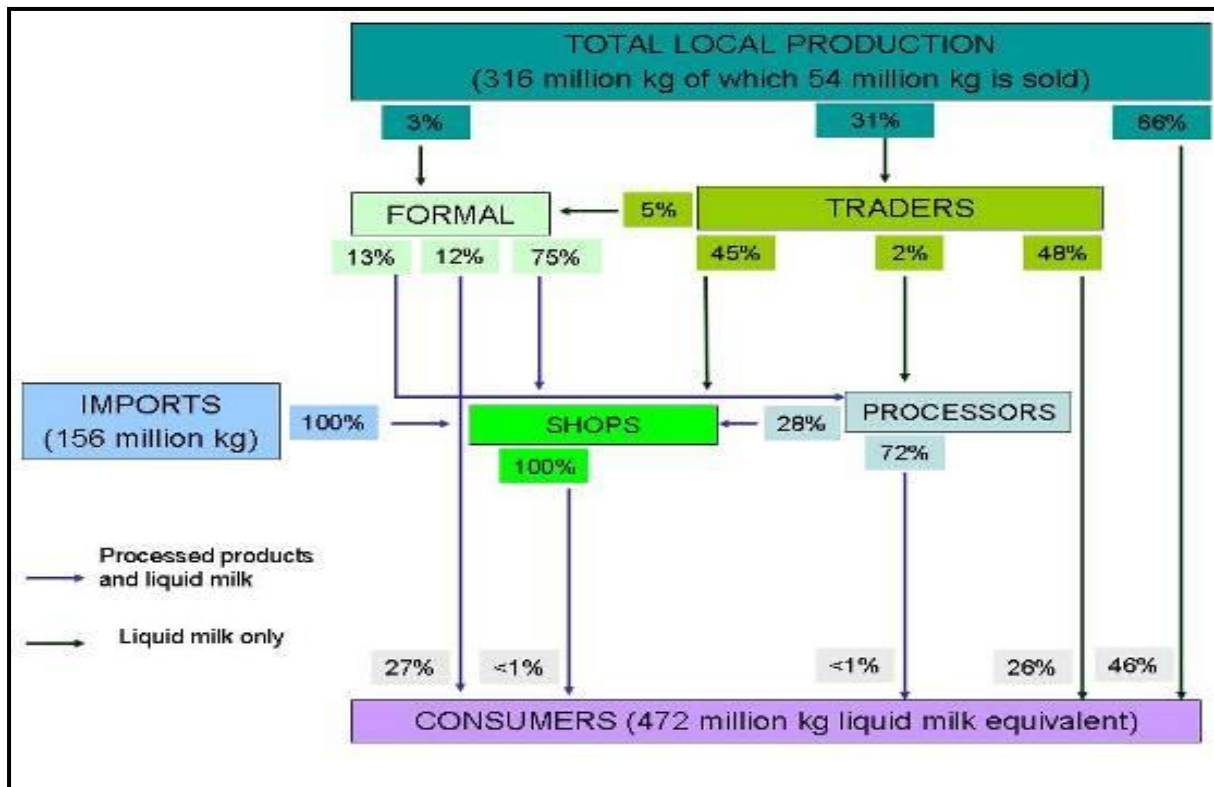
Source: ILRI-WB survey, 2007.

Figure 3. The action research model for training and certification of informal milk traders.

Source: ILRI, 2013.