Smallholder Dairy Farmer Access to Alternative Milk Market Channels in Gujarat.

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Introduction

Although India is already the world's largest milk producer, dairy production continues to grow with growing demand. There has been a significant increase in milk production (about 4.5% per annum) broadly from early 1970s to the late 1990s. Growing demand is likely to drive production to from some 90 million tons currently, to 180 million tons in 2011-12 (Sharma et al, 2003). However, some 80% of milk marketed still passes through traditional channels handling raw milk and traditionally processed products (Dairy India, 1997), in spite of the high profile given to cooperative dairy development through the Operation Flood programs. Liberalization of the dairy sub-sector since 1991 has allowed formal, private processors to compete increasingly with both the traditional market, and the cooperative processed milk market. Further, the growing middle class is likely to increase the demand for the more formally processed products, which the traditional market generally cannot deliver. This will additionally lead to growth in share of the formal, organized market, including both the cooperative sector and the private sector, which currently split that market about evenly.

Will an increased role of private formal dairies provide pressure for a change in the structure of production, due to their incentives to favor larger milk producers, who may be able to supply higher quantities and quality of milk at lower collection costs? This study addresses the links between smallholder dairy farmers and alternative traditional, private and cooperative sector milk markets and service providers, using data collected in the traditional Indian dairy heartland, the State of Gujarat.

Dairy production and milk marketing systems in Gujarat

Gujarat is one of India's largest milk producing States (6.6% of national production), and exhibits levels of per capita milk availability higher than the national average (Sharma et al, 2003). It is also recognized as the source of the Operation Flood program, which from 1971 to 1997 supported dairy cooperative development throughout India using resources generated from sale of milk powder food aid. It is thus recognized as the heartland of India's

dairy cooperative movement, following the "Anand Model" of primary village cooperative societies, linked to district federations and state cooperative unions. Dairy cooperative thus play a larger role in Gujarat than in any other Indian State. However, the traditional market which dominates Indian dairy generally, still plays an important role. At the farm level, the traditional market is represented by private milk traders or vendors (*dhudwallas*) who buy milk directly from producers and either deliver it directly to urban consumer households, or to institutional buyers such as restaurants, or to wholesalers and other retailers. They often operate by motorcycle. Dairy cooperatives and private formal processors, in contrast, collect milk at established village collection points, and unlike the private traders, milk price to farmers is generally scaled according to quality measured by milk fat and solids. In the analysis which follows, private and cooperative processors were combined into one category primarily because private processors accounted for only 3.5% of milk production in the area, but also because as indicated, they share operate similar collection and payment practices.

As in many parts of India, milk production in Gujarat is largely by smallholder producers with a few buffalo or cattle, in systems closely integrated into crop production through use of crop-residues such as rice straw. The data were gathered during a survey conducted in nine districts of Gujarat in 2001. A total of 797 households were randomly selected from 60 villages. The data gathered covered a wise range of household and farm information, and mean values by main milk outlet choice are shown in Table 1. Households were also identified that had been part of the dairy development efforts of BAIF (Bharatiya Agro Industries Foundation), a large Indian NGO with substantial credibility in serving smallholder farmers through extension, training and service provision. Each surveyed household was geo-referenced using a GPS unit, and a detailed road network of the area was digitized using available maps. Distances from each farm to the nearest road and to the nearest large urban centre were computed using geographical information systems (GIS) software. Other GIS-derived indicators were calculated for each household, and combined with the household data using the method described in Staal et al 2002, including mean population densities and an agroclimatic indicator, PPE (ratio of annual precipitation over

overall potential evapo-transpiration). Integration of these GIS-derived variables allows better measurement of locational differences than do locational dummy variables, which in turn improves the parameter estimates for non-locational variables which may display some spatial autocorrelation due to similarities in some household characteristics within some areas.

Household were also identified as "scheduled tribe", or non-tribal. Compared to non-tribal households, tribals are generally poorer, with less land and less education, and often work as wage laborers in non-tribal holdings. As shown in Table 2, tribal households also tend to be further from market, live in lower potential agroclimates (lower PPE), and exhibit lower milk productivity.

At the household level, a total of 717 households were surveyed, 626 of whom kept cattle and/or buffalo. However, only 383 households reported selling milk to one or more of the three channels namely: Individual customers, private traders and dairy cooperatives/processors. The keeping of cattle and buffalo is not necessarily a market-oriented activity, given the strong household demand for consumption of milk and milk products, which are a staple protein in a largely non meat-eating society, and also due to the need to keep cattle for traction. As shown in Figure 1, it is estimated that 72% of production is marketed while 28% is retained for domestic consumption. The dairy cooperative societies take the largest proportion of the marketed milk (41.5% of production) while very little milk, 3.5%, goes to private processors. Private milk traders form a significant component of milk buyers, accounting for 13% of all milk that is produced by the household. Another 14% of the produced milk is sold directly to consumers.

Model

A two-step analysis is conducted to explain milk market participation and conditioned on that, milk outlet choice, and their determinants. These steps include a simple probit to

assess market participation, followed by the application of McFadden's choice model, using a conditional (fixed-effects) logit.

Milk market participation is examined by applying a simple probit analysis to the decision to sell milk (1=yes, 0=no), applied only to households keeping cattle and/or buffalos. Mills Ratios for that decision are then computed and introduced as additional explanatory variables into the next step, which applies McFadden's choice model (Green 2003), using a conditional (fixed-effects) logistic regression, which has the ability to examine unordered choice decisions.

Given a set of unordered choices 1, 2, …, T, y_{it} indicates the choice actually chosen by individual i, so that $y_{it} = 1$ if individual i chose choice t, and $y_{it'} = 0$ for $t' \neq t$. The model estimated is thus:

$$y_{it} = [x_{it}, w_{it} * c_{it}]$$

Where x_{it} are attributes of the choices T for the ith individual and w_{it} are attributes of the individual i, which are interacted with c_{it}, choice from among T for individual i. In the absence of attributes of the choices (and so the absence of the independent variables x_{it}), then the model is exactly the same as the multinomial logit.

Decision in participate in milk markets

The results of the probit analysis of the decision, for milk producing households, whether or not to sell milk, are shown in Table 3 (y=1 if the household sells milk, y=0 otherwise).

Variables positively associated with the choice to sell milk were: households who are non-tribal and who were located in a BAIF-supported village, better agroclimate (higher PPE), numbers of buffalo (measured in TLU), and availability of milk collection centres locally. No variables were negatively associated with the milk sale decision.

Farmers in villages assisted by BAIF, were more likely to participate in the sale of milk than the non-BAIF farmers. This suggest that sustained, competent development

intervention can have a positive impact on the level of market orientation. In contrast, the variable measuring farmer access to public extension services was not associated with either choice.

Non-tribal farmers, meaning generally those belonging to favoured castes, are 68% more likely to sell milk. This may mean the social barriers exist to non-tribal household participation in milk markets. However, the result may also relate to adherence to traditional roles, in the case that milk marketing does not fall with traditional roles of some groups. This result should be explored further, given the potential implications for barriers to income generation among less favoured groups.

Spatial factors like rainfall/agroclimate (PPE) and population density are also important predisposing factors, and both have a positive impact on participation in milk sales. However, access to irrigated land is not significant. Together, the PPE and irrigation results suggest that dairy production in Gujarat is primarily dependent on rain-fed production systems and fodder, and does not significantly depend on irrigated fodder, at least not directly within the producing households. Markets for fodder, particularly rice straw, may allow irrigation to indirectly support milk production. Regardless, access to irrigated land by the household is not shown to be a significant barrier to milk marketing.

The numbers of buffalo owned by the household (measured in TLU) have a significant and positive association with milk marketing, while number of cattle is not significant. This clearly reflects the fact that buffalo, most of which are high grade dairy breeds, are regarded as specialist milk animals, while cattle serve multiple purposes including traction. This is also reflected in larger trends in India of falling numbers of cattle with increased mechanization of agriculture, and higher proportions of buffalo (Sharma et al, 2003).

Travel time to the largest urban centre is not significantly associated with milk market participation. This may partially be because there is little variation in this variable (mean travel time is 0.37 hours and standard deviation is 0.16). Instead, availability of processors collection centers locally are more important indicators of market access, demonstrated by

their strong positive association with milk sale. This points to the significance of institutional development in the integration of farmers with the market.

Some of the variables not significantly associated with milk sale are also revealing, including sex of the household head, human capital, household composition, and land size, besides those mentioned above. It should be noted that 96% of the households were male headed, so that there was very little spread on this variable. Household composition in terms of adults and dependents had not relationship with the decision to sell, neither did age or education levels of the household head, all suggesting that the milk marketing enterprise has be human resource or capital constraints.

An important result, from the perspective of opportunities for resource poor households, is the complete lack of any association between land holding size and the decision to sell milk. This further supports the evidence provided by growing landless dairy production, that in the context of efficient fodder markets, including the local barter of labor for fodder between land-rich and land-poor households, access to land is not an impediment for participation in market-oriented milk enterprise.

Choice of milk market outlet

The conditional (fixed effects) logit analysis evaluated farmers' choice of milk marketing channel among those available in this area: direct sales to individual customers, sales to generally informal private traders/venders and sales to cooperatives/private dairy processors. The latter two milk channels are included explicitly, thus the comparator variable is direct sales to customers.

The results indicate that farmers are less likely to select the private traders market channel when there is the option of selling to individual customers. Similarly, though not statistically significant, households may be less likely to select the coop/private processors channel than the individual customer channel. Although search, bargaining and delivery costs for sales to individual customers may be high, the preference for selling to them may be

indicative of higher prices (Table 1), or other factors, although separately price is not a significant variable.

The higher the number of adults in the household, the more likely that private trader channel and coop/private processor channel will be selected than individual customers. Given that sales to individual customers may require higher transaction costs, the rational behind this result may reflect scale of production rather than labor availability.

Households assisted by BAIF are also more likely to select the private traders and dairy coop/processor channels instead of the individual customer channel, again pointing to the positive impact of sustained development interventions on market-orientation.

Another important result is that non-tribal farmers are less likely to select the cooperative/private processor channel, and are significantly more likely to sell to individual customers. This suggests that tribal, socially disadvantaged households may value cooperative services and assured markets, while more advantaged non-tribal households may be more willing to face the higher risks and returns of individual sales. Similarly, households with more land are less likely to sell through either the private traders channel or the coop/private processor channel, which may also reflect better ability to handle risk. As expected, households that kept higher number of livestock are more likely to select both the private traders and dairy coop/processor channel as opposed to selecting the individual customer channel. The interpretation here is that farmers producing more milk seek out channels that than more easily accept larger, and possibly more variable, quantities of milk.

The Mills Ratio result, with respect to dairy coops/processors, suggests that there are unobserved characteristics that influence both the decision to sell milk (first regression) and the decision to sell to that market channel (second regression). This may point to other, uncaptured services from dairy cooperatives, such as farmer sense of empowerment, that are reflected in tribal group preferences for that channel..

Travel time to urban centers is associated with more sales to private traders, who may be able to provide milk collection services beyond the reach of processor collection routes.

Interestingly, the results indicate that households are less likely to select channels that paid cash, or that took milk on informal credit. Conversely, channels that offered monthly payment or provided formalized credit terms (written contract) were more likely to be selected (the base comparator in the analysis).

Conclusions

In spite of the importance of cooperative milk markets in Gujarat, the results indicate continued preference for and strong role of direct sales from producers to buyers, in spite of potential transactions costs associated with that market. The first barrier to market access is thus a saturation of local markets, in which case buyers turn to other institutions such as traders and processors to overcome distances to areas of net demand. More well endowed and favored producers (non-tribals), are more likely to continue to market directly, possibly due to a greater ability or willingness to accept risk.

Less favored groups show less likelihood to sell milk, and when they do are more likely to sell to dairy cooperatives, which although tend to offer lower prices, may offer other benefits. The Mill Ratio results suggest that there are other attributes of dairy cooperatives that are not captured by the variables used here. Additional work should be undertaken to understand whether lower sales by tribals are due to barriers or to tradition, and also to understand what elements of cooperatives may enhance their participation.

Although only marginally significant, private traders appear to be the second preferred choice after direct sales overall. They are the preferred choice when producers scale up volume of production, and also seem best able to service producers in areas furthest removed from urban markets. These informal market players would seem to continue to play a vital role even in Gujarat, the backyard of the cooperative movement. There is no evidence in the results that informal markets will diminish under increased scale of production, or that processed milk markets are differentially more attractive than informal traders to large scale producers. Policies that would allow informal players improve their performance, including quality control, are likely to serve the interests of both small producers and consumers.

Finally, there is little evidence in the results of significant barriers to resource-poor households market-oriented milk production, besides the issues related to tribal groups discussed above. Of particular note, given the large landless populations in India, is the lack of evidence that land scarcity is an impediment to engaging in the milk enterprise. The results generally point positively for the continued development of smallholders as the dominant players in the Indian dairy industry.

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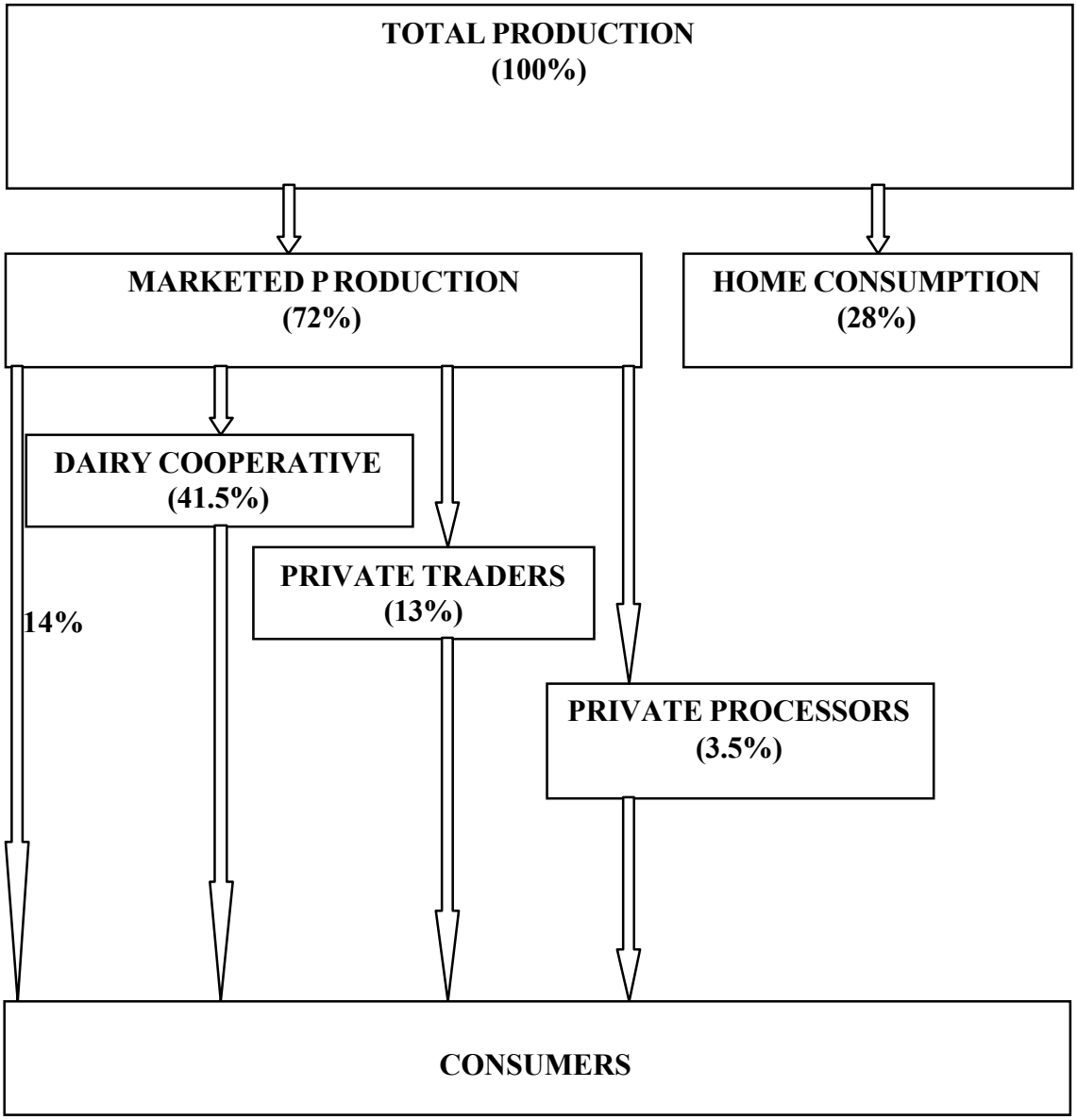

Figure 1. Milk flows in Gujarat, base on farm-household surveys.

Table 1. Characteristics of surveyed households in Gujarat, stratified by main milk outlet.

	Individual customers N=109(mean)	Private traders N=54 (mean)	Dairy coop and processors N= 221 (mean)
Age of the hh head (years)	49.25	45.50	49.63
Sex of the hh head (1=male)	0.98	0.93	0.95
Farming experience of the household head (years)	27.40	18.19	26.17
Education level for the hh head (years)	5.74	7.61	7.62
Number of adults (>20years) in the hh	5.17	4.52	4.11
Dependent ratio (persons<14 years &>65 years)	0.30	0.26	0.26
BAIF assisted (1=yes)	0.64	0.85	0.67
Farmer type (1=non-tribal, 0=tribal)	0.92	0.63	0.59
Land size (acres)	3.99	3.05	1.71
Livestock extension service availability (1=yes)	0.93	0.96	0.90
Precipitation/evapo-transpiration ratio	0.46	0.56	0.60
Availability of private milk collection centre (1=yes)	0.25	0.93	0.08
Availability of coop milk collection centre (1=yes)	0.17	0.24	0.84
Population density (village level)	299.80	247.66	436.94
House type (1=*pucca* (good), 0=*kachha* (poor))	0.55	0.44	0.47
Practice irrigation (1=yes)	0.41	0.20	0.58
Travel time to nearest large urban centre	0.37	0.46	0.35
Distance (km) to nearest large urban centre on national highway	0.50	10.16	1.49
Distance (km) to nearest large urban centre on state highway	7.83	5.71	14.34
Distance (km) to nearest large urban centre on metalled road	14.63	16.24	7.71
Total cattle Tropical Livestock Units (TLU)	2.10	2.77	2.67
Total buffalo Tropical Livestock Units (TLU)	0.95	1.53	1.21
Cash sale (single sale/verbal contract)	0.68	0.26	0.10
Credit sale (single/sale/verbal contract)	0.24	0.70	0.69
Credit sale (written contract/monthly payment)	0.08	0.04	0.21
Stall feeding only/mainly (1=yes, 0=no, mainly grazing)	0.76	0.57	0.76
Annual milk production per cow/female buffalo (liters)	2008.85	2246.16	2078.98
Milk price per liter (Rs)	14.0	12.0	11.3

Table 2. Selected characteristics of surveyed households stratified into tribal/non-tribal households.

	Tribal households N= 261(mean)	Non-tribal household N=456 (mean)
Education level for the hh head	5.25	7.24
Land size (acres)	1.12	3.10
Precipitation/evapo-transpiration	0.66	0.47
Availability of private milk collection centre (1=yes, 0=no)	0.15	0.22
Availability of coop milk collection centre (1=yes, 0=no)	0.52	0.41
Population density (village level)	420.99	328.06
House type (1=pucca, 0=kachha)	0.25	0.54
Travel time to nearest large urban centre	0.40	0.37
Total cattle TLU	2.77	2.41
Total buffalo TLU	0.75	1.19
Cash sale (single sale/verbal contract)	0.05	0.39
Credit sale (single/sale/verbal contract)	0.86	0.44
Annual milk production per cow/female buffalo	1533.31	2008.37

Table 3. Results of probit analysis of the factors determining the decision to sell milk.

	Coefficient	p-value
Age of the of the hh head	-0.0011	0.8230
Years education of hh head	0.0121	0.3730
HH dependent ratio (<14yrs & >65 year)	-0.2098	0.4630
Number of adults in the household (>20yrs)	-0.0424	0.1090
BAIF (1 if BAIF assisted, 0 otherwise)	0.6029***	0.0000
Non-tribal farmer	0.6709***	0.0000
Land size (acres)	0.0041	0.7520
PPE	1.4164***	0.0020
Population density	0.0002***	0.0020
Travel time to nearest urban centre	0.4349	0.3260
Cattle TLU	0.0394	0.1860
Buffalo TLU	0.2615***	0.0000
Coop collection centre (1=available)	0.6162***	0.0000
Private trader milk collection centre (1=available)	0.5244***	0.0020
Extension services available (1=yes)	0.2481	0.2130
Irrigation (1 if hh practices irrigation, 0 otherwise)	-0.1008	0.4070
Constant	-2.1544	0.0000
Number of observations	626	
Log pseudo-likelihood	-336.509	
Overall percent correct predictions	74%	

*Significant at 0.10 probability level, **Significant at 0.05 level, ***Significant at 0.01 level

Table 4. Results of conditional logistic regression on choice of milk market outlet (direct customer sales, private traders, cooperative/private processors)

Variable	Coefficient	P>|z|
Private traders	**-18.272*** **	**0.002**
Dairy coop/processors	-5.712	0.154
age*private traders	-0.007	0.797
age*dairy coop/processors	0.019	0.377
education*private traders	0.035	0.668
education*dairy coop/processors	0.085	0.171
dependent ratio*private traders	0.872	0.630
dependent ratio*dairy coop/processors	1.256	0.350
Adults*private traders	**0.357***	**0.062**
Adults*dairy coop/processors	0.140	0.368
BAIF(1,0)*private traders	**3.412*** **	**0.001**
BAIF(1,0)*dairy coop/processors	**1.219***	**0.099**
Non-tribal farmer*private traders	-1.239	0.327
Non-tribal farmer*dairy coop/processors	**-2.315** **	**0.012**
land size*private traders	**-0.223***	**0.081**
land size*dairy coop/processors	**-0.307*** **	**0.001**
extension village*private traders	**10.534***	**0.056**
extension village*dairy coop/processors	2.038	0.310
ppe*private traders	3.071	0.326
ppe*dairy coop/processors	3.375	0.144
Travel time*private traders	**4.810***	**0.073**
Travel time*dairy coop/processors	0.806	0.687
Total TLU*private traders	**0.851*** **	**0.000**
Total TLU dairy coop/processors	**0.658*** **	**0.000**
Mills ratio*private traders	-0.354	0.843
Mills ratio*dairy coop/processors	**-2.401***	**0.076**
Population density*private traders	0.000	0.119
Population density*dairy coop/processors	0.000	0.407
Milk price offered in channel	-0.074	0.252
Mode of payment (1=cash,0 otherwise)	-2.791***	0.001
Mode of payment (1=informal credit, 0 otherwise)	-2.472***	0.003
Whether milk is tested (1=yes, 0=No)	-0.035	0.932
Number of observations	558	
Log likelihood	-131.520	
Overall percent correct predictions	74%	
Percent correct predictions: channel is selected	80%	
Percent correct predictions: channel is not selected	72%	

*Significant at 0.10 probability level, **Significant at 0.05 level, ***Significant at 0.01 level