INDIGENOUS MARKETS FOR DAIRY PRODUCTS IN AFRICA: TRADE-OFFS BETWEEN FOOD SAFETY AND ECONOMICS

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Introduction and Background

In the absence of information on which to base policies in emerging dairy markets in developing countries, public officials have tended to rely on models for dairy product marketing and health assurance derived from industrialised countries where large-scale production systems, cold-chain pathways and milk pasteurization and packaging are key features. These models have invariably failed in many African market situations where small-scale dairy systems without cold-chain market pathways currently dominate and will continue to do so in the foreseeable future. The main reason is simple: many resource-poor consumers simply refuse to pay the extra costs that pasteurized, packaged milk incurs, and prefer to buy raw milk and boil it themselves. But the role of traditional preferences should not be discounted: in Kenya, high-income consumers express the same preference for raw milk as do those with lower income, and often end up buying more of it. As a result, informal or raw milk and traditional product markets generally dominate in developing countries, comprising over 90% of the market in Tanzania and Uganda, for example, and some 83% of the market of the world's largest milk producer, India. In Kenya, the informal market has some 85% market share.

The issue, of course, is public health concerns linked to raw milk. Current dairy market policies throughout the developing world have largely been adopted from the West, and reflect international standards of food safety, etc. However, as the percentages above show, they are being systematically ignored, and as a result, most consumers buy milk and dairy products that are completely outside any regulatory environment. It is possible that to better address the public health issues, policies may need to take a more pro-active approach to informal milk trading, and which better address the realities of consumer willingness to pay for higher standards. The policy question which needs to be answered is thus: is it preferable to maintain strict milk standards which result in higher costs and thereby free most marketed milk into informal channels, or is the public better off by standards that are relaxed but capture more of the informal market? If standards were relaxed to allow raw milk marketing, yet maintain some regulations regarding handling and if some incentives were given to milk traders to comply (e.g., training and certification), then a much larger proportion of the milk market may fall under regulatory control, improving the average standards of milk in the market.

An important step to addressing this issue is to collect quantitative and qualitative information about milk-borne health risks under different production and marketing situations. This paper describes specific dairy marketing studies in Kenya, Ghana and Tanzania aimed at assessing public health risks from informally marketed milk and examines the economic trade-offs that policy makers should consider. Preliminary results from Kenya are presented and recommendations on cost-effective and practical interventions to improve milk safety made.

Studies of Indigenous Dairy Markets in Kenya, Ghana and Tanzania

Kenya, Ghana and Tanzania were selected by the International Livestock Research Institute (ILRI) for milk market studies on which alternative policies can be assessed. Informal milk market agents targeted in the studies to quantify milk-borne health risks and assess economic trade-offs included farmer dairy co-operatives, small traders using bicycles and public or private transport and small retail outlets, such as dairy kiosks and shops. Sites in each country were chosen to represent contrasting levels of market access and types of dairy production systems. Data were collected through participatory research with stakeholders and questionnaire methods. Between 1999 and 2001 respondents were randomly selected within strata that differentiated production system (extensive and intensive) and human population density (urban and rural). Data on milk handling practises by consumers and market agents; dairy product consumption and preferences were collected along each

milk market channel. Raw milk samples were collected at retail points for laboratory assessments. At the same time economic data including revenues, costs, capital equipment, labour and taxes were collected, and market points were geo-referenced.

Milk-borne health hazards were assessed using various tests to quantify occurrence of brucellosis (MRT and ELISA), *E. Coli* 0157:H7 (culture), adulteration (specific gravity), butterfat (Gerber method), antibiotic and antibacterial residues (Charm AIM test kit), bacterial counts (standard plate counts). The influence of handling practices was collected by questionnaire and the data analysed to estimate health risks to consumers from the hazards. In addition, risks of zoonotic tuberculosis were investigated through speciation of *Mycobacteriaceae* isolated from patients suspected to be suffering from tuberculosis. The principals of Hazard Analysis Critical Control Points (HACCP) process were considered and applied for each major hazard. Economic and GIS analyses focused on market structure, conduct and performance including variation in risk due to seasonality and access to capital; effects of price and non-price factors of government policies; market margins; and spatial factors influencing marketing behaviour and performance. Regression, principal component and clustering procedures involving milk quality and profit margin parameters were used to identify homogenous groups of market agents, pathways and trade-offs in quality and profit. Preliminary results from Kenya are presented.

Preliminary results from Kenya

Consumption patterns

Most consumers expressed a preference for raw over pasteurised milk, mainly due to the relative lower cost of the former (the cost of raw milk was half that of pasteurised milk in many areas). Consumption is mainly of liquid milk. Raw fresh milk was purchased by 29% of households (hh) in Nairobi (avg = 5.5 litres/hh/month) in comparison to 93% of households in both Nakuru urban (avg = 22.5 litres/hh/month) and rural (avg = 24.3 litres/hh/month). The total liquid milk equivalent of pasteurised milk and processed dairy products consumed in Nairobi, Nakuru urban and Nakuru rural were 15.6, 3.8 and 0.2 litres/hh/month, respectively. Pasteurised milk was purchased in Nairobi, Nakuru urban and Nakuru rural by 78%, 34% and 5% of sample households, respectively. Both raw and pasteurised milk were purchased in larger quantities as income class increased. All households in urban areas and 96% in Nakuru rural reported boiling milk prior to consumption, mainly as an ingredient in other foods, mostly tea. The key findings here were that raw milk is bought by wealthy as well as poor households, and that significant pastuerized milk markets are limited to major urban areas, where the informal market has difficulty meeting all demand.

Health hazards in milk

Preliminary results showed that overall, 4.7% and 10.4% of samples taken from consumer hh and market agents, respectively, had specific gravity below 1.026kg/litre and therefore suspected of adulteration by added water. The overall mean for total solids (TS) in milk was 12.3%, not significantly different from the 12.7% given by O'Conner (1995) as the average TS for bovine milk. These rates indicated that previous reports of widespread adulteration of milk by small traders are exaggerated. The overall average total bacterial plate counts (TPC)/ml in milk from farmer groups were high at 39.8×10^6 (lowest for milk from farmer groups using short market chain, highest for mobile traders, milk–bars and shops/kiosks using long market chains. Similarly, the overall average coliform bacteria plate counts (CPC)/ml was lowest in milk from farmer groups (16×10^3 cfu/ml) and highest among mobile traders, milk–bars and shops/kiosks (50×10^3 cfu/ml). Raw milk samples from consumer hh and retail outlets also reflected the same picture where samples from Nakuru rural (short market chain) had markedly lower bacterial counts than milk collected from consumers in urban areas (long market chain). Classification of milk samples with unacceptably high counts according to national standards and proportion of households boiling milk before consumption is presented in Table 1.

Table 1. Milk samples with unacceptably high bacterial counts according to Kenya Bureau of Standards and proportion of households boiling milk

District	Samples with total counts exceeding standard[1]		Samples with coliform counts exceeding standard[2]		Proportion of hhs boiling milk before consumption
	n	%	n	%	%
Dry season					
Nairobi	41	84	22	48	100
Nakuru urban	47	82	22	39	100
Nakuru rural	36	35	11	11	96
Wet season					
Nairobi	44	83	36	69	
Nakuru urban	34	61	29	52	
Nakuru rural	31	27	17	15	

Overall prevalence of brucellosis antigens in consumer-level samples as determined by both ELISA and MRT were 4.9% and 3.9%, respectively. At the informal market level, ELISA and MRT classified 2.4% and 3.4%, respectively, as positive. Informally traded bulked raw milk from dairy co-operatives and milk bars had the highest proportion of positive brucellosis samples. Nearly all these samples were from Narok District where extensively grazed pastoralist zebu herds predominate. Of 264 milk samples tested for faecal coliforms, 22% and 1% contained *E. coli* and *E. coli* 0157:H7, respectively.

Anti-microbial residues exceeding EU maximum residue limits were detected in 9.4% and 5.7% of consumer- and market-level samples, respectively. The proportion of consumer-level samples from rural areas with antibiotic residues was three times those from urban areas. Among informal market level samples, the proportion testing positive for residues decreased with increasing levels of bulking with milk bars and small mobile traders having a much higher proportion of samples with anti-microbials compared to samples from dairy co-operatives. Given the finding that all milk consumed in urban households was boiled before consumption, antibiotic and antibacterial residues can therefore be considered the major health risk since boiling does not eliminate the residues.

Milk handling practices by market agents

Methods of milk handling were markedly different between types and scales of business. The use of plastic containers used was recorded because most are not food-grade quality, and were found to be associated with higher coliform bacterial counts than metal containers. Smaller market agents used more plastic containers (up to 89% for mobile agents) than larger scale market agents such as dairy cooperatives that used plastic containers in only 10% of cases, the rest being mainly aluminium metal churns. Smaller agents reported that they used cheap plastic containers, because their equipment was often confiscated by health officials. On average, 28% of milk from all traders was not treated for preservation in any way, 47% was refrigerated/chilled and 19% was boiled. Notably, hardly any chemical preservatives were recorded as being used by small-scale market agents to lengthen shelf-life. Only 2% of traders indicated that they used hydrogen peroxide, though 3% said they use other unspecified preservation methods. Efforts are needed to reverse this practice by introducing the recommended lacto-peroxidase system (LPS) for milk preservation (see FAO Home Page) in circumstances where cooling by refrigeration is not. Overall, only 12% of milk handlers had received any form of training in milk handling and quality control but this had a wide range from only 4% of mobile traders to 43% of dairy cooperative staff. Small traders had been in business for a short period of only 2.5 yrs (SD=2.9), many times less than farmer groups (mean=24yrs). This may indicate a high turnover in the milk market business, or an expanding market with several recent entrants. These factors need to be considered in any milk hygiene improvement efforts.

[1] 2 million c.f.u/ml

[2] >50,000 c.f.u/ml

Homogenous groups of market agents

Cluster analysis combined with principal component analysis was conducted on variables for quality, scale, margins, etc. The clusters of market agents identified are mainly separated on the basis of scale of business, milk quality and profit margins (Table 2). Small traders were found to be statistically grouped together irrespective of licensing, and milk quality is not a major problem of small traders compared to other groups. A critical control point was identified among a few medium scale market agents who enjoyed the highest profits and were distinguished by the highest mean total bacterial counts and adulteration. The low milk quality and high margins by these medium scale traders is an indicator of some trade-off between quality and margin. Given that large-scale traders supplied through short market chains were excluded from this cluster, this implies that the trade-off only applies to bulked milk travelling through long market chains. Currently, milk traders in Kenya must have fixed premises before they can qualify for trade licenses. However, the fact that smaller, mobile, unlicensed traders show no significant difference in milk quality from licenced fixed vendors suggests that there is no justification for this requirement.

Table 2. Associations among principal components and clusters: Summary of means of new variables and major clusters with significant frequencies

	New variable				
Cluster frequency	Large-scale/ Experience	Low quality	High margin	Relative scale of business	Milk sold per day (litres)
214	**-0.31**	-0.07	0.13	Small	99
81	-0.08	0.09	**-0.70**	Small	109
24	0.15	**0.41**	**0.88**	Medium	842
27	**2.47**	**-0.39**	0.14	Large	4447

Conclusions

The key findings in Kenya include:

- consumers generally prefer whole raw milk, even those who can afford pasteurized milk
- more than half of samples exceed bacterial count and coliform count standards, but nearly all consumers boil milk before consumption, eliminating any bacterial threat to health
- anti-microbial residues were found in many samples, and since they are not destroyed by pasteurisation, they may pose the major long-term public health threat in milk
- small mobile vendors use poor quality containers, mainly due to policies that exclude them from applying for licensing
- regardless, the quality of milk they deliver does not differ significantly from those with fixed premises and licenses

Findings from Ghana and Tanzania, still being completed, indicate similar results. The Kenyan policy to attempt to implement strict international milk quality standards is clearly not working, and further, attempts to police small mobile traders may actually reduce milk quality, by forcing them to use cheap containers due to frequent confiscation. A fundamental factor in determining trade-offs between milk safety and economics in traditional and emerging dairy markets is how to ensure that consumers are being supplied by milk that is "safe" by the standards considered appropriate by them. Public contribution here should be through education to allow informed choices. This would allow consumers to make informed choices to allow the battle between formal and informal milk markets to be fought on the basis of quality and price and not on perceived health risks which are in any case significantly reduced or eliminated by the common practice of boiling milk before consumption. A policy of training and certification of small traders, allowing them to operate legally, is likely to result in both higher milk quality and better service to consumer preferences.

Reference

FAO Home Page. The Lactoperoxidase System for Milk Preservation.
http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGA/AGAP/lps/dairy/lactoper.htm.