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A Framework for Traceability and Transparency in the Dairy Supply Chain Networks

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Abstract

Food processing industries are assuming greater importance and processed food is now not a matter of choice but it is a necessity. As a result there is greater awareness of safety concerns, emerging risks and challenges in the context of food products. Consumers want guarantees for food characteristics, thus, calling for transparency and effective response in case of any food related health problem. This paper presents a framework for transparency, traceability and information flow for management of dairy supply chain networks. This paper follows a case study approach and presents findings from three types of dairy supply chains as prevalent in India. The paper analyses complexity of dairy products as well as processes in terms of intrinsic and extrinsic factors and their effects on the underlying dairy supply chain networks (DSCN). Governance mechanisms dovetailing various stages of the DSCN are presented in terms of their gaps and adequacy. Key components of the presented frameworks are harmonization of national standards with codex standards, hygiene control, strengthening quality control systems, enhancing information flow across stages, animal health care, disease free zones and formation of cooperatives of small dairy processors (CSDP) in line with the present dairy cooperative society (DCS). CSDP aims at collective action and public-private partnerships by the unorganized sector units to face the competition from large organized processors of dairy products in terms of quality, transparency, traceability and information flow. Transparency of a DSCN is the extent to which all its stakeholders have a shared understanding of and access to the product related information without loss, noise, delay and distortion. Given the perishable nature of dairy products, an effective traceability system is an important tool not only to manage food quality and safety risks, but also to promote the development of effective dairy supply chain management. This paper contributes to the nascent literature on transparency and traceability issues of dairy supply chain networks. Findings would be useful for policy makers in framing standards and effective regulations. Analysis of complexity would be useful for dairy industry managers.

Keywords: Dairy Supply Chain Networks, Public Policy, Public Private Partnership, Sustainability, Traceability, Transparency.

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1. Introduction

In today's time producing safe food is now not a matter of choice, it is a necessity. As a result of liberalized trade policies advocated in WTO agreements, globalization of food trade and technological advancements there is greater awareness of safety concerns, emerging risks and challenges in the area of food safety. Today, due to increased awareness, consumers demand safe, healthy and quality food and dairy products. Consumers want guarantees for food characteristics, thus, calling for transparency and effective response in case of any food related health problem. Transparency in food supply chain (FSC) could be essentially demonstrated by application of food quality and safety standards and supply chain governance mechanisms, i.e. organizational arrangements between supply chain actors for information flow and exchange. Traceability is an important issue in FSC management in case of high perishable food products which are subject to rapid deterioration such as dairy and meat products. It is very important that the main actors responsible for governance and management of food quality and safety, the governments and the food industry should have an effective traceability system to trace and monitor food borne risks.

2. Literature Review

Transparency of a supply chain is the extent to which all its stakeholders have a shared understanding of and access to the product related information that they request without loss, noise, delay and distortion (Hofstadel, 2005; Deimel et al., 2008). Researchers (Trienekens et al., 2012) have characterized transparency in FSC according to five main components or actors, namely, government as well as consumers, food companies, standards (quality as well as safety), governance (arrangements) and information systems (ICT). The governance mechanisms are set of arrangements and agreements between supply chain actors that form organizational infrastructure for information exchange, and are therefore, an important enabling factor for transparency in supply chains (Trienekens et al., 2012). Governance mechanisms may be formal, such as contracts between partners in the supply chain or informal based on trust, commitment and reputation. The governance mechanisms provide the necessary information of product and processes. Predefined production standards, specified in quality and safety standards are important elements of transparency network. Information flow in the context of transparency depends upon integrity of product, processes, and resources, which must comply with predefined specifications. Product integrity implies that the product achieve desired characteristics when production processes and use of resources comply with specifications.

Tracking is the ability to follow the downstream path of a product along the supply chain (Dabbene et al., 2014) and traceability refers to access of product related records in the upstream stages of supply chain (Bechini et al., 2008). Recently (Aung and Chang, 2014) defines traceability in terms of what, how, where, why and when aspects of underlying product along a supply chain. An effective food traceability system is important tool not only to manage food quality and safety risks, but also to promote the development of effective FSC management (Manzini and Accorsi, 2013). Researchers have also defined four attributes of food products from the perspective of the end consumers namely, sensory attributes, health attributes, convenience attributes and process attributes.

Milk being a natural product has in build variability. Quality and composition of milk is highly depended on various external factors. The dairy supply chain like other food supply chain is a directed network of business processes with precedence relationships. The dairy and food supply chain possesses special characteristics of products and processes, whose data recording and information flow is essential for all the stakeholders to ensure transparency of the dairy products (Trienekens et al., 2012).

In India the unorganized sector processes about 22 per cent of the total 35 per cent of milk processed. The unorganized processors, comprising of small dairies and halwaiis, mainly deal with production of the traditional Indian dairy products and sweets (IAI, 2011; IBEF, 2012). The unorganized dairy processors, lack investments, equipment and technology necessary for producing high quality dairy products meeting international safety, packaging and transparency standards (Gupta, 2007; IAI, 2011). These products normally have short life, packed in normal conditions and are sold across the counters (Dabbene et al., 2014).

Accessing developed country food markets entail meeting stringent food safety requirements. Food retailers impose protocols relating to pesticides residues, field and pack house operations, and traceability. In the emerging food systems dominated by domestic urban and export markets, small-holders are at a disadvantage mainly due to their scale. The problem of coordinating with many small farmers is exacerbated by their geographical dispersion, low educational levels and poor access to capital and information (Humphery, 2005). The small-holders in the FSC face problems in meeting the standards, as well as in delivering a regular supply to buyers, due to a number of interrelated factors. Small-holders usually have a short history of presence in the market and lack branding or reputation. To enable small-holders to remain competitive in such a system, new institutional arrangements are required. In this regard collective actions and public private partnerships (PPP) can play a key role in creating farm to fork linkages that can satisfy market demands for food safety, while retaining the small holders in the supply chain (Narrod et al., 2009).

3. Methodology

This paper follows a case study approach and presents findings from various types of dairy supply chains in India. The data concerning different types of dairy supply chains in and around Gwalior region of Madhya Pradesh State of India has been collected for the purpose of study. Madhya Pradesh and specially the Gwalior region have been selected as it is emerging as one of the key milk producing, processing and marketing hub in India. The configuration of dairy supply chains is almost similar throughout India and the variables in this regard find a great amount of similarity. Therefore, the dairy supply chains in and Gwalior region could be considered as true representative of Indian dairy supply chains. The results are based on focus group interviews with the domain experts of the Indian dairy supply chains. The focus group comprised of academicians, bureaucrats and people associated with dairy supply chain, namely, dairy farmers, milk collectors, processors, distributors as well as retailers and the consumers.

4. Discussion and Conclusion

Figure 1 depicts framework for analysis of transparency, traceability and information flow adapted to dairy supply chain. This framework is based on Trienekens et al. (2012) transparency framework.

Dairy supply chain comprises of number of stages or business processes comprising of production and delivery, which are interlinked sequentially and or parallel with precedence relationships for production of number of dairy products. Thus, quality and safety of dairy products depends upon the entire supply chain as the product quality at every stage depends upon product and processes quality at preceding or intermediary stages. The final acceptance of the product is by the consumers, which depends on combination of three factors of quality, price and safety. In the present study the characteristics of the dairy supply chain are grouped as intrinsic and extrinsic characteristics for the product and attributes of processes. This classification is in line with Trienekens et al. (2012) for the food products. Table 1 depicts the special characteristics for dairy supply chain.

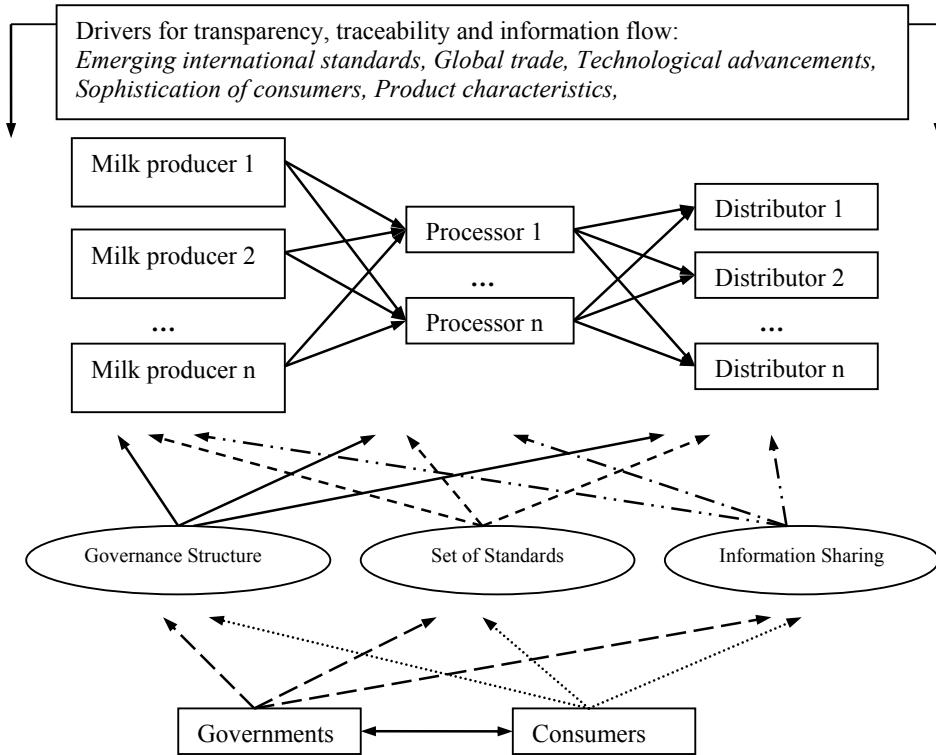


Figure 1: Framework for analysis of transparency, traceability and information flow adapted to dairy supply chain based on [12] transparency framework.

Table 1: Dairy product and process attributes.

Types of special characteristics	Description
Product intrinsic attributes	<ol style="list-style-type: none"> 1. Perishability and rapid deterioration in quality of milk and milk products with time and temperature. 2. Variability in milk and milk products due to <ul style="list-style-type: none"> - variation in fat and SNF content of cow and buffalo milk - variation due to difference in cattle feed, fodder, genetic composition, breed etc. 3. Seasonality <ul style="list-style-type: none"> - lack of milk production in lean season due to lack of green fodder - lack of milk production due to lack of drinking water for the cattle in lean season - use of skimmed powder for production of milk and milk products in lean season - high production of milk and milk products in flush season
Product extrinsic attributes	<ol style="list-style-type: none"> 1. Source and history of milk and other inputs such as fodder, vaccination, type of cattle or buffalo, storage, handling and transportation conditions etc. 2. Processing technology and resources used in production process of dairy products
Process attributes	<ol style="list-style-type: none"> 1. Mixing of raw milk collected from different sources before processing makes the traceability difficult. 2. Complex production scheduling due to sequential continuous and discrete production

The different actors of transparency of dairy supply chain have their own perspectives regarding attributes of dairy products and processes, which may impact various processes and their alignment in the dairy supply chain. In the study the intrinsic and extrinsic attributes of dairy products have been matched with their demands and developments. This classification is in line with earlier researcher classification for the food products. Table 2 depicts these attributes for dairy products.

Table 2: Dairy product attributes and demands from the perspective of consumers and governments

	Demands from consumers and government	Developments
Intrinsic attributes		
Sensory attributes	Taste, odour, colour and freshness	<ul style="list-style-type: none"> - Various types of flavours and tastes are formulated to give sensory appeal to milk products.
Health attributes	<ul style="list-style-type: none"> - Infant and baby foods. - Less fat content milk products – such as toned milk and skimmed milk powders. - Milk based health drinks and foods. 	<ul style="list-style-type: none"> - Implementation of food standards and strict compliance and monitoring. - Hygienic and safe packaging with proper labelling - Milk and milk products are regarded as rich source of protein for infants, growing children, aged and vegetarian population. - Implementation of food standards and strict compliance and monitoring. - Increase in sales of ready to use milk products - Factory production of traditional Indian dairy products
Convenience attributes	<ul style="list-style-type: none"> - Ready to consume milk based products such as yogurt, flavoured milk, cheese balls and slices etc. - Traditional Indian dairy products and sweets such as <i>shrikhand, lassi, chanch, kulfi, rasogolla, gulabjamun etc.</i> 	<ul style="list-style-type: none"> - Green production.
Extrinsic attributes		
Process technology	<ul style="list-style-type: none"> - Energy conservation and use of energy saving technology in chilling, storage, transportation and processing of milk. - Use of permitted pesticides and additives in cattle feed production. - Use of permitted levels of additives in processing of dairy products. - Animal welfare and care. - Input materials (fertilizers, pesticides, etc.) - Disease prevention in milch animals - Biotechnology. 	<ul style="list-style-type: none"> - Implementations of food standards and scientific based permitted levels of pesticides and additives in milk and milk products. - Legislations on animal welfare. - Cattle vaccination programmes and cattle disease free zones
Impact on environment, people and society	<ul style="list-style-type: none"> - Environment, Global warming, Damage to ozone layer by increasing methane levels from cattle. Deforestation, Soil erosion due to cattle grazing. - Packaging material. - Labour and human rights, Working conditions and safety. - Entrepreneurships and training, Labour rates and working conditions. - Dairy cooperative legislations. - Community - Social and economic dimensions of dairy farming. 	<ul style="list-style-type: none"> - Sustainable dairy supply chains. - Reverse logistics for collection and recycling of packaging materials used in tetra packs, poly packs, glasses and aluminium foils.
Supply and demand	<ul style="list-style-type: none"> - Mixed farming system. - Culture preferences for milk and milk products. - Dairy cooperatives. - Reduction in non-tariff trade barriers and government subsidies for free world trade of dairy products. - Fair trade practices, Obscure contracts. 	<ul style="list-style-type: none"> - Human resource development - Corporate social responsibility (CSR) - Dairy cooperative reforms - Post WTO regime and free global trade of food products. - Legislations against unethical trade practices. - Increasing consumer demand for fair trade products. - CSR of multinational companies.

Quality, safety, transparency, traceability and information flow are the main challenges faced by the Indian dairy supply chain. These challenges are more pronounced in unorganized segment of the dairy sector. As the manufacturing of the traditional Indian dairy products is dominated by the unorganized sector, it is imperative to increase the quality and safety standards of these products. Indian dairy cooperatives have created a big infrastructure mechanism for procurement, processing and marketing of milk and milk products in the major milk

sheds in the country. The professional management of dairy cooperatives has emerged as a main challenge which has resulted in stagnation of the cooperatives and hindering their expansion. The organized sector private processing firms have also restricted themselves in processing of high value western dairy products and due to their lack of scale have not invested in milk procurement infrastructure.

In the present study two frameworks have been proposed to enhance transparency, traceability and information flow in Indian dairy supply chains. The first framework is to enhance quality, safety, transparency, traceability and information flow in the Indian dairy supply chains to meet domestic and global demands of dairy products. The framework is depicted in Figure 2. This framework is based on enhancing effective implementation of new food safety standards (FSS) 2011 and comprehensive development of quality and infrastructural factors. A similar kind of framework is also given by Trienekens et al. (2012) for management of transparency in FSC.

The proposed framework is to facilitate India to compete with other countries in global and domestic market post free and liberalized world trade of food and dairy products. The main elements of the proposed framework for enhancing quality and safety of the Indian dairy products are strict and proper implementation of the new FSS (2011), harmonization of national food standard with codex standard, strengthening quality control systems, hygiene control and promotion of clean milk production, enhancing transparency and traceability of dairy products produced by organized and unorganized sector, enhancing information flow in the Indian dairy supply chain and animal health care and disease free zones.

Another framework is proposed for enhancing quality, safety, transparency, traceability and information flow of traditional dairy products and sweets produced by unorganized sector, small dairies and halwaiis. This framework is depicted in Figure 3. It is based on compliance of national and international standards by the unorganized sector dairy units through collective action and public-private partnerships. A similar framework is practiced by the Kenya's beans smallholders and the Indian Mahagrapes- farmer cooperatives for export of beans and grapes respectively (Narrod et al., 2012).

In the proposed framework collective action is through formation of cooperatives of small dairy processors (CSDP) on the lines of existing dairy cooperative societies (DCS) by the unorganized small dairy units and halwaiis. The CSDP have to set up necessary milk procurement infrastructure and testing facilities for procurement of milk through their own milk collection centers from the small dairy farmers and rural households. In order to focus on milk production the CSDP have to provide necessary assistance to small rural dairy farmers through cattle extension services. The CSDP have to partner with the government through PPP model for development of infrastructure facilities such as roads, electricity, sanitation and clean water to facilitate channelizing and procurement of milk from the rural areas for necessary processing and marketing. Credit and other financial assistances also have to be provided by the CSDP to the small dairy farmers for purchase and maintenance management of cattle.

In order to enhance the information transparency, infrastructure system is required to be created in the dairy supply chain for continuous flow of information and data exchange and sharing with all the partners. The CSDP is required to create real time monitoring systems based on ICT by ensuring same information standards throughout the cooperative chain. Installation of GPS on transportation vans should be used for monitoring movement and handling of raw milk to ensure effective quality control and traceability of raw milk. Packaging, labelling and bar-coding of the dairy products should be done as per international food standards.

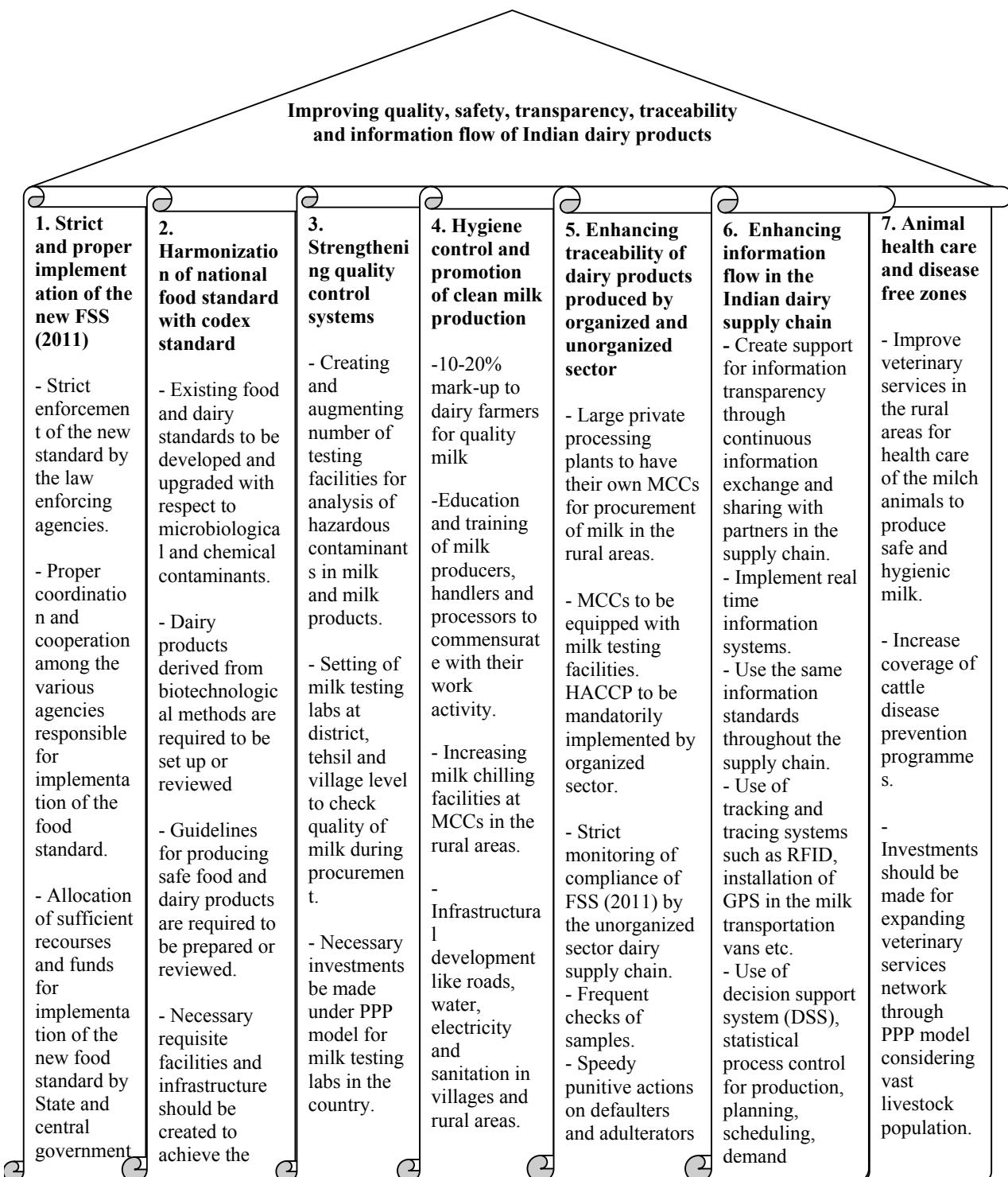


Figure 2: Framework for enhancing quality, safety, transparency and traceability of the Indian dairy products

To ensure compliance of quality and safety standards and to meet transparency and traceability requirements of urban domestic and global markets the CSDP is required to provide quality assurance, training, information and R &D support to its members. The CSDP is to formulate standards and procedures for manufacture of traditional dairy products in accordance with existing national and international food standards. The CSDP has to set in place mechanism for checking quality and safety standards, residue levels, and chemical and microbiological levels in the dairy products meant for domestic and export markets. The CSDP is to ensure that export oriented dairy products comply with packaging, labelling, bar-coding, information of raw milk quality and source, cattle vaccination, feed etc. requirements in accordance with the transparency and traceability requirements of international food standards. The CSDP is also to provide training R&D and financial support to the member dairy units and halwaiis. The R&D and new product development is the key for continuous product improvement to cater for domestic and global consumer market preferences and tastes.

The marketing and distribution of traditional dairy products produced by the member dairy units for domestic and export market are to be handled by the CSDP. There should be refrigerated vans for collection and transportation of these products from dairy units to the transit warehouses for distribution. CSDP is to have professionals including those from other countries for marketing and advertising of the Indian traditional dairy products in global market.

Transparency, traceability and information flow are the main factors required for improving quality of milk and milk products in India. Governance mechanisms, information systems and food standards are the necessary means to achieve transparency and traceability in food supply chains. In spite of the existing food standards and regulations there have been occasions when the Indian dairy products have been found lacking to meet desired quality and safety standards. Therefore, there is a need to continuously evolve and upgrade existing food safety standards which are to be made more scientific and to harmonize them with codex standards. At the same time necessary mechanisms are to be in place for effective implementation of these standards along with penalties and punishments for the defaulters. However, to achieve the requirements of codex standard there is need for capacity and infrastructure expansion in the Indian dairy sector in a phased manner. There has to be a network of milk testing labs in the rural areas supported by advanced testing labs for testing of dairy products of the processing units.

The first framework proposed in the present study is to enhance quality, safety, transparency and traceability in Indian dairy supply chains. This framework is designed so that India can compete with other countries in global and domestic market post free and liberalized world trade of food and dairy products. This is a comprehensive framework which takes into account the entire Indian dairy sector including both organized and unorganized and their potentials and weaknesses in producing and marketing traditional and western dairy products.

The second framework proposed in the present study is to enhance transparency and traceability in unorganized sector, small dairies and halwaiis through information flow and compliance to the food standard and governance mechanisms. This framework is based on collective action and public-private partnerships by the unorganized sector dairy units. The framework aims at collective action through formation of cooperatives of small dairy processors (CSDP) on similar lines of existing dairy cooperative societies (DCS) by the unorganized sector, small dairy units and halwaiis to enhance quality, transparency and traceability of their dairy products to face competitions from large organized dairy processors.

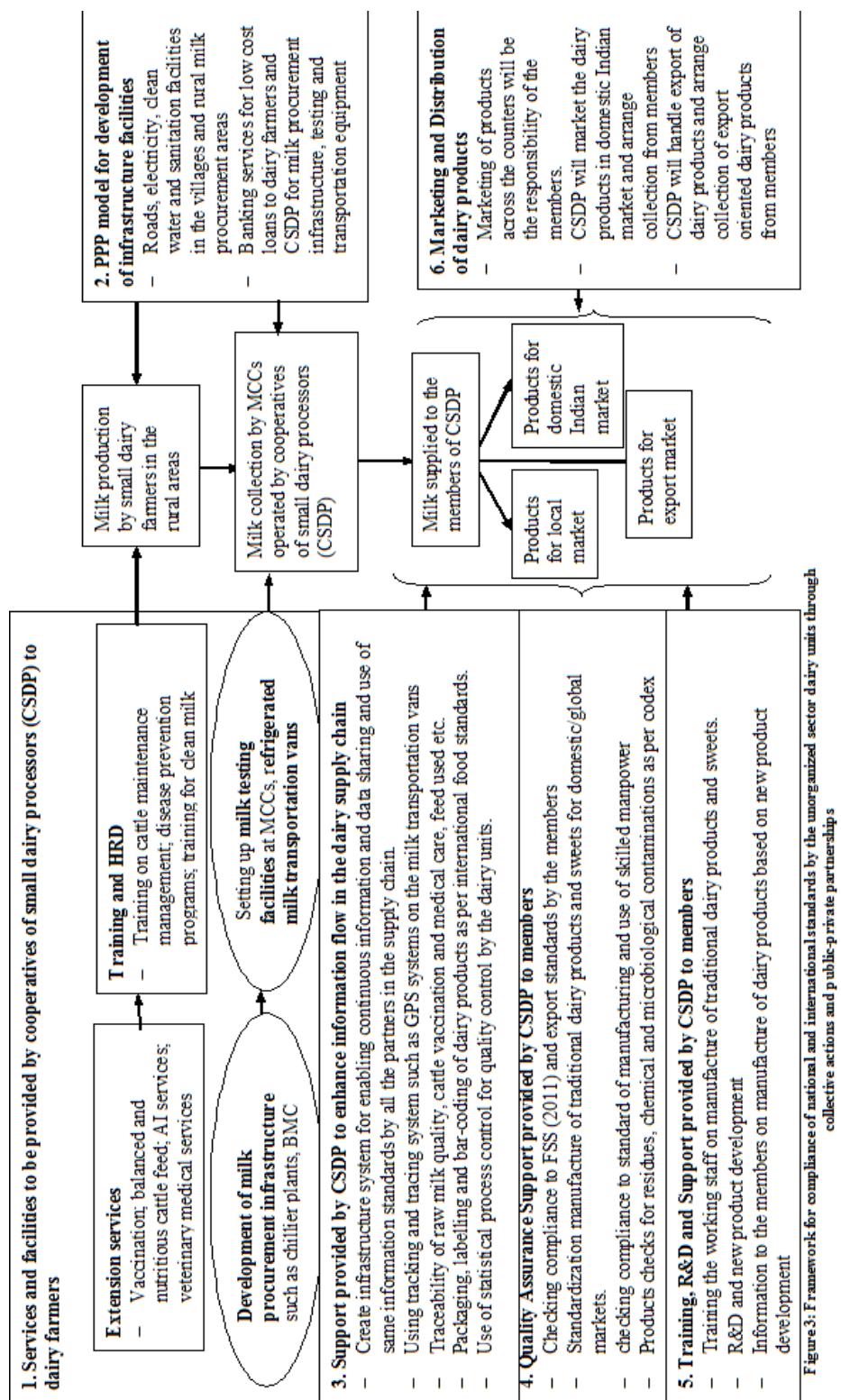


Figure 3: Framework for compliance of national and international standards by the organized sector dairy units through collective actions and public-private partnerships

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