Organized Symposium: Issues in the development of dairy value chains in developing countries

Session rationale: Value chain analysis (VCA) has gained popularity as an approach in development economics. VCA can not only provide answers to questions such as whether a supply chain is creating value and how that value is distributed amongst participants, but also recognise that different segments of the chain are interrelated. Furthermore, VCA can, in many instances, determine the factors constraining the development of one or more parts of the chain.

The information gained through value chain analyses can guide policy interventions leading to the reallocation of resources and support programmes for the benefit of the most vulnerable groups within a chain. Therefore, VCA is a valuable tool for investigating the role that value chains play in achieving specific development policy objectives, such as poverty alleviation, sustained growth, inequality reduction and/or to improvements in food security and food quality.

The purpose of this session is to discuss the findings from six value chain analyses applied to smallholder dairy sectors in developing countries (two in Africa, three in Asia and one in Latin America). The focus on dairy value chains is due to the multiple benefits that, when operating properly, they can provide to small-scale farmers. Smallholders are important as they produce the great majority of milk in developing countries. Benefits may include, for instance, a more reliable and substantial source of income that is generated every day; and also improved food security both directly through increased economic access to food, and indirectly because milk is a balanced, nutritious food.

The case studies to be presented in the session address several common issues facing the dairy sector in developing countries including: low and volatile prices paid to farmers; market access; concerns about milk quality due to lack of appropriate infrastructure to deal with perishability, poor management practices and adulteration; logistic bottlenecks; opportunities to increase domestic supply; and relationships between different agents along the chain (e.g., farmers and processors or processors and supermarkets). However, each case addresses topics relevant to other countries and possibly other sectors. For example, solutions to combat the effects of climate change while also improving the livelihoods of smallholders (e.g., use of carbon credits in the dairy sector).

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Description of the symposium format

1. Questions to be examined

Issues to be explored in the session include:

- Prices paid to farmers.
- Efficiency of milk production and milk stations' operation.
- Technology adoption.
- Alternative dairy production systems (e.g. dual production).
- Milk quality issues and their impact on the supply chain.
- Impact of dairy production on household and community nutrition.
- Organisation of the dairy supply chain's stakeholders.

- Retailing of dairy products.
- Consumers' demand and preferences for dairy products.
- Climate change and carbon-neutral milk production.

The key questions addressed in discussion will be:

a. Which benefits are generated by enhanced co-ordination amongst value chain participants?
b. What are the main barriers to achieving such co-ordination, both in getting started, and in maintaining the co-ordination over time?
c. Will the smallholder dairy sector persist in the long term, and should it be assisted to do so?
d. Which forms of value chain analysis are most useful in guiding action by stakeholders, governments and development actors?
e. Informal versus formal sector: which development pattern to choose?

2. Approach taken

All the case studies are based on value chain analyses that highlight a variety of aspects of the results. The following are short abstracts of the case studies.

Contribution 1

Carbon insetting in the dual purpose cattle value chain in Nicaragua

Mixed crop-livestock systems provide the livelihoods for many smallholders in Central America. Climate change and degradation of natural resources lead to low productivity, food insecurity, low income and impact negatively on the environmental footprint. Payment for ecosystem service (PES) schemes via carbon credits can address this. Whereas initiatives are already being implemented (coffee and cocoa), the livestock sector has largely been ignored, despite its high share in greenhouse gas (GHG) emissions, its economic importance and the great GHG mitigation potential of livestock related interventions. Integrating carbon credit purchases into a company's own supply chain, or carbon 'insetting', improves animal productivity, increases adaptability to climate change and provides income. Livestock-related activities eligible for carbon credit certification were identified and the potential of carbon insetting in the smallholder dual purpose cattle value chain was assessed, including socio-economic implications of carbon efficient livestock practices and trade-offs between adaptation, mitigation and livelihood benefits.

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Contribution 2

Issues on the development of dairy value chain in rural India

In an effort aimed at transforming small-holder dairy value chains in Bihar, Value Chain Assessments were undertaken. Four value chains representing different domains (2 replications of each of Rural to Urban/ Urban to Urban) were studied. An evidence based systematic approach was used to select the geography. The key actors associated with each of the value chains were studied. The tools that are predominantly of the type of Focus Group Discussions, Semi-structured interviews and Rapid Rural Appraisal exercises, which were developed for value chain assessment in the Livestock and Fish CRP (CGIAR Research Program) were employed after adjusting them to fit to the local context. This comparative analysis is expected to characterise different types of value chains and their respective components. Challenges and opportunities for different components of these value chains would be highlighted. The process and experiences of adoption of the methodology would be presented.

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Contribution 3

Identifying Barriers for the Development of the Dairy Supply Chain in Malawi

Fractured supply chains have been identified as a barrier to growth for the agricultural sector. Dairy is a key investment sector for the Government of Malawi, donors such USA, Japan and Belgium have focused part of their development aid on the sector. Despite this, domestic production response is unimpressive. This is not surprising several factors hamper the sector development. This case study presents some of the results of an analysis of the dairy supply chain in Malawi. The methodology used consisted of a combination of surveys, semi-structure interviews and secondary information from farmers to consumers. Highlights of the results are: efficiency heterogeneity in dairy production and lack of cows constraining the pass-on programme; infrastructure constraints at the milk bulking group level; prices paid to farmers are sporadically adjusted in an inflationary context; low milk quality standards due to lack of enforcement; high margins for mass consumption milk in supermarkets.

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Contribution 4

Do Smallholder-inclusive Business Models offer Opportunities for Growing the Indonesian Dairy Sector?

The Government of Indonesia aims to increase Indonesia's self-sufficiency in dairy through a variety of value chain strategies focused on assisting smallholder dairy farmers. This study examines the *Makmur Agro Satwa* (MAS) cooperative business model operating in Sukabumi, West Java, Indonesia. MAS transformed from a small traditional dairy farm to a vertically-integrated cooperative that includes a milk processing plant. MAS provides credit, inputs and technical assistance to members. A unique aspect of the MAS business model is they market directly to approximately 300 regional primary schools through 'guaranteed purchase arrangements'. Livelihoods among MAS smallholders are compared to farmers selling through a traditional dairy cooperative in the area. We attempt to understand farmers' marketing options and perceived benefits and risks of each of the models. We examine whether one type of business model is more likely to drive adoption of improved management practices and technology and to encourage smallholders to scale-out.

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Contribution 5

Influence of innovation platforms on information sharing and nurturing of smaller innovation platforms: a case study of the Tanzania Dairy Development Forum

This paper pursues two objectives: partially to test a conceptual framework for monitoring and evaluating innovation platforms; second, to assess how the Tanzania Dairy Development Forum (DDF) is changing the Tanzanian dairy industry's institutional environment and organization. Qualitative and quantitative data were collected through key informant interviews, focus groups discussions, and individual interviews to understand how the DDF operates. The data, classified along key constructs of structure of the platform, conduct of participants, and performance in terms of nurturing regional platforms, were analysed to identify relationships between structure and conduct, and between conduct and performance. The results validate the conceptual framework for monitoring and evaluating innovation platforms: elements of the structure of the DDF influence information sharing by its participants, and information sharing in turn influences nurturing of regional

platforms. The Tanzania dairy industry is still undergoing a process of institutional change fostered by the DDF.

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Contribution 6

Dairy value chains in Pakistan: stakeholders' involvement and constraints analysis

The dairy sector plays a significant role in the national economy of Pakistan. Over the past decade, milk production has risen by more than 35%, mainly due to the increase of cattle population. The informal sector represents the major end-market with more than 95% of the milk sold. This study examines the dairy value chain in Punjab province which counts with almost two thirds of milk production in Pakistan. Focus group discussions were conducted with different stakeholders involved in the value chain (producers, inputs providers, traders/retailers, and consumers). Data on breeding and feeding systems was collected, as well as information on producers' linkage to the market and access to technology and input services. Traders/retailers' networks, price setting related to milk quality, and marketing strategies were analysed. A list of constraints at different levels of value chain was identified, suggesting prioritizing interventions to increase productivity and resource use efficiency of smallholders.

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3. Format to be used

Session structure	Presenter	Institution	Time (Min)
1. Introduction to the session	Philip Leat	SRUC	5
2. Case study 1: Nicaragua	Rein Van der Hoek	CIAT	9
3. Case study 2: India	Nils Teufel	ILRI	9
4. Case study 3: Malawi	Cesar Revoredo-Giha	SRUC	9
5. Case study 4: Indonesia	Risti Permani	U. Adelaide	9
6. Case study 5: Tanzania	Jean-Joseph Cadilhon	Egerton Uni.	9
7. Case study 6: Pakistan	Abedullah	ILRI	9
8. Discussant	Derek Baker	U. New England	10
9. Questions from attendants/ interaction with the floor			20
10. Session closure	Philip Leat	SRUC	1
Total			90

4. Plans for discussion

The discussion will be motivated by a discussant with experience in the dairy sector in developing countries, and be guided by the chair. Questions (a) to (e) above will be introduced and opened to discussion. The floor will then be open for questions from participants. In addition to the presentations, papers will be produced which are expected to be part of a journal special issue.

Available papers of the session

INTERNATIONAL CONFERENCE OF AGRICULTURAL ECONOMISTS
ICAE
29th | Milan Italy 2015
UNIVERSITÀ DEGLI STUDI DI MILANO AUGUST 8 - 14
AGRICULTURE IN AN INTERCONNECTED WORLD

Paper 1: Identifying Barriers for the Development of the Dairy Supply Chain in Malawi

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Identifying Barriers for the Development of the Dairy Supply Chain in Malawi

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Abstract.

Fractured supply chains have been identified as a barrier to growth for the agricultural sector. Dairy is a key investment sector for the Government of Malawi, donors such USA, Japan and Belgium have focused part of their development aid on the sector. Despite this, domestic production response is unimpressive. This is not surprising several factors hamper the sector development. This case study presents some of the results of an analysis of the dairy supply chain in Malawi. The methodology used consisted of a combination of surveys, semi-structure interviews and secondary information from farmers to consumers. Highlights of the results are: efficiency heterogeneity in dairy production and lack of cows constraining the pass-on programme; infrastructure constraints at the milk bulking group level; prices paid to farmers are sporadically adjusted in an inflationary context; low milk quality standards due to lack of enforcement; high margins for mass consumption milk in supermarkets..

Keywords: Malawi dairy supply chain, development economics, industrial organisation.
JEL codes: O, L.

IAAE

Identifying Barriers for the Development of the Dairy Supply Chain in Malawi

1. Introduction

Fractured supply chains have been identified as a barrier to growth for the agricultural sector. Dairy is a key investment sector for the Government of Malawi, donors such USA, Japan and Belgium have focused part of their development aid on the sector. Despite this, domestic production response is unimpressive. This is not surprising several factors hamper the sector development.

The improvement of the situation of poor smallholder farmers in Africa is increasingly thought to be linked to their access to markets where they can sell their products and also access technology, and new inputs. One of the ways farmers link to larger markets is becoming part of supply chains, along which products such as wheat or milk are further processed into final products such as bread or pasteurised milk before they reach consumers.

This case study presents some of the results of the DFID/ESRC project "Assessing the Contribution of the Dairy Sector to Economic Growth and Food Security in Malawi", which partnered Scotland's Rural College (SRUC, UK), Lilongwe University of Agriculture and Natural Resources, Bunda Campus, (Malawi), and the African Institute of Corporate Citizenship (AICC), Lilongwe (Malawi).

The purpose of this paper is to present some of the results from an analysis of the dairy supply chain in Malawi.

The structure of the paper is as follows: it starts providing a background of the main features of the dairy sector in Malawi. It is followed by the methods used for the analysis. The next section presents and discusses the main results and the last section gives some conclusions.

2. An overview of the dairy sector in Malawi

Malawi is located in south eastern Africa, bordered by Zambia to the north-west, Tanzania to the north-east and is surrounded by Mozambique to the south. The Great Rift Valley runs from North to South with Lake Malawi, Africa's third largest inland lake, running down much of its eastern border.

The country is divided into 3 regions: the Northern Region with Mzuzu, the country's third largest city, as its capital; Central Region within which the national capital of Lilongwe is located; and the Southern Region which contains the country's second largest city, and commercial centre, Blantyre.

Malawi has a rapidly growing population; official figures indicate a population in 2008 of 13 million and a growth rate of 2.8 per cent p.a. (NSO, 2008). Later estimates suggest a population of 16.8 million (estimate July 2013, NSO, 2014). The rural population is somewhat over 11 million and approximately two-thirds of rural dwellers are smallholder farmers with an average land holding of 1.2 ha. This has led to land being heavily worked, which with a lack of inputs, has resulted in low productivity and some degradation. Whilst food surpluses are regularly produced, malnutrition is prevalent with 2006 figures suggesting stunting of 45.9 per cent and underweight at 19.4 per cent (World Food Programme, 2010).

2.1 Malawi's milk industry

Rural milk production has been a long established practice in Malawi, traditionally drawing on the production of the Malawi Zebu. The wider sale of milk originated in colonial times in the south of the country, where colonial settlers kept Jersey, Ayrshire and Friesian cattle (Munthali et al., 1993). Whilst most of the country is suitable for dairy production (M-Livestock Consultants, 2013), approximately 90 per cent of commercial milk production is located in the Southern Region where the Shire Highlands (a plateau East of the Shire River which runs between Lake Malawi and the Zambezi River) is a major area of agricultural production. Most of the remaining commercial production supplying milk processors is in the Central Region, with only very modest supply to a processor (MDFA) occurring in the North. However, milk has traditionally been more of an integral part of the diet of people in the northern part of Malawi (Munthali et al., 1993), so that self-consumption by smallholders' families and informal raw milk sales are relatively prevalent in the North.

Malawi has approximately 10,000 dairy cows and 1.2 million Zebus that are used to produce cross breeds (M-LC, 2013). Raw milk production is mainly undertaken by smallholder farmers with typically 1-2 cows. These farmers, which number between 5000 and 7500 (there is no clear registration and recording system), produce 80-90 per cent of the milk. Efforts to increase the dairy herd are primarily focussed through the Dairy Farming Programme, with strong support from donor agencies and the Milk Producers' Association of Malawi along with the 3 regional producer associations. These are the Shire Highlands Milk Producers Association (SHMPA) in the South, the Central Region Milk Producers Association (CREMPA), and Mpoto Dairy Farmers Association (MDFA) in the North. Dairy animals are very largely provided to farmers as part of a 'Pass On' scheme, which embraces a loan element, in which a farmer, who has complied with a series of

conditions (access to feed, provision of basic animal housing and equipment, attended training, etc.), receives a heifer with the requirement that the first heifer produced is passed on to an approved recipient (which represents repayment of the loan).

Dairy farmers deliver milk twice daily to a milk bulking group (MBG), which in turn supplies a processor with which they have a contractual arrangement. There were 46 MBGs delivering milk to processors in mid-2013.

- In the South, the main production area, there were 24 major delivering MBGs and 7 smaller ones (delivering less than 700 litres per day), supplying in total between 35,000 and 45,000 litres of milk per day.
- In Central region there were 15 actively delivering milk with a daily collection of 2,000 to 5,000 litres, depending on the time of year.
- In the North, there were 14 active MBGs. Whilst the milk production of farmers was 2,400 litres, only about 100 litres were supplied to the mini processing plant established by MDFA following closure of the main commercial processor. Locally vended milk accounted for 1,750 litres.

The MBGs are supported by the milk producer associations in getting established, the development of their producers and their dealings with milk processors. There are basically three types of processor: commercial dairies which draw milk from MBGs - of which there are two in the Central region and a further two in the Southern region; privately owned small scale dairies which utilise milk from their own dairy cow herds - of which there are two; and micro processors which are very limited in number and process milk from smallholder farmers and are managed by the farmers themselves.

The pattern of milk usage by processors indicates that: 33 per cent of milk intake goes to pasteurised milk which largely serves the urban market; 50 per cent goes to ultra-high temperature (UHT) production which provides a much longer shelf-life and is suited to sale in rural areas and export markets (which has the appeal of foreign exchange earnings and good margins); and 17 per cent goes to other products, e.g., yoghurt, chambiko (fermented milk) and butter. The tightness of milk supplies to processors serves, amongst other things, to inhibit further product development.

Key facts from an analysis of the sector, which is based on primary sources (own data collection) and secondary ones (e.g., Imani, 2004; Chitika, 2008; M-Livestock Consultants, 2013) are as follows:

- A high percentage of the milk sent to the MBGs and processing companies is rejected due to quality problems, estimated at 17 per cent (Chimbaza, 2012). Alcohol and specific gravity tests are used at the MBG to determine whether the milk is soured or has been adulterated with water. Some of this rejected milk finds its way into the informal raw milk market.
- The four main processors possess considerable negotiation power. There is a very high level of concentration in milk purchasing, with the three top processors representing approximately 97 per cent of the total collections in the South and Central regions in 2012.
- The processing sector is operating well below capacity. In the South the plants are working at approximately 40-50 per cent of their current capacity, whilst in Central Region one of the plants is operating at 30-40 per cent and the other at very much less. Chimbaza (2012) puts the capacity usage as low as 20 per cent. This situation leads to higher processing costs, a limited supply of products and reduced competitiveness.
- Between 2008 and 2013 the supply of milk to processors was price elastic with an estimated long term value of 1.44, which indicates that processors' capacity utilisation could be improved if the milk price paid to farmers were increased (Revoredo-Giha et al., 2013).
- The processing sector makes profits, despite its high costs, by targeting the affluent part of the urban population. The Comprehensive Food Security and Vulnerability Analysis of the World food Programme (WFP, 2010) identified households in the two highest wealth quintiles, 'wealthy' and 'wealthiest', as consuming milk on 0.3 and 0.9 days per week on average, with households in the 'medium', 'poor' and 'poorest' quintiles consuming milk on only 0.2, 0.1 and 0 days respectively.
- Only approximately 50 per cent of milk is sold through formal channels. Consequently, the domestic supply of milk to processors is restricted. The rest is sold unpasteurised through informal channels to the rural population and less affluent urban segment.
- Mark-up practices at the retail level lead to the highest margins being taken on the smallest packs of milk which are most affordable for low income consumers (Akaichi, et al., 2013).

3. Methods

Value chain analysis (VCA) has gained popularity as an approach in development economics. VCA can not only provide answers to questions such as whether a supply chain is creating value and how

that value is distributed amongst participants, but also recognise that different segments of the chain are interrelated. Furthermore, VCA can, in many instances, determine the factors constraining the development of one or more parts of the chain.

The information gained through value chain analyses can guide policy interventions leading to the reallocation of resources and support programmes for the benefit of the most vulnerable groups within a chain. Therefore, VCA is a valuable tool for investigating the role that value chains play in achieving specific development policy objectives, such as poverty alleviation, sustained growth, inequality reduction and/or to improvements in food security and food quality.

The fieldwork was carried out in two stages:

- As part of the first stage, a stratified random sample was developed using information provided by the MBGs and the University of Malawi and covered selected MBGs in the three milk producing regions namely: Mzuzu Milk Shed Area in the Northern region, Lilongwe; Milk Shed Area in the Central region and Blantyre Milk Shed Area in the Southern region. A survey to 450 producers over the country was carried out in April 2013;
- The second stage, carried out during June-July 2013 comprised surveys to milk bulking groups (semi-structured interviews with 25 milk bulking groups, north, centre and south regions of Malawi); with most of the processors and several stakeholders (including donors); visits to retailers in order to carry a survey to retail shelves (retail audit to collect retail prices); and interviews to consumers.

In addition, prices paid to farmers were studied using a dataset constructed based on the monthly reports produced by the Shire Highlands Milk Producers Association (SHMPA), which provided information of farmers' deliveries to milk bulking groups (MBGs) associated to the main Malawian dairy processors: Dairibord Malawi Limited, Lilongwe Dairies Limited, Suncrest Creameries Limited and Sable Farming Company and to small processors (named as 'Others'). They covered the period September 2008 until July 2014. The dataset comprises the monthly quantity of milk delivered by farmers to the different milk bulking group; the prices paid by processors to the milk bulking group; the price received by farmers and the total discounts applied to milk prices. It should be noted that the number of actual number of farmers delivering milk is not available; therefore, it is not possible to estimate the average delivery per farmer. In order to carry out the analysis by procesors, the information was aggregated by processor, i.e., to milk delivered to each processors

and the weighted average price paid by processor to farmers. The number of milk bulking groups by processor in the Southern region is depicted in Figure 2.

Figure 2 here

4. Results and discussion

Five key issues have been identified so far from the analysis:

Efficiency heterogeneity in dairy production and lack of cows constraining the pass on programme - Producers have different levels of efficiency in the production of milk and several reasons have been identified for this (e.g. feed quality and quantity). In addition, lack of cows was voiced as an issue that restricted farmers' membership into the pass-on programme (an efficient way to expand of number of well-qualified dairy producers). The programme is restricted by the speed at which heifer calves are born from new members' cows. In-calf heifers are often (but not exclusively) passed to female members of the household, with many milk bulking groups targeting households in poverty.

Infrastructure constraints at the milk bulking group level - There are problems with break down of generators and also electricity black-outs, leading to spoilt milk. Nearly half the MBGs do not have a backup generator / energy source. Cost of energy is a continuously cited problem. There can also be delays in processor uplift meaning those milk bulking groups with limited excess storage capacity can be faced with spoiling of milk or being unable to accept additional deliveries from farmers.

Prices paid to farmers - Proper returns are needed for the expansion of any economic activity and dairy is not an exception. The price of milk in Malawi is set by processors and as shown in Figure 1, it is characterised by the sporadic adjustment of prices (nominal price expressed in Kwachas/litre). In a country with an annual inflation of above 20 per cent this sort of adjustment implies that any increment in the actual price is actually eroded by inflation reducing its purchasing power as can be seen in Figure 2 by the real price of milk.

The implications of low prices are quite clear and in the words of Brian Lewis, SHMPA advisor to the question what the main driver for producers (e.g., more cows, better feeding, better training) are, he answered: "the main driver? is price, when the milk price is good, farmers want to produce, they

feed their cows better, get their cows in calf quicker, everything works; there's money to pay for veterinary bills, to rear the heifers properly, the whole thing works. When the price of milk is poor everything is the opposite, farmers don't want to spend money on treatment for their cows, so the cows don't do very well, the heifers grow in four years instead of two years, the cows are producing eight litres instead of fifteen litres after they calf. It comes the time to do AI [artificial insemination] and they say I cannot afford it […] the fundamental thing is money".

Low milk quality standards - The operation of the supply chain is bugged by issues of poor milk quality. The bacteriological level of raw milk is generally high and as a result the milk sours quickly. This is due in many cases not only due to unhygienic production conditions or the fact that farmers often use poor quality water to clean and dirty containers to carry the milk to the MBGs but also due to adulteration.

Although the quality of the milk is inspected when delivered at the MBGs, only adulteration of milk with water (with a lactometer) and the acidity (with an alcohol test) for sourness are checked. Further tests are carried on by processors.

Despite testing, milk adulteration problems do remain, with water added to milk (estimated at 15 per cent of milk delivered) or bicarbonate of soda to reduce sourness. It is estimated that about 17 per cent of the milk produced by smallholder farmers is rejected by milk processors as being unfit for processing (Chimbaza, 2012).

The lack of enforcement as regards quality means that there are opportunities for profiting by lowering the standards. This happens, for instance, in the form of new MBGs opened by traders seeing business opportunities. The new entrants are less stringent on quality so farmers shift to them because they accept more water for the same price. Note that processors always agree to take the milk even if they have an existing MBG next door for fear that if they do not one of their competitors will.

High margins for mass consumption milk in supermarkets - The majority of processed milk is purchased by consumer from supermarkets and small shops. An analysis carried out last year (Akaichi et al., 2013), which consisted of collecting ex-factory prices, recommended-by-processors retail prices and actual retail prices for pasteurised milk, ultra-pasteurised milk, powdered milk, chambiko, yogurt, cheese, butter, margarine, spread and ice cream in nine supermarkets located in

the two main Malawian cities of Lilongwe and Blantyre found that although processors recommended retail margins between 12 to 22 per cent; actually those margins fluctuated between 13 to 149 per cent.

As shown in Table 1 the highest retailers' margins were found for the 250 ml. bags of pasteurised and ultra-pasteurised milk. This is important for food security since these products are targeted at low income consumers.

Table 1 here

5. Conclusions

Highlights of the results are: efficiency heterogeneity in dairy production and lack of cows constraining the pass-on programme; infrastructure constraints at the milk bulking group level; prices paid to farmers are sporadically adjusted in an inflationary context; low milk quality standards due to lack of enforcement; high margins for mass consumption milk in supermarkets.

A conclusion reached by every analysis of the Malawi dairy sector is that there is not enough supply of milk (e.g., IMANI Consultants, 2004). It is difficult to argue with this conclusion as indeed there is the need to increase milk productivity. In view of this, the straightforward recommendation would be to focus any investment or donation on the farming stage of the chain using all kind of available technologies to expand the supply of milk such as increasing the number of cows, replace the cows for ones with higher yields, to improve the quality of feed, to subsidise feed, to educate farmers on better practices to improve the quality of milk, just to name some. However, the question is whether just to focus on the supply of milk is enough?

Simple observation of Figure 1 above, would make anybody wonder why if there is not enough milk in Malawi (either because it is not produced or because it is rejected due to quality) the price paid to farmers in real terms does not go up as in any normal market to encourage farmers to supply more or attract additional farmers into the sector? Probably the plain answer would be that the dairy supply chain does not operate properly.

The impressive progress in agricultural technology such as new seed varieties or on livestock genetics and their potential for rising agricultural productivity has the risk to overshadow other more basic needs for the development of agricultural sectors in Africa. As such the determination of fair producer prices, the enforcement of quality standards, or overseeing retail margins applied to

food products may sound modest in comparison with peak technology; nevertheless, without those measures there is highly chance that supply chains will not operate properly, smallholder producer will not rip the benefits of new technology and ultimately this will not have the expected impact on reducing poverty, generating growth and improving food security.

The point on the previous observation is not to stop efforts to increase farmers' productivity through new technology. It is rather to highlight the need to reform alongside the supply chain to make it operate properly before introducing the new technology. It is said that "developing smallholder agriculture can be effective in reducing poverty and hunger in low income countries but only through sustainable access to markets can poor farmers increase the income from their labour and lift themselves and their families out of poverty" (Wiggins and Keats, 2013); however, this will only be true if supply chains or markets operate as they should be and only then smallholders will ripe the benefits arising from innovations, the dairy sector will flourish as expected in a white revolution, and the population will improve their food security.

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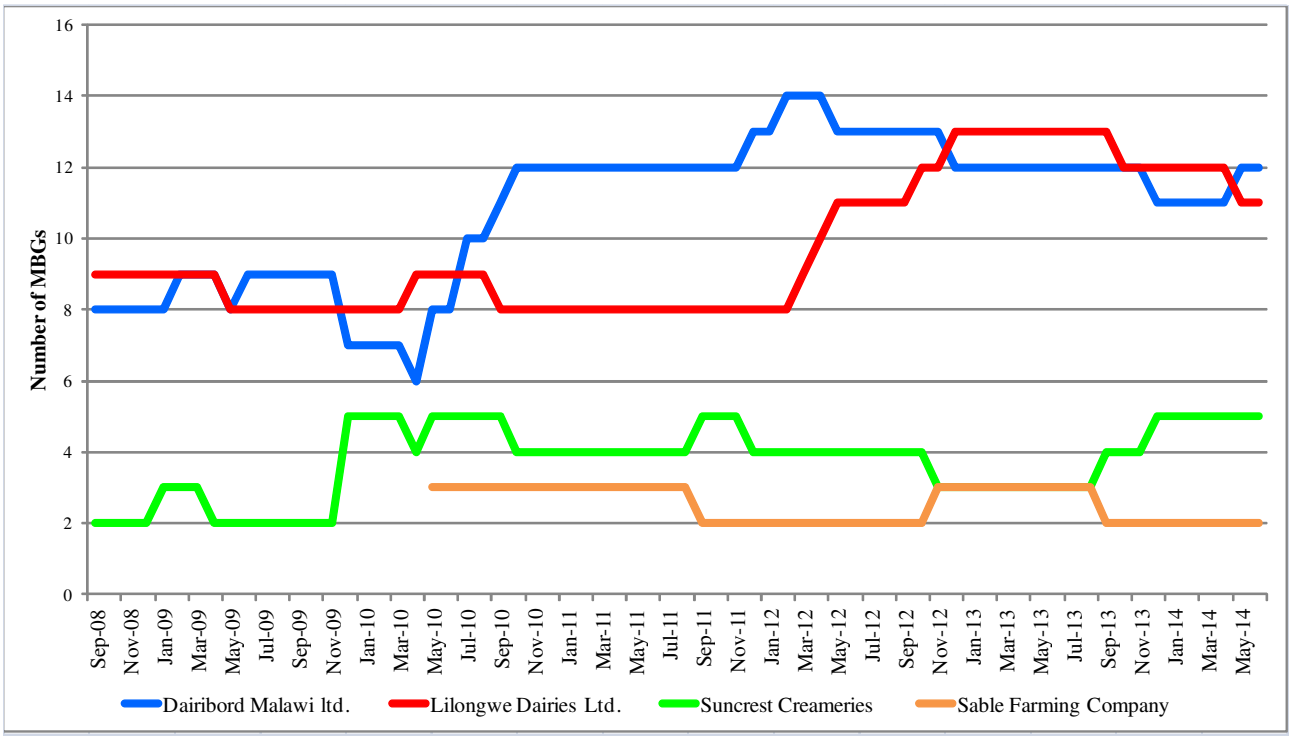
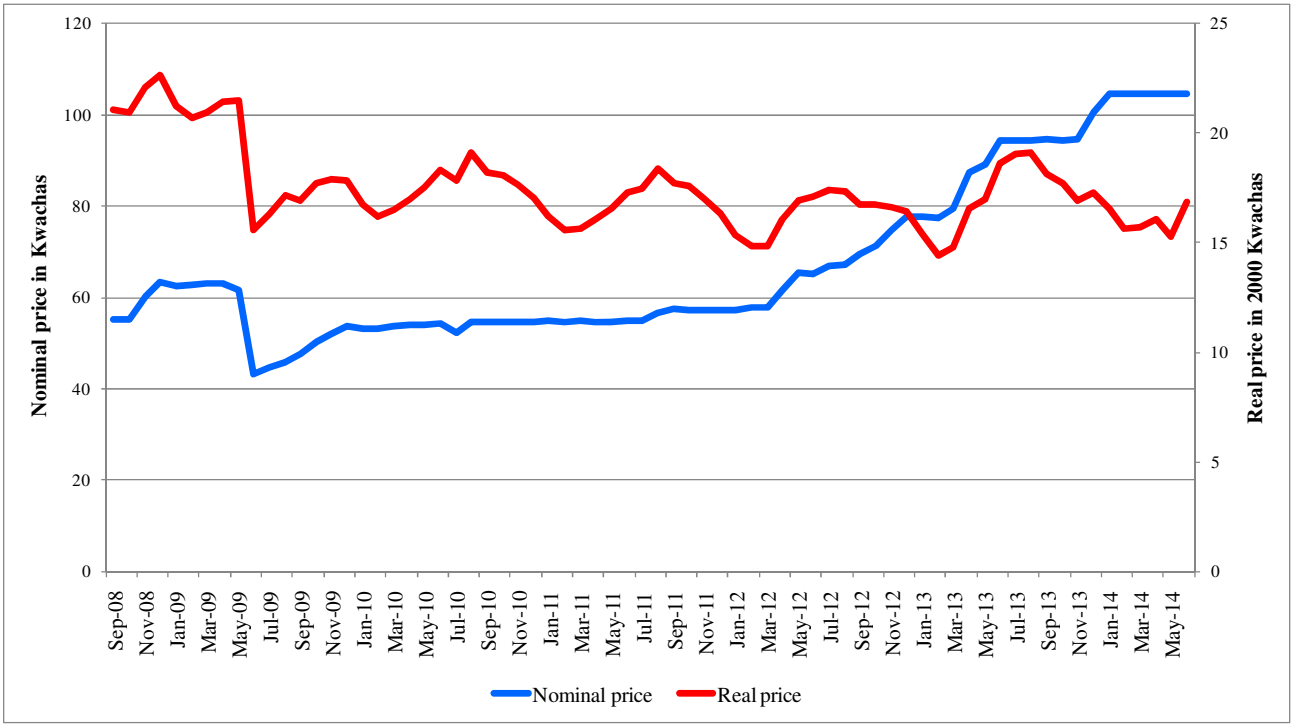
Tables and Figures

Figure 1: Number of Milk Bulking Groups by processor



Source: Shire Highlands Milk Producers Association.

Figure 2: Nominal and real weighted average price of milk paid to farmers by processors



Source: Own elaboration based on Shire Highlands Milk Producers Association (SHMPA) data.

Table1: Wholesale, recommended, retail prices (in Malawian Kwacha) and the computed margins

	Wholesale price	Recommended sale price	Retail price	Recommended margin (%) - A	Retail margin (%) - B	Difference (B-A)
Pasteurised milk - 250ml						
Processor 1	83	95	123	14	48	33
Processor 2	63	75	157	19	149	130
Pasteurised milk - 500ml						
Processor 2	120	140	185	17	54	38
Processor 3	145	165	185	14	28	14
Ultra-pasteurised milk - 250ml						
Processor 4	77	90	173	17	124	107
Processor 1	98	115	177	17	80	63
Ultra-pasteurised milk - 500ml						
Processor 4	98	115	198	17	102	84
Processor 1	175	210	198	20	13	-7
Chambiko - 250ml						
Processor 1	130	150	173	15	33	18
Processor 2	100	120	148	20	48	28
Processor 3	134	155	153	16	14	-1
Chambiko - 500ml						
Processor 1	240	276	277	15	15	0
Processor 2	190	230	278	21	46	25
Processor 3	210	255	240	21	14	-7
Yogurt - 250ml						
Processor 1	200	233	285	17	43	26
Processor 2	148	180	220	22	49	27

Source: Own elaboration based on stakeholders information.

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Do Smallholder-inclusive Business Models offer Opportunities for Growing the Indonesian Dairy Sector?

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Abstract

The Government of Indonesia aims to increase Indonesia's self-sufficiency in dairy through a variety of value chain strategies focused on assisting smallholder dairy farmers. This study examines cooperative business models operating in West Java, Indonesia including a small traditional dairy farm that has transformed to a vertically-integrated cooperative that includes a milk processing plant; and a traditional farmer-cooperative-processor model. We attempt to understand whether one type of business model is more likely to drive adoption of improved management practices and technology and to encourage smallholders to scale-out. The study finds that poor quality-based pricing systems combined with access to information about product quality can indeed lead to adverse impacts on input use and adoption of innovations.

Keywords: Indonesia, dairy, smallholder, business models, cooperatives, farm revenue, adoption of innovations, standard compliance, value chains

JEL codes: Q12, Q13

IAAE

1. Introduction

In developing countries of Asia the growth of the agricultural sector has been increasingly driven by increased demand for livestock products and other high-value crops (World Bank 2009; Reardon and Timmer 2014). This shift has stimulated the so-called agribusiness transition, where the agribusiness sector's contribution to GDP begins to exceed that of primary agriculture (Gulati *et al.* 2005; Briones and Felipe 2013). (Lee *et al.* 2012). Global agribusiness has been increasingly dominated by value chain relationships in which the lead firms engage in various forms of vertical coordination and integration. The lead firms have played a key role in driving product differentiation and the adoption of process controls focused on providing quality assurances (Humprey and Memedovic 2006). One key question is who gains and who loses from quality-focussed competition. The competition may expose risks to small farmers who are unable to comply with industry standards and therefore are unable to participate in the market.

Despite gaining in importance, the process of standards compliance is often viewed as a 'black box' given a lack of understanding of how farms actually do (or fail to do) to comply with standards (Henson and Hooker 2001). One important question is how various 'institutions' in vertical coordination affect farmers' decisions on input use and, therefore, farm performance.[1] This aspect has not been much discussed in the literature. There are only few exceptions which motivates this study to better understand how chain actors are interacting to increase quality and quantity of production.

A seminal study by Saenger *et al.* (2014) suggested that the presence of third-party contract enforcement stimulated farmers in the Vietnamese dairy industry to use 12% more inputs, which resulted in increased productivity. Similarly, a separate study by Saenger *et al.* (2013) examined if and how price incentives or penalties influenced input use and output quality. They found that penalties encouraged farmers to use more inputs and bonus payments generated higher use of inputs.

[1] In addition to contract farming, according to Gulati, et al. (2005) examples of institutions for vertical coordination of agrifood supply channels include "grades and standards, price information services, inspection and certification services, contract farming, farmer cooperatives, professional associations, and vertical integration (i.e. when a firm undertakes more than one function in the chain)".

Using data from dairy industry in Indonesia, this study extends analysis by Saenger *et al.* (2014) and Saenger *et. al* (2013) by using non-experimental data to examine how participation in certain types of business models influence farmers' on-farm decisions, particularly input use and adoption of innovations, and therefore farm performance as measured by farm revenue and yield. This paper is particularly interested in the transformation of dairy industry in West Java, Indonesia, which has seen the emergence of smallholder-initiated vertically-integrated business models (hereinafter the SVI business models). Compared to the traditional farmer-cooperative-commercial processor model, their production volume is much lower but seems to promise potentials. This type of business model has successfully upgraded its activities from a traditional dairy farm to a cooperative that includes a processing plant. They source fresh milk from local dairy farmers and involve farmers' wives in milk processing implying its potential contribution to the local economic growth and women empowerment. They also diversify their markets from only having one dairy cooperative as its buyer, to thousands of primary school students through school milk programs.

In addition to looking at differences in farm performance between the SVI business models and traditional models, this study explores specific characteristics of business models. The characteristics of dairy business models are arguably multi-dimensional and complex. They should also capture information flows, arrangements on the provision of technical advice, contracting and pricing systems as addressed by Saenger *et al.* (2014) and Saenger *et. al* (2013). This study considers the associations between these characteristics with not only the input quantity as in Saenger *et al.* (2014) but also the farm innovations, defined in this study as the adoption of high quality input. A hypothesis to be tested is that a 'mismatch' between the milk quality indicator influenced by an innovation and the quality indicator used in pricing systems will result in sub-optimal outcomes for producers. This aspect has not been much discussed by the literature.

The contribution of this study to the existing literature is as follow. To the authors' knowledge, there are few studies that address the nexus between adoption of innovations, farm performance and business models. In dairy industry for example, many studies focus on adoption of innovations by looking at differences between adopters and non-adopters and how the adoption of innovation impacts farm performance (Klotz *et al.* 1995; El-Osta and Morehart 2000; Foltz

and Chang 2002; Mayen *et al.* 2010; Latruffe and Nauges 2013). On a different vein, several studies examine the link between vertical coordination and smallholder's exclusion in market channels by looking at smallholders' participation in a specific supply chain arrangement (for example contract farming, cooperative selling institutions, and direct selling to consumers) (Holloway *et al.* 2000; Barrett *et al.* 2012; Fałkowski 2012).

There are a growing number of studies looking at the link between pricing, contracting and farm practises (Saenger *et al.* 2013; Saenger *et al.* 2014). Whilst those studies provide extremely helpful insights into the mechanism of how farms comply with quality standards, they only consider specific aspects of business models (i.e. contracting and quality-based pricing). An additional analysis of adoption of innovations will therefore provide a better understanding of how farms comply with industry requirements.

Sectoral and country-specific analysis as presented by this study is warranted. It is argued that key change agents vary by chain and each supply chain has different leverage points for improving the sustainability of agrifood chains (Lee *et al.* 2012). This country-specific analysis also invites comparisons with dairy industry analysis in other regions, for example Central and Eastern Europe (Dries *et al.* 2009), Latin America (Farina *et al.* 2005), China (Jia *et al.* 2012) and Vietnam (Saenger *et al.* 2013; Saenger *et al.* 2014).

The remaining of this paper is organized as follows. Section 2 reviews relevant literature on value chain transformation, governance and characterisation of business models. Section 3 presents a brief overview of Indonesia dairy sector by focussing on its high-level transformations. Using data from a dairy household survey, Section 4 discusses datasets and characterizes business models in focus regions. Section 5 presents a simple conceptual framework and empirical evidence to test the relationship between business models, input use, adoption of innovations and farm performance. Section 6 concludes.

2. Value chain transformation and characterisation of business models

2.1. Value chain transformation

The transformation of agricultural and food value chain has generally been initiated by a lead agent at different segments of value chains. For example, the structuring of dairy sectors in the

European region is driven by investments at differing production levels. In countries close to the European Union, the transformation of the dairy chain was mostly driven by investments in dairy *processing*, while in countries further from the European Union, and less advanced in transition, *retail* investments are playing a more important role (Dries *et al.* 2009).

Increased consolidation between chain actors stimulates the implementation of standards across food and agricultural sectors. It is argued that private standards, which is used as a marketing strategy, rather than public standards that are becoming the main drivers of the transformation (Henson and Hooker 2001). Private standards are used to increase profits through allowing product differentiation; reduce costs and risks in supply chains (Henson and Reardon 2005). The cost reduction may come from standardized process to manage procurement chains and systems.

Governments' responses to these developments in the private sector vary by country and change over time. Government interventions have been traditionally justified by the perception of food safety and quality as a public good.[2] Given the increasing complexity and competition in food systems, there is an increased expectations on governments to develop regulatory frameworks for effective quality monitoring systems as well as providing a 'level playing field' on which quality-based competition can take place (Henson and Reardon 2005). However, several food safety scares, for example the discovery of melamine to illegally boost the protein reading of the milk in China (Jia *et al.* 2012), test and provide evidence of governments' lack of capacity to monitor and enforce public standards; but at the same time, interestingly, seem to justify a further role of governments in quality monitoring. Government assistance is particularly directed to 'marginalized groups' for example small farmers who are struggling to comply with industry standards. Thus, contemporary agrifood systems have been governed by inter-related public and private standards (Henson and Reardon 2005). There has not been much discussion on the transformation driven by smallholder-initiatives highlighting the contribution of this paper.

[2] Aung and Chang (2014) offers a good review of defnitions of food safety and quality. In brief, food safety refers to all hazards that can harm the consumer; while quality is related to not only the properties of the food but also how those properties being perceived by consumers.

2.2. Business models

Smallholder farmers' strategies to maintain market participation and gain value added can be considered as a key part of their business models. The FAO defines that the term 'business model' as the rationale for how a company creates and structures its relationship to capture value (FAO 2012). A firm-level business model is likely associated with its position in and contribution to the value chain governance, defined as 'the definition and enforcement of instructions relating to product design, process controls and timing' (Humprey and Memedovic 2006). The development of value chain governance is associated with firm size and industry concentration as it has need of economies of scale in defining and communicating instruction and instructions need to be enforced by the threat of sanctions (Humprey and Memedovic 2006).

Good business models can affect not only the farm performance but also stimulate within-chain growth, and, at a larger scale, industry growth. Taking lessons from business literature, in practice, a successful business model has the following components: "i) customer value proposition; ii) profit formula; and iii) key resources and processes" (Johnson *et al.* 2008). A good business model defines how the business entity needs to create value, for example revenue and profits, for itself while providing value to the customers (Johnson *et al.* 2008). One may argue that a good business model requires or encourages adoption of innovations. Studies on understanding the relationship between adoption of innovations and business models are quite limited highlighting the contribution of this paper.

3. Overview of Indonesian dairy sector

The Indonesian dairy sector is characterized by the dominance of smallholder production. There are 192,160 dairy farmers managing about 3 cows each on average. Nearly 90% of these farms are located in West, Central and East Java with a small proportion of around 2% is located in Sumatra. Limiting factors such as tropical climate, land and feed scarcity, labour cost, transaction and transportation costs are evident (Beghin 2006). The average productivity of cattle in Indonesia is nearly half of the international standard at 12-14 litres per day.

Although domestic production continues to increase by an average of 8% between 2005 and 2010 (FAO 2012), local demand seems to grow at a faster rate. Currently domestic production capacity can only meet less than one third of local demand for milk products, a decrease from 47% of local consumption in 2007. Whilst Indonesia's estimated per capita milk consumption was only 13 litres per annum in 2013, which was significantly lower than 22 litres in the Philippines and 34 litres per capita in Thailand (USDA 2013), the size of its population and its income growth still signals enormous opportunities. Changing consumer preferences as indicated by more concerns over food quality, food safety and food attributes has encouraged increased demand for high value food commodities and animal-source protein such as dairy products.

Regulations on food safety and quality standards in Indonesia exist, but the monitoring and enforcement of the regulations especially at pre-processor segments remains a challenge. In regard to milk quality, the Indonesian government imposes the so-called SNI or the National Quality Standard. The SNI 3141.1:2011 sets detailed indicators for example in regard to fresh milk: protein (minimum of 2.8%); fat (minimum of 3.0%); maximum Total Plate Count (TPC) 1 million; and non-fat solids (minimum of 7.8%) (BSN 2011). Morey (2012) suggested that only 12% of milk production meeting the minimum quality standard. However, another study reported that majority of dairy cooperatives have been able to meet standards for these milk content indicators (Murti *et al.* 2009). A study in Bogor, Sukabumi and Cianjur taking 351 sample suggested that nearly 80% of milk being sampled meets the SNI standard although the occurrence of E. *coli* is concerning (Suwito and Andriani 2012). In addition to food quality standards, all food products must meet various other regulations including registration at the Food and Drug Control Body (BPOM); the labelling and advertisement of food products in Government Regulation No. 69 Year 1999 and Halal certification. These regulations are also applicable to imported dairy products.

Initial market observations suggest that majority of dairy products are produced by commercial manufacturers. These processors use state-of-the art machines and many of their facilities have ISO 22000 on food safety management and HACCP certification. Prices are quite uniform at Rp 1500 per 100 ml or approximately US$ 1.5 per litre. There is an increasing trend among manufacturers to focus more on fresh milk products. One company even uses 'honest milk' as their branding demonstrating the use of 100% fresh milk in their dairy products.

Several regulations are applicable to cooperatives and dairy farms. Cooperatives must acquire a legal status through a formal registration at the Ministry of Cooperatives and Small and Medium Enterprises. If they are processing their milk, they must meet the same requirements as commercial dairy processors including Halal certification, labelling, BPOM registration number, etc. Our field visits suggest that some small-scale dairy processors receive technical assistance from universities to make nutritional information label on their product packages. Dairy farms that process their milk production must also obtain BPOM registration number, acquire Halal certification and in addition obtain a certificate of home industry food production from the Mayor of the city or municipality in which the farm is located.

At the retail sector, the Indonesian government also regulates food safety and quality aspects. Government Regulation No. 28 Year 2004 on Food Safety, Quality and Nutrition stipulates that retailers must manage the following aspects: proper shelf arrangement to avoid cross contamination; control revenues and sales; 'stock rotation' according to expiry dates; control environmental aspects eg temperature, humidity and air pressure.

Figure 1 illustrates the complexity of regulations and governance in dairy supply chains in Indonesia. Given the complexity of regulations applicable to dairy supply chains, vertical coordination is expected. Vertical coordination through cooperatives (or called KUD (village unit cooperative) in the Indonesian context) is not a recent phenomenon. The first cooperative, Pengalengan Dairy Cooperative in West Java, was established in 1948. The number of cooperatives has increased between 1980s and 2000. Recent observations, however, suggest that some of these cooperatives are no longer operating. Nevertheless, the GKSI continues to serve as a representative of dairy farmers that attempts to influence government policy making and negotiates with the Indonesian Association of Milk Processors (IPS), which consists of large-scale dairy manufacturers such as Nestle, Frisian Flag, Sari Husada, Indomilk and Ultra Jaya. Given their positions as an intermediary institution, cooperatives also have a role in aiding government to distribute support, such as government-purchased dairy cows and credit subsidies (Nugraha 2010). Previous studies find significant variations in performance between cooperatives (Andri and Shiratake 2005; Nugraha 2010).

Despite continued importance of cooperatives, several transformations in the dairy supply chain have happened in the last decade. One significant change is that new investors tend to focus on fluid milk segment, which has expanded over 10% annually in the last five years. Second, there has been a change in the governance of dairy value chains from state-controlled systems through the role of cooperatives to private governance. The involvement of private sector has resulted in an improved partnership between processors and smallholder dairy farmers. A number of dairy processors provide both technical and financial assistance to individual farmers as well as KUDs to improve their milk quality, feed and fodder, animal health and biogas.

Another transformation is an increased number of new business models which allow smallholder dairy farmers not only improving on existing production activities but also adding value by taking on more functions in the chain in particular processing and coordinating a chain segment. One hypothesis, which needs to be tested, is that the above demand-driven positive industry development is able to drive changes in farm practises including adoption of innovations. The second hypothesis is that whether these changes would lead to improved farm performance and allow them to scale out.

4. Data and field observations

4.1. Dairy survey

This study uses data from a dairy farm household and cooperative survey in Bogor, Sukabumi and Cisarua districts, West Java, Indonesia. The face-to-face survey to farmers and cooperative staff members was conducted between December 2014 and January 2015. Interviews were conducted by 16 experienced enumerators, who participated in a three-day enumerator training workshop conducted in Bogor. The information was collected using a 20-page structured questionnaire, which was translated into Bahasa Indonesia. To design the questionairre, we conducted several focus group discussions and one-on-one interviews with various stakeholders in the chain, including dairy farmers and cooperative leaders. We also conducted pre-tests prior to launching the survey. The questionnaire consisted of 10 modules covering aspects such as household characteristics; farm characteristics (e.g. capital, asset, credit, forage management,

production, marketing, adoption of innovations, access to information); household consumption as well as measures of farmers' attitudes related to risk-taking activities, perception of change.

Bogor, Sukabumi and Cisarua districts were selected purposively for a number of reasons. Although milk production in these districts only represent 7% of total milk production in West Java, they present potential market opportunities due to their close proximity to Jakarta as the main market in Java; and have been relatively under-researched compared with other milk production areas such as Bandung and Garut. High land conversion from agricultural land to manufacturing and real estates in addition to other classical problems faced by dairy farmers such as limited access to input and credits, limited access to market information and lack of knowledge about good farming practises, have characterized the regions to mirror issues in other regions.

The population defined in this study is all dairy farmers who currently manage a dairy farm and live in Bogor, Sukabumi and Cianjur districts. A list of all active dairy farmers and their production or herd size to develop a sampling frame was obtained from cooperatives. We excluded farmers who owned a dairy farm in these three districts but lived in other city, for example Jakarta. We also asked all cooperatives whether there were any 'independent' dairy farmers (i.e. those who are not supplying to coops/direct selling to consumers); or farmer groups that they knew of. This was to ensure that we had a complete list of all farmers operating and residing in the area. In total, there were 5 cooperatives being surveyed and one farmer group who just turned to be a processor in 2011 and, then, formally became a cooperative in 2013. Due to confidentiality reason, we name these cooperatives as Coop A, B, C, D, E and F.

We used stratified random sampling. Farmers in each coop were divided into two strata based on their herd size (i.e. the first stratum consisted of those who managed equal or less than 4 cows; the second stratum was otherwise). In each stratum, we took random sample proportional to the stratum size. In total, we have complete datasets from 219 dairy farming households. The sampling process was done using STATA statistical software.

4.2. Field observations on types of business models

This section focuses on examining the transformations of dairy supply chains in focus regions. More specifically, it investigates existing business models which cover cooperatives' marketing channels and how the channels are characterized by cooperatives' relationships with farmers and buyers; and quality testing and quality-based pricing. Table 1 presents cooperative characteristics.

First, cooperative interviews suggest that, in contrast to traditional views seeing dairy market as a monopsony where the IPS has the ability to control the market; many cooperatives have options to diversify their marketing channels. Figure 2 presents cooperatives' marketing channels. There is a tendency that newer cooperatives i.e. Coop D and E established in 1999 and 2009, respectively, have minimal reliance on large processors. Both of these cooperatives process 100% of their milk and sell directly to distributors or consumers. These cooperatives, however, are relatively small compared to the other four cooperatives with production capacity of slightly above 200,000 litres per annum. The three biggest cooperatives, in terms of total milk production, still deliver 80-95% of their milk to major processors. However, closely looking at their buyers, there is an indication that the market is quite competitive. A cooperative has options to switch buyers. A previous study on Coop F suggests that in 2010 the cooperative sold 75% of their milk to different processors. None of those processors are currently supplied by any of the surveyed cooperatives.[3]

Second, it is interesting to learn that farmer members of vertically integrated Coop D and Coop E have 'less exclusive relationships' with these cooperatives. Their members sell only 20-30% of their total milk production to these cooperatives. These young cooperatives are located in an area where dairy production is quite concentrated and the nearest cooperative is only 2 kilometres away. They are still striving to recruit and partner with reliable farmer members. Given a decreasing number of dairy farmers in the area, these cooperatives are competing to get suppliers i.e. farmer members. The newest cooperative has a strategy to recruit farmer members by setting its price 20% higher than average market price. However, its inability to supply inputs to farmers, particularly concentrates, discourages many farmers from exclusively supplying to this

[3] Reference is not included as it can reveal the identity of the cooperative.

cooperative. Many of these farmers remain members of more well-established cooperatives which supply concentrates and provide them access to public programs.

Third, increasing demand for quality fresh milk seems to have encouraged the application of quality testing at the cooperative level. All of the surveyed cooperatives define that that they have a written contract with their buyer and mentioned that part of the contract is an agreement to supply high quality milk. Testing at the cooperative level is common. In terms of quality standards i.e. Total Plate Count (TPC) and Total Solid (TS), there are some variations between cooperatives, particularly in their TPC levels. It is concerning to see that all of the six cooperatives report average of TPC (i.e. range between 2.1-10 million) that is well above the national standard at 1 million.

Fourth, only one of the six cooperatives, namely Coop F, suggests that the processor provides price premium for quality milk.[4] A noticeable characteristic of Coop F that might contribute to its bargaining position is that based on the distance to the closest cooperative, the cooperative has less competition than other cooperatives in Regions A and B. In addition, its close distance to one of the biggest cities in Indonesia, and therefore potential suppliers, means it may have a competitive advantage. While the average price they receive is similar to that of other cooperatives, this situation might mimic what has been defined by Barrett *et al.* (2012) as a 'take-it-or-leave-it' offer, and, if turned down, find an alternative buyer at low marginal search costs.

Fifth, all of the six cooperatives reported that they provide technical assistance as well as financial assistance to their members. Only one cooperative stated the absence of concentrate sales in their business activities.

Given the above differences, it is evident that Coop D and E share similarities. We therefore name these cooperatives as the SVI business models i.e. smallholder-initiated vertically-integrated business models, whilst other cooperatives belong to the 'traditional model' where

[4] An interview with one of the main dairy processors in the focus regions suggest that this processor is offering price premium up to 20% above the normal price for quality milk. Quality-based pricing using TPC and TS are the two main determinants of price premiums and these are formally presented by the processor in a table distributed to supplying cooperatives.

farmers supply to cooperatives, then majority of the milk is being supplied to commercial dairy processors.

5. The relationship between business models, input use, adoption of innovations and farm performance

In general, innovations in agriculture can be classified according to their impact on markets and market forces. The categories include new products, yield-increasing innovations, cost-reducing innovations, quality-enhancing innovations and innovations that protect health and the environment (Sunding and Zilberman 2001). Innovations are heterogeneous. However, in many cases innovations may imply the use of better quality inputs. For example, innovative dairy farm may adopt several types of innovations, for example, they may purchase feed and use a refrigerated transport unit (i.e. cooling tank) while traditional farms only give forage to their cows and transport their milk in a plastic container.

Previous studies (Sandmo 1971; Saenger *et al.* 2014) focused on information asymmetry that may lead to price uncertainty. With information asymmetry, farmers will pay input cost that is less than their expected price of output. Consequently, optimal output quantity with information asymmetry is lower than without.

To look at on-farm practices, this study focuses on one type of input used in dairy farming, namely concentrate. The adoption of innovations is defined as the use of high protein concentrate. In recent years, the content of the protein in the feed ration of dairy cows has been studied more intensively. The effective level of crude protein in the diet might vary between regions. Under Swedish conditions, for example, 17% protein content in the diet is sufficient, while 13-13.5% protein is too low and resulting in decreased milk yield. (Frank and Swensson 2002). In Indonesia, most concentrate available at the markets have less than 55% TDN and less than 13% protein content (Bamualim *et al.* 2009). Therefore, the use of 16% and above protein concentrate can be considered as 'innovations'. In our datasets, 97% of respondents reported that they feed concentrate to their dairy cows; but only 9.95% use high protein concentrates (i.e. 16% and above protein content).

5.1. Basic estimates

First, following Saenger et al. (2014), this study investigates whether business model characteristics are associated with input use i.e. the quantity of concentrate fed to each animal. The study initially assumes that all of the right-hand-side variables are exogenous. It applies the following regression:

$$Y=\mathrm{BM_i}\beta_1 + \mathrm{x_i}\beta_2 + u_i \quad (1)$$

Where Y is one of the dependent variables, namely the average quantity of input being fed to one cow per day (CONC_QUANT), (log) daily farm revenues (DAILY_REVENUE) and daily yield per animal per day (YIELD). This study also includes an innovation index (INNOV_INDEX) i.e. a farm-level adoption of innovation index valued between 0 and 20 derived from 20 dummies on whether the farmer used a specific type of innovation since 2010 ranging from the use of Artificial Insemination to use of automatic milking machine. This study also uses a Probit model to see the determinants of adoption of high protein concentrate.

BM is a dummy which equals to one if the farmer is part of the SVI business model and zero if he or she is part of the traditional model; x is a vector of explanatory variables including individual and farm characteristics; u_i is the error term.

This study includes individual characteristics such as head of household's age (HH_AGE) (and its squares); education ($EDUC$); and the number of householders aged above 10 (HH_SIZE). It also includes farm characteristics such as a dummy on whether dairy is the household's main activity ($DAIRY\_MAIN$); the number of dairy cows currently managed by the household ($FARM\_SIZE$); a dummy on whether the household owns a land (with or without title) (OWN_LAND); and the number of years operating in dairy business ($DAIRY\_EXPERIENCE$).

Table 2 presents descriptive statistics by the type of business model. Farmers participating at the SVI business model have significantly higher use of high protein concentrate and receive higher revenues. However, they produce lower output and use less concentrate. It is noticeable that farmers at the SVI model are better educated than those at the traditional model and they have a larger dairy farm.

Table 3 presents the OLS and Probit results. Participation at the SVI business model is associated with higher probability of adopting high protein concentrate as shown by Column (1) of Table 3. There is no evidence of its significance for other outcomes, namely the amount of concentrate, innovation index, yield and revenue.

To further investigate the characteristics of dairy business models, the business models are defined by four variables: i) a dummy of whether the farmer has a (verbal or written) contract with his/her buyer (CONTRACT); ii) a dummy on whether the farmer knows the level of Total Solids (TS) of his/her milk (KNOW_TS); iii) the presence of quality-based pricing (Q_PRICE_BONUS); iv) a dummy on whether the cooperative becomes the farmer's main source of information about sales (COOP_INFO_SALES); and v) the interaction between variables ii) and iii).

Table 4 presents the results. The role of cooperatives as proxied by COOP_INFO_SALES is positively associated with the amount of concentrate per animal per day. In contrast, the presence of quality-based pricing as indicated by Q_PRICE_BONUS is negatively associated with input use. At a glance, this result seems to contradict the ones suggested by Saenger et al. (2014). This might reflect a mismatch between input innovation and quality measures. The premiums are more focused on TS and concentrate may not impact the TS as much. There seems to be no general consensus on the scientific evidence of concentrate use and milk yield and quality indicators given multiple factors affecting the optimum level of concentrate feeding (e.g. the feeding frequency, cow's production phase, breeds, quality of concentrate, etc.). A study suggests that dietary protein, as provided by concentrate, has no effect on milk protein or solids-not-fat percentage (Jaquette *et al.* 1986). Indeed, feeding excessive crude protein can reduce milk protein. Another study using Holstein-Frisian cows grazing tropical pastures which examines the frequency and level of concentrate fed suggests that milk fat percentage was lower for cows given 8 kilograms grain concentrate daily than for those given 2-4 kilograms, and there is no significant difference in protein percentages across treatments (McLachlan *et al.* 1994).

Next, this study evaluates the relationship between quality-based pricing and *the quality* of concentrate being used. Milk solids components include fat, protein, lactose and minerals. It is argued that the level of crude protein in feed does not influence milk fat percent; but its effects

on milk protein percent vary depending on diets and other factors. High crude protein can increase milk protein percent if previous diet was deficient; whilst low crude protein can decrease milk protein percent if diet is deficient. Generally, diet deficiency is found in many dairy farms in Indonesia due to poor quality forage.

Column (2) of Table 4 presents the results. In regard to access to information, there is a positive association between contract farming and farmers' knowledge of their Total Solids level and the use of high protein concentrate. Whilst the presence of bonus payment is not significant for the adoption of high protein concentrate, its interaction with KNOW_TS suggests that the effect of access to information about milk quality differs between farmers in 'quality-based bonus payment system' and those who are not. The negative coefficient suggests that the effect of farmer's knowledge on their decision to adopt high protein concentrate becomes less significant for those who are involved in a bonus payment system.

5.2 Propensity score matching

One may argue that selection into a particular business model is based on a non-random decision. Previous estimates might therefore be subject to selection bias. This study therefore uses propensity score matching (PSM). The treatment is participation at the SVI business model (i.e. $T = 1$); it is zero when the farm takes part of the traditional business model ($T = 0$).

Let Y denote the outcome variable. We consider three outcome variables as in the previous estimates, namely $DAILY\_REVENUE$, $INNOV\_INDEX$ and $YIELD$. The parameter of interest is the average effect of treatment on the treated (ATT):

$$ATT = E(Y^1 - Y^0 | T = 1) \quad (12)$$

The expected value of ATT is defined as the difference between expected outcome values with and without treatment for those who actually participated in the treatment. Following previous studies (Caliendo and Kopeinig 2008), to address selection bias the PSM estimator for ATT can be written in general as:

$$ATT^{PSM} = E_{P(X)|D=1}\{E[Y^1 | T = 1, P(X)] - E[Y^0 | T = 0, P(X)] \quad (14)$$

Where $P(X)$ is the propensity score $P(T = 1|X) = P(X)$. The estimation procedure consists of two steps: i) estimating a probit model to gain the propensity score each farm i; and ii) evaluating ATT by using four different matching algorithms. The PSM estimator is simply the mean difference in outcomes which relies on two main assumptions. First, the conditional independent assumption (CIA) (or uncounfoundedness) assumes that systematic differences in outcomes between treated and comparison individuals with the same values for covariates are attributable to treatment ($Y^0 \perp T|X$). The second matching assumption is the common support assumption stating that the propensity score is bounded away from 0 and 1 ($0 < P(X) < 1$).

Choosing covariates may involve some complexities. Implementing matching requires choosing a set of variables that influence simultaneously the participation decision and the outcome variable. Omitting important variables can increase bias in resulting estimates (Heckman *et al.* 1997; Caliendo and Kopeinig 2008). Furthermore, only covariates that are unaffected by treatment should be included; they should either be fixed over time or measured before participation and data for both participants and non-participants should be coming from the same sources (Heckman *et al.* 1999; Caliendo and Kopeinig 2008). However, 'too good data' is not expected either as they will fail the common support assumption (Caliendo and Kopeinig 2008). The inclusion of non-significant variables will not bias the estimates or make them inconsistent; but it will increase their variance. Finally, it is important to note that the propensity score estimation is not to predict selection into treatment as accurately as possible but to balance all covariates (Augurzky and Schmidt 2001; Caliendo and Kopeinig 2008).

Table 5 presents percentage bias for each covariate by four different matching algorithms. The test uses the *pstest* command in STATA. There is a significant reduction in bias after matching and, most importantly, the t-test suggests that there is insignificant difference in matched non-adopters and adopters for any of the covariates. Table 6 suggest that the mean and median bias are all well-below 20% as required indicating a relatively successful matching.

Table 7 reports the average treatment effect on the treated after matching. The results show that the adoption of high protein concentrate has no significant effect on neither the innovation index, revenue nor yield. All of the matching estimators suggest similar results.

6. Concluding remarks

Investigating the link between input quantity and quality; business model characteristics in particular the ones explaining access to information about quality; and farmer's involvement in quality-based pricing system is not straightforward. The study finds that providing access to information about milk quality and improved quality of input is not a stand-alone solution to help farmers improve their farm performance. Poor quality-based pricing systems combined with access to information about product quality can indeed lead to adverse impacts on input use and adoption of innovations. Future work will further look at the endogeneity as well as correlation between several business characteristics models used in this study. In particular, what particular aspects of the smallholder-inclusive vertically-integrated business models that can be improved to scale-out. One policy recommendation from this study is that public and private programs should re-assess whether farm innovations are actually translated into improved yield and welfare. Improved livelihoods would require chain actors to positively respond to change in farm practices by providing price that can compensate the marginal cost of innovations.

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Table 1. Cooperative characteristics

Criteria	COOP A	COOP B	COOP C	COOP D	COOP E	COOP F
Total milk production in 2013 (litre per annum)	2,943,895	792,026	1,349,699	203,413	219,000[a)]	4,222,804
Start year	1973	1973	1998	1999	2009	1970
Active members	200	121	250	33	121	500
Members' average farm size	5	5	4	3	5	10
Meeting frequency	Every three months	Once a month	Once a month	Once a month	Once a month	Once a year
Relationships with the main buyer						
(i) Contract	Yes	Yes	Yes	Yes	Yes	Yes
(ii) Provision of services						
* Technical assistance	Yes	Yes	No	No	No	Yes
* Financial assistance	Yes	Yes	No	No	No	Yes
* Bonus for quality milk	No	No	No	No	No	Yes
* Bonus for higher volumes	No	Yes	No	No	No	Yes
* Concentrate sales	Yes	Yes	Yes	Yes	No	Yes
Quality standards (based on coop interviews; TPC in millions, TS in %)	TS 11.5-12%	TS 11.5%, TPC 3 million	TS 11.5%, TPC 2.1-2.3 million	TS 11.5%, TPC 2.2 million	TS 12%	TS 11.5%, TPC 5-10 million
Price (Rp/litre)						
*Paid to farmers	4200	4200	4200	4000	5250	4200-4500
*Received from processors/products	5000-5500	5400	5500	Vary by (processed) products	Vary by (processed) products	5000
Distance to nearest coop (in kilometres	25	15	2	2	2	40

Source: Authors' survey.

Note: a) Estimation based on daily production 600 litres per day, multiplied by 365 days.

Table 2. Descriptive statistics, by business model

Variables	Type of business model		Difference
	Non-SVI (Traditional model) N=168 (73.68%) (A)	SVI (Smallholder-initiated vertically integrated business model) N=60 (26.32%) (B)	(A) – (B)
Farm input and output			
INPUT_QUAL	0.065	0.217	-0.151***
CONC_QUANT	6.087	4.407	1.680***
INNOV_INDEX	4.982	5.650	-0.668
YIELD	12.596	11.068	1.528*
DAILY_REVENUE	11.793	12.138	-0.345**
Individual and farm characteristics			
HH_AGE	46.202	44.850	1.352
HH_AGE_SQ	2260.548	2148.350	112.198
EDUC	6.810	8.067	-1.257*
HH_SIZE	3.798	3.300	0.498*
DAIRY_MAIN	0.845	0.917	-0.071
FARM_SIZE	7.649	11.617	-3.968*
DAIRY_EXPERIENCE	14.611	15.300	-0.689
OWN_LAND	0.363	0.567	-0.204**
WALK_KUD	0.131	0.167	-0.036
Business model characteristics			
CONTRACT	0.423	0.283	0.139
KNOW_TS	0.351	0.383	-0.032
Q_PRICE_BONUS	0.292	0.533	-0.242***
COOP_INFO_SALES	0.506	0.367	0.139

Note: Standard errors in parentheses. $p<0.01$, $p<0.05$, $p<0.1$

Table 3. OLS and Probit: The impacts of smallholder-initiated vertically-integrated model

VARIABLES	(1) Probit: Adoption of high quality concentrate	(2) OLS: Concentrate	(3) OLS: Innovation index	(4) OLS: Yield	(5) OLS: Revenue
SVI	0.0883***	-1.604	0.274	-1.615	0.0764
	(0.0165)	(0.922)	(0.586)	(0.882)	(0.153)
HH_AGE	-0.00209	0.0172	0.0371	-0.00800	-0.0370*
	(0.00871)	(0.0504)	(0.0959)	(0.161)	(0.0165)
HH_AGE_SQ	-1.61e-05	-6.83e-05	-0.000457	9.44e-05	0.000337*
	(7.52e-05)	(0.000452)	(0.000675)	(0.00124)	(0.000157)
EDUC	0.00305	0.0467	0.172*	0.140*	0.0565***
	(0.00342)	(0.0407)	(0.0830)	(0.0664)	(0.0104)
HH_SIZE	0.00421	0.0392	-0.0599	-0.110	0.0149
	(0.0142)	(0.0891)	(0.200)	(0.295)	(0.0374)
DAIRY_MAIN	0.00514	0.112	0.164	0.651	0.103*
	(0.0580)	(0.210)	(0.451)	(0.751)	(0.0472)
FARM_SIZE	0.00243***	-0.0376**	0.00641	-0.0381	0.0484**
	(0.000574)	(0.0142)	(0.0152)	(0.0428)	(0.0134)
DAIRY_EXPERIENCE	0.00598***	-0.0226	0.144***	-0.0423	0.00803**
	(0.00159)	(0.0316)	(0.0266)	(0.0321)	(0.00273)
OWN_LAND	-0.00867	0.225	0.0647	-0.0581	-0.0380
	(0.0593)	(0.460)	(0.437)	(1.013)	(0.0438)
WALK_KUD	-0.00744	0.0806	-0.0593	-0.0184	-0.134*
	(0.0424)	(0.422)	(0.454)	(0.386)	(0.0636)
Constant		5.414*	1.054	12.60**	11.76***
		(2.215)	(2.281)	(4.501)	(0.316)
R-squared		0.088	0.247	0.039	0.524

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Coefficients in the Probit model are marginal effects. All predictors at their mean value. Number of observations=228.

Table 4. OLS and Probit: Concentrate use and adoption of innovations

VARIABLES	(1) OLS: Concentrate use	(2) Probit: Adoption of innovations (High protein concentrate)
HH_AGE	0.0644	-0.00193
	(0.0621)	(0.00339)
HH_AGE_SQ	-0.000540	-9.37e-06
	(0.000618)	(3.39e-05)
EDUC	0.0567	0.00526***
	(0.0408)	(0.00180)
HH_SIZE	0.143*	-0.00275
	(0.0704)	(0.00989)
DAIRY_MAIN	-0.0308	0.00882
	(0.224)	(0.0515)
FARM_SIZE	-0.0346	0.00261***
	(0.0200)	(0.000922)
DAIRY_EXPERIENCE	-0.0167	0.00418***
	(0.0292)	(0.00136)
OWN_LAND	-0.0528	0.0146
	(0.348)	(0.0402)
CONTRACT	-0.473	0.0598*
	(0.635)	(0.0335)
KNOW_TS	-0.613	0.0797**
	(0.386)	(0.0312)
Q_PRICE_BONUS	-1.831***	0.0764
	(0.281)	(0.0609)
Q_PRICE_BONUS_KNOW_TS	0.258	-0.149**
	(0.561)	(0.0609)
COOP_INFO_SALES	0.974**	0.00211
	(0.243)	(0.0239)

Note: Clustered standard errors in parentheses. $p<0.01$, $p<0.05$, $p<0.1$. Coefficients for the Probit model are marginal effects. All predictors at their mean value.

Table 5. PSM SVI Participation: Tests for selection bias after matching.

Variable	%bias			
Matching algorithm	One-to-one matching	k-nearest neighbours matching	Radius matching	Kernel matching
HH_AGE	3.1	-9.2	-12.1	-11.1
HH_AGE_SQ	1.9	-12.5	-14.2	-12.8
EDUC	-5.8	0.3	-5.6	-6.1
HH_SIZE	1.3	-0.9	8.3	9.8
DAIRY_MAIN	0	5	6.1	3.9
FARM_SIZE	5.1	30.2	24.5	24.8
DAIRY_EXPERIENCE	7.2	5.2	-0.5	1.4
OWN_LAND	0	-4.4	6	8.1
WALK_KUD	0	-16.3	-14.9	-14.7

Note: The treatment is participation at a smallholder-initiated vertically integrated business model. One-to-one matching is without replacement. The *k*-nearest neighbours matching algorithm applies caliper=0.1 and number of neighbours=5. Radius matching applies caliper=0.1. Kernel matching applies bandwith=0.001. Propensity scores are estimated using probit model.

Table 6. PSM SVI Participation: Statistical tests to evaluate the matching

Matching method	Pseudo R2	Likelihood ratio Chi2	p>Chi2	Mean Bias	Median Bias
Before matching	0.083	21.72	0.01	23.3	22.3
One-to-one matching	0.003	0.51	1	2.7	1.9
k-nearest neighbours matching	0.067	9.09	0.429	9.3	5.2
Radius matching	0.05	6.12	0.728	10.2	8.3
Kernel matching	0.051	6.22	0.717	10.3	9.8

Table 7. PSM: The impact of participation at smallholder-initiated vertically-integrated business models

Outcome variable	Matching algorithm	Treated	Controls	ATT*	SE*	z-value
INNOV_INDEX	One-to-one matching	5.67	5.07	0.80	0.50	0.11
	k-nearest neighbours matching	5.61	4.82	0.63	0.52	0.23
	Radius matching	5.34	4.88	0.58	0.62	0.35
	Kernel matching	5.34	4.93	0.06	1.20	0.96
YIELD	One-to-one matching	11.02	12.34	-1.33	0.85	0.12
	k-nearest neighbours matching	11.26	12.50	-1.23	1.00	0.22
	Radius matching	11.12	13.33	-0.93	1.09	0.39
	Kernel matching	11.12	13.30	-1.99	1.72	0.25
DAILY REVENUE	One-to-one matching	12.03	12.02	0.04	0.15	0.76
	k-nearest neighbours matching	11.99	11.82	0.10	0.23	0.66
	Radius matching	11.87	11.84	0.13	0.19	0.48
	Kernel matching	11.87	11.86	0.17	0.39	0.66

Note: Coefficients for ATT and standard errors are bootstrapped, replications=50.

Figure 1. Regulations and governance in dairy supply chains in Indonesia

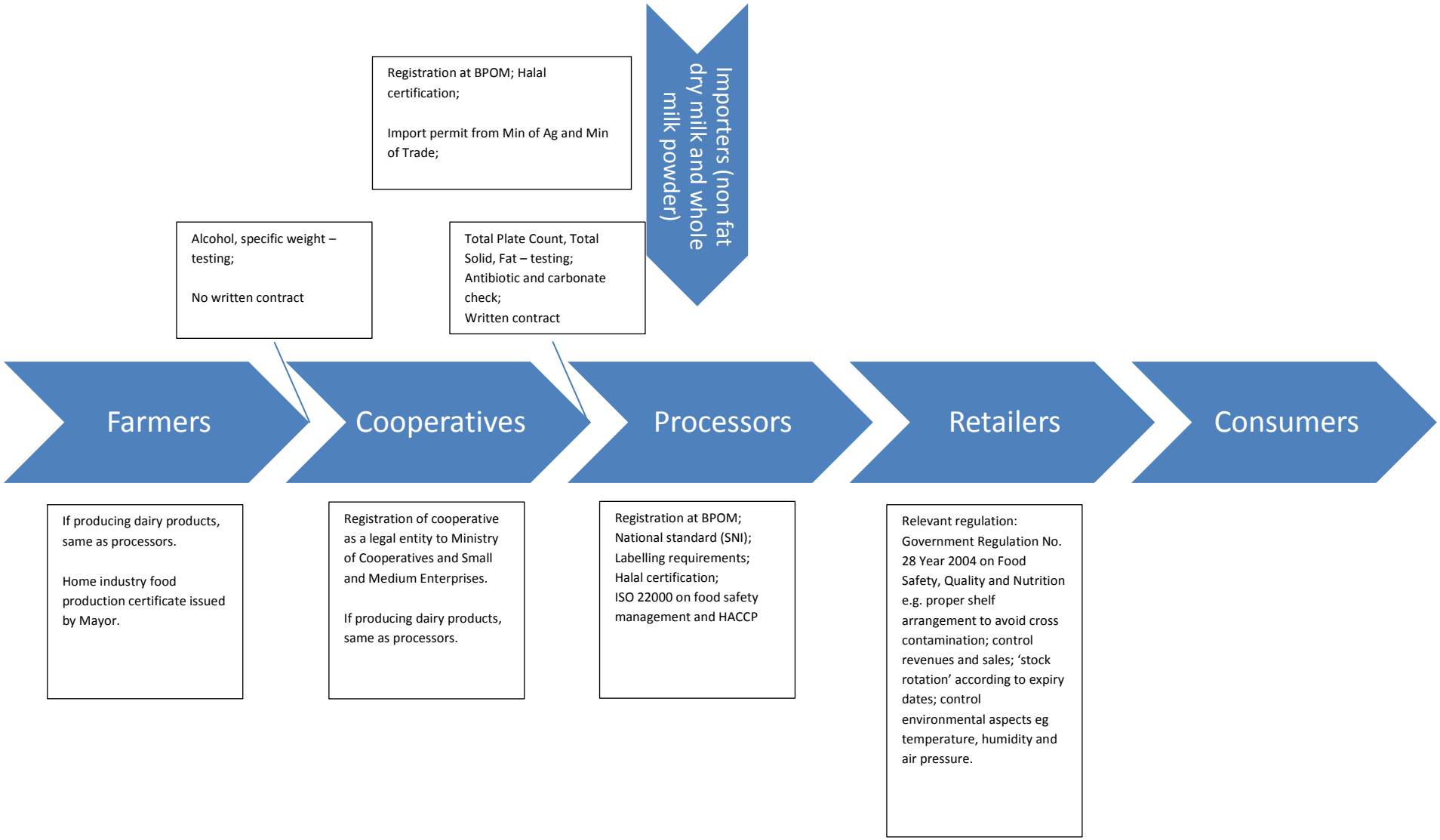
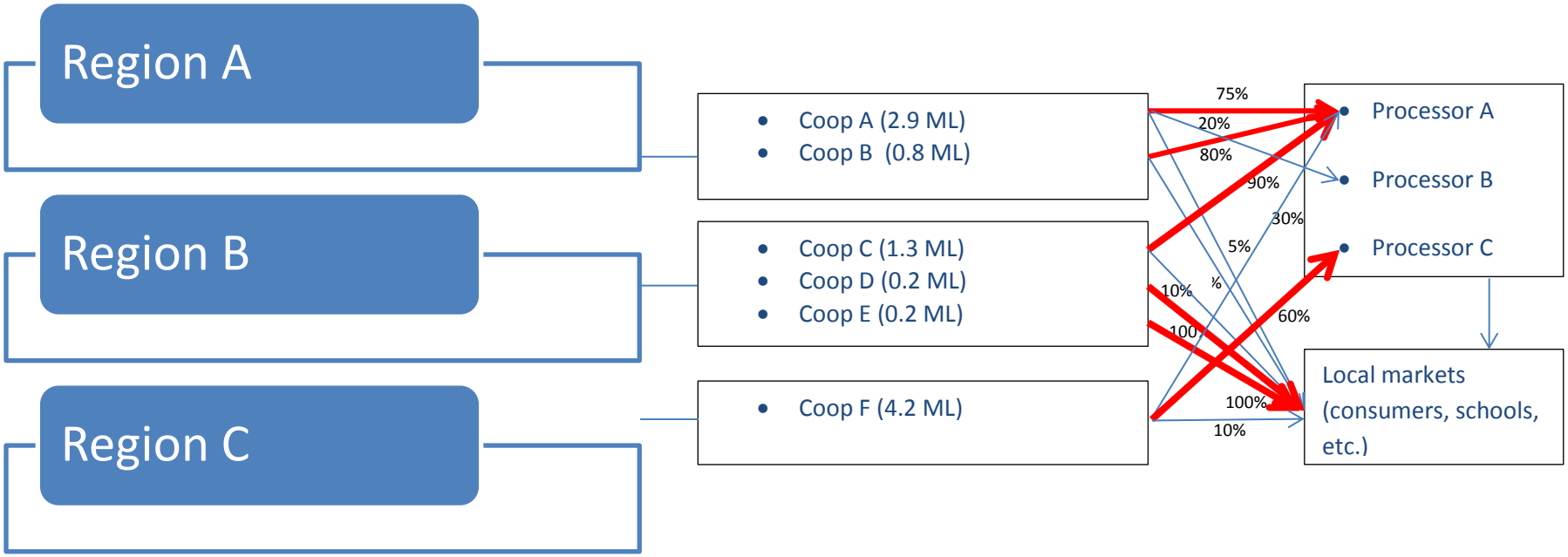


Figure 2. Cooperatives' marketing channels



Source: Authors' survey.

Note: % means percentage of the cooperative's total production that is sold to particular buyer. The thick red line denotes percentage above 50%. The numbers in brackets are total milk production in 2013 (in million litre).

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Influence of innovation platforms on information sharing and nurturing of smaller innovation platforms: a case study of the Tanzania Dairy Development Forum

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This paper pursues two objectives: partially to test a conceptual framework for monitoring and evaluating innovation platforms; second, to assess how the Tanzania Dairy Development Forum (DDF) is changing the Tanzanian dairy industry's institutional environment and organization. Qualitative and quantitative data were collected through key informant interviews, focus groups discussions, and individual interviews to understand how the DDF operates. The data, classified along key constructs of structure of the platform, conduct of participants, and performance in terms of nurturing regional platforms, were analysed to identify relationships between structure and conduct, and between conduct and performance. The results validate the conceptual framework for monitoring and evaluating innovation platforms: elements of the structure of the DDF influence information sharing by its participants, and information sharing in turn influences nurturing of regional platforms. The Tanzania dairy industry is still undergoing a process of institutional change fostered by the DDF.

Keywords: Capacity strengthening; communications; dairying; impact assessment; innovation systems; policy; Tanzania.

JEL codes: L14; Q13; Q16; O31.

1. Introduction

1.1. Overview of innovation platforms

Value chain actors in agricultural related products have devised several mechanisms aimed at improving the overall performance of a value chain. Essentially, coordination and engagement between value chain actors operating in agricultural related value chains has experienced changes and shifts over the past five decades. In the 1960s and 1970s, the flow of information on agricultural innovations followed a linear approach, with scientists being the major knowledge generators. However, a key weakness of the linear approach was the disregard of farmers as equal knowledge generators whose innovations could be equally unique and important as those recommended by the scientists (Pali and Swaans, 2013). To address the weaknesses in the linear approach of promoting agricultural innovations, more participatory and holistic approaches were introduced in the 1980s (Anandajayasekeram, 2008). These more participatory approaches included Farmer Field Schools (FFS) and Farming Systems Research (FSR). Despite the approaches being regarded as more participatory, they only involved scientists and producers without acknowledging equally important roles of other actors in agricultural value chains. The segregation of other crucial value chain stakeholders from the 'more participatory approaches' therefore necessitated a re-think on the approaches to make them truly participatory (Simpson and Owens, 2002). As a result, systems approaches were introduced in the 1990s and focused on generation and application of knowledge to influence social and economic changes. Especially, Agricultural Knowledge and Information Systems (AKIS) gained prominence during the 1990s. This marked the start of systems institutionalization (Reynolds et al., 2008).

In the 2000s the systems approaches morphed into innovation systems that were more promising in enhancing productive interactions between value chain actors. The concept of innovation platforms, also known as multi-stakeholder platforms, learning alliances, innovation networks, inter-professional platforms or R4D platforms depending on local project context, is founded on the innovation systems approach. The principle components of innovation platforms include improved communication, information and knowledge sharing, as well as co-creation of solutions to challenges facing agricultural value chains. Cadilhon (2013) defines innovation platforms as 'equitable, dynamic spaces designed to bring heterogeneous actors together to

exchange knowledge and take action to solve a common problem.' Adekunle and Fatunbi (2012) on the other hand regard innovation platforms as 'dynamic networks of stakeholders interacting and learning together through generating, disseminating, and adopting innovative outputs realized through their engagements.' The dynamism of innovation platforms is appreciable through the open, evolving membership often drawn on the basis of issues being addressed and the expertise of the participants (Fadeeva and Mochizuki, 2010).

1.2 The Tanzania Dairy Development Forum as an innovation platform

The Tanzania Dairy Development Forum (DDF) is a multi-stakeholder platform that is easing the coordination and engagement of dairy value chain actors in Tanzania. The forum, launched in February 2013, is a culmination of efforts by dairy stakeholders in the Tanzania dairy industry to create an informal forum where all stakeholders could participate and jointly address challenges that they were experiencing along the dairy value chain. This followed previous attempts by development partners involved in the Tanzania dairy industry to build up multi-stakeholder groups, which died out every time after the completion of their project timelines. From this experience, the current Dairy Development Forum is constituted under the stewardship of the Tanzania Dairy Board (TDB), which acts as its secretariat. This therefore makes DDF immune to collapses influenced by the exit of development partners and other major dairy value chain actors operating in Tanzania because the secretariat will outlive any project initiated by development partners. DDF holds two meetings annually and has so far held five meetings during which dairy stakeholders have been able to share experiences, learn from other forum participants, get challenged, build consensus and forge common understanding on addressing challenges ailing the dairy value chain.

Currently the DDF is co-hosted by the TDB, Sokoine University of Agriculture (SUA), the International Livestock Research Institute (ILRI), the International Center for Tropical Agriculture (CIAT), Heifer International, The Netherlands Development Organization (SNV), Land O' Lakes, and the Tanzania Ministry of Livestock and Fisheries Development (MLFD). Participation in the forum is however open to all dairy value chain actors and interested stakeholders including input suppliers, producers, processors, traders, development partners,

policy makers, research organizations and academic institutions operating at different scales in the dairy value chain.

With a dynamic membership that changes depending on the topics being discussed, the forum has successfully held meetings, where participants interact akin to an innovation platform setting, to share knowledge and co-create solutions to challenges ailing the dairy value chain. Currently, the forum is pursuing five objectives that include: nurturing innovation platforms from regional down to milkshed level; promote investments in the dairy sector by both the public and the private sector through evidence-based information sharing; aggregate, synthesize and disseminate useful information to all dairy stakeholders; act as a platform where Tanzanian dairy stakeholders can interact in a consultative forum to share information and generate knowledge; and promote the professionalization of the Tanzanian dairy industry through a change in culture and adoption of best standards and practices. These objectives are aimed at addressing feeds scarcity in Tanzania often experienced during the dry seasons resulting in plummeting milk production and overreliance on milk imports (Suttie et al., 2005). Secondly, DDF aims to improve the quality and quantity of the dairy herd in Tanzania stemming from the fact that over seventy percent of the total dairy herd is composed of indigenous breeds (Njombe et al., 2011). Lastly, the forum also intends to identify gaps in dairy technology and agribusiness skills in the Tanzania dairy industry, and address them. The structure of the DDF is illustrated in Figure 1.

The DDF has identified innovation platforms as key catalysts in addressing institutional constraints of the Tanzania dairy industry. This is informed by the success of the Tanga Regional Dairy Platform, which was established in 2008, in addressing challenges on market access, seasonality of milk supplies and advocacy (Cadilhon, 2014). Arguably, the Tanga regional dairy platform has played a key role in making Tanga the leading region in dairy production, processing, and marketing with its major processor, Tanga Fresh Limited. Most notably, Tanga Fresh Limited is the largest dairy processor in Tanzania. The DDF therefore seeks to replicate and expand this success across all regions in Tanzania. Ideally, nurturing regional and milkshed level dairy innovation platforms will provide an institutional environment through which desired changes can be enacted through participation of all dairy stakeholders. Such local-area platforms are already evolving in Morogoro and other regions and districts.

Hounkonnou et al. (2012) regard the creation of an enabling institutional environment as a precondition for achieving increased productivity as evidenced by the industrial and green revolution. This outlook is shared by the World Bank (2012) in their view of innovation platforms as stimulators of institutional changes through enhanced participation of stakeholders and strengthening of linkages between policy processes. Accordingly, in the Tanzania dairy industry, it is imperative to use the innovation platforms as change agents to influence institutional change in the dairy industry if meaningful advancement is to be attained. The objective of this study is to assess how the Tanzania DDF is contributing to foster changes in the country's dairy industry.

2. Literature review

2.1 A dynamic model of institutional building within industry organization

Aoki (2011) explores the different types of institutions created in human societies. The first institutional layer is constituted by informal societal rules which affect human behaviour and thinking. All members of society believe their counterparts will act according to the predominant societal rules. These informal rules often emerge as 'common beliefs'. A second layer which can evolve from the first is the substantive institution, which is created by several individuals or organizations to act as a means to organize part of society or an industry. Institutions with substantive forms act as societal objects and they help mediate strategic interactions and individual beliefs among their agents. Importantly, the substantive forms of institutions require the collaboration of all agents involved to be realized. As a result, individual attributes of the agents are expressed less and instead, shared beliefs become more pronounced. Furthermore, institutions in their substantive form ease the individual burden of information processing because all agents contribute their information into the shared institution.

The process of institutional evolution is complimentary and dynamic according to the theory of institutions-as-cognitive media proposed by Aoki (2011). Importantly, legal frameworks are seen as the third stage of institutional development and they emerge from the two other institutional processes. This contrasts with other theories positing that institutional evolution is initiated and guided through policy with Government as a single actor creating various institutions. The contention that Aoki (2011) seeks to answer is whether institutions can be designed or not, and

whether institutions beget social order or vice versa. Aoki in the end views institutional evolution as a product of self-enforcing patterns often played out through social interactions and individual beliefs. However, these patterns and beliefs may sometimes be mediated by enforceable laws, norms, and organizations as cognitive-media to bridge between behaviours and beliefs.

Aoki's (2011) framework is relevant to the object of this study because the Tanzania dairy industry is still in a process of structuration. Although the Tanzanian Government and the TDB may be setting up regulations for the dairy sector, daily practices of milk marketing are often still informal in nature (Njombe et al., 2011), therefore reinforcing common beliefs and practices in the industry. Finally, as an open multi-stakeholder platform representing the dairy industry to solve common issues and assist policy decision making, the Tanzania DDF can be seen as a substantive institution according to Aoki (2011).

2.2. Monitoring and evaluating innovation platforms

Monitoring and evaluation are fundamental components of ensuring sustainability in every project undertaking. Innovation platforms, as engagement spaces that ensure continuity of innovations through change of focus from time to time undoubtedly require strong monitoring and evaluation mechanisms to ensure that the change of topics under focus does not forestall the implementation and uptake of outputs from previous platform innovations. However, being multi-stakeholder platforms, there are diverse interests involved and it is therefore crucial to have a negotiated set of monitoring and evaluation criteria.

Cadilhon (2013) recommends a conceptual framework suitable for monitoring and evaluating innovation platforms at any stage of maturity during the lifecycle of the platform. It hypothesises that structure of an innovation platform influences the conduct of its participants, which then influences the overall performance of the innovation platform in attaining its present objectives (see Figure 2). The conceptual framework breaks down the industry data within which the innovation platforms are based into three categories namely: structure; conduct, and performance. For structure, the framework recommends the study of elements such as membership to innovation platforms, decision making processes, legal and regulatory and cultural frameworks; age, gender, levels of education of platform participants among other demographic variables. Elements for evaluating the conduct of participants within innovation

platforms include information sharing, trust, coordination, joint planning, and communication. Lastly, to evaluate the performance of innovation platforms, the conceptual framework recommends measuring indicators that reflect the objectives set by the platform participants themselves. In the case of DDF, its performance can be approached through the constructs of advocacy, capacity building, value chain development, market access and nurturing of other dairy multi-stakeholder platforms.

The literature review above has provided two frameworks to shed light on how the DDF operates to achieve its objectives of dairy development. Within Aoki's (2011) continuum for institutional evolution, the DDF can be seen as a substantive institution meant to promote individual and organizational change that should also cumulate into policy change to help shape the development of the Tanzanian dairy industry. Cadilhon's (2013) framework with its synthesis of elements from industrial organization economics, new institutional economics and business marketing relationship literature, fits well in Aoki's (2011) overall theory of institutional evolution while also suggesting individual constructs to quantify the complex interactions of the multiple stakeholders involved in the DDF and the wider Tanzanian dairy industry. This article aims to provide an empirical validation of both frameworks described above in the context of the DDF.

3. Methodology

3.1 Data Collection

Both qualitative and quantitative data were collected using three survey instruments: focus groups discussions, key informant interviews, and individual questionnaires. All survey tools are available upon request from the authors.

Focus groups were conducted at the beginning and at the end of the data collection. Before the start of the data collection, three focus groups were conducted with participants of the DDF in Dar es Salaam, Morogoro, and Tanga. These focus groups informed the questionnaire design and aided the refinement of the questions used in the individual questionnaires to adapt them to the local context. At the end of the data collection exercise, another two focus groups were conducted to seek clarifications on unclear initial findings and evaluate the survey process.

Key informant interviews were conducted to provide in-depth insights on the structure, conduct, and performance of the DDF. The respondents targeted for the key informant interviews were members of the DDF advisory committee, which represents influential dairy value chain actors in the Tanzania dairy industry. The advisory committee members work closely with the secretariat in the management of the DDF and in pursuing its objectives. The data collected through the key informant interviews was qualitative and was utilized for triangulation. The advisory committee has eight members, of which five were interviewed as key informants.

The questions for individual respondents were derived from a comprehensive literature review and modified from the deliberations of the first three focus group discussions. The individual questionnaire was also pretested in Dar es Salaam and Morogoro before being deployed for data collection for this study. The individual questionnaires were segmented into three broad categories. The first part covered the structure of the DDF, innovation platforms or associations that the respondents were participating in. The second module addressed the conduct of the dairy industry participants with questions covering information sharing, communication, joint planning, coordination, and trust, as well as a focus section that delved deeper into information sharing with 12 specific statements. Lastly, the third module had a general section with three statements for each performance element that included advocacy, capacity building, value chain development, and nurturing or regional platforms. Twelve focus questions on nurturing of regional innovation platforms and thematic working groups then followed. For data on conduct and performance, a five-point Likert scale was used (5=strongly agree, 4=agree, 3=undecided, 2=disagree, 1=strongly disagree). By the end of the study duration between July and September 2014, 83 individual interviews had been conducted.

3.2 Sampling for individual survey

The individual respondents interviewed for this study were selected through random stratified sampling. The population of DDF participants comprised of people from different nationalities who had participated in meetings organized by the DDF. However, only participants residing in Tanzania were considered. The resident participants were divided into seven strata that included input suppliers, producers, processors, research and academic institutions, development partners, policy makers and traders. A sample from each stratum was then randomly drawn

proportionately to the size of the stratum within the population. The stratification of the respondents enhanced the representativeness of sample. The total number of DDF participants was 114 and out of this, 43 DDF participants were selected. For DDF non-participants, paired sampling was used whereby the respondents sampled would be requested to recommend dairy value chain actors operating within the same value chain actor category and with a similar operational scale. Accordingly, the 43 DDF participants yielded a separate sample of 43 DDF non-participants.

3.3 Data analysis

Descriptive statistics of the quantitative data obtained provided an overview of the characteristics of the population sampled.

A reliability analysis was done using Cronbach's Alpha test to gauge the internal reliability and evaluate the viability of conducting a sensible factor analysis using the data collected for the focus constructs of conduct (information sharing) and of performance (nurturing of smaller platforms). For the conduct data, the Cronbach's Alpha was 0.876 while for the performance data the Cronbach's Alpha was 0.886 against a minimum reliability score requirement of 0.7 (Tavakol and Dennick, 2011). This indicated that there was internal reliability of the data and factor analysis was possible.

Factor analysis was performed to observe the underlying dimensions and enable use of normalized factors for subsequent regression analysis. Varimax rotation was used to ensure that the factor components were orthogonal. The factor analysis reduced the information sharing variables from 12 to three factors with factor loadings ranging from 0.94 to 0.729 (See Table 1).

Likewise, the performance variables were reduced from the initial 12 variables to two factors with factor loadings ranging from 0.911 to 0.392 (Table 2). According to Vaus (2013), all factor loadings above 0.3 can be regarded as significant. All the factor loadings were statistically significant and loaded positively.

Conduct factors were regressed using an overall least-squares regression model against the structural variables to test the influence of DDF structure on the conduct of its participants with a focus on information sharing. A similar procedure was undertaken to regress the performance factors against variables representing conduct. All quantitative analyses were undertaken using

IBM SPSS Statistics 22 for Windows. Finally, the qualitative data collected through the focus group discussions, key stakeholder interviews, aside conversations during the individual surveys and observation of how the DDF participants interacted when they gathered, were used to triangulate and illustrate the relationships identified through the analysis of quantitative data.

4. Results and discussion

Men accounted for 74.7% of the total respondents with the respondent ages ranging from 22 to 71 years. The average age was 44.48 years. Most of the respondents were literate having studied up to the university level (36.1%), primary school (3.6%), high school (7.2%), diploma (12.0%), postgraduate (33.7%), and PhD (6.0%). Participants of DDF meetings accounted for 49.4% of respondents while the rest had not participated, or had no information about DDF. In terms of actor type, policy makers accounted for 27.7%, producers 16.9%, processors 10.8%, research and academic institutions 10.8%, input suppliers 22.9%, and development partners 10.8% of the respondents. One key informant mentioned that the low representation of women in the sample was reflective of the dairy industry where up-to-recently low education levels of women in a relatively man-dominant society had led to women's low level of participation at decision-making or representation level in the dairy industry.

4.1 Relationships between structure and conduct of the DDF

Table 3 shows the result of the regression analysis to identify relationships between structure and conduct of the platform. Attendance in DDF meetings was significant at 95% confidence interval and was positively influencing dissemination of information by DDF to regional platforms and dairy stakeholders. Qualitative data gathered can help explain these results. Participants of DDF meetings would continuously share information with their regional platforms counterparts and stakeholders on the issues discussed during the DDF meeting. This helped the DDF to disseminate information shared during its meetings even to those dairy stakeholders who had been unable to attend. A major motivation for participation in the DDF meetings was to benefit from the information shared by the keynote speakers and between the attending dairy stakeholders. One of the DDF participants interviewed remarked: 'I attend DDF meetings to meet different stakeholders and share information and ideas applicable in my activities and later share with those unable to attend. DDF will ensure that the dairy industry grows because of ease

in coordination among stakeholders. All stakeholders focus on one topic and solve it through DDF.'

Funding source of the organization of the respondent also influenced dissemination of information to regional platforms and stakeholders, significant at 95% confidence interval. In particular, respondents from associations requiring membership fees and government-funded institutions acknowledged the DDF's dissemination of information to regional platforms and dairy stakeholders more than respondents from NGO-funded organizations. This was attributable to the structure of the government's administration and structural hierarchy of associations easing the process of information dissemination. Particularly, the government-associated participants and policy makers invited to the DDF meetings represented the different levels of government including national ministry, regional administrative secretariat, and local government authorities. Membership associations largely comprised of regional and district level producers' associations. The Tanzania Milk Processors Association (TAMPA) was highly rated by processors interviewed during the study in its information sharing efficiency. Producers also had a national association: the Tanzanian Milk Producers Association (TAMPRODA). At the regional and district level, producers had umbrella producers' associations formed by several village and ward level producers' associations. These membership associations at the national, regional and district levels were sending representative participants to DDF meetings. After the DDF meeting, the representative participants would then share the information learned during the forum thereby having a multiplier effect on the dissemination of information shared during the meeting. This eased the flow of information disseminated during DDF meetings. This contrasts with information dissemination by individual DDF participants who were not under obligation to share the knowledge and information gained with dairy value chain actors after the end of the DDF meetings.

4.2 Relationships between conduct and performance of the DDF

The conduct factors for information sharing as well as other general conduct variables were used as independent variables for regression against each of the performance factors. For the independent factors and variables, four were found statistically significant to explain variations in the factor 'DDF nurtures regional platforms': reliability of information from platform partners;

joint planning of activities within platforms; dissemination of information to regional platforms and stakeholders by DDF; and reliability and quality of information shared by other value chain actors (see Table 4).

Notably, whereas increased reliability on information shared between platform partners contributed positively to the nurturing of regional platforms, an increase in quality and reliability of information shared between value chain actors had a negative influence on the nurturing of regional platforms. This is a crucial finding for the DDF as it seeks to nurture more regional and milkshed-level dairy platforms. Value chain actors who had better quality and more reliable information sharing between them did not see the need for innovation platforms because they were comfortable with the interactions and the reliable information that they could exchange between themselves. This hints at the need to understand the quality and reliability of information sharing between value chain actors whenever efforts are being made to nurture regional and milkshed-level dairy innovation platforms. This finding backs previous results by Swaans et al. (2014), who report that inclusive innovation is more easily attainable in settings similar to those of innovation platforms as opposed to pursuing a value chain context to stimulate innovations. Sufficiency in quality and reliability of information being shared between dairy value chain actors will undoubtedly result in declined interest to participate in dairy innovation platforms which have as objective to improve information sharing in their industry.

Dissemination of information to regional platforms and stakeholders, as a conduct factor, positively influenced the nurturing of regional platforms by the DDF. Whereas there were only two regional dairy platforms already established in Tanzania (Tanga and Morogoro), other regions were equally interested in establishing both regional-level dairy platforms and district-level dairy platforms. The finding that dissemination of information was positively influencing the nurturing, growth and development of the regional platforms is therefore a timely finding that will assist the DDF to focus its efforts on effective ways of nurturing regional-level and milkshed-level dairy platforms. In particular, this result provides further justification to the current efforts of the TDB and its development partners to set up innovative communication channels (wiki, radio programmes, mobile phone, text messages) to disseminate its information to dairy stakeholders who cannot attend its meetings.

4.3 Changes in institutions in the Tanzanian dairy industry

The qualitative data gathered from key informants and focus groups provided further evidence on the transition of institutions in the Tanzanian dairy industry. In particular, respondents confirmed that the Dairy Development Forum was an informal mechanism for coordinating dairy stakeholders in Tanzania. It thus contributes to fulfilling one of the Tanzania Dairy Board's roles, as defined by the Dairy Industry Act. This new legal framework has provided a chance for those dairy stakeholders who could not participate in the legally formal and statutory Annual Council of the TDB to participate in the legally informal DDF. Importantly, even though the DDF is an informal legal entity, its establishment was ratified by the Annual Council. Through its open and voluntary participation, the DDF is more inclusive than the Annual Council. Swaans et al. (2014) observed in India and Botswana that formal and informal institutions were crucial partners in enabling a sustained innovation process within innovation platforms.

Qualitative information indicated that the DDF was influencing institutional rearrangements in the Tanzania dairy industry. The TDB has especially benefitted from the DDF in discharging its duties of coordinating the dairy industry in Tanzania. This requires that the TDB continually collect data about the dairy industry, synthesise it and implement its targeted dissemination to dairy industry stakeholders. Through the forum, TDB is able easily to collect national data on the trends in the dairy industry and thereby able to advise its parent ministry on dairy development policies as well as optimal strategies for promoting the Tanzanian dairy industry.

As part of the coordination, it is the role of the TDB to oversee the establishment and facilitation of dairy stakeholder associations. The qualitative data collected by this research ascertained that through the DDF, the TDB has benefited through the consultative engagements of stakeholders focused on nurturing dairy innovation platforms at the regional and district levels and, with greater difficulty, at village level. The TDB and individual actors also have a better platform for advocacy on dairy issues through the DDF. Evidently, the TDB is using the DDF to address institutional constraints it was facing in coordinating and collecting information from dairy stakeholders in Tanzania before the establishment of the DDF. This achievement within the short duration that DDF has been in existence heralds significant institutional realignments within the Tanzania dairy industry. Relating back to Aoki's (2011) framework, DDF is already at the

intermediate level of institutional evolution with interrelationships between different institutions in the Tanzania dairy industry being explored.

5. Conclusions

The conceptual framework proposed by Cadilhon (2013) and used in this study hypothesized that structure of an innovation platform influences the conduct of its participants, which then influences the overall performance of the platform in attaining its present objectives. Our review of the Tanzania DDDF shows that the structure of the platform is influencing the dissemination of information to regional platforms and stakeholders. Secondly, this study has also identified that conduct of the DDF participants in the form of information sharing is contributing to the nurturing of regional platforms, which is a specific development objective of the DDF. Accordingly, we can partially validate the conceptual framework that structure of innovation platforms influences the conduct of their participants, which in turn influences the performance of the platform in terms of achieving its objectives. Further analysis from the data collected and future data collection exercises using similar methods should investigate whether other structure and conduct variables can be linked to other constructs of performance relevant to the DDF. This study also provides baseline data for future comparisons if data collection is continued regularly as part of a monitoring and evaluation framework. The statements and Likert scales used in this research to quantify levels for conduct and performance of the Tanzanian dairy industry actors could be administered in future at regular intervals to DDF participants and other dairy actors so as to monitor the evolution of the conduct elements that are likely to influence attaining the DDF development objectives.

Furthermore, Aoki's (2011) framework of three levels of institutional evolution is also partially validated. The DDF can be considered to be an intermediate level of institutional development whereby the different dairy stakeholders in Tanzania are already exploring ways of partnering to improve the dairy industry in Tanzania. However, the third level that hypothesizes empirical and policy changes in an industry resulting from institutional rearrangements has not been validated by this study. Cognizant that the DDF has been in existence for less than two years, it is still too early to observe changes in policy making as a result of the DDF's undertakings, especially through the work of its task forces. Future research could try revisiting the Tanzanian dairy

industry with Aoki's (2011) framework in mind to see whether the DDF reaches the next level of institutional evolution through influencing policy changes in the Tanzanian dairy sector.

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Tables and Figures

Table 1: Factor analysis for information sharing

	Rotated Component Matrix			
Factors	**Original variables**	1	2	3
Dissemination of information to regional platforms and stakeholders by DDF	8. DDF facilitates information sharing on establishment and management of regional innovation platforms	.940		
	7. The DDF facilitates flow of dairy industry information to regional innovation platforms	.905		
	6. We get enough information from DDF	.765		.349
Quality and reliability of information disseminated by value chain actors	2. The information we get from value chain partners is reliable		.929	
	3a. The information we get from the other platform partners/organization is reliable.		.798	.335
	1. We are satisfied with the quality of information we get from value chain partners	.371	.729	
Information sharing between value chain actors	2a. The information we get from the other platform/ organization partners is useful.			.908
	1a. We usually share information about our activities with other stakeholders.			.854

Factor analysis statistics: Cronbach's Alpha: 0.792; Kaiser-Meyer-Olkin Measure of sampling adequacy: 0.671; Bartlett's test of sphericity chi-square: 229.342 with significance .000.

Table 2: Factor analysis for nurturing of regional platforms

	Rotated Component Matrix		
Factors	**Original variables**	1	2
DDF nurtures regional platforms	7. DDF provides a platform for regional innovation platforms to learn from other successful examples of working IPs	.911	
	5. DDF assists to advocate concerns of regional innovation platforms at the national level	.874	
	8. DDF enables regional innovation platforms to expand their knowledge of dairy innovations.	.851	
	6. DDF encourages regional platforms to change their focus of discussion from time to time	.808	
	3. The DDF is involved in capacity development of members involved in managing working groups and taskforces	.392	
DDF remains neutral in its interactions with regional platforms	12. The DDF remains neutral in its interactions with the activities of working groups and taskforces to ensure they achieve their goals democratically		.806
	11. The DDF remains neutral in its interactions with the activities of regional IPs to ensure they achieve their goals democratically		.802

Factor analysis statistics: Cronbach's Alpha: 0.886; Kaiser-Meyer-Olkin Measure of sampling adequacy: 0.724; Bartlett's test of sphericity chi-square: 331.519 with significance .000.

Table 3: Regression analysis for structure – conduct

Dependent variable: inf1. Dissemination of information to regional platforms and stakeholders by DDF					
	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	-3.207	.942		-3.403	.002
Mem_1a Attendance in DDF meetings	*.332*	*.159*	*.313*	*2.095*	*.047*
Actor: input supplier	-.359	.461	-.162	-.780	.444
Actor: producer	.260	.584	.103	.445	.660
Actor: Development partner	.462	.847	.144	.546	.590
Actor: Academic / Research	-.008	.616	-.003	-.013	.990
Actor: Policy maker	-.136	.596	-.059	-.228	.822
Funding : operation generated*	1.554	.888	.806	1.750	.093
*Funding: Government Funded**	*1.993*	*.806*	*1.010*	*2.473*	*.021*
*Funding: Membership Fees**	*3.099*	*1.188*	*.849*	*2.609*	*.016*
Organization: Government	.867	.526	.433	1.650	.113
Organization: NGO	1.591	1.200	.548	1.326	.198
Organization: Private	.494	.666	.242	.742	.466
Organization: Association	-1.035	1.042	-.323	-.993	.331
Regions: Dar es Salaam	.247	.464	.127	.532	.600
Regions: Tanga	.182	.478	.076	.381	.707
Regions: Others	-.788	.452	-.368	-1.745	.094
Gender: Male	.702	.355	.317	1.978	.060

Model statistics: R-Square: 0.711; Sig.: 0.004.

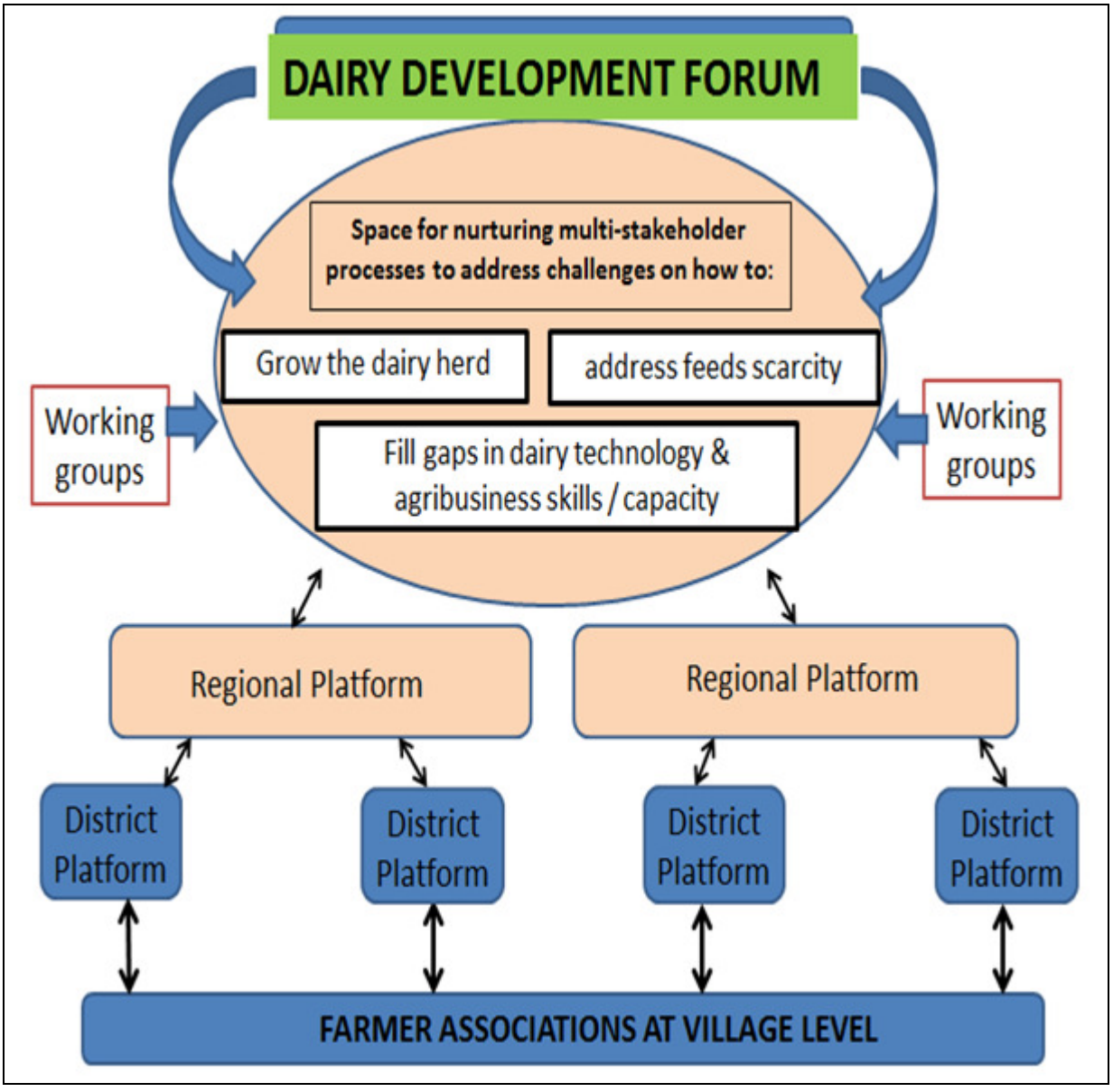
*Control for source of funding: NGO

Table 4: Regression analysis for conduct – performance

Dependent Variable: Nurtactor_1 Nur1. DDF nurtures regional platforms					
	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	-4.748	1.665		-2.851	.007
Con1_3 3a. The information we get from the other platform partners/ organization is reliable.	*1.769*	*.449*	*1.047*	*3.942*	*.000*
Con2_2 5. We use contacts with other platform/ organization actors to get information relevant to our activities.	-.475	.240	-.292	-1.977	.055
Con2_3 6. We are satisfied with the communication frequency we have with other platform / organization members.	-.304	.160	-.284	-1.906	.064
Con5_1 13. We plan our activities together with our platform/ organization partners	*.403*	*.142*	*.393*	*2.843*	*.007*
Infosactor_1 inf1. Dissemination of information to regional platforms and stakeholders by DDF	*.643*	*.138*	*.589*	*4.651*	*.000*
Infosactor_2 Inf2. Quality and reliability of information disseminated by value chain actors	*-.661*	*.274*	*-.583*	*-2.416*	*.020*
Infosactor_3 Inf3. Information sharing between value chain actors	-.244	.160	-.237	-1.522	.136

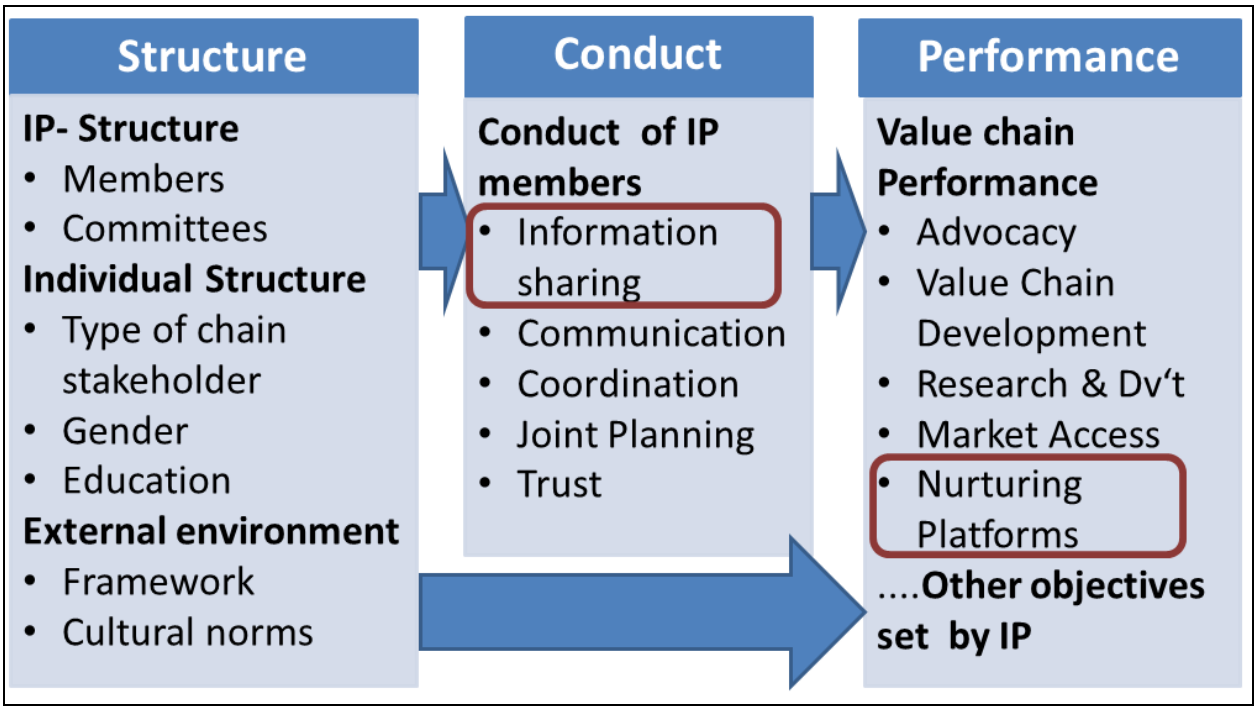
Model statistics: R-Square: 0.464; Sig: 0.000

Figure 1: Structure of the Tanzania Dairy Development Forum



Source: Tanzania Dairy Board

Figure 2: Conceptual framework used for monitoring and evaluating the Tanzania Dairy Development Forum



Source: Adapted from Cadilhon (2013)

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<u>Paper 4:</u> Dairy value chains in Pakistan:

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Dairy value chains in Pakistan: Stakeholders' involvement and constraints analysis

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Abstract

The dairy sector plays a significant role in the national economy of Pakistan. Over the past decade, milk production has risen by more than 35 percent, partly due to the increase of cattle population. The informal sector represents the major end-market with more than 95 percent of the milk sold. This study examines the dairy value chain in Punjab province which accounts for nearly two thirds of milk production in Pakistan. Focus group discussions were conducted with different stakeholders involved in the value chain (producers, inputs providers, traders/retailers, and consumers). Data on various nodes of the dairy value chain including breeding and feeding systems, access to technology and input services as well as information on producers' linkage to the market was collected. Traders/retailers' networks, price setting related to milk quality, and marketing strategies were analyzed. A list of constraints at different levels of value chain was identified, which would assist in prioritizing interventions to increase productivity and resource use efficiency of smallholders.

1. Introduction

Livestock contributes 55.9 percent to agricultural value added much more than the combined contribution of major and minor crops (37.2 percent). Gross value addition of livestock has increased from Rs.756.3 billion (2012-13) to Rs.776.5 billion (2013-14), showing an increase of 2.7 percent as compared to last year. During the same period, milk and meat production has increased by 3.2 and 4.5 percent, respectively (Government of Pakistan, 2014a). Livestock is the single largest subsector within agriculture, accounting for roughly 55.4 percent of agricultural GDP and 35 million people are engaged in livestock-related activities (Government of Pakistan 2012-13b). The recent growth of livestock sector and its contribution in agriculture GDP indicate its enormous potential for economic growth and food security in the country. Historically, subsistence and small holders dominate livestock sector because it is one of the prime source to meet their nutrients and proteins need. In addition to this, it provides food security and cash income on daily basis. Livestock is not only considered a source of risk reduction in agriculture portfolio but it also provides financial security against unfortunate events and calamities, leading to rural population empowerment and socioeconomic development. It can play an important role in poverty alleviation by uplifting the socioeconomic conditions of rural communities in Pakistan.

The high growths of population, urbanization, per-capita income and export opportunities are fueling the demand of livestock and livestock products. Increase in demand and production cost has augmented the retailer's and consumer's price index of milk, meat and by products. It is because Pakistani livestock herd contains substantial number of unproductive and low productive animals, claiming their share in feeding and management and leaving fewer for the more productive stock. As a result, this leads to decrease national averages of milk and meat production. Further, the composition of the national herd is also not economical and appropriate in several ways. This implies that national herd with its present level of per animal productivity is unable to meet the rising demand of livestock products (Iqbal and Munir, 1999).

The productive potential of animals mainly depends on quality of nutrition, genetic makeup and animal health system (Ahuja *et al*., 2003). Basically milk production depends on four dimensions of animal husbandry practices i.e. breeding, feeding, health-care and management practices. Proper breed management and improvement plays a vital role in milk productivity. Therefore,

maintenance of high quality and productive dairy breeds of buffaloes and cattle are crucial to improve the profitability of livestock sector. It is observed that milk production varies from 3 kg/day to 20kg/day and 5 kg/day to 38kg/day in buffaloes and cattle respectively, depending on type of breed. There is general shortage of purebred stock in the provinces. Consequently, majority of farmers practice non-descript and indiscriminate breeding methods in all type of livestock farming. The other issue in cattle and buffaloes breeding is non-availability of high quality breeding bulls and male buffaloes at farm level. Farmers are not aware which breed is more appropriate in the circumstance they are operating and how to achieve and maintain that breed. It is worth to highlight that milk is produced as a primary livestock product; specific breeds for acquiring meat are rarely developed in the country, which in turn affects supply position of meat and meat products for meeting domestic and export demand. It is observed that the same breeds developed for milk production are being used for meat, affecting the farmers' profitability considerably.

Initially, low genetic potential with fewer nutrient supply (lack of concentrate, feed and fodder both in quantity and quality) are considered as leading contributing factors in low milk production. Muzzafar *et al*. (1999) concludes that national livestock is undernourished up to the extent of 30-40 percent and probably it is one of the reasons of low milk productivity. Similar conclusion is drawn by Yadav *et al*. (2014), where they identified feed and fodder scarcity are most limiting factors that account for half of the total loss followed by problems in reproduction and health. Farmers are unaware about the role of balanced diet (concentrate feed and green fodder) in milk production.

Animal health is another important factor that affects the animal milk productivity and profitability of raising livestock. Some diseases may cause heavy financial losses to livestock holders because of high treatment costs, animal death, and reduction in milk production, leaving fewer resources for the remaining animals in stock. Animal health and breed management related problems are poorly handled by individual farmers and provincial government. Traditional practices of management e.g. poor housing, environmentally inappropriate living conditions of animals and limited water supply are being practiced in the area.

The dairy subsector is in the process of commercialization but bulk amount of milk collection from millions of geographically dispersed small farms in a cost-effective mechanism is a big challenge for public and private sector. Milk supply chains involve various marketing intermediaries, ranging from milk collectors locally known as dodhis (dominate traditional marketing channels), to large commercial dairy processing firms. These processors procure milk from small and large farms through modern marketing channels, and after value addition sell packaged UHT-treated milk and other milk products to retailers and big shopping malls (Sadaf and Riaz, 2012). Milk collected through traditional versus modern marketing channels has significant difference in terms of food safety standards and milk quality including fat content (Ayyaz *et al.*, 2011). However, at present, share of milk supply through modern supply chains is very small. Roughly, 97 percent of total milk produced is marketed through traditional channels (informal channels), while the remaining 3 percent is procured and processed by commercial firms. It is important to note that milk consumers in Pakistan are price-conscious because of low per capita income. Therefore, demand for raw milk is high as compare to process milk. On one hand to create awareness among consumers about the risk involved in the use of raw milk is a key area that required attention and on the other hand transportation of milk from rural areas to the processing units timely and safely in a cost affecting manners is another challenging task.

In the light of existing gaps at various nodes of dairy value chain, great potential of research based interventions exists. Some of these interventions could be completed in short duration but some others may require longer time to get affective. Accordingly, interventions can be prioritized with respect to available time and resources. Thus, a closer interaction with different stakeholders of dairy value chain is required to explore appropriate intervention at each node of dairy value chain. By looking at type of constraints, research based interventions could bring a significant change to improve efficiency of entire dairy value chain including livestock productivity per animal. Any such improvement in dairy value chain is also expected to reduce the cost of milk production, shifting the small holders at new production frontier and thus higher profitability level.

In the light of above discussion, the specific objective of present study is to identify constraints faced by different stakeholders involved at different nodes of dairy value chain. By keeping this in view, the International Livestock Research Institute (ILRI), which leads the livestock

component of Agricultural Innovation Program (AIP), conducted a rapid assessment of dairy value chain in selected districts (Bahawalnagar and Jhang) of Punjab province. The Focus Group Discussions (FGDs) with male and female participants are carried out separately by employing well-structured tools to identify constraints faced by different stakeholders involved at different at nodes of dairy value chain.

The identification of constraints through rapid assessment is meaningless without suggesting the possible solution of these constraints. Therefore, AIP/ILRI organized a one day stakeholder consultation meeting with different specialist of dairy value chain to identify the possible solution of these constraints. Among these includes, farmers, veterinary experts, breeders, feed and fodder specialist, economists etc. The possible solutions suggested by the experts are also incorporated at the end of this report.

2. Methodology and site selection procedure

In order to select the study site we purposely selected divisions, districts and tehsils and afterwards we randomly selected two villages in each selected tehsil. Livestock population data is collected for all divisions of Punjab province to identify the most representative divisions based on highest number of dairy animals (cattle and buffalo). Faisalabad and Bahawalpur divisions have been selected for our dairy value chain rapid assessment. The same criterion of highest number of dairy animal is employed to select district in Faisalabad and Bahawalpur divisions. Thereafter, livestock population data of all districts of Faisalabad and Bahawalpur divisions have been compiled to identify the most representative districts within each of these two divisions. Finally, District Jhang and Bahawalnagar are selected for the project sites.

Finally, after selecting most representative districts, the third step was the selection of tehsils (sub-administrative unit of district). Subsequently, we gathered tehsil wise livestock population data from District Livestock and Dairy Development Department (L&DDD) of Jhang and Bahawalnagar. Three tehsils were selected: one from Jhang and two from Bahawalnagar namely Jhang, Bahawalnagar and Haroonabad, respectively. The justification of selecting two tehsils in Bahawalnagar district is that it is one of the poorest districts in Punjab province in terms of per-capita income and infrastructure. Haroonabad tehsil is selected because its larger share of agriculture area falls under Cholistan desert and very little areas have access to irrigation

facilities. However, majority of the agriculture area in Bahawalnagar tehsil has good access to irrigation facilities. Ground water quality conditions also vary in these tehsils. This will allow us to compare between the two different areas which have different characteristics but are adjacent to each other.

Afterwards, two villages from each tehsils were randomly selected by taking care that selected villages should be at least 15 kilometers apart from each other and 15 km away from the city center. We gathered 20-25 livestock male and female farmers in two separate groups to investigate different practices on feeding, breeding, epidemiology and for the assessment of dairy value chain. FGD's of male and female were conducted separately because social barrier do not allow joint FGD's of male and female in Pakistan. Our trained male and female enumerators interviewed each gender group. In order to give broader coverage, it was taken care that female participants in each focus group discussion belong to different families than males.

The input service providers are competing with each other to capture the bigger share of limited market. Therefore, surveys with different input service providers in each village were conducted on individual basis in order to avoid any conflict. The appointment with these input suppliers was made in advance in each village through resource person to assure respondents' availability in the village. Milk vendors and retailors were identified in each village with the help of resource person to map the flow of milk and to quantify its movement. This helps us to map the dairy value chain in each village. The problems and constraints faced by milk vendors and traders were also identified to develop and introduce possible interventions to break these constraints in the project sites.

3. Results and discussion

3.1. Importance of animals, source of income and role of women in livestock

In the FGDs questionnaires, first session is on general information assessment tool dealing with reasons of keeping animals, livestock population and sources of income. Because of limited space basic information about family structure has been excluded.

The investigation of reason to keep animals helps to identify and prioritize possible interventions at farm level. While conducting FGDs, we ask farmer an open question to give three major

reasons of keeping animals. The overall percentage distribution of farmers indicate first most important reason of keeping animals is of milk production (89 percent) while 52 percent of farmers consider animals as cash in hand (Figure 1). Fattening is ranked third most important reasons of keeping animals. The results indicate that farmers in the study areas are keeping animals mainly for milk production, implying that they could be interested to have breeds with higher milk production. Therefore, there is a scope for future research to identify high milk production breeds in these areas. The final objective of fattening the animals is to earn money by selling them; therefore, animals as liquid money and fattening could be interrelated, implying that research should focus to find out the ways that can help farmers to increase animals' weight in minimum duration of time with least cost. This requires further innovations in feed, fodder, identification of area specific breed and management related issues.

<< Insert Figure 1>>

Farmers were asked about their major sources of income, and the contribution of each source in terms of percentage. In order to clear the concept of percentage, we used 100 counters (beans) to distribute it among various income sources. It is important to note that results are based on pooled information of male and female FGDs and across all villages. Results indicate that crops are contributing highest followed by livestock, non-farming activities and remittances (Figure 2). This implies livestock is second biggest source of income among rural community.

<< Insert Figure 2>>

Female participation in livestock farming activity is significant in developing world. Through FGDs we attempted to investigate the allocation of time of different family members for different activities. We specifically asked participants about their time allocation on a busy day among different activities during particular time interval. Results are based on pool data from male and female FGDs conducted separately by male and female enumerators respectively, in each village. Table 1 summarizes the allocation of time by different family members from 5am to 7pm.

<< Insert Table 1 >>

The results indicate that from 5am to 12pm, 53 percent of household head (husbands) are involved with animals while 50 percent of the wives are busy in helping their children. In the

same time interval (5 am to 12 pm), other family members (male and female) are also involved in different activities. Interestingly, 35 percent of male family members other than household heads are busy in education related activities while 29 percent of female family members are involved in helping their younger brothers and sisters to prepare them for school. A small number of husbands (18 percent), wives (12 percent), and both young male and female (18 percent) are allocating their time for crops. It is worth to note that the same numbers of young male (18 percent) and slightly less numbers of young female (12 percent) are allocating their time to take care of the animals. However, it is interesting to highlight that no husband is allocating time to animals within this time interval while 18 percent of the wives are devoting their time to animal husbandry which are even more than the number of wives allocating time to crops (only 12 percent). If we simply add up the percentage of wives and young female (22+12=30 percent) who allocate time to animals and compare it with the total proportion of husband and young male (18 percent), it shows that more female are working with animals within this time interval (5am to 12pm). Hired male labors are involved in both crop field and livestock activities, but most of them work in crop field (70 percent) from 5am to 12pm.

In the second time bracket (12pm to 3pm), 59 percent of household head (husbands) eat and sleep while 42 percent of the wives are busy in cooking. Among the young male 44 percent spend their time in eating and sleeping and only 22 percent spend their time in taking care of the animals. It is important to note that 60 percent of hired labors work with animals during this time interval. The conclusion is, only young males and hired laborers take care of animals within this time interval.

During the third time bracket (3pm to 7pm), highest number of household heads (42 percent) work with animal comparing with those who work in the fields (29 percent). Also the highest numbers of wives (35 percent) allocate their time to animals and in addition to this 12 percent of young women are involved in animal related activities. Evening is crucial time when lot of activities has to take place related to animals such as milking, feeding, watering, and selling milk. All these agricultural activities are labor intensive. That is why 65 percent of hired labors are also involved in animal husbandry during this time interval. If we consider the in-depth analysis of total family labor, then again it is clear that more females (wives and young girls) are spending their time taking care of animals during this time interval.

Overall, it is clear that females are more intensively involved in taking care of animals than males. This implies that promoting dairy sector in Pakistan is a direct source of providing employment to uneducated rural women at their door step. This will help them to increase their economic power (empowering women), as livestock is significantly contributing in household's total income.

3.2. Feed assessment

Feed assessment is one of the most important components in keeping animals and to get highest milk production. Therefore, before suggesting any intervention it is important to understand seasonal feed availability, feed use, feed conservation strategies being adopted, feed quality measurements and the technical/institutional support in terms of services, if any. These variables have significant variation across villages (within the study area) that need to be identified. In depth exposure of feed related farm practices helps to develop for possible interventions for the study areas.

Four feeding systems are prevailing in Punjab province. These are stall feeding, grazing cum stall feeding, grazing in field and nomadic. These feeding systems vary for a particular region with the change in seasons. Variation in feeding system has impact on milk production. Therefore, it is interesting to study the variation in feeding systems across seasons and regions. There are four seasons in Pakistan, spring, summer, rainy season (monsoon) and winter. As mentioned earlier, we joined data of male and female focus group discussions which were conducted separately in each village by male and female enumerators, respectively. Results are based on joint information from both groups. Nomadic system does not prevail in the study areas and mainly two feeding systems exist, i.e. stall feeding, and grazing cum stall feeding. It is generally observed that stall feeding is dominant in all seasons and in majority of the villages. However, percentage distribution across seasons also indicates that grazing cum stall feeding is common in summer and rainy season compared to spring and winter.

Feeding systems not only affect animal health but also milk production. Farmers adopt different feeding systems for different types of animals in each of the four seasons in order to use their limited resources efficiently. It is observed that heifers, males and young males are being treated differently in terms of feeding than lactating and non-lactating females. Similarly, lactating and

non-lactating females are treated differently in terms of feeding system. Result of the FGDs indicates that stall feeding is dominant almost in all villages and seasons for all kind of animals.

Availability of green fodder (fodder and forage) may vary within the months throughout the years, depending on cropping pattern, temperature and availability of water. We ask the farmer during FGDs about the availability of fodder on Likert scale (0-10) for each month. The lowest number, 0 indicates that no green fodder is available, 1-3 stands for extremely short, 4-5 indicates that fodder is just adequate and as we move above 5 it reflects fodder is more than needed. The highest number 9-10 stands for surplus of green fodder. We pool the data for all villages across genders by month to investigate the overall situation in the study area. Result of compiled data provides evidence of extreme shortage of green fodder during the period of April to June (Figure 3). Most probably it is due to extremely high temperature and minimum rains during these three months. In addition, there is also shortage of canal irrigation water during this period. This implies that any possible intervention in order to improve the supply of green fodder during these specific months should take care of water related constraints mentioned above. The identification of critical months through FGD's in terms fodder supply is extremely useful because it draws attention of researchers, policy makers and business community to adopt an appropriate strategy to ensure continuous supply of green fodder to livestock. Among these strategies could be green fodder conservation (silage) practices or introduction of new fodder and grass varieties.

<< Insert Figure 3 >>

In dairy value chain, livestock farmers use different types of feeds to get highest milk production from their animals. In order to investigate the contribution of different kinds of feeds in each month, we asked farmers to give weight to each type of feed in the range 0 to 10 in such a way that if we add-up these numbers then it should not exceed more than 10, indicating that one digit can represent 10 percentile. The largest number represents the highest contribution of that particular type of feed.

It is observed from the farmers' response that major feeds include, crop residues (wheat and rice straw, maize, sorghum stover, etc.), green forage (grass, weeds, fodder crops) and concentrates (compounded feeds, feed ingredients e.g. brans, grains, oilseed cakes, etc.) in all six villages. In

addition to this there is minor contribution of grazing and conserved feeds. On the basis of overall situation in all six villages, we conclude that contribution of crop residues is highest in May and June and lowest in March (Figure 4). The lowest consumption in March is mainly because two villages (Noor Sar and 67/4-R) are not using any crop residue in this month. Moving average trend indicates that contribution of crop residues in total feed decreases during February to April, increases from April to June and then sharply declines from June to August. Starting from August to November it slightly increases. This is probably due to the crop harvest period and also to the lack of fodder and forage during the period of April-June

<< Insert Figure 4 >>

The overall situation for all six villages indicate that contribution of green forage is minimal during the months of May and June when availability of crop residues is maximal, and highest during the months of March and July (when availability of crop residues is lowest) followed by April and December (Figure 5). Moving average trend indicates that how the contribution of green forage increases and decreases over the year. This indicates that there is cycle of availability or contribution of green forage in total feed which indirectly relates with cropping pattern.

<< Insert Figure 5 >>

Based on pool data for male and female FGD's and for all six villages, analysis indicate that use of concentrates is minimal in the study area round the year except in January, February, and November when it is slightly higher than minimum (Figure 6). The moving average trend also does not indicate high variation in the contribution of concentrates in total feed over different months of the year. The low use of concentrates might be due to limited financial resources or lack of awareness about the contribution of concentrates in milk production.

From the above discussion it is generally observed that farmers are not selecting a balanced diet (a proper combination of different feeds) in order to maximize the profitability from livestock. Rather farmers are serving animals by offering a higher proportion of crop residues or green forage depending on the availability but their decision is not based on profit maximization. Most probably it is due to lack of information about the contribution of balanced diet in milk production and fattening. Based on this information, the International Livestock Research

Institute (ILRI) team can play an important role by filling such information gap among farmer's community with the collaboration of local extension officers.

<< Insert Figure 6 >>

3.3. Relationship of water and feeding system with milk production and fodder value chain

Water is an important element for the survival of any living organism. There are different sources of water that are being used for livestock in the study areas. The water availability varies in summer and winter season due to variation in rainfalls. Although, there are four seasons in Pakistan but in terms of water availability and its use for livestock these four seasons can be merged into two seasons. These are summer season (April-October) and winter season (November-March). The analysis from the focus group discussions confirm that there are two main sources of water both in summer and winter seasons in each village, i.e. pound water and tab water. The water in pound is being stored from canal or rain while tab water is being supplied through pipelines by the government. It is generally observed that majority of the farmers are using pound water for their livestock in both summer and winter seasons. In summer season because of high temperature farmers are relying more on pound water. When farmers are asked how many times animals are being served with water in a day. Majority of the livestock farmers are serving their animals twice a day in both seasons (summer and winter) and there are few who are serving thrice a day only summer. Less than one percent farmers are giving open excess to water to their animals. As milk contains 77 percent of water, implying that milk production strongly correlates with the availability of water to animals. This indicates that huge potential exists to enhance milk production simply by improving water availability to animals.

Beside the contribution of water in milk production, we also attempted to investigate the relationship between feeding system and milk production. Results indicate that milk production with stall feeding and grazing cum stall feeding varies between high to very high in all four seasons except in summer season when milk production goes down because of extremely high temperatures (Figure 7). On the other hand milk production with grazing in field varies from low in winter season to intermediate in spring and rainy seasons while in summer milk production with grazing is also very low. However, low milk production with grazing in field during winter,

spring and rainy seasons cannot solely be referred to low nutritive feed rather it is because majority of animals which are completely depending on grazing are approaching to dry period.

<< Insert Figure 7 >>

We also attempted to investigate the flow of fodder and therefore, we interviewed different actors involved in the "fodder value chain". We specifically asked the farmers how many of you are selling fodder and to whom. Similarly, we asked them how many of you are buying fodder and from whom. As previously discussed, there is a shortage of green fodder during specific months of the year. Therefore, subsistence livestock farmers purchased green fodder from different channels. The results indicated that 50 percent of the livestock farmers purchase green fodder from fellow farmers while 29 percent of the farmers purchase fodder from retail shops (local name "tall") to fulfill their fodder requirement in lean period. These retailers purchase fodder in standing form from big farmers. Some farmers are selling and others are buying green fodder in standing form (cut and carry). It is observed that 14 percent of the farmers also purchased green fodder from landlords in standing form (Figure 8).

<< Insert Figure 8 >>

Two sale channels of green fodder are most popular among livestock farmers in the study villages which include fellow farmers and retail shops. It is observed that 50 percent and 14 percent of the farmers sell their excess fodder to the fellow farmers and to retail shops, respectively (Figure 8). Results of the FGDs reveal that only few farmers are aware about fodder conservation methods but no one is conserving the fodder for the months when there is extreme shortage.

3.4. Ranking of breeds, breeding techniques, success rate and availability of semen

We attempt to rank different breeds by using farmer's knowledge about different characteristics of each breed. This helps to understand the parameters on the basis of which farmers are deciding future animal's breed. This leads to identify characteristics of the animals that are important to farmers. In-depth understanding of farmer's decision making process can help us to determine the direction of future breeding research. It is observed that most common breeds of cattle are, Shaiwal, Cholistani, Friesian, Jersey and cross bred while most popular breed of

buffaloes is Neeli Ravi. The percentage distribution of farmers having these breeds varies from area to area.

We further try to understand from the farmer's point of view what are the most preferred characteristics of these breeds. Through cheap talk first we enlightened the farmers about these characteristics (high milk production, early maturity, adaptability, calving rate, survival in drought, fattening, low price to purchase, demands less feed, etc.). We asked the farmer to give weight to each trait (characteristic) in such a way that total weight should not exceed 100, so that weight given by farmers can be translated directly into percentage. We further investigated the relative importance of these traits. We asked them to select one possible option for each trait among three options, i.e. (very important, important and least important).

Based on FGD's, it is observed that characteristics of high milk production and adjustability with changing weather conditions in Sahiwal breed are highly demanding and popular among farmers. Overall, weight given by farmers to the characteristic of high milk production is dominant followed by the weight given to adaptability (flexible to weather conditions). Therefore, breeders should further focus to improve these traits in Sahiwal breed.

Among the study area, Cholistani breed exists only in Bahawalnager district. It is not dominant because less than 30 percent farmers are keeping this breed. The district is facing serious irrigation water deficiency and fodder crop cannot compete with cash crops, creating fodder deficiency for animals. Farmers have very clear understanding that animals from Cholistani breed are consuming less feed. This is the reason why Cholistani breed is popular in Bahawalnagar district. Weather conditions are harsh especially in summer season when temperature rises to 50°C. Cholistani breed has ability to survive in harsh environment. When we investigated what are the important characteristic of this breed, farmer's response are exactly matching with the prevailing conditions in the area. Farmers believe that Cholistani breed is consuming less feed and their response varies from 39 percent to 90 percent and moreover, this characteristic is weighted as very important. The second most important characteristic of Cholistani breed observed by farmers is adaptability (flexibility to survive in harsh environment). It emerges from discussion that Cholistani breed is more appropriate for Bahawalnager district but its presence is not that high as it should be. This, implies, researchers have potential to

intervene by creating awareness among farmers about the quality and characteristics of Cholistani breed.

Friesian is another commonly observed breed in all villages of the study area. High milk production, high calving rate, prettiness, adaptability, low price and early maturity are common features of this breed. Farmers gave highest weight to high milk production trait followed by high calving rate and early maturity. In addition to this, farmers in all villages believe that high milk production and early maturity characteristics in Friesian are of high importance, implying that these traits demands breeder's attention for further innovation.

Cross breed is not very common and farmers give highest weight to adaptability followed by high milk production and high calving rate for this breed. However, in terms of relative importance adaptability and high milk production traits get highest importance.

Neeli Ravi is the second most important breed after Sahiwal which is present in all villages of our study area. The most important features of this breed are best milk quality, high milk production, adaptability and high calving rate. It is interesting to note that farmers give highest weight to best milk quality trait in all villages of our study area, implying that Neeli Ravi breed has best milk quality. Moreover, they believe that best quality milk is the most important trait of Neeli Ravi. The second most important trait observed by farmers is high milk production. Based on the above discussion, it is important to identify the parameters that determine the high quality of milk so that breeders can further focus to improve those parameters. In addition to this breeders should explore phenotype characteristic of Neeli Ravi breed that are responsible of high milk production. The identification of such characteristic would help to improve milk production of Neeli Ravi breed. Only six percent farmers in one village village are keeping Jersey breed and farmers give 100 weights to high milk production trait. Farmers believe that this characteristic is of high importance.

After discussing about the strengths and weaknesses of different breeds from farmers' perspective we try to investigate breeding techniques, their success rate and source of supply. In this section of breeding tools we try to get the percentage of farmers (within participants' of focus group discussions) using different breeding techniques (natural, artificial and both) for insemination. We divided our discussion in two sections, first we gathered information about

percentage of farmers using different techniques of breeding (insemination) in cattle and then in buffaloes. Subsequently corresponding to each breeding technique we tried to investigate the source of breeding material. Finally, we also tried to explore the success rate of each breeding technique. Among the service providers' major player includes: fellow farmers, landlords, technicians and private practitioners who are responsible to provided AI services in the study area. These information about breeding techniques, their success rate and sources of supply helps to identify possible interventions to improve the supply chain of breeding material.

Artificial insemination (AI) in cattle varies from nine percent to 88 percent while the success rate fluctuates from six percent to 77 percent, indicating the presence of enormous potential both at delivery level and on the part of technicians' capacity building process that can be explored to make significant improvement in adoption and success rate. If we look at service providers in all villages then it is evident that only private practitioners and diploma holders are involved in providing AI services and no veterinary doctor or government hospital provides AI services in any of study village. Many of these private practitioners even don't hold any certified diploma and they learned AI from some veterinary doctor or technician. Therefore, a large potential exists that can be procured through capacity building of technician, improving awareness about AI among farmers.

Farmers who are practicing only natural insemination (NI) in cattle through bull vary from 12 percent to 48 percent and its success rate varies from 15 percent to 85 percent. In case of NI it is difficult to control and maintain high quality breeds because suppliers of NI services are not business oriented rather majority of them are keeping bull for some other purposes (plowing, pulling cart to transport feed and fodder, pulling water from well, etc.). Therefore, it is preferable to motivate farmers to adopt AI technique but in order to do so it is important to improve the services of AI at farm level. NI services are mainly provided by fellow farmers or landlord and in majority of the cases at free of cost.

Farmers practicing only AI in buffaloes are few and the proportion of farmers in this category varies from zero percent to 64 percent. Subsequently, success rate of AI in buffaloes varies from 20 percent to 80 percent which is not as low as in the case of AI in cattle. On the supply side, practitioners are the only sources of AI in buffaloes. Just like in cattle, huge potential of AI exists

in buffaloes that can be explored. Before introducing any innovation, it is important to investigate among the two players (farmers, private practitioners) who are responsible of low adoption of AI in buffaloes. If the constraint is on the adoption side, then it is important to work with farmers to improve their awareness about AI in buffaloes. It might be the case that farmers are reluctant to adopt AI in buffaloes because of low success rate, unavailability of AI services and high costs. Then intervention is required to improve its success through training of private practitioners. In order to improve the availability of AI services, market based option needs to explore to enhance the supply of AI in buffaloes.

There are different challenges (constraints) faced by farmers while adopting any breeding technique of their choice. In order to identify these constraints, farmers employing any particular breeding technique (AI, NI or both) are asked to report one major limitation faced by them in availing that specific breeding technique. These constraints are listed in the table of constraints, which includes lack of information about breed, unskilled technicians, unavailability of quality semen, and unavailability of government services.

We also attempted to explore farmer's constraints in availing different kind of breeding material. We specifically asked them which types of breeds are available under AI services. Semen availability of Cholistani breed is very low but it can survive under feed constraint and in harsh environment. Similarly, in farmer's opinion Friesian is assumed to be highly milk producing breed but the availability of semen of these breeds are not common. In buffaloes Neeli Ravi is assumed to be high milk producing breed but again semen of pure Neeli Ravi is rarely available. Partially, this explains why adoption of AI is low both in cattle and buffaloes. In order to boost AI technique in the study area, special attention is required to increase the supply of Cholistani, Friesian and Neeli Ravi semen.

3.5. Epidemiology Assessment

Animal diseases are an integral part of dairy value chain. Through FGDs with farmers, we tried to investigate the major diseases of animals in all study areas. At the first stage we asked the farmers what percentage of animals gets sick and then we assumed that these sick animals are equal to 100 percent. Subsequently, we asked the farmers to allocate sick animals among different diseases in such a way that summation of these sick animals should be equal to 100.

Finally, we asked them among the sick animals how many died due to each disease and we converted these dead animals into percentage of sick animals. In fact we did all this process by giving 100 beans to farmers and asked them to assume that these are your animals in whole village. We asked them to divide the beans into two parts, one for healthy animals and second for sick animals. We counted the beans under sick animals and in this way we find the percentage of sick animals. One of the enumerator asked the participants of FGDs to state the possible diseases in the village and he/she wrote the disease on a chart. Subsequently, we mixed the beans to make it 100 and asked the participants to assume that these are total number of sick animals in the village and now allocate these beans to different diseases written on the chart. In this way we got percentage of sick animals from each disease. Then we ask them to shift the beans below under each disease equal to the number of animals died with that particular disease (Figure 9).

<< Insert Figure 9 >>

It should be noted that data reported in Figure 9 is not based on real information rather it is just to explain the process. Our results based on FGD's demonstrate that HS is the deadly disease which is responsible for highest percentage of deaths in all sites of our study area followed by Black Quarter and Babesiosis. Vaccination in advance to control these diseases could be an effective tool to minimize or control the deaths.

In addition to this it was also observed that farmers more frequently interact with quacks not only for general information but also to discuss drugs and treatment related issues than any other source information. It might be, in farmer's opinion quacks have more authenticated and reliable information than any other person who is also accessible to them. However, it should be noted that quacks are not highly qualified and cannot provide scientific based information to farmers, indicating an existence of potential for improvement.

3.6. Value chain mapping

We tried to map the milk value chain by investigating major actors that includes producers and milk vendors. We pooled the data for all study sites and based on average values we mapped the milk value chain to get the more meaningful insight. In dairy milk value chain, there are different actors involved like dodhis, milk collection centers (MCC), hotels/sweet shops, milk shops and consumers (urban and rural) as shown in Figure 10.

It is observed that 10 percent of the milk is consumed by farmers while the rest is sold to Dodhis (54 percent), MCC (21 percent), milk shops (2 percent), rural consumers (4 percent) and urban consumers (9 percent). These figures demonstrate that dodhis and collection centers buy 75 percent of total milk production from farmers and play a key role in the milk value chain. Farmer's families also consume 10 percent of total milk production. It is important to note that more than fifty percent milk (54 percent) reaches consumers through dodhis (a traditional approach) while only 21 percent of the producers directly sell milk to collection centers, indicating the existence of large potential. This implies that farmers can increase their profitability by directly selling milk to collection centers. It is worth mentioning that dodhis also sell 36 percent of their total milk collection to collection centers at a higher price than they pay to farmers, indicating that farmers' money is going in dodhis pocket. However, we tried to investigate why farmers are not selling milk directly to collection centers. We find multiple reasons of it that includes, farmers' financial constraints motivate them to involve in check off services with dodhis, large distance to collection centers make it uneconomical and farmer's time constraint. Dodhis mainly sell milk to urban consumers (42 percent), collection centers (36 percent) and to hotels/sweet shops (13 percent). Dodhis are the main source of supplying milk to urban consumers but milk is being transported through unrefrigerated vehicles in all study sites. The majority of milk collection centers are established by Nestle, Engro and Haleeb.

<< Insert Figure 10 >>

It is surprising to note that nine percent of urban consumers purchase milk directly from farmers, indicating that they are not satisfied with the quality of milk supplied by dodhis or prices of milk at village level are significantly low. However, based on our personal observation we can argue, price difference between rural and urban areas is not that high to cover the opportunity cost of travelling on daily basis. This also reflects that people in urban areas are willing to spend more for high quality of milk because they are travelling long distances to buy it. This implies that urban consumers are willing to pay more than the prevailing price at least equal to the transportation cost plus the opportunity cost of their time. This reflects an opportunity for unemployed people to get involved in supplying highly quality milk to urban consumers.

Although, consumers come at the last end of dairy value chain but they are prime user of all products being produced as a result of different processes taking place within the value chain.

Hence, it is worth to say that whole chain completely depends on determinant of consumers' demand which includes preference for quality and willingness to pay for it, their purchasing power and preferences for taste. Consumers have their own decision criteria to purchase high quality product but at lowest possible prices. We have attempted to investigate the consumer's sources of buying milk and milk products such as yogurt, deshi gee and butter and how they weighted the importance of these products for their family. It is important to note that our results based on individual consumer survey which was conducted with rural consumers only. We surveyed 13 to 15 consumers in each village. Purposely we included more non-livestock farmers in our survey to investigate the major sources of supply of milk and its byproducts to non-livestock rural community. It is observed that majority of the rural consumers are purchasing milk from neighbor livestock farmers. It is further observed that percentage distribution of yogurt consumers under the option of home produced is comparatively higher than that of home produced milk. This indicates, that even those consumers who are purchasing milk from neighbors prefer to prepare yogurt at home rather to buy it from retailers (village shops). There are three major sources of supplying dehsi ghee to consumers which includes, home production, neighbor farmers and dairies. Our result reveals that distribution of consumers among different sources is scattered but majority of the consumers are relying on neighbor farmers to purchase dehsi ghee. Butter is another byproduct of milk which is also prepared from yogurt. Again neighbor farmers are the main source of supply of butter to consumers.

3.7. Consultation Meeting on Dairy Value Chain Assessment

Dairy value chain rapid assessment (DVC-RA) identifies various constraints faced by stakeholders at different nodes of the chain. In order to improve the efficiency and profitability of DVC, exploring and implementing the solutions of above constraints is the next challenging task. Solutions of constraints are explored by conducting a one day brainstorming session with livestock experts from all over the country. The session served as a foundation stone for developing action plan of AIP/ILRI livestock future activities. Hence, all future activities will be based on interventions suggested by the knowledgeable experts during brain storming session. The participants of this consultation meeting have been divided into three groups; namely management and animal health, feeds, fodder and rangeland and reproduction and breeding. The solutions of the constraints cited above under different sections of the report are summarized in

Table 2. It might not be possible for AIP livestock component to implement solutions or introduce intervention to break each and every constraint. It might be that some of these constraints do not fall in ILRI's purview. Therefore, suggested interventions are prioritized by looking at the availability of resources and timeframe to implement them at farmer's field.

<< Insert Table 2 >>

4. Summary and conclusions

Results of FGDs identified many potential areas in dairy value chain paving the way for significant improvement. These constraints can be classified into short, medium and long term strategies. There are constraints that could be resolved in short duration of time by making small investments and improving farm management through participatory approach and creating awareness. Other constraints require medium term strategies which include development of physical infrastructure at community level and improvement in the structure of input services delivery. Some other issues demand longer term strategies involving research activities. However, each category of constraints require scientific based interventions to exploit existing potential at different levels of dairy value chain.

It was observed that the contribution of crops in total income is highest followed by livestock, non-farming activities and remittances, implying that livestock is becoming second largest source of income. The results of FGDs, indicated that farmers are keeping animals mainly for milk production. This implies that breeders should concentrate to develop area specific high milk production breeds. Hence, there is a scope of future research to identify and develop high milk producing breeds in Pakistan's Punjab, especially in relation to cattle.

Females are also involved in taking care of animals. This implies that promoting dairy sector in Pakistan is a direct source of providing employment torural women. Expansion of livestock sector could help them to increase their economic well being, because livestock is significantly contributing in household's total income.

Regarding the availability of green fodder in different months of the year, extreme shortage of green fodder during the period of April to June was observed. Most probably it is due to high temperature, minimum rains and shortage of canal water during these three months. Hence, any

possible intervention in order to improve the supply of green fodder during these specific months should overcome these constraints. Regarding water availability, it is generally observed that majority of the farmers are using pond water for their livestock in both summer and winter seasons. In addition to this, majority of farmers are watering their animals twice a day which is affecting milk production.

To prepare an effective action plan for improvement and betterment of dairy animals, AIP/ILRI organized a one day expert consultation meeting with different stakeholders (academic, scientists, private enterprises). The experts were divided into three groups, namely; feeds, fodder and rangeland, reproduction and breeding, and management and animal health. Problems/constraints related to the respective disciplines were shared with the groups to identify possible solutions. The experts suggested possible solutions to various constraints faced by different stake holders at different nodes of dairy value chain.

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Table 1. Activity clock by family members for 14 working hours

Members		5 am -12 pm	%	12-3 pm	%	3-7 pm	%
Husband		Involve in animal	53	Involve in animal	-	Working with animals	42
		Involve in crops	18	Eating and sleeping	59	Working in fields	29
		Helping Children	-	Working in fields	23	Watching TV	19
		Business (input suppliers etc.)	29	Teaching children	18	Talking with Farmers	10
Wife		Involve in animal	18	Eating and sleeping	24	Working with animals	35
		Involve in crops	12	Working in fields	17	Working in fields	10
		Helping Children	50	Teaching children	17	Watching TV	25
		Breakfast	20	Cooking	42	Talking with Farmers	20
		Knitting	18	-	-	Teaching children	10
Other family member	M	Involve in animal	18	Involve in animal	22	Involve in animal	18
		Involve in crops	18	Eating and sleeping	44	Eating and sleeping	29
		Helping Children	29	Working in fields	12	Working in fields	35
		Study	35	Teaching children	10	Teaching children	-
		-	_	Game	12	Game	18
	F	Involve in animal	12	Involve in animal	-	Involve in animal	12
		Involve in crops	18	Eating and sleeping	18	Talking with friend	24
		Helping Children	29	Working in fields	29	Working in fields	12
		Breakfast	21	Teaching children	20	Study	18
		Study	20	Lunch	33	Dinner	24
Hired labor		Involve in animal	30	Involve in animal	60	Involve in animal	65
		Involve in crops	70	Eating and sleeping	40	Working in fields	15
		Helping Children	-	Working in fields	-	Talking with friend	10
		Involve other activities	-	Teaching children	-	Game	06
		-	-	-	-	Watching TV	04

Table 2. List of constraints and possible interventions

Constraints	Interventions
Feeds, Fodder and Rangeland	
Constraints	**Interventions**
1. Adulteration and high prices of concentrate feed and absence of law to ensure high quality concentrate feed	1. Currently majority of the feed supplier are not even mentioning the ingredients on concentrate feed bags. Without knowing the ingredients it is difficult to evaluate the existing market price of these products. Therefore, government should play its effective role to supply the high quality feed at reasonable prices.
2. Unavailability of inputs in the vicinity of village	2. ILRI is planning to provide technical assistance to landlords in establishing silage business which will ensure the availability of fodder to small livestock growers in the vicinity of village. 2.1. National Research (NR) institutes should play their role to train farmers how to produce concentrate feed. ILRI is also taking initiative to provide different methodologies to farmers to produce concentrate feed by using their own ingredients (inputs). 2.2. ILRI is taking initiative to teach farmers that how to recognize breed by looking at the color of straw so that farmers should not be betrayed by technician.
3. Lack of awareness among farmers about balanced diet	3. An intensive capacity building process is required to aware farmers about balance diet. ILRI is establishing farmers' teaching school to demonstrate different technologies including balance diet. ILRI is also in the process to develop and distribute a feed chat that will help farmers to decide a combination of feeds based on animal weight.
4. Scarcity of good quality fodder seed, information and financial constraint	4. ILRI is in the process to identify best maize fodder variety in terms of highest amount of nutrients. In addition to this ILRI is in the trial process to distribute seed of "Rhod grass" to farmers to motivate for a multi-cut grass. 4.1. Private seed suppliers are also helping to fill this gap. 4.2. In order to break the financial constraint government can increase the amount of credit flow in livestock sector.
5. Extreme shortage of	5. One possible option is to create awareness among farmers to promote

green forage during April to June	silage and hay. Second possible solution is to motivate big landlords to start the business of making silage in each of the area. ILRI will work on both directions to minimize the shortage of green forage during these months.
6. Limited financial resources restrict to expand livestock	6. Livestock sector is contributing 55% in agriculture GDP and government of Pakistan should increase the credit flow in this sector accordingly. This will definitely help to break the financial constraint in order to expand the livestock sector.
7. Scarcity of water for irrigation and animal rearing	7. Scarcity of water for crop irrigation is a policy issue and research institute like (ILRI) and NAR's are not in a position to do something for it. However, water for animal should not be a constraint because animal can drink pound water, bore water and canal water and at least one of these options is available in each village. However, non-availability of water to animals round the clock could seriously affect milk production. ILRI will attempt to create awareness about the importance of water for milk production among farmers through farmer's teaching school in the study area.
8. Fodder can't compete with cash crops, making fodder crop uneconomical	8. Multi-cut fodder crops that can compete with cash crops need to be introduced. In the long-run government should put more resources to develop locally high productive fodder/grass seed which is currently being imported from abroad and high cost of seed to farmers making its production uneconomical.
9. Absence of easy access to credit	9. It is observed that small amount of credit as compared to crop sector is being allocated to livestock sector. Therefore, provincial secretary of livestock and other livestock related institute should present an emerging picture of livestock sector properly so that financial institute (such as state bank) can start to think realistically to allocate more resources to livestock sector.
10. Unavailability of community land for grazing	10. Government has distributed a large amount of land among agricultural graduates to boost up the agriculture sector in Punjab province by forgetting the importance of grazing to boost up the livestock sector. Government should prioritize intervention based on contribution to GDP. For the promotion of livestock sector, government should allocate land to establish grazing for each community (village level) but to take care of its sustainability property right should be well defined.
11. Absence of information to improve feed for	11. As discussed earlier, ILRI is in the process to develop a feed table that will help farmers to supply a balanced feed to their animals. This feed

fattening	table will be distributed among farmers to update their knowledge.
Reproduction and Breeding	
Constraints	**Interventions**
1. Unavailability of qualified doctors	1. Majority of farmer's livestock related problems are due to their negligence, lack of awareness and interest in livestock farming. Therefore, farmer's training cum awareness program could significantly improve productivity.
2. Low success rate but high prices of AI services	2. Lack of applied knowledge to observe the peak time of heat among animals is leading towards high cost of AI services. An awareness program could help farmers to reduce the cost of AI.
3. Unavailability of AI services round the clock	3. Well trained government technician should be available on call round the clock. In order to make the system workable, technician should be entitled to get a reasonable incentive for supplying AI services during off times.
4. AI technician betray farmers in delivering promised quality semen	4. Each breed has a straw of particular color and farmers should be equipped with this knowledge through capacity building so that technician can't betray farmers. ILRI is taking initiative along these lines
5. Dearth of information among farmers to select appropriate breed	5. In addition to this farmers should be aware about the most appropriate breed based on feed availability, climatic situation and physical infrastructure.
6. Unavailability of good quality semen in terms of milk production	6. Again this is because of lack of information among farmers. Cholistani breed is popular in Bahawalnager area and it also has good milk production capacity but farmers are not serving balanced diet to the animals and then making responsible to breed for low milk production. Similarly, Sahiwal breed is popular in Jhang and government laid emphases on Sahiwal breed through Sahiwal breed conservation program. However, Friesian and Holstein jersey breeds are also suitable for Jhang. 6.1. Organization of animal festivals and milk competition would help to select best bull for semen collection and to demonstrate that proper management of local breeds can produce high amount of milk. .

	6.2. Promotion of record keeping habits in livestock farming not only helps to identify problems but also leads towards solution.
7. High mark up in case of delayed payment of AI services	7. When technician will not be paid in cash then he/she has right to charge high mark up to cover the risk of defaulters he/she is facing and to compensate the interest on delayed payment
8. Animal market at long distance restricts diversification of breeding material	8. Scientific community believes it is not a constraint. Almost each village has different kinds of breeding animals but farmers are not keeping male animals for longer period. Rather they sell male animals in the first year of their age. In addition to this majority of the farmers are using AI services.
9. Short lactation period of dairy breed	9. Short lactation period is not a constraint rather considered as advantage.
10. High transportation cost to avail AI services	10. Technician are travelling long distances to provide AI services, therefore, travelling has to be paid by the farmer or has to shoulder by government through subsidy. Another, possible option is to establish small veterinary center at each union council level by the government.
11. Less heat tolerance in dairy animal (especially in Buffaloes)	11. Yes, buffaloes are more sensitive to heat than cow. However, buffalo's milk is more valuable than cow. Hence, there is tradeoff between high return and additional cost on housing to maintain that return.
12. Unavailability of AI services from government	12. Government departments are not dealing with the supply of AI services. It is observed, private service providers are dealing it more efficiently which is also sustainable. As long as private sector is providing these services, it is not a constraint.
Management and Animal Health	
Constraints	**Interventions**
1. Frequent attacks of diseases including FMD, red water, HS, worms, Black quarters, Mastitis, infertility and prolapse of uterus	1. Vaccination of FMD and HS is available and is only the matter of awareness among farmers. ILRI is attempting to provide practical evidence to farmers by treating their animals during project period and teaching through demonstration that how small investment on vaccination can significantly affect the profitability.
2. Poor sewerage system increases the lice probability	2. Improvement of sewerage system and provision of clean drinking water falls in jurisdiction of local government. However, involvement of local communities could contribute to its sustainability.
3. Lack of veterinary services at	3. Provision of mobile veterinary service could be an immediate solution. However, establishment of small veterinary centers at each union

reasonable distance 4. Lack of quality vaccines and medicines at reasonable prices 5. Quacks (non-degree holders) are available to resolve epidemiology problems but because of their poor knowledge high morbidity and mortality rate occurs. 6. Absence of livestock insurance	council level is a more affective and sustainable option in the long run. 4. By collecting samples of different vaccines from different locations and after testing these samples in the laboratory, ILRI can play its vital role by providing more authenticated evidence of low quality vaccines (if exists) to government. This quantitative based evidence could encourage administration to take action against suppliers of fake vaccines and medicines. 5. Establishment of small veterinary centers at union council level (as suggested earlier) could help to resolve this issue. Through capacity building, it is important to improve the awareness of farmer about the poor knowledge of Quacks that can help to motivate farmers to visit or invite some qualified veterinary doctors for the treatment of their animals. ILIR together with national research Institutes (NRS) is working on capacity building of farmers which will improve farmers' basic knowledge about the symptoms of different diseases and their possible treatment. 5.1. Elimination of Quacks through legislation is another viable option but it will not work without providing substitute to farmers i.e. establishment of small veterinary centers at the union council level or mobile veterinary clinic. 6. Currently no financial institute provides livestock insurance to farmers in Pakistan, indicating that economic viability of livestock insurance is not established yet. ILRI can play its vital role by providing empirical evidence of economically viable livestock insurance which will help to attract some local and international financial institutes to establish such insurance system in Pakistan.

Figure 1. Overall percentage distribution of farmers by reason of keeping animals

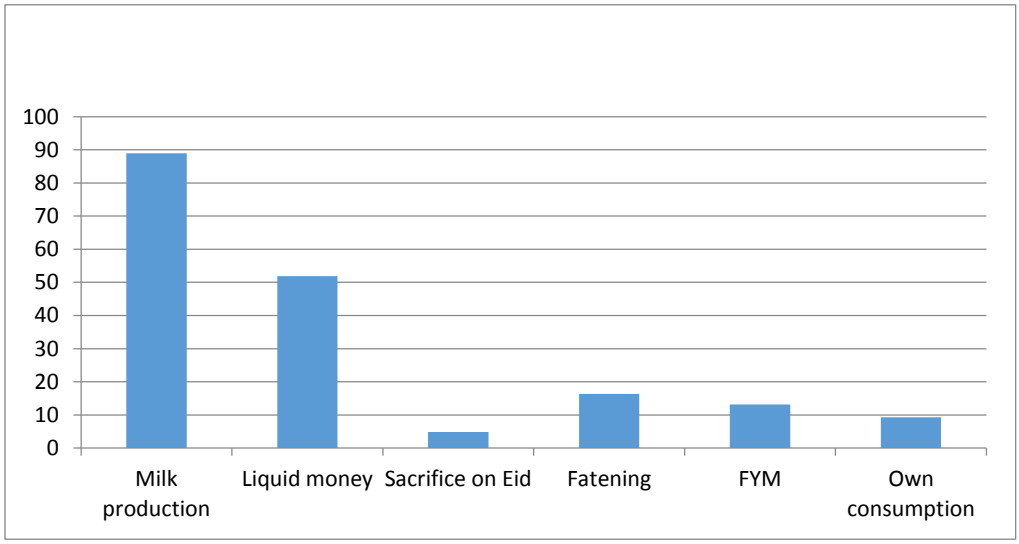

Figure 2. Overall sources of income in the study area

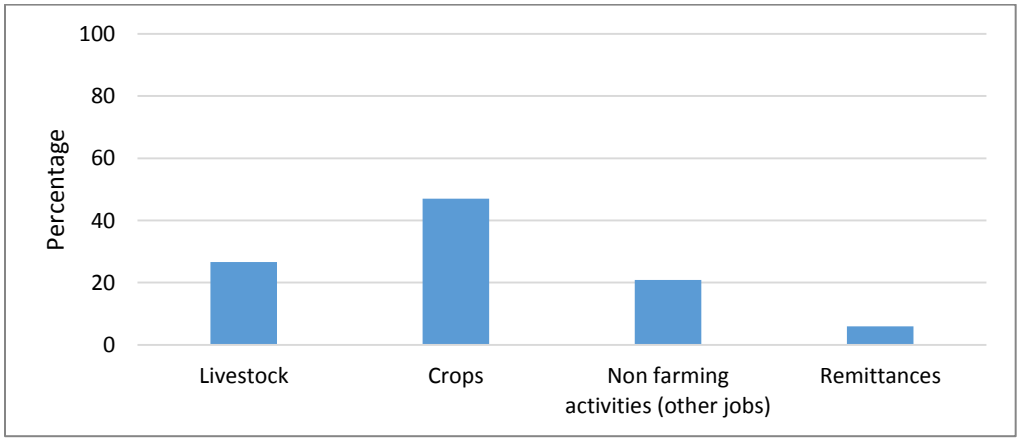

Figure 3. Overall green fodder availability in the study area

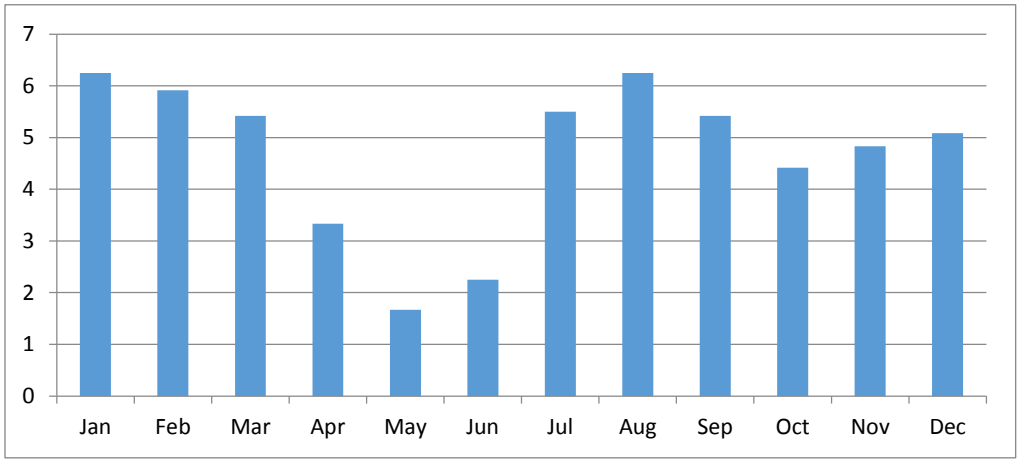

Figure 4. Overall contribution of crop residues in total feed in the whole study area

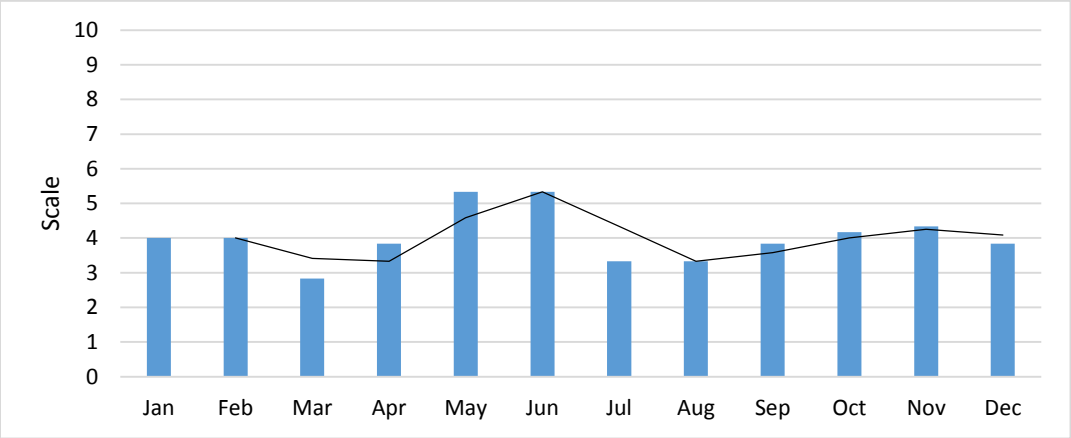

Figure 5. Overall monthly contribution of green forage in total feed in whole study area

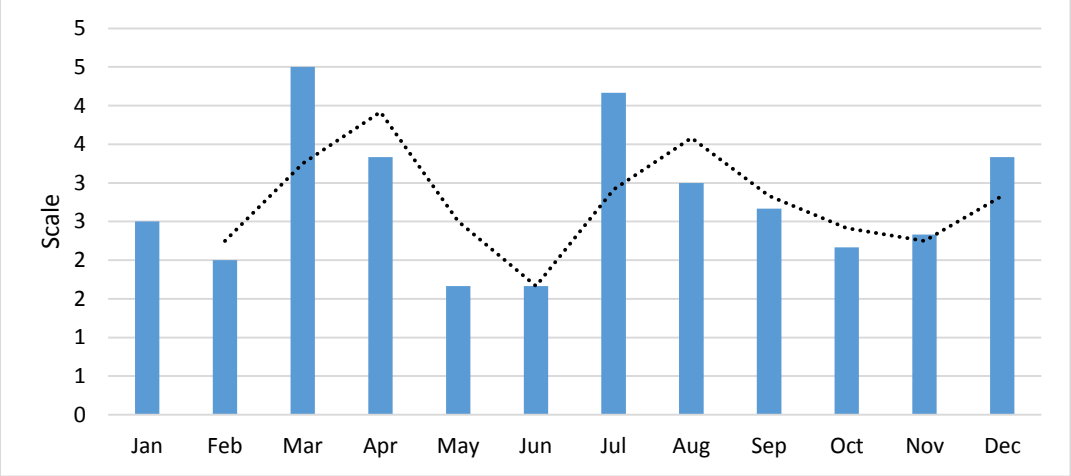

Figure 6. Overall contribution of concentrates in total feed in whole study area

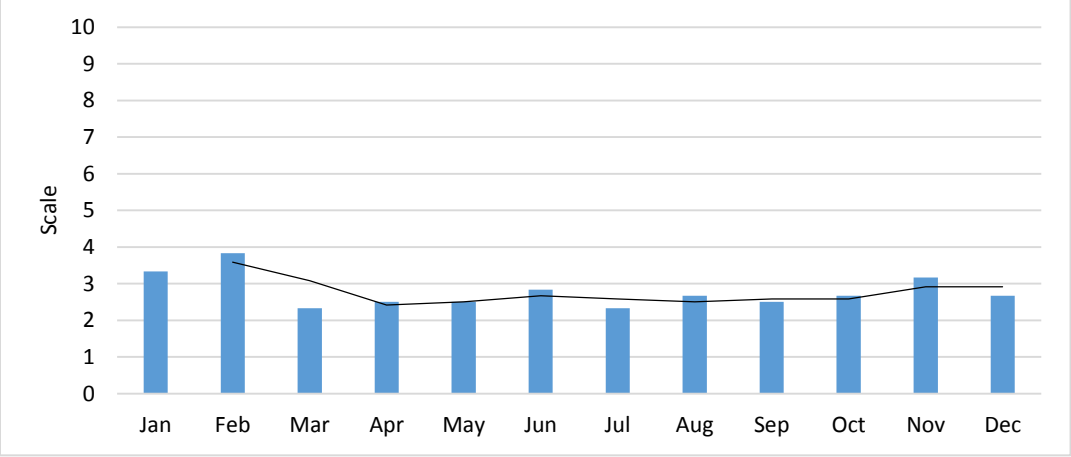

Figure 7. Overall relationship between milk production and feeding system in the study area

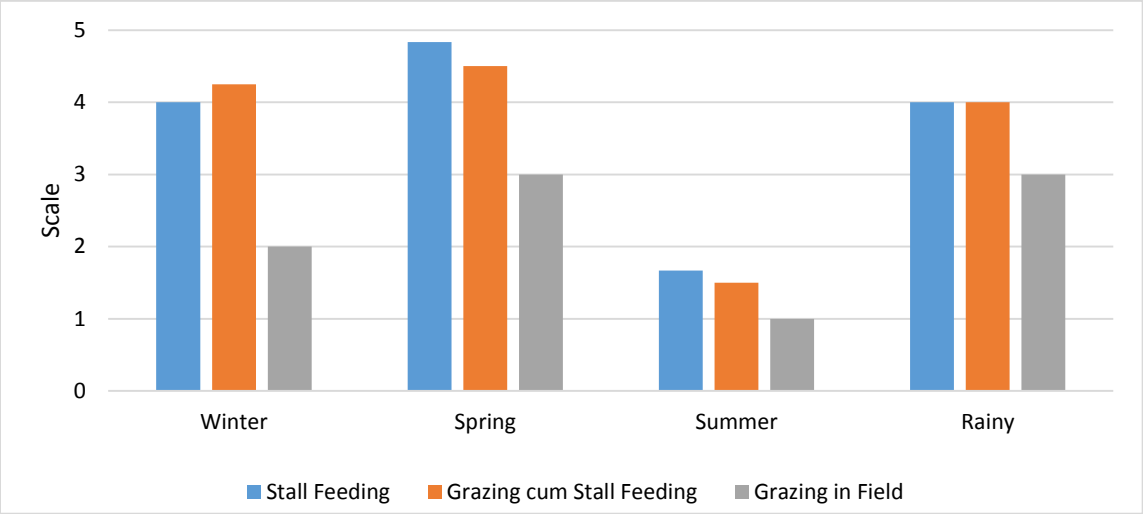

Figure 8. Fodder sales and purchase channels

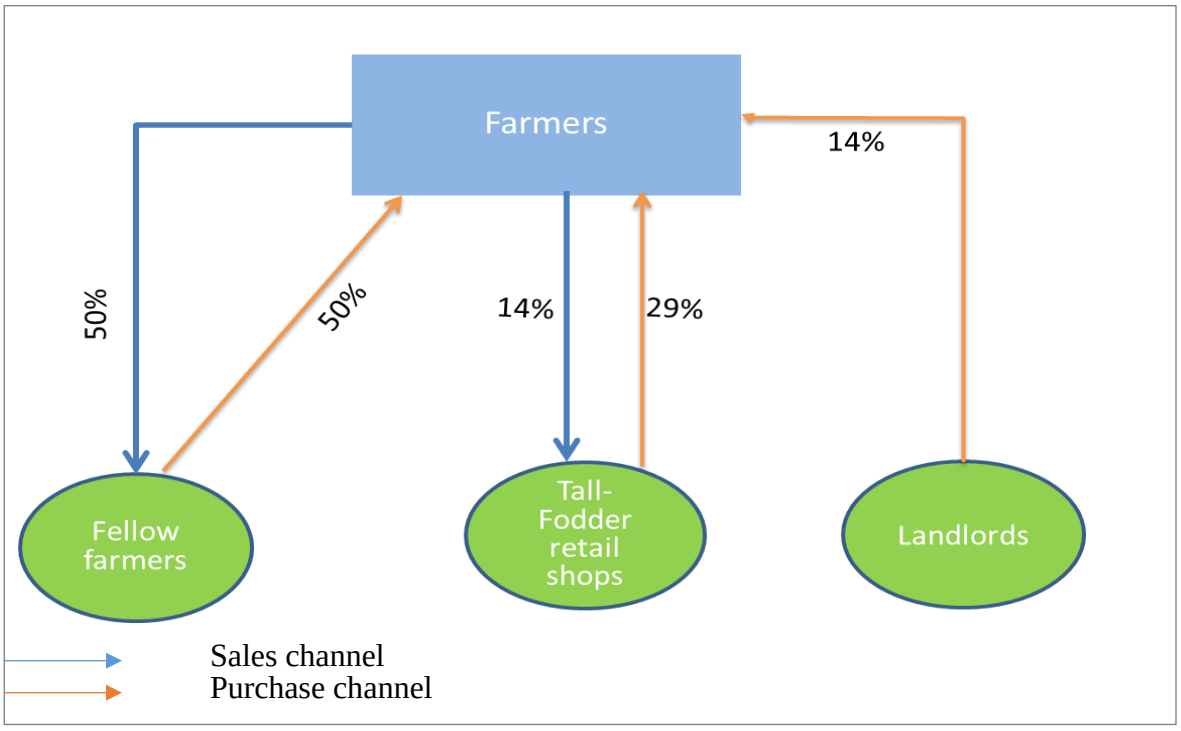

Figure 9. The process of getting information about sick, health and died animals

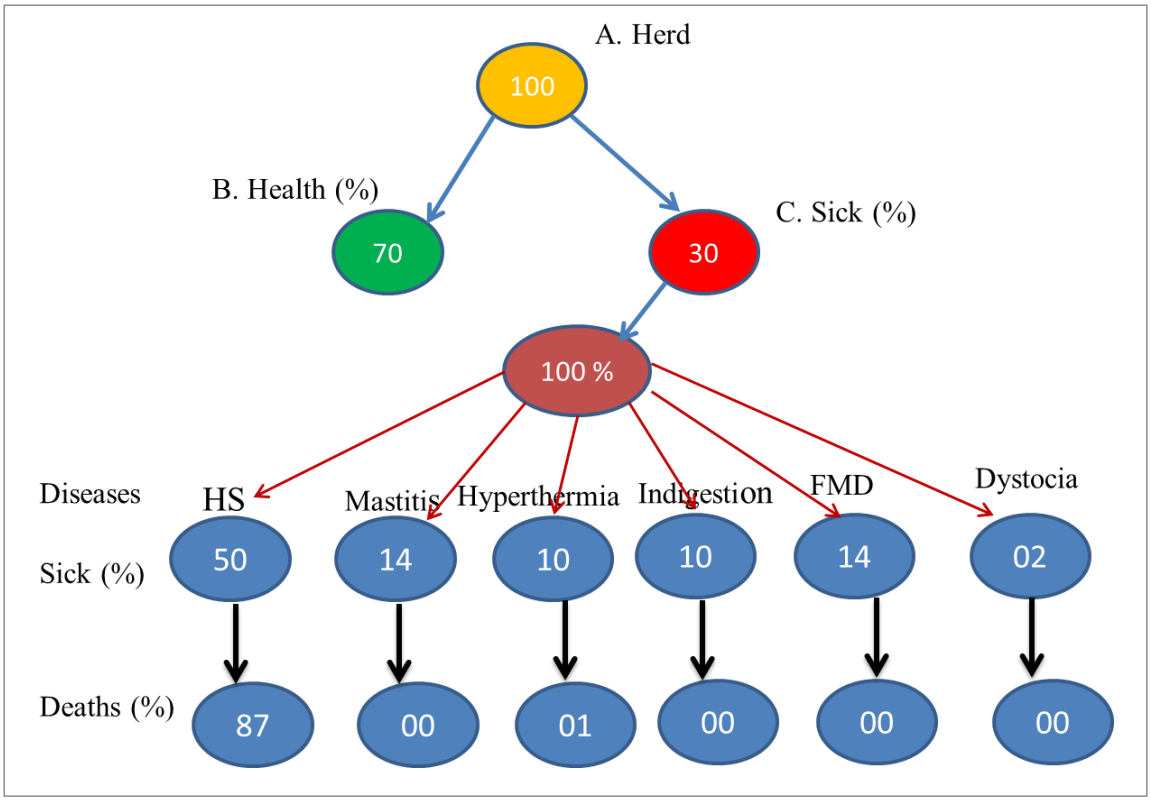

Figure 10. Flow of milk in dairy value chain