EFFECT OF TECHNOLOGICAL INNOVATION AND APPLICATION ON SMEs IN PAKISTAN: AN OVERVIEW OF THE DAIRY SECTOR

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DEDICATION

This work is dedicated to my Late grandfather Headmaster Abdul Khaliq (January 1926 – December 2021). He was a teacher by nature which reflected through his day-to-day interaction with people around him. I feel enriched by his values of hard work, tolerance, and patience. He, being man of academia himself, was so proud of my pursuit of doctorate level research. Sadly, he departed for his eternal abode just before the publication of this doctoral work. I, however, was lucky enough to have a chance to discuss its content with him and have his blessings for its successful completion.

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Abstract

Pakistan's livestock sector, notably the dairy sector, contributes little at the national and household levels, despite its potential and enormous population. Inefficient livestock output due to traditional production methods, substandard breeds, poor feeding, poor housing conditions, inadequate health care and services, and insufficient capital investment are all contributing causes of the sector's low output level. Therefore, the aim of the present study is to explore the status of technological innovation, identify the factors affecting it, develop and evaluate the framework for enhancing the innovation capability in dairy farms through knowledge sharing. The present study is designed for two reasons: (1) Studies on technological innovation in rural dairy sectors have been carried out previously. Yet, the research into this trend in South Asia is limited. Research with a specific focus on the Pakistani dairy industry is even more so; therefore, the current study will update the body of literature in the context mentioned earlier (2). Despite the technological advancement in the dairy industry growing rapidly, the Pakistani dairy industry comparatively lacks in technological innovation despite the significant potential to grow, so that the current study will help the government, marketers, and dairy owners develop effective strategies and frameworks. Following an extensive literature review, the researcher develops a conceptual framework that extends the existing framework of Dependency Theory and Appropriate Technology Theory. These theories have been selected for particular emphasis here because they deal explicitly with the choice of techniques in developing countries. Moreover, taken together, they address, or allow being addressed, the range of issues that are raised by the research questions outlined earlier. The mixed-method approach was applied to use the strength and advantage of both quantitative and qualitative methods while eradicating the weaknesses associated with each of them. A close-ended survey questionnaire collected the quantitative data from 100 randomly selected dairy suppliers and entrepreneurs. At the same time, the qualitative data for the study was collected from 8 rural small and medium-sized dairy organisations owners. Microsoft Excel 2019 was used for quantitative data analysis, and thematic analysis was used to interpret qualitative data. Findings from the present study indicated that implications for the use of technology are speed, efficiency, and effectiveness. However, most of the rural sector in Pakistan is without electricity and consumes raw milk in rural localities devoid of milk processing capabilities. It also implies that local

innovation in the existing dairy practices in rural Pakistan has not progressed as the supplier matches the demand characteristics of rural consumers. The rural diaries serve specific rural catchment areas in and around the village, which does not store raw milk due to its perishability. Neither has shown any evidence of technology to produce a wide variety of milk by-products of human consumption. The non-availability of technology is plenty with awareness, education, from environmental surroundings, is evident. The role of influencers like the Pakistan government at central and provincial levels has shown evidence in policy making initiatives, having the capabilities of infusing technology like genetic technology in breeding, fodder with nutrition, medical support through a veterinary doctor for animal health and well-being important from the functional perspective of development. The present research concluded, it is evident that the problem is complex the solution is not straightforward, as the diverse perspective in the responses has opened debates on the possibility of solutions. The location-based disadvantage for the rural small dairy farmers is a structural issue that requires an innovative solution both in terms of using technology and its adoption to benefit a larger catchment of small dairy farmers. The respondent stated that both government officials and dairy-based academia's challenge are to engage traditional people with traditional practices in the dairy sector to adopt modern tools and practice with the rationality of each step. The present research provides recommendations for dairy farm owners, marketers, government, and policymakers to maximise production through technological innovation to meet the domestic and international demand for higher profits and sustainable market share. The present study is the first among the academic studies that contributed to applying Dependency theory and appropriate technology model in the context of the Pakistani rural dairy industry. These models conventionally pay attention to the need for technological adoption in developing countries and its applications in sector development. Whereas, based on these models very little research work is done in Pakistan, particularly in the dairy industry. The authors provide a theoretical contribution by discussing the present state of technology utilisation in Pakistani dairy SMEs, as well as the critical factors influencing technological adoption. Furthermore, this study provides a realistic procedure for rural dairy owners and regulatory agencies to collaborate on technical improvement in the industry to assure a large supply of hygienic dairy products for increased profitability, poverty alleviation and foreign exchange through quality export.

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1. CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Agriculture accounts for roughly 22.04 per cent of the Pakistani economy's overall Gross Domestic Product (GDP) (Pakistan Bureau of Statistics, 2020). The dairy industry is one of the most important agricultural components. Pakistan's agricultural system relies heavily on livestock and dairy production. The sub-sector accounts for around 11% of total GDP and 56% of total agricultural GDP (Pakistan Bureau of Statistics, 2020). With enormous animal numbers and milk production, the country ranks fourth globally (Archive Pakistan, 2016-17). A single year's milk production is expected to be 42000 tonnes. According to another source, Pakistan's current farm animal population includes 23.34 million buffaloes, 22.42 million cattle, 24.24 million sheep, 49.14 million goats, and 0.77 million camels. According to the Pakistan Livestock Census (2020), 30-35 million individuals in rural areas are raising cattle and producing dairy products on a small level.

Current dairying in Pakistan is a combination of conventional and commercialised ways of growing dairy animals and producing dairy products. Industrial agriculture with imported dairy supplies has expanded during the last two decades, accounting for around 1% of total raw milk production. With changing human requirements and urbanisation, the traditional system is on the verge of transitioning from subsistence to more commercial and large-scale production processes over the time mentioned above (Ali & Afzal, 2020). Furthermore, a policy created at the government level in 2007 (Pakistan's first-ever Livestock Policy) placed a strong emphasis on the growth of the dairy sector. This has enticed several private stakeholders to participate in dairy farming, procurement, and processing.

Despite its potential and large population, Pakistan's livestock sector, particularly the dairy sector, contributes little at the national and household levels (Akhtar, Khalid & Khan, 2020). The inefficient output of livestock because of the conventional way of production, bad breeds, poor feeding, poor housing conditions, inadequate health care and services, and insufficient capital

investment are all factors contributing to the sector's low production level. Since then, various dairy technologies have been transferred through both the governmental and non-governmental sectors, as well as large efforts to disseminate dairy technologies through the support of governmental and non-governmental organisations in various parts of the country, including the study areas. However, the rate of adoption of dairy technologies by farm households varies widely. As a result, the value of dairy technology varies depending on the farm household. As a result, information on the current state of technological innovation and the impact of dairy technology adoption on the livelihoods of smallholder farmers is critical for policy development and effective management of extension programmes and would aid in the development of practical recommendations to improve the sector's performance. To improve the intervention, it was necessary to assess the adoption and intensity of improved dairy technologies in the study area, such as the use of improved breeds, Artificial Insemination Services (AIS), housing improvements, improved feed or forage development, regular vaccination, and adequate production methods.

Innovation is recognized as the main source of economic development and growth (Abetti, 2000). It helps in improving the business activities by lowering cost of production and leads to new products and services. Based on Schumpeter's definition of innovation extracted four different types of innovation which are further divided into technological and non-technological innovations, technological innovation is defined as the technical process through which improved and new technologies are introduced by commercialization. SMEs are of growing importance to technological innovation. Venkatesh and Bala (2008) found that in the United Kingdom, between 1945-1983 innovation intensity increased amongst very small firms and declined amongst the medium sized ones. SMEs are important in any country's economy. They play a critical role in countries' national employment, domestic services and products, and overall economic performance (Adams et al., 2006). In using current technological innovations, some industry leaders have responded to the need for organizational change in 21st century through integrating disruptive technological innovations (Ameen, 2012).

There is a rapid move by small businesses toward adopting and integrating disruptive technological innovations to target new markets and value networks (SMEDA, 2000). The active approach for implementing organizational change leads to the creation of new management dilemmas which

must be addressed by business leaders to be more efficient, profitable, competitive, and sustainable (Cheng, 2009). Although, dairying contributes significantly towards the rural economy of Pakistan, industrialization of this sector is still in its nascent stage. The organized dairying in the state is largely governed by the cooperative sector. Cooperative dairies of the state procure only about 5.4 per cent of the marketable surplus milk of the state, which is far below the national average of the same. A major share of the marketable surplus milk of West Bengal gets converted into cream, which is totally handled by the unorganized sector. As milk-based sweets are more popular in the eastern states of Pakistan, Punjab is the most important market for these sweets. So, consumption of milk is concentrated in the sweetshops of the city of Punjab. Thus, to complete urban status of Punjab and government regulations prohibiting maintenance of cattle in the city, milk comes from the adjoining districts of Punjab. Among the adjoining districts, North Punjab is the highest milk producing district of the state. Due to these reasons, majority of the milk in Punjab comes from North.

Under UNDP program processing facilities were created mainly through adaptation of Western technology with and without modification for manufacturing of recombined milk, milk powder, butter, and ghee (Abdullah, 2004). Successful implementation of this programme has made the country largest milk producer in the world. Currently, Pakistani dairy industry is undergoing some phenomenal changes to convert ‘increased milk availability’ into ‘better quality products’ and to become a major player in international market. In Pakistan middle class population is witnessing a revolution in information technology, leading to increased consumer awareness. Due to changes in consumer- concerns and perceptions on nutritional quality and safety, increase in disposable income, and availability of new technologies; the demand for new products and processes is increasing (Staal et al. 2008). For ages, traditional dairy products have enjoyed an eminent position in the Pakistani food ethos. The market for traditional dairy products far exceeds that of conventional dairy products like butter, cheese, and milk powder. The market for value-added indigenous dairy products is set for a rapid growth. The operating margins of traditional products such as are also much higher than those of western dairy products. However, major strength of traditional dairy products sector is mass appeal of such a wide variety of products.

The rapidly growing demand for these products by consumer presents a great opportunity for modernization of this sector. The opportunity provided by increased availability of liquid milk can now be used by modernizing traditional dairy products sector. This will help in tapping potential demand for Pakistani milk products in both domestic and foreign markets. In recent past, modernization efforts have been initiated for various traditional dairy products. Some organized dairy factories have started mechanized production of sweets and these products are now being marketed under various brand names over both the domestic and international markets. However, Ishaq et al. (2017) study reveals how traditional milk production has remained unchanged for long time and marked with small scale of operation, little control over quality and unhygienic handling that has human skin contact in the rural parts of the country. The inadequacy of packaging during the production of milk under the ambient environmental conditions results in product deterioration, particularly in summer months. High microbial contamination results in low shelf life of milk and poor quality of product made from such milk. Afzal (2008) stated that to overcome inherent disadvantages associated with conventional methods of manufacture of milk and milk-based sweets, such as inefficient use of energy, poor hygiene and sanitation, non-uniform product quality, etc. attempts have been made by various research institutes and organizations to develop equipment and process for mechanized and automated process of manufacturing of these products. High growth rate of milk-based animal variants production in Pakistan market and attractive domestic and export potential for catering to Pakistani population abroad has resulted in increased demand for milk. Issues like satisfying customers' need for milk by products like butter, cheese, yoghurt, cottage cheese, milk-based sweets show an evolutionary journey of how raw milk has been processed using different fermentation process which every developing nation has experienced (Staal et al. 2008). However, the issue that is also important is to be understood from consumers' palate point of view encompassing healthiness, freshness, purity. The totality of the consumption process has been undergoing a slow change which is why the need to harness the power of the small dairy farmers of Pakistan and their involvement to meet the market-based demand needs to be probed. The current milk production by small dairy farmers in Pakistan is highly unorganised, leading to adulteration while they form over 50% of aggregate volume of milk production in the country, managed by the small families (Amin et al. 2010). While the developing economy needs new avenues for growth and development, the use of rural economy and developing the ability to create an inclusive consumption-based economy is gaining ground.

Michelini (2012) research highlighted how new business model in low-income markets requires social innovation at structural and process activity level. Therefore, the demand for quality milk is also on the rise, though the age-old practice of milk production and Pakistan rural –urban state of transportation supported by cold supply chain is still an unfinished national development agenda.

With increase in consumer's perception of quality and freshness in from milk and milk-based by-products, the aspect of maintaining total quality of the raw milk production processing is important more as milk-based by-products production is dependent on the raw milk processing. As the market for milk is maturing in its life cycle stage, there is increased stress and emphasis on sourcing methods, storage, and packaging methods and/or post manufacturing quality milk to bring out overall improvement in the milk by-products. The current method used in the rural sector of dairy production shows the use of traditional milking process using hands, that risks the hygiene factor, while it also exposes the vulnerability of the milk being adulterated in the process is usually done by the female members in the rural dairy family (Amin et al. 2010). The lack of knowledge, and availability of technology and innovation for a home-based dairy farmer in Pakistan has been a challenge. However, their geographical spread that is fragmented throughout Pakistan shows their capability in achieving aggregate volume of fresh milk production to be highest creates hope in developing the rural economy making it inclusive for nation building. The milk production by small dairy farmers that accounts over 50% of total volume in Pakistan, requires to adopt technology-based solutions, innovation in socio-economic conditions. Afzal (2008) argued that Pakistan needs increased institutional support for achieving a standardised raw milk manufacturing process that is meets the international norms and making it fit for consumption.

Technology helps in manufacturing uniform quality product, and for milk pasteurisation process, it extends the shelf life and increased acceptance in the masses for milk and its by-products. While manufacturing dairy products in traditional ways is limited to rural areas due to lack of knowledge, technology in dairy sector has also created avenues in animal breeding. The biotechnology and genetics have helped to identify and isolate those strains of gene which makes the offspring of the buffalos and cows more productive (milk) and disease resistant. The application of technology in animal health and wellbeing is not available to the rural farmers. Similarly, technology in storing the raw milk for packaging leads to the opportunity of marketing the item to the demand centric

areas. In recent past, scattered efforts of mechanized production have been initiated by few milk-based sweet manufacturers. So, it is milk, one of the most important traditional dairy products, is requires for modernization in terms of procurement of raw milk, processing as per FAO standards, storing it, packaging it and lastly should be transportable through cold food supply chain that requires infrastructure linking logistics and transportation support. There is currently a vast gap in rural areas, from knowledge, technology and innovation in milking, raw milk processing capabilities, storage, and transportation and inability to develop milk-based by-products in mass scale. Application of modem technologies in the production of milk, by organized sector would help in sustaining the overall growth of this segment arid in adding more value to the dairy business in general. The issue is large scale operators with MNCs have been already present, but their presence is limited while the total volume of milk from the rural sector in Pakistan especially family owned home based dairies contributes to over 50%. However, these small milk dairy owners suffer from lack of hygiene due to predominance of manual methods of milking, and no appropriate solution to process raw milk as per global standards, store it in refrigerated condition forcing them to sell it in rural locality. The viability of establishing rural urban supply chain transportation linkages for milk supply especially the cold supply chain requires institutional aid, at infrastructural and technology application areas along with huge investment that requires government involvement.

Better value addition to dairy business would ultimately lead to better livelihood of Pakistani rural farmers who are in millions. However, till now, none of the big dairies of Pakistan have entered in the milk business is in the cooperative format that has been predominant method in both developed and developing nations (US and India). This can be attributed mainly due to the lack of information on the interplay between the technical and economic aspects of modernizing the milk manufacturing. For transforming unorganized rural milk business to a modem, organized industry which is automated, formulation of proper strategies using scientific production practices, tools are the need of the hour. The study attempts to explore prospect of modernization of milk production and marketing. Therefore, the key features of existing rural milk industry, including its location, quantum, employment generation etc., requires to be considered from Pakistan government as it presents an opportunity to harness the aggregate milk volume rural dairy farmers produce that requires technology infusion and innovation in structural perspective to design a

viable model of enterprise for socio economic development. Due importance has been provided on the indigenous technology (traditional milking methods by hand) deployed for production of this traditional product. The economic aspect of milk production under unorganized sector has also been studied in detail.

As milk has a very short shelf life as a food product, its distribution is not conventional and marketing system is of great significance for the economy that is relevant for this study. So, efforts have been focused on understanding of the trade practices of dairy business that is limited to the rural sector, where the inadequacy of the infrastructure spells low level of development in rural urban divide. As good quality product can only be prepared from good quality raw material, quality of milk greatly influences quality of milk by products in the commoditised market. So, the present study has considered for milk-based by-products like sweet makers, yoghurt, cheese, butter, cottage cheese as the ultimate usage of this produce depends on lifestyle demand that is mostly related to urbanised sector (Sadia et al. 2012). However, to convert the viability of rural raw milk into a marketable commodity in milk variants, requires advanced technology offering solution with higher processing speeds, greater volume and effectiveness and efficiency. The technology is also requiring eliminating the germs, dirt, contamination and eliminate the chances of adulteration through machine-based older in the context of rural dairy farmers, their geographic location, which is scattered in Pakistan, along with the industry association, SME sector, entrepreneurship initiatives, central and provincial government roles that impact the future opportunities. Efforts have also been rendered to estimate the market size of milk. Based on this study special emphasis has been put to identify problems of current system of milk production in rural areas and its marketing based on the adoption of technology, innovation. The government through policy changes is instrumental institution, in the development of unorganized food sector, developing the rural economy to find solutions for a sustainable solution, establishing small scale industries. The issue is pertinent for the dairy sector which in the rural areas is limited to traditional manual practices and suffers greatly in terms of technology, innovation and knowledge that is required for development. It is evident that the problems discussed and the issues still unresolved requires a holistic approach to bring out a credible solution. While there are case studies from the governments around the world, scrutiny of the current and the past government policies towards

the sector, the rural area and the strategies adopted to revive the economy is still on the outlay, the other dimension of entrepreneurship and SME is also worth a debate in this research context.

1.2 SMEs Pakistan

Pakistan is developing country with status of emerging economy. SMEs are playing role of engine in its move towards economic growth and development. Globally evidence from the developed nations' show that governments stress on the importance of the role of SMEs in the entire industrial structural hierarchy even though they have small turnover. Their ability to develop a seed idea into a business venture has time and again, shown the resilience in terms of contributing to the national economy. Some of the examples are Japan, Korea in the last century that have found government support to growth and contribute to the national economic growth. It can be concluded that SMEs are vital for their respective local economy job creation, bringing in more liquidity, contribution to national GDP. In this context, Pakistan as a developing economy has been actively following the south Asian model of SME development with the SMEDA (Small and medium enterprises development authority) established to address this issue. Even though SMEs contribute to around 40% of GDP, their role is limited to few sectors particularly manufacturing. The widespread belief from all sections of society shows their allegiance to the role SMEs have played for nation building with one school of thought supporting its resilience amidst downturn, while others supporting creative ideas into business, enabling skill development and sustainability.

The main challenge the Pakistan SMEs faced is the inclusivity of technology when compared to the large-scale industries. The SMEs have high productive failure rates which is due to the lack of technology infusion even though they form the pillar of employment through entrepreneurship. While lower output and performance is cited in many sectors, the use of technology to boost efficiency and performance has been generally considered ideal method to transform an industry. The issue is specifically true when the output of the production, be it a product or service require the use of technology and innovation to adapt the existing business process to enjoy the benefits. However, the lack of knowledge alongside the issue of technology has plagued the SME sector in Pakistan. Individually people venturing out in Pakistan with a novel business idea has been found to face financing challenges, particularly entrepreneurial education to survive the completion and sustain the start-up business model. Hence, what is thought as a driver of local economy especially a growth generator, the nature of SME in the industry hierarchy faces far more challenges. The

same for the dairy sector is a gap as not much entrepreneurship in this sector has found success due to the traditional dairy methods, and inadequate knowledge support in utilising the technology factor in transforming home-based business to SME scale.

Technological innovation plays a crucial role to determine the success of firms and development of the national economies (Cheng, 2009). A comprehensive package of government measures offered to promote and support SMEs is currently facing problems such as lack of entrepreneurship, poor labour skills, outdated technology, insufficient R&D, low standards of production, difficult access to funding, as well as high and increasing competition from global competitors (Haque, 2003). Despite the implementation of a long-term competitive strategy for the dairy sector in Pakistan since 2005, many firms are still facing a lack of price competitiveness with firms from neighbouring countries, a lack of funding support and management skill, and a low level of innovation (Khan, 2004). The above trend has been continuing which shows that the successive Governments in the country has not been able to show the development in dairy sector especially addressing the issue of urban demand and rural milk supply capabilities. The plight of the system in SME which is a platform for an organised form of business is facing lot of challenges that impacts the rural population who wishes to establish a

Most SMEs in Pakistan use out-dated technology with an uneconomic scale of operation causing an avoidance of strategic development of product and process innovations. They do not consider innovation and technology management to be a priority, and in the main, follow traditional practices by simply copying foreign products, sometimes with minor changes, and neglecting consumer needs (Government of Pakistan, 2008). This leads to barriers to growth, not only in terms of creativity, but also innovation opportunities. Shortages of skilled workers are also another main issue faced by SMEs in the dairy industry. A survey conducted by the National Economic & Social Development Board (NESDB), together with the World Bank, in 2007 showed that such issues limit the innovation efforts of firms and reduce the potential for productivity-growth through innovation (Ameen, 2012).

In addition, dairy SMEs are also faced with regulatory and legislative constraints, often seen as hampering factors in terms of innovation as they might be difficult to accommodate. The issue of intellectual property for SMEs in Pakistan is a good example. There is no concrete measure to protect intellectual property locally. Once a new product is introduced to the market by one vendor, such a product is generally imitated by another vendor after a short while, since there is no strong

encouragement and support for trademarks, registration of intellectual property, licensing, and copyrights from the government in Pakistan (Usmani, 2006). These factors are all considered barriers to the development of new innovations for SMEs, and consequently result in inefficiency regarding innovation management. Understanding and discovering the innovation capacity of dairy SMEs and assessing their barriers to growth in the innovation domain, therefore, should be an essential subject of study to help SMEs in the dairy industry to convert the difficulties into opportunities. Such an understanding will assist these SMEs to examine and reflect on their existing practices and identify areas for improvement.

1.3 Development of Dairy Processing SMEs

The dairy sector, which is the focus of this study, is regarded as one of the most important industries in Pakistan, with a high growth potential. The sector was officially established in 1970 and to monitor and control production, quality, and safety standards of food products at the same time (Haque, 2003). During the initial stage in the early 1970's, R&D in the industry was limited to processed milk products. Most of the exported food products in this phase were processed milk products. The quality of products steadily increased from the late 1970's onwards as the products were increasingly being exported to international markets. Local and foreign investments, for instance, were actively promoted via investment promotion packages (i.e., an import-substitution strategy), including guarantees against nationalisation or competition from state enterprises, and tariff and business tax exemptions on imports of capital goods and raw materials (Garcia, 2003). The number of dairy firms proliferated between 1980 and 1985 in accordance with the rapidly increasing export volumes of processed dairy products.

As noted by (Haque, 2003), approximately 10 new processed dairy firms were established annually during this time. Activities such as R&D, training, improvement of product safety and production standards were also promoted by government agencies (i.e., Department of Medical Science (DMC), Department of Export Promotion (DEP) with the collaboration from importing countries such as Canada, the United States (US), and France. Since 2000, there have been a higher number of dairy firms entering the domestic market due to greater demand from customers and higher requirements of foreign countries. During the years 2000 to 2002, when various countries entered international trade, there was, however, a drastic change in customer needs, involving greater levels of hygiene and sanitation during production, and an adherence to environmental regulations,

which directly impacted on dairy processing firms (Malik, 2004). These changes in market conditions have led to problems with production and marketing in various dairy firms. Manufacturing facilities being unprepared to comply with the standard set by client countries (e.g., European countries), for instance, is one of the most common problems experienced by dairy firms in Pakistan. Low awareness of the crucial role of innovation is also common among dairy SMEs (Afzal, 2006).

Pakistan total production of milk in 2007/2008 was 42.17 million tonnes. The traditional sweet, which absorbs majority of the country's total milk production, has received little attention due to its concentration in the non-organized sector. Only some selective attempts have been made in the past to understand different dimensions of this industry. Mazari, (2003) has reported that the cream-based sweets dominated the Punjab market as compared to other ingredient-based sweets such as khoya sweets, concentrated, cultured etc., with 60% market share on volume basis. Cream is used as an ingredient in different kinds of sweets. Its preparation is mainly confined to the cottage sector, largely in the eastern Pakistan. Regular production of cream is used for creating variety of milk by-products that are prepared etc. The life cycle analysis of the dairy industry in Pakistan shows that the rural orientation to use raw milk still uses the traditional delicacies, while the growth of the urban consumers in Pakistan seeks standardised products of milk that has quality embedded in them (Muhammad et al. 2014). The consumer demographics with rise in consumerism, shows that the market is ready to accept different variants of milk products that requires technology-based processing capabilities, supply chain distribution keeping perishability factors in mind (Ansari et al. 2018). Though the modelling of the enterprise on cues from western developed nations and developing nations has been quite evident towards ‘cooperatives’ that harness the power of small business owners, the reality of non-participative support from various stakeholders in Pakistan rural areas has adversely impacted the future growth of the dairy industry and the maturity level against time.

1.4 Significance of the Study

Even though the government has recognised the dairy sector as one of the key priority sectors for growth, farmers, who are the primary stakeholders, continue to face fundamental inherent constrains. They have limited options to directly access the latest technology, customers, or

industry because of low capital investment and, as a result, have little influence over the price or quality of milk due to small-scale operations and minimal resource inputs (Tahir, 2019).

In Pakistan dairy industry in general is characterized by many home-based family-owned diaries that has not been able to scale up to SME level. Most of the fragmented dairy farmers that capture a large fraction of the market (about 50% aggregate milk production by volume in Pakistan) loses out on the power to adopt machine-based milk processing and milk by-products manufacturing capacities for market centric orientation with a wide variety of products (Eiriz et al. 2013). These products which are primarily created by the firms in response to the consumer needs are a key characteristic that contributes to the role of product innovation in this industry. It is evident that non-human intervention lessens the risk of germ contamination while the state-of-the-art milk processing plants show end to end support to store and package raising the shelf life of the raw milk. The implications show that market is evolving as per consumer needs and the requirement to meet market centric demands require the use of technology in processing stage for achieving higher speed in production and variety in milk by-products output.

The core activities of the automated dairy sector include manufacturing, logistics, distribution and retailing which in a traditional home-based start-up is very rudimentary in nature (Bourtakis et. Al., 2014). The use of human hands and limited resources from family deployed to upkeep animal health and hygiene, milking by hands, feeding the animals, storing the milk for distribution within locality forms the standard stages of milk consumption at rural areas. Even though the technology of the west has been introduced in SMEs, the dairy sector in rural areas suffer from knowledge inadequacy which is not sufficient to leverage technology in the dairy industry which is under constant changes (Dervitsiotis, 2010).

This topic has been chosen as little research has been done in dairy sector. Pakistan is country with population of 220 million of which 63% comprise of youth (Cooper, 2008). If encouraged and with relevant knowledge understanding of SME's Youth can be encouraged towards entrepreneurship and play pivotal role in development and progress of Pakistani economy. Being an entrepreneur, one does not have access to knowledge base to Pakistani economic and business environment. Failures of SMEs to maintain their existence and growth have been a major concern since past decades in Pakistan. The research is vital for the development of the rural economy of Pakistan, as it helps to understand the production dimensions that is ideal for the meeting the consumption economy with the emergence of urban cities in Pakistan. The dairy sector in the rural

area that is scattered and fragmented has the potential to impact the lives and lifestyle of the urban population in Pakistan. The inability of rural small dairy farmers with appropriate knowledge, technology to enable them to shift from traditional dairy practices is unable to meet the demands of increasing population. The lack of innovation in home based dairy business, the access to the milk production for achieving diverse milk products that consumers in urban cities is shifting, is an indication of rural nonparticipation and inability to meet the supply demand metrics (Ansari et al. 2018). The lack of institutionalised help for the small dairy farmers in rural areas of Pakistan, in terms of technology help, innovation has not been evident amongst all the industrialisation process in the country. The issue is lagging as even developing and developed nations have started to deal the matter to feed their population with appropriate organisational models, methods, and practices with embedding of technology bringing in innovation in respective nations strive towards the future. The rationality of the investment in the Pakistan economy and to sustain has a good measure of the population consumption which can be tapped from its agriculture, dairy, mining that are location specific sectors and can significantly contribute to the Pakistan GPD (Gross domestic product) in consumption perspective.

The middle class in Pakistan is surging with minimum disposable income at hand (Kharas, 2017; Rehman et al., 2022). Therefore, the present research intends to draw the attention of Pakistani youth towards entrepreneurship. This research will help make Pakistan's dairy business procedures strong since past studies or research in the same field found could not put forth a trustworthy statistical analysis. Frequently, the causes for failure were discovered imbedded in discussing what is required for success. The changing consumption patterns of the urban population present an opportunity for Pakistan's dairy sector, which influences the domestic economy. The research, on the other hand, aims to discover the challenges that Pakistan's SME sector faces, the perspective of dairy farmers with the option of entrepreneurship challenges in the dairy sector, the absence of technology as a driver of efficiency that can contribute to building rural dairy farmers harness the power for better living and national building. The aspect of how institutional roles and national policies impact the dairy sector in Pakistan is also explored in terms of the gaps that exist. The transition journey requires a considerable amount of process-based innovation to progress socio-economic development in Pakistan.

An efficient domestic agricultural commodities system is vital to promoting and sustaining growth and development in the dairy and livestock sectors, according to recently defined Rural Development policies and strategies (Tahir, 2019). While the prospect for future economic growth lies in making the livestock system a successful agent of transformational development that helps expand the food market by motivating the millions of poor small-scale farmers to participate consistently and efficiently, the implementation of the policy notes that this objective can only be accomplished through transformational development of the livestock system At this point, achieving this vision currently requires that development practitioners be able to judge their efforts to promote dairy technology, which will help farmers improve their standard of living. Alternatively, they should be able to develop new insights that will benefit the dairy sector further (UVAS, 2020). The results of this study would enable them to better plan for future development projects or programmes that focus on the benefit of small-scale farmers. Moreover, since government policymakers require micro-level information to formulate appropriate policies, conducting relevant research will benefit policymakers because it will help them justify whether increased funding or support is needed in this sector, and to quantify the extent to which farmers have adopted improved dairy technologies and their impact on income and asset building. The findings of this study could also be applied to other similar regions, serving as a point of reference, and a benchmark for subsequent research. The desired result of this research would be the production of grassroots information that is accessible to various stakeholders, helping to facilitate well-informed research and development practices that minimize their drawbacks and any other associated concerns.

1.4.1 For Business Studies

Findings from this study may be of value to businesses by enabling SMEs to gain knowledge concerning effective strategies, benchmarks, and best practices for sustaining and integrating supply chain and information channels into their business processes in dairy sector innovation in socio economic context. Information from this study may be obtained and used by SME leaders, managers, supervisors, and other practitioners to implement guidelines and procedures to support training initiatives. Information from this study may also be adopted and adapted by members of compliance and ethics committee to develop legal and ethical policies. The research intends to identify the obstacles for home-based family business model which is not able to find SME scaling

up provisions in rural Pakistan context. The matter is important, and it impacts the small dairy farmers in Pakistan, their future and growth making the national contribution to economy linking local economy to build a sustainable model (Ansari et al. 2018). The business perspective of creating abilities in the rural milking process is rudimentary now, which has the potential to grow and meet the consumption parameters of the growing population in Pakistan economy. The role of dairy and its demand in recent years, has been expanding in the Pakistan market prompts the question of how to tap the domestic capabilities of the rural dairy farmers who are operating in an environment devoid of technology and innovation.

Previously, studies on technological innovation in rural dairy industries were conducted. However, there has been little investigation into this pattern in South Asia. It is even more important to research with a special emphasis on the Pakistani dairy business. Therefore, this research intends to find out how the technology embedding in the milk production, animal lifecycle and well-being is positively impacted, and the possibilities of process 'technology' to increase the shelf life of rural milk to benefit Pakistani consumers. The appropriateness of technology like 'pasteurisation' of raw milk that increases the shelf life of raw milk, increasing the viability of commoditisation of the milk is an opportunity. This research intends to discover the options and forces currently acting as challenges in creating rural marketing avenues for urban and rural Pakistan. The storage options with appropriate technology and its financing options in rural areas are developing those gaps of the cold supply chain. Therefore, to meet the national innovation level for developing process-centric measures to aid rural inclusivity in domestic production, the choices and options are explored in this research. Even though the level and type of innovation required is high and wide, ranging from animal breeding, milk processing and packaging, the research intends to identify the applicable model for ushering a transition to SME level automation. The modern-day business fundamentals in the consumption-based economy show that food products require health and hygiene factors to be as per the world standards, which is why the technology embedding in the existing rural traditional methods of milking is explored. Though there are several stakeholders to this issue, when technology is being used as a core factor to bring in the transformation in Pakistan rural sector dairy processing, the rationality of the issue in current perspective is evident, as it offers to build an inclusive domestic consumption culture opposing the import-based options.

1.5 Rationale of Study

1.5.1 What is the Issue

Despite a great importance of technological innovation of dairy products in Pakistan these products are still produced manually in small scale. Technology is being perceived as a leveraging factor for development perspective in any issue in the society. The aspect of dairy sector in rural areas of Pakistan which is lagging in terms of development is a national issue that has been ignored for long (Imdad, 2017; Zaid, Hayat & Bacha, 2019). The initiatives from the individual dairy farmers in rural setting and the challenges faced in venturing into entrepreneurship for transforming the home-based dairy operations to SME involving technology and automation is explored in this research. The above discussion shows that rural farmers do not have knowledge and access to technology, from genetic to milk processing equipment, cold food supply chain, to increase the viability. That is why the research is important for understanding and exploring the possibilities to harness the power of fragmented rural dairy farmers milk production in Pakistan.

1.5.2 Why it is an Issue

There is hardly any quality control, and the shelf life of the product is poor in rural diary settings. The current methods of manufacture of these products are primitive and based on techniques that essentially remained unchanged over ages. The rural scale operations are associated with inefficient use of energy, poor hygiene and sanitation and non-uniform product quality. Most of the preparations are labour intensive and rely on local inputs, makes the home based start up to suffer from lack of growth and development. The small dairy farmers with decreased milk production per animal, has tried to increase herd size, to 4-5 in a family. However, the milk output in manual milking process is lower every year, and its consumption is localised in rural sector which shows that rural setup of dairy suffers from the technology inclusion. It uses the traditional milking practices, and absence of genetic technology for animal breeding, lack of animal wellbeing and health issues, that impact the rural farmers to grow. All of these also contribute as a challenge for the dairy farmer in rural perspective while the institutional role failing with governments (central and provincial), SME sector bias to manufacturing, banking not willing finance has eliminated the chances of the growth and development in this sector.

In Pakistan organized dairy industry in the past showed a very little emotional commitment to traditional dairy products. As a result, most of the developments in the dairy industry in Pakistan have been directed towards the manufacture of European or Western type dairy products for which equipment and expertise were readily available from industrially developed countries. In the days following independence, there was tremendous scarcity of milk, especially in the metros. So, organized efforts were concentrated in encouraging dairy production through marketing of liquid milk, either as fresh milk or with the help of recombining milk powder and butter.

The production and efficiency of production depends on availability of infrastructure, technology that also impact the quality. The milk production critically depends on such infrastructure, investment knowledge and finally market it to demand prone areas and lack of any of these makes the whole initiation in the venture futile. The institutional framework, including research institutions play very important role in scientific and sustainable dairy production along with the political willingness to aid a particular sector. Therefore, an attempt has been made to understand the causes behind the constrained technology use in the rural dairy sector of Pakistan (which accounts for the nation's 50% aggregate production capability and has the potential to uplift the industry in the global dairy market). In the end, suggestions and recommendations have been made for modernizing this traditional dairy product sector as to how the stakeholders in the country can contribute, especially to understanding the potential this sector possesses, making an inclusive growth to be a part of Pakistan's economic development by channelizing the rural dairy to market to urbanization and consumer demand. In the present perspective, the study will be very significant since the dairy industry's future will depend upon the ability to derive maximum value from its potential resources. The study will likely provide extensive insight into strategic planning for the entry of organized players in the milk production business.

1.5.3 Focus of the Study

However, at a broad level, the research interests of this study may be summarized as follows, with the understanding that the above questions derive from the application of these broad sets of interests to a specific context:

- To the extent that a study of technology specific to dairy sector, animal health, process-based innovation for setting up small scale milk processing plant in rural setup, technology in packaging and storage, technology in cold supply chain to market rural produce to urban areas.

The study of change dimensions, challenges at rural level, role of institutional aid, the dynamic processes associated with viability of the entire project, which is not possible for rural dairy farmers alone, to bring in technological innovation. Specifically, the introduction of new technologies in the dairy sector of developing countries may be viewed as reflecting a process of rationalization of agriculture in the Third World. The focus, therefore, is on the characteristics of this process of rationalization at national level, exploring an opportunity of rural milk and milk products, able to reach the as reflected by the dairy development case.

- To the extent that a study of innovation must necessarily also address the organizational and institutional context, encompassing rural and national level issues to enable the milk procurement, processing and packaging is a possibility for safe consumption culture. It tries to focus how adulteration and contamination in rural milk is eliminated using adaptive technology and innovation at a small scale in rural sector. The concern here is with the structures that are associated with the innovation process, which is a requirement in the Pakistan dairy sector to equip the rural dairy farmers to find new avenues to market their daily fresh produce. Specifically, the planning, implementation and performance of an innovation occurs within an organizational and institutional context which has an important influence on the overall process. On the other hand, the innovation process itself has important implications for this context. In other words, the overall process could either tend to reinforce these structures or to change them. Since organizations and institutions are associated with structures of dominance which require bases of legitimation to reproduce them over time.
- Underlying the structures and processes associated with innovation is the logic of decision or choice, the rationality that informs and is influenced by these structures and processes. The concern here, therefore, is fundamental to the focus on rationalization and legitimation. To the extent that the logic of decision informs the rationalization process, it represents a dominant rationality. To the extent that this logic of decision legitimates the structures associated with the process it represents a dominant ideology. The focus here, therefore, is on the rationality and ideology that underlies the rural dairy development program of Pakistan.

1.6 Scope of the Study

This research has focused mainly on the role of innovation in small and medium-sized firms in dairy industry of Pakistan. The complete development cycle of innovations, achieved by the Pakistani dairy SMEs, from the objectives for innovation development, main innovation activities, barriers to developing innovations and the role of different types of innovations will be investigated in this research.

Over the past few years, dairy development has emerged as one of the major components of the overall effort to modernize and develop the rural sector of the Pakistani economy. The basic aim of the dairy development program is to upgrade the quality of the large cattle population in Pakistan by artificially inseminating local cows with semen from proven exotic bulls, to produce high milk-yielding cross-bred offspring which are suitable for dairy purposes. In this way it is intended to increase milk production in Pakistan, hence addressing the nutritional needs of a large and growing population and to create employment opportunities for the large numbers of rural unemployed and underemployed. One of the most important aspects of this approach is improving dairy technology. However, the strategy could not ensure widespread adoption and failed to curb excessive dairy production. As a result, it urges investigation of the issue of what causes are causing inadequate technology adoption in the Pakistani dairy industry and what sort of revolutionary framework should be presented or implemented to solve this phenomenon.

This study is based on the current state of technological innovation a in rural dairy sector of Pakistan and factors affecting the adoption of technology. Moreover, the study also intends to suggest a framework of technological innovation management and its application in Pakistani rural dairy SMEs.

1.7 Research Technique

An analytical focus on what is commonly referred to as the problem of choice of techniques in developing countries allows us to deal in a reasonably well integrated manner with the range of questions outlined earlier. This is not to suggest that this research is a study only of choice of techniques in developing countries, but rather that through such a focus it is possible to address a wider range of issues in an organized and systematic manner.

The problem of choice of techniques has conventionally been dealt with from a largely economic perspective, the emphasis having been on specifying those characteristics of a technique which are

important in terms of the efficiency of that technique in a particular context. The central question has generally been: What factors need to be considered, and how, when deciding about a new technique in a developing country? In our discussion, we will deal with the more generalized problem of choice of techniques. In other words, it is viewed not only as a question of "how to choose" but also in terms of the structures and processes of decision making that accompany choice, and the consequences of the choice for these structures and processes. In this sense, the way the problem of choice of techniques is approached here is intimately tied in with the structures and dynamics of technological change in a developing country, as also with decision making and the behaviour and functioning of organizations.

1.8 Research Aims and Objectives

At a general level, the purpose of carrying out such a study was to address the issue of the causes and consequences of innovation in the agricultural sector of developing countries, with a specific emphasis on the political implications of innovation. The aim of the research is to determine technological innovation factors effect on SME's success and failure in Pakistan. The study would provide a strong understanding of the dairy sector and their role in success and failure when using technological innovation. It will also aim to bridge the gap in knowledge pool of this sector in Pakistan.

1.8.1 Research Objectives

The objective of the research would be:

- To investigate current of state of technological innovation in rural dairy sector of Pakistan
- To identify different factors that can measure technological innovation and its management & application in rural dairy sector
- To suggest a framework of technological innovation management and its application in Pakistani rural dairy SMEs

Regarding the rationale for selecting the above listed questions for research, it is sufficient to state at this stage that this result from an appreciation of the recently increasing belief that research

conducted along disciplinary lines tends to exclude important issues and relationships which are vital to an overall understanding of the problem of development. Secondly, a comprehensive study of the overall context within which a process is taking place is necessary to understand the subtleties and complexities of the process, its causes, and its consequences. That the ranges of issues described earlier do in fact reflect the dominant issues in current development research. Thus, this study may be described as an interdisciplinary contextual analysis of agrarian innovation in a developing country with the focus on the set of questions raised earlier.

1.8.2 Research Questions

The study would be based on the following research questions:
RQ1: What is the current state of technological innovation management, and its application play any role in the rural Pakistani Dairy Sector?
RQ2: What are different factors impacting the rate of technological innovation in the rural dairy sector of Pakistan?
RQ3: What framework can be suggested for Pakistani Dairy SMEs to manage and apply technological innovation in rural areas?

1.9 Outline of the Thesis

Chapter one- The first chapter outlines the background of how technology and innovation has shaped the industrial sectors and presents an opportunity for those which have not yet explored it. The discussion leads to establishing the need for research, the rationale, research framework and research technique, the SME sector in Pakistan, focus of the study. It has led to formation of research aim, objectives, and questions.
Chapter Two – The second chapter is about revisiting the theories and past academic research on dairy sector, technology in dairy sector, innovation, factors and challenges in SME sector, entrepreneurship.

Chapter Three – The third chapter outlined the research based on the research onion a framework that helps in systematic approach to the final data collection goal. The research approach, research

design, research methods, research philosophy, choice of quantitative methods in collecting the primary data with justification is done.

Chapter Four – The chapter four focussed on the analysis and discussion of three segments of respondents who are critical in addressing the research problem. The government official in rural and agricultural industry, the dairy technology academic scientist, and the SMEs owners of rural dairy sector of Pakistan. Each of these segments of respondents answered relevant questions related to the open-ended interview questions pertaining to the current situation and research context.

Chapter Five – The discussions brought in criticality of existing situation, in rural SME sector, dairy farming, government initiatives, available dairy technology and innovation, capabilities of dairy processing challenges, supply chain and storage challenges is detailed out. The findings show that inadequacy of structural, process-based innovation in Pakistan rural sector has not led to any development patterns to aid the traditional milk processing technology. It was concluded that gaps remain in addressing rural capabilities in the absence of Pakistan government contribution, for enabling entrepreneurship and SME level organisation. The empirical studies show Asian and western dairy development to adopt technology to bridge operational gaps making end to end process more market centric, hygienic. Lack of innovation due to traditional milking process (closed innovation) in storage, processing milk by-products, structural and policy gaps has led to very slow development and innovation at rural dairy sector.

Chapter Six - It is the final chapter of the study gives the presentation of the summary of key findings. It provides the conclusion of the study and discusses the theoretical and managerial implications of the results. Finally, it ends up discussing the research limitations and recommendation for the future studies on same or relevant research topic.

2. CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The literature review describes the dairy production and SME sector definition, which helps broaden the knowledge base and narrow it down to a sector where specific methods and practices are used. The literature review also uses the research viewpoints to position the work to align or opposes the views. This process has been applied in this chapter as SME, and its role has been defined in Pakistan's perspective as a nation focusing specifically on the dairy sector. The support infrastructure of SMEs and their management is differentiated by identifying problems in the dairy sector. The discussion relates to the history of dairy development, practices and performance, changes in demand for milk, and issues of entrepreneurship that impact rural dairy farmers. The literature also delves deep into how dairy SMEs in Pakistan economy is perceived, the issues that impact competitiveness factor, the role of technology in dairy ranging from genetics, dairy equipment technology, dairy processing technology, milk preservation technology for by-products, technology in nutrition management, lactation management and the rationale for adoption. The literature expands to address a range of innovation, in the dairy sector, in SMEs of Pakistan, the scope of R&D (internally and external to firms), technological inefficiency in SMEs of Pakistan, and factors challenging SME dairies in the country. The discussion from the different empirical studies in small dairy owners, inefficiencies in dairy supply chain linking existing dairy technology, attempts to find out the research gaps. The context of the topic has been explored in a manner that results in the identification of variables which is the key in bringing out the effectiveness in dairy technology, dairy supply chain network and possibilities of innovation in the dairy sector for Pakistan where the background of the research is based.

2.2 SME Concept and Characteristics

2.2.1 Definition of SMEs – Country Perspective

A review of existing literature indicates no universal definitions of SMEs; rather, the country-specific legislation and geographical position determine its definition (Gilmore et al., 2013). For instance, the European Commission considers SMEs as firms with less than 250 employees while the National Small Business Act 102 (1996) in the South African context classify SMEs into four groupings, namely, survivalist enterprises, medium scale enterprises; small enterprises, and very small enterprises (Raza et al., 2018). In Germany, SMEs are defined as firms with less than 100 employees, while in France, less than 500 employees are considered SMEs (Raza et al., 2018). The definitions of SMEs also vary according to the type of business or sector. For example, in the Japanese context, the manufacturing, mining, construction and transportation sectors define SMEs as firms employing not more than 300 employees with a capital investment not exceeding 100 million (yen). Wholesale businesses define SMEs as business organizations investing less than 300 million (yen) with an employee strength of a maximum of 100 employees. In comparison, retail businesses define SMEs as firms investing less than 10 million (yen) annually and employing not more than 50 employees.

2.2.2 Defining SME in Pakistan

Differences in definition also exist regarding SMEs contribution towards economic development and the existing social conditions prevailing in a country (Mendes and Lourenço, 2014). Nevertheless, the basic measurement tests of SMEs in different states are recognized as the extent of invested capital, labour force, and annual turnover (Hafeez, 2014). In **Pakistan**, different sources have defined SMEs in different ways. These sources are the Small and Medium Enterprises Development Authority (SMEDA), SME Bank and Punjab Industries Department, State Bank of Pakistan, Federal Bureau of Statistics, Sindh Industries Department (SMEDA, 2018). Like other developed and developing countries, in Pakistan (a developing nation), there is no common definition of an SME. In Pakistan, the definition of SME as given by SMEDA reads – SMEs are firms having a maximum of 250 employees with paid-up capital up to 25 million (rupees) and annual sales up to 250 million (rupees). SMEDA is an autonomous institution under the Ministry

of Industry and production of Pakistan, established in 1998, linking the SMEs (small, medium) companies with facilities, grants, and proposals from various stakeholders.

In addition, the number of employees working in a firm is the criteria to classify an SME into a small or a medium scale enterprise. Small firms in Pakistan are also defined as those with an employee count not exceeding 35, while mid-sized firms have employees between 36 and 250 (SMEDA, 2018). Meanwhile, more than 250 employees are categorized as large firms in Pakistan (Raja & Majid, 2016). The definition of SMEs as given by SMEDA in Pakistan can be exhibited in the following table –

Table 2.1 Definition in SMEDA Perspective

SMEs DEFINITION BY SMALL AND MEDIUM DEVELOPMENT AUTHORITY (SMEDA) OF PAKISTAN			
Institution	**No. of Employees**	**Paid up Capital**	**Annual Sales**
SMEDA	Up to 250	Up to Rs. 25 Million	Up to Rs. 250 Million
Source: SMEDA (2018).			

Apart from the above definition, other definitions of SMEs exist as proposed by various other Pakistani institutions, such as the State Bank of Pakistan (SBP) defines an SME based on the nature of business, the extent of capital investment, the number of employees, and the net sales value per year. Nevertheless, the definitions of SMEs as proposed by various institutions are enumerated in table 2.

Table 2.2 SME Definitions by Different Authorities

SMES DEFINITIONS BY DIFFERENT AUTHORITIES IN PAKISTAN		
Institution	Small	Medium
SME Bank	Total Assets of Rs.20 Million.	Total Assets of Rs. 100 Million
Punjab Small Industries Corporations	Fixed investment up to Rs. 20 Million excluding land and building.	N/A
Federal Bureau of Statistics	Less than 10 employees.	N/A
State Bank of Pakistan	An entity , ideally which is not being a public limited company, and having employees not more than 250 (manufacturing) and 50 employees (trade/services) and also fulfills one of the following criteria:	
	(i) Total assets at cost excluding land and buildings in trade/service up to Rs. 50 Million.	
	(ii) Total assets at cost excluding land and building up to Rs. 100 Million in manufacturing.	
	(iii) Net sales not exceeding Rs. 300 Million as per latest financial statements in any case (manufacturing, service, trade), (same as for both).	
Punjab Industries Department	Fixed assets with Rs. 10 Million excluding cost of land (same as for both).	
Sindh Industries Department	Entity engaged in handicrafts or manufacturing of consumer or producer goods with fixed capital investment up to Rs. 10 Million including land & building (same as for both).	
Source: Small and Medium Enterprise Development Authority of Pakistan (SMEDA).		

The most acceptable and practical definition of SMEs in Pakistan is the one given by SMEDA, which acknowledges an SME as an organization having paid-up capital up to 25 million in rupees, sales up to 250 million in rupees and employee strength of 250 people. This definition given by SMEDA is criticized because it fails to segregate the difference between small and medium firms and among Manufacturing, Service and Trade sectors (SMEDA, 2018). The implementation of this definition has also remained a critical issue. Meanwhile, one of the commonly used definitions of SMEs is the one proposed by the State Bank of Pakistan that considers SMEs as any privately owned economic enterprise involved in manufacturing, trading or services business having an annual sales or turnover not exceeding 300 million (rupees) in a particular financial year; or any other manufacturing firm with a cumulative asset not exceeding 100 million (rupees) not including fixed assets such as land and buildings with maximum 250 employees or any services or trading associating total assets up to 50 million (rupees) not including land, buildings and not more than 50 employees (Dar et al., 2017).

Khalique et al. (2015) insinuate that the Pakistani government and the associated political regimes have not successfully designed a synchronized definition of SMEs. Therefore, the need to propose a harmonized definition of SMEs that considers micro, medium, small- and large-scale enterprises

and helps to commence a sound mechanism for the development of SMEs in Pakistan. Hussain et al. (2015) argue that no standard or uniform definition of SMEs has existed in the Pakistani context that has affected SMEs' advancement and success, especially for the dairy sector. Even though it is an established sector that typically involves manufacturing as a thrust area, the dairy sector has been confined to unorganized status mostly due to home-based start-ups and the lack of united force exhibited by dairy farmers to get national-level recognition.

2.3 Entrepreneurship in SME

The entrepreneurship dimensions of the management are a response towards the dynamism in the external business environment (Camra-Fierro et al., 2012). While authors have linked the creative side to deal with the complexity of the situations, the issue in the SME perspective is more critical. The SMEs lack the quality of the workforce and the process of entrepreneurship to launch and drive the business concept from start-up to sustain it (Raziq and Khair, 2015). Closely linked to economics, entrepreneurship is an act that can use the skills to find the opportunities at the right time and act on them. The typical SME constraints are found across cultures. The lack of funding and the inability to fight the economic crisis drives the lack of market demand and bad decisions, leading to a complex situation (Raza and Majid, 2016). Thus, the entrepreneurship requires adopting practices or tactics that can drive the existing condition of the business to explore, with the element of innovation. The fine line of exploitation and exploration differs in the approach as the planned approach works better in the outcome.

According to Hassan et al. (2018), the development of an entrepreneurial approach is dependent on the creation of a business plan, hiring human resources, acquiring material and finances, deploying a leader to drive the direction of the venture’s success. The degree of risk-taking capabilities depends on the entrepreneurship ecosystem, and for SMEs is limited to the assistance programs, services offered, and support provided. Non-governmental aid also helps SMEs bring a new dimension not directly but indirectly, as entrepreneurship also requires meeting the regulations and laws of the industry or the sector (Hughes and Mustafa, 2017). Hence, the entrepreneurship concept gets accepted by mainstream firms. It gains capabilities over time to build a viable business model that also requires continuous solutions to its problems. Social entrepreneurship is emerging strongly in the 21st century, political entrepreneurship, which depends on the knowledge factor. Nations worldwide acknowledge that the growth potential of

SMEs is immense and how they contribute to the national economic growth has been a proven method (Pinho et al., 2018). It distinguishes the types of entrepreneurships from 'ethnic entrepreneurship' that defines the people engaging in a particular geography/culture or profession. There is a high degree of uncertainty in the SMEs due to which entrepreneurship is also linked to risk-taking, to the business venture based on the idea. Rezazadeh (2017) classified that risk(s), ambiguity, true uncertainty as the latter is often linked to the creation of novel good. The strategies that SMEs use are usually technology to harness resources and leverage capabilities, gain business intelligence, operations, and productions efficiency, forecast, and analyse the future, and improve quality or continuous improvement.

The nexus of technology and capabilities is closely linked as it aids in the endeavours to drive the intent and meet the requirements to meet the opportunity conditions and satisfy the need for achievement (Khan, 2016). However, entrepreneurship needs to be the strategy concerned with growth, creating wealth/generating revenues, and creating value using the SIPOC framework (supplier, input, process, output, customer). Sulistyo (2016) argued that the leadership drove the SMEs' social influence to seek aid and overcome the challenge. The decisions taken are important for the leadership as collaboration practice is used to gain the upper hand in the knowledge domain and build on the existing experiences. Rowland-Jones et al. (2008) argued that the leadership ability to do financing of the idea is the fundamental success of SME. Several methods like bootstrapping, apart from seed capital invested, are required. Benguria and Santos (2008) added that other instances of SME's ventures that lack knowledge, skill, and experience are also linked to a lack of knowledge to protect businesses with trademark, intellectual property, copyrights, patents that larger businesses can capitalize on it.

According to Shabbir et al. (2016), the indicators of entrepreneurship success are defined by the network of relationships at business to business, business to the consumer level, ability to enter high growth market, targeting customers missed by others. SME gaining on competitive advantage is operational efficiency, lowering the cost factor or time, or achieving exceptional manufacturing/services contributing to entrepreneurial success. Rezazadeh (2017) argued that the most important facet contributing to the growing sector, despite being the small average incumbent size of the firm, deployment of technology that leads to opening more employment, increases the

capabilities. The perspective of technology-enabled entrepreneurship in the SME sector's dairy sector is rare, though IT-based start-ups in Pakistan are common.

The issue in the perspective of the above research is pertinent, as the context is to promote the SME sector, and the involvement of the entrepreneurs in the dairy sector of Pakistan has inadequate academic support. The national-level policy of Pakistan national government towards promoting the SME dairy sector through entrepreneurship support (financial, infrastructural, technological) for starting up and contributing to the national economy does not have adequate research. The factor of private participation in the national interest projects has SME and entrepreneurship helping boost development prospects for the nation, with Chaudhry (2000) academic research stating its contribution to employee contribution. The prevalence of entrepreneurship in the manufacturing sector, and technology start-ups, social sector have been an example in the past that has been ignored in dairy farming and contributing to Pakistan national economy.

2.3.1 Schumpeter Theory of Entrepreneurship

As the single labour force on a Pakistani dairy unit, one of the farmer's most essential tasks is to combine the roles of entrepreneur, manager, and artisan in such a manner that this combination allows him to be successful. Because the demand for entrepreneurship is a novel scenario for dairy farmers, it is uncertain if dairy farmers have the necessary entrepreneurial skills. In dairy farming, like in small and medium-sized enterprises, the position of the owner/entrepreneur is prominent (SME). As a result, the SME literature on entrepreneurship in is chosen as a starting point for this thesis. This section introduces important characteristics of entrepreneurs and entrepreneurship.

The notion of entrepreneurship has been seen from numerous perspectives and dimensions. In some ways, these perspectives and approaches are referred to as entrepreneurship theories; these theories are presented by many thinkers and experts who have only observed or experienced a single contributory component of entrepreneurs. Entrepreneurship theories are divided into three categories: economic theories, social theories, and psychological theories. Schumpeter's proposed innovation theory is based on the economic ideas of entrepreneurship.

The concept introduced in 1932 provided a completely new and previously unknown facet of entrepreneurship and fundamental causes or characteristics of entrepreneurs. This approach is

opposed to traditional conceptions of entrepreneurship, which regard entrepreneurs as organisers and managers who manage for someone else and are compensated by owners. After considerable study and thought, Schumpeter has concluded that creativity is the component that distinguishes a common risk-taker from an entrepreneur, as an entrepreneur, according to Schumpeter, is someone who "Creatively destructs" or is a "Creative destroyer."

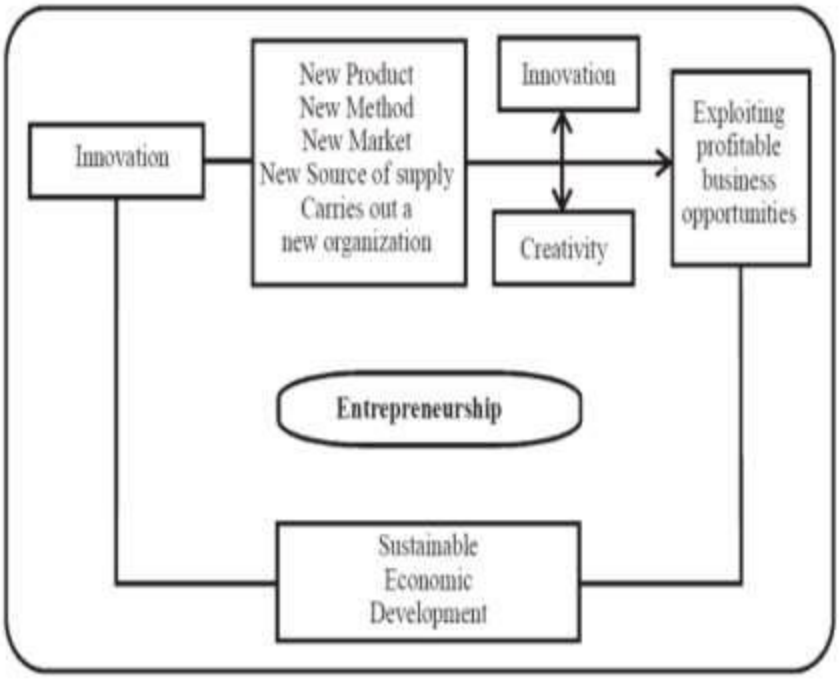
In 1942, Joseph Schumpeter declared and invented "creative destruction" in his neoclassical book on political economics titled "Capitalism, Socialism, and Democracy." In the book, he defines creative destruction as a "process of industrial mutation that ceaselessly revolutionises the economic structure from within, endlessly destroying the old one, incessantly building a new one" in the book. The total of creative destruction is innovation, which uses resources to produce something new and original for the market/customers. According to Schumpeter, an entrepreneur artistically destructs; he does not include administration of factors/resources or organisation of factors of assets as the heart and spirit of the entrepreneur.

Simply, innovation is a "new idea, device, or approach." However, innovation is frequently defined as superior solutions to suit new requirements, unarticulated wants, or current market demands. Innovation provides more efficient goods, processes, services, technology, or business practices to markets, authorities, and society. The phrase "innovation" may be described as anything unique, more effective, and novel that "breaks into" a market or community.

According to Schumpeter, innovation is the "essential feature of economic transformation." He contended that economic transformation focuses on innovation, entrepreneurial activity, and market power, which are critical from a market perspective. He wanted to demonstrate that only innovation's market strength can give enterprises better and put enterprises in a comfortable position than outdated arrangements or invisible elements such as price competition. He said technical innovation frequently produces transitory monopolies that allow for extraordinary gains that competitors and imitation quickly erode. These transitory monopolies were necessary for enterprises to develop new goods and processes; it implies that innovation is a journey, not a destination. According to Schumpeter, investing in innovation is the most significant way for a company to dominate or control a market for a while.

According to Joseph A. Schumpeter, innovation is nothing more than a "new combination of factors of production" that must break the repetitive cycle of economic and market activity. Entrepreneurs, according to him, are those who creatively disrupt the immobile cyclical flow of activities and market supply. This technique carries the most severe danger, which typical businessmen do not accept. He defines an entrepreneur as someone who engages in creative activities. Entrepreneurs are innovators who bring/commercialise new products and services; he is always seeking new ways and new combinations to use the elements of production and concentrate on uniqueness in-market offers. Society owes a great deal to these innovators, who take risks and uncertainties to create newer/fresher and ground-breaking items.

Figure 2.1 Schumpeter's view of Entrepreneurship



Schumpeter also distinguishes between innovator and inventor, which may seem like a layperson but not to Schumpeter. According to him, an inventor develops a new way of accomplishing something or a new product technique/application of a factor of production in a novel way. On the other hand, the innovator is the one who takes such findings and turns them into new products or services. An inventor is focused on the technical aspects of the development, but an innovator is

more focused on the economic and tangible elements of the product. According to Schumpeter, an inventor can also be an innovator in some instances. As an innovator, he is more valuable since he creates/discovers something (creator) and leverages that originality to generate economic value. In a nutshell, inventors find new methods, and innovators are those who implement those new ways for the first time, giving them a commercial edge. It is dangerous to utilise or rely on anything that has never been attempted before, and entrepreneurs bear this risk; therefore, innovation becomes their major purpose and trait.

Schumpeter's idea has been heavily criticised for a variety of reasons. Though the critique is not conclusive, there are a few dimensions on which this theory does not adequately explore or provide light. According to Schumpeter, the creative or inventive entrepreneur focuses solely on invention; however, detractors argue that this is not the only decisive trait/function of entrepreneurs. Some of the most typical criticisms levelled towards this idea are as follows:

1. This approach concentrates solely on the function of entrepreneurship's invention and ignores other vital and equally significant components of entrepreneurship, such as organisation and managerial abilities.

2. The theory does not support the concept of risk-bearing as much as it supports the concept of innovation. It appears that risk-taking comes first, followed by innovation, but according to various experts, entrepreneurship is all about risk-taking, analysing uncertainties, and finding techniques to mitigate their impact.

3. Surprisingly, this approach significantly weakens or entirely ignores the traditional characteristics of entrepreneurship, in which the entrepreneur assembles and employs factors of production to create a real product or service. According to this notion, only genuine entrepreneurs are innovators, but what about classic company models and traditional approaches to wealth creation?

Despite its crucial criticism, the notion of innovation has a lot of validity when it comes to distinguishing between typical corporate houses and entrepreneurship. "Innovation certainly, develops a resource," Peter F Drucker said of this strategy. It gives it economic worth." According to Drucker, the only characteristic that entrepreneurs must possess is invention. He has spoken out against opponents and has defended the beliefs of his predecessor. According to a widely held

belief, each new concept will necessarily have dangers and uncertainties, and if one proceeds with it, he or she is just shouldering the risk. In contrary to detractors, Schumpeter has really undertaken risk elements inside the ambit of innovation in a very subtle way. His viewpoints are especially pertinent to emerging and low-income countries, where innovation must be supported and promoted as a means of improving living and job circumstances. The transition of an agricultural economy into an industrial one necessitated a great lot of initiative and adjustments on the part of businesspeople and managers, who became more and more entrepreneurs and innovative entrepreneurs. Innovation must be apparent in any of Schumpeter's five stated fields. It should be highlighted that innovative entrepreneurs have made incalculable contributions to the expansion and stability of capitalism, as well as to the acceleration of economic progress.

In simple words, the spirit of Schumpeterian entrepreneurship is innovation (s), which is "*The introduction of something new-a new idea, method or device*". Innovation is critical to the economic success of any firm, region, or country. As technology evolve, the sizes of old goods and businesses shrink. Inventions and inventors are the foundations of any economic unit's future. According to Thomas Edison, innovative brilliance is "*1 per cent inspiration and 99 per cent perspiration*" (Hisrich et al., 2019). Innovation keeps businesses afloat and moving forward (Peters, 1997). Companies must always be on the lookout for new business possibilities including new variables, procedures, and goods (Drucker, 1999). Profit and public recognition are the benefits for entrepreneurial efforts in organization and invention. The Schumpeterian entrepreneur, however, is more than just an economic, management, or home entrepreneur (O'Boyle, 2017). That is, entrepreneurs are motivated by more than just a financial motivation, since there are higher and unusual values underlying entrepreneurial successes and breakthroughs. Higher values may include achievement, social welfare, poverty reduction, or assisting the poor.

2.3.2 Kunkel's Theory of Entrepreneurship

John H. Kunkel has also provided a unique perspective on entrepreneurship. Concerning the growth of entrepreneurship, he has offered a theory of entrepreneurial behaviour. Kunkel's theory is associated with individuals' stated actions and their relationships to their prior and current surroundings, social hierarchies, physical circumstances, and behavioural patterns influenced by reinforcing and opposing factors present in the setting. As a result, entrepreneurial orientation is a

product of past and current environmental and social structures, and deceptive economic and social rewards easily influence it.

Kunkel stated that, "The supply and development of an entrepreneur depends upon the existence and extensiveness of four structure i.e., limitation structure, demand structure, opportunity structure, and labour structure." He has emphasised the four sorts of structures for entrepreneurship development:

1. Demand Structure- An economic demand structure exists. This structure is evolving daily due to economic advancement and government policy. Individual behaviour may be more entrepreneurial by influencing the significant demand factor's structure.

2. Opportunity structure- The opportunity structure is established by a combination of capital supply, managerial and technical skill production techniques, labour and market, training opportunity, company creation, and various activities.

3. Labour structure- Several elements influence labour structure, including the source of livelihood, conventional viewpoint, and life objectives. The quality of labour influences the birth and expansion of entrepreneurship. Labour intensive, rather than capital intensive, will better suit our interests. The problem of labour immobility can be alleviated by providing infrastructure amenities, such as efficient transportation, wherever entrepreneurship is encouraged.

4. Restriction structure- The limitation structure can be social and cultural. This structure has an impact on an entrepreneur's development.

The theory presupposes perfect frameworks for entrepreneur supply. However, there is a common disparity between aims, structures, and the actual occurrence of entrepreneurs. It is because there are insufficient or erroneous perceptions. In practice, entrepreneurship is also regulated by a unique set of circumstances that are not commonly available in the environment. John H. Kunkel's idea emphasised structural categories such as demand, opportunity, labour, and limitation. The growth of an entrepreneur is influenced by the entire system. Kunkel has expressed their own point of view on the topic of the psychological theory of entrepreneurship. This hypothesis explains the psychological motivations that drive the emergence of entrepreneurship.

The above theories are pertinent to the dairy sector of Pakistan as it is in of technology to overcome the traditional dairy production process, storage and creating a cold supply chain to spread milk by-products for the population to consume. The central focus these theories is on the individual and his character inference from environmental circumstances in general and internal values.

2.4 Contribution of SMEs in Pakistan

In Pakistan, SMEs are considered the backbone of the state economy, and their contribution is approximately 40% of the country's GDP, 30% in export, and 80% in overall employment (Raza et al., 2018). Moreover, SMEs play a significant role in social development, i.e., uplifting the social status of people and improving their lifestyle (Raza et al., 2018). Hassan et al. (2018) argue that the economy of Pakistan is largely SME driven, and SMEs represent more than 90% of the total business establishment in the country. Currently, approximately 3.2 million business units exist in this country, and these establishments mainly deal in manufacturing, wholesale, social and personal services, and hospitality. SMEs in Pakistan mainly add value to the manufacturing business.

However, the most prevalent SME sectors in Pakistan contributing to the economic growth are the 'Agri-based Industry', 'Cutlery and Stainless Utensils', 'Surgical equipment', 'Fan manufacturing', 'Fisheries', and 'Dairy and Livestock (SMEDA, 2018). SMEDA stated that Pakistani SMEs possess the flexibility and dynamism as feasibility studies conducted to strengthen the country's economic situation by generating employment, upgrading skills and knowledge of the workforce, technological diffusion, and innovation, and earning foreign exchange. SMEs are also playing a significant role in profitably and efficiently mobilizing domestic resources and create employment opportunities. While SMEs specialized in various sectors in Pakistan contribute in different ways to the country's socio-economic development, the current literature focuses mainly on the dairy SME sector in Pakistan in dairy sector improvements in technology.

2.5 Dairy Sector of Pakistan

2.5.1 Context of Dairy Sector Development

The dairy processing for milk in the rural hinterlands of Pakistan is mostly a generic model due to the above discussed national structure. Ali (2013) stated that the small herdsman has limited financial capabilities and have developed milk processing units only when the number of cows/buffalos started increasing in their holding. Burki and Khan (2011) argued that the manual extraction process of milk in the rural sector by hands had been a trend from the nomads practising subsistence farming. The progress and sustenance of civilization have been happening only on human civilization's capabilities domesticating the animals for centuries (Raja, 2001). The animals in small numbers in agricultural societies are mostly privately held by families as the breeding helped increase the numbers and meet the local milk demands in villages. Therefore, the development of the cottage industry of milk in Pakistan expanded gradually as the output of milk started meeting the consumption demands as Raja (2001) argued that small size 1-2 animals per family increased to 3-4 animals per family.

2.5.2 Rural dairy contribution: an early growth phase

Afzal (2008) explained that the dairy process in rural Pakistan is a daily chore done by dairymaid and dairymen, where hand-based milking is the predominant method. The economic angle of the milking process and production for the domestic and local populations depend on the population's catchment size. Ahmad et al. (2012) confirmed that over the years, the small number of animals in the herd and local consumption trends have helped the dairy industry to grow and finally gain momentum in serving a wider catchment area. The author further stated that the urbanization process of major cities in Pakistan, from the agriculture societies, has led to the establishment of the cottage industry. The increase in the herd population emerged strongly, and ‘dairy farming’ was established, though per animal yield decreased over the years. The concept has more cows/buffalos, with larger breeds under a shed or a barn. The economies of scale for the milking process depended on 15-20 cows/buffalos per individual engaged in the milking task. The streamlining of tasks with twice-daily milking, with average hours less than three hours a day for each animal, is a general trend in Pakistan. The average milking routine to give rest to the herd is

about 300-320 days annually. However, the milking pattern due to lack of technology is based on knowledge and folklore, which resulted in 20days of the production cycle for the smaller herd.

The increase in the herd size and barns with sheds led to the storage of bigger bins and bulk milk transport to the surrounding areas apart from the domestic and local population consumption (Garcia et al., 2003).

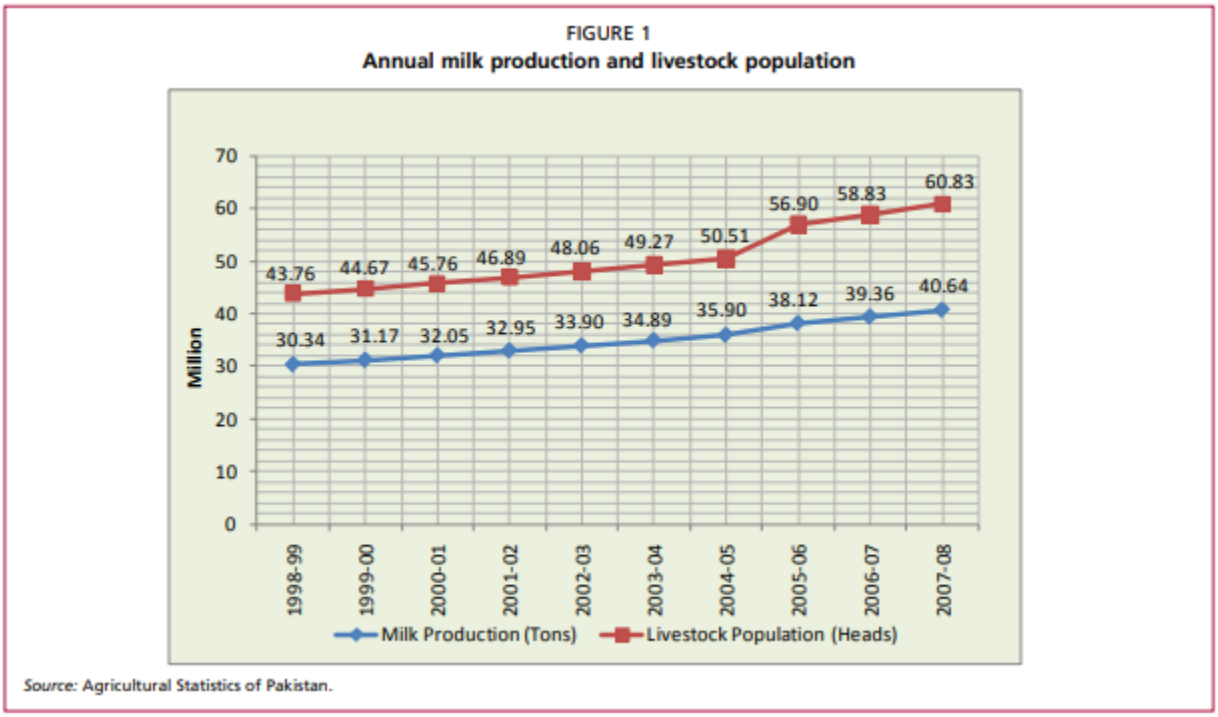
Table 2.3 Household Animal Ownership Statistics

No. of animals	Ownership by household (%)
1–2	27.32
3–4	23.73
5–6	14.32
7–10	13.68
11–15	6.29
16–20	2.65
21–30	2.58
31–50	2.71
51 or more	6.72
TOTAL	**100**

Source: Pakistan Livestock Census, 2006

It led to a cluster of milk production units in all villages of Pakistan that has developed self-sufficiency in terms of production and meeting the consumption needs. Garcia et al. (2003) added that the small herdsman with growing breeding options increased the size of livestock and either started to produce own milk processing system in rural scale or became contractors to supply fresh milk to others who are skilled to process milk products (cheese, butter) or sell it as milk in faraway regions. It led to the establishment of a marketing chain in rural and urban linkages. Ahmad et al. (2008) stated that many animals joined the farm programme PDDC. The use of transportation formed a critical part of how the dairy's milk production is routed through the marketing chain and sold fresh, gaining the expected price per litre. The monetization of the milk and the perishability factor led to rural dairy farmers in Pakistan entering the commercial milk production strategy by showing abilities to produce milk in rural settings and sell it premium for an urban setting. Most of the milk production comes from Buffalos and cows. In Pakistan, around 80% of the national milk production happens in the rural areas, with only 5% in urban areas, rest 15% in peri-urban areas.

Figure 2.2 Annual Milk Production Livestock Population



The milk production statistics show that in the decade 2000-2010, the aggregate milk production in Pakistan has increased by 36%, primarily due to aggressive animal breeding, leading to an increased animal population engaged in milk production. Bilal et al. (2008) argued that milk production quality remains low, and the volume from the aggregate animals is far below the world average in measuring animal production. Much of it is not scientifically addressed. Most animals are not fed with appropriate livestock feed, lacking medical attention to the animals, which drastically impacts milk production volume. Ahmad et al. (2012) stated that in the period 2000-2010, the rural people engaged in milk production is 30-35 million who earn 40 % of their income from milk production and segmentation shows that 34% of people are very poor, with the majority having (1-3), (4-6) cows in their household.

2.5.3 Change in Economics and Demand of Milk

The above economic opportunities are waiting to be tapped how the rural Pakistan dairy farmers from small individual owners began to tap the metropolitan supply chain to use the production to be marketed. The price rise in the input elements has seen a phenomenal increase over the decades,

while Soomro et al. (2014) argued that maintaining herd health is the single source of sustenance for the farmers.

Table 2.4 Price increase in animals and fodders.

Input	Price (rupees) 2000	Price (rupees) 2007	Increase
Milch animal	20 000	60 000	200%
Cotton seed cake	270	560	107.4%
Wheat bran	170	380	123.5%
Maize cake	370	680	83.78%
Fresh milk	20	32	60%

Hence, the impetus to the Pakistan dairy industry is balancing the higher demand of the metropolitan cities where the population agglomerated and the rural side supply constraints that require two most important things – technology to produce quicker and then transport to the right place at the appropriate time to get a premium price. Tostivint et al. (2017) argued that the lack of technology in milking for procuring the huge volume of milk, processing it, store it for food supply chain in the rural setup to the urban is missing in Pakistan.

The herdsman found the model of increasing the herd to be a profitable venture and kept the mating cows/buffalos separate during the mating period. However, selecting the best mating animal depends on the local stock, though each female animal got to mate at least once in the rotation. Still, the national average of reproductive performance is inadequate due to a lack of technology (Qureshi et al. 1998). Even the milking activity, which is a rudimentary process of hand-based milking and breeding in Pakistan, showed that the attending of each animal for grazing had to be systematized, and the use of a bin for cow/buffalo fodder was introduced (Tostivint et al. 2017). It is evident from the discussion and analysis that the initial years of the Pakistan dairy industry is limited to manual labour for grazing, milking, and breeding, while the perishability of milk forced them to sell the overproduction milk to neighbours or local area. Hence, the freshly produced milk cannot travel far due to the lack of cold supply chain process from the rural, peri-urban areas to the Pakistan urban areas from where the maximum demand is created. Garcia et al. (2003) argued that it is a structural challenge in setting up cold SCM for milk procurement, milk processing and post-production distribution activities is rudimentary that still requires a considerable amount of

work, and inputs from diverse stakeholders associated with meeting the transportation of fresh milk to potential buyers' market. The implications are that rural milk production is a waste that cannot process the entire raw milk volume, storing it in pre- and post-processing to increase shelf life (Tostivint et al., 2017).

2.5.4 Issues Impacting Dairy Sector Competitiveness: Pakistan

The role of government ushered in technology infusion in the dairy sector in Pakistan though it formed a centralized role in processing milk (Garcia et al., 2003). However, the challenges of dairy technology not expanding to the rural sector, or as SME (small and medium enterprise) faced challenges of investment, technological orientation and skill development associated with dairy farming (Burki et al. 2004). The public governance of the ministries and the importance of the food and dairy sector over some time was realized (Iqbal et al. 1999). It led to establishing the 'National dairy start and establishing the 'Livestock policy in 2007' (Afzal, 2007), which led to concentrated power of technology and milk product creating problems not allowed to address the geographical challenges. However, it harnesses the production processing speed (Cain et al., 2007). Ahuja (2013) stated that the small dairy farmers did not have technical knowledge and orientation to embrace new technology, finance to set up SMEs, and lacked the broader level of awareness. Their intention for adopting automated dairy processing that would help the dairy sector to improve in Pakistan. The poor livestock management and its breeding with the absence of supporting health services for livestock presented a big challenge. Afzal (2008) argued that the need for a technology-enabled solution, especially to establish corporate dairy farming, is crucial is a vital strategy perspective, in livestock management for small dairy farmers, increased access to support services for animal health wellbeing is ideal for long term goal achievement of low milk productivity issue. The Pakistan government has ignored the above issue mainly due to lack of funds and failure to establish the rural-urban cold supply chain (Rehman et al. 2017). It has led to demand and supply mismatch in the milk production and consumption, the price differentials in the country, while mostly the consumer's paying capability has raised their expectation level. Idrees et al. (2007) stated that issues like low quality, contaminated milk, lack of hygiene, adulteration, and government intervention at local city or rural towns plague the dairy processing industry. The government here plays a piecemeal approach as the setting of dairy plants require financing and a nationalist policy roll-out to match the urbanization pace. The primitive nature of

policy address and limited opportunities for the small dairy farmers to enter the enterprise ventures have resulted from a poorly structured and approach of dairy sector treatment at the national level (Rangnekar and Thorpe, 2001), as reported in a developing economy like India. It is a generic problem for developing nations as the potential challenge for a small herdsman with one to a maximum of five animals, therefore is hinged in the ability of their income capabilities to be harnessed, mental orientation about a technology-based dairy plant that is dependent on the financial backing and support from the local nodal agencies for incubation or mentoring for venturing.

2.6 Technology in Dairy

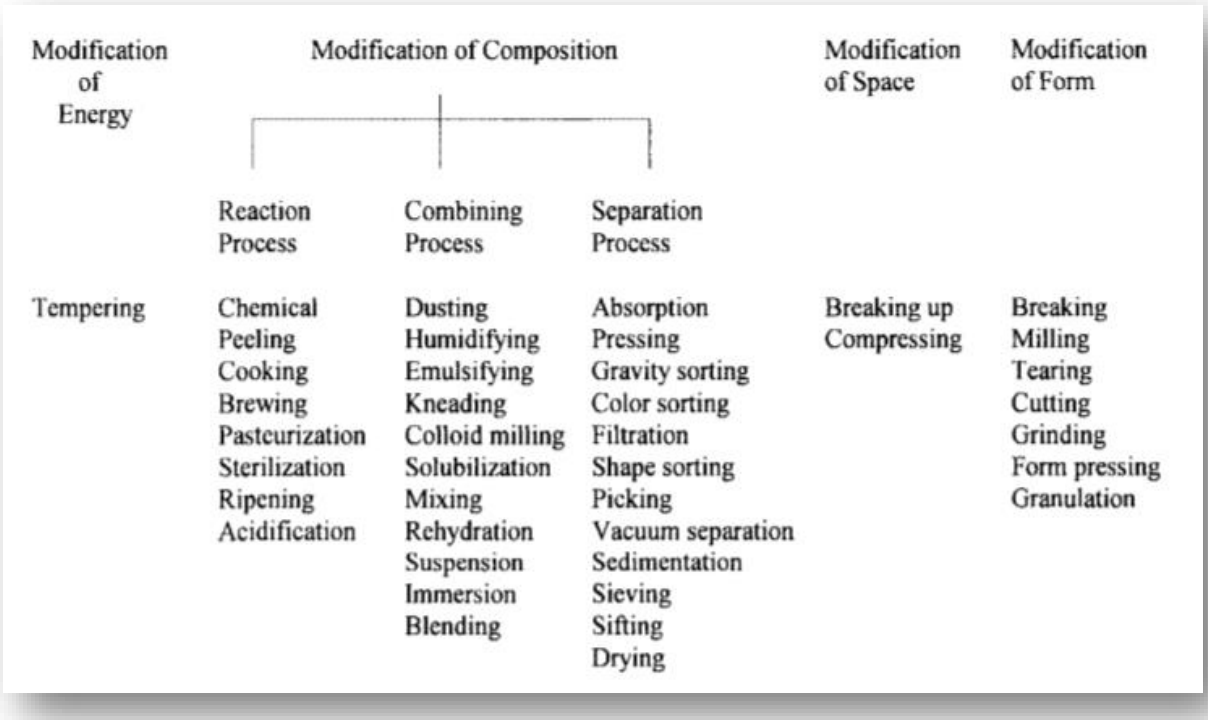
The importance of equipment-based processing of milk and segregating it to a wide variety of milk products requires the inclusivity of technology in the dairy domain. The technology ‘’is the science of applying rule-based knowledge leading to output, either using raw materials; semi-processed items to produce finished goods.’’ Hence, the technology embedded ness in operations helps to process faster and better to assist not only milk production but also livestock and bring in biodiversity (Gura, 2013), that is an economic point of view, while the most visible output is the quality factor. Ullah et al. (2016) stated that using technology eliminates manual labour and processes the same activities using advanced methods. However, the problem is to acquire the working knowledge through proper channels or using a collaboration route. The technology is differentiated in mechanical or even digital. In contrast, the aspect of chemical and biological technology in the dairy domain as several disciplines have contributed to their research in the food processing industry in which dairy technology is a subset. Ahuja (2013) showed that the developing nations of Asian origin against the developed nations worldwide had taken the first step towards improving the pre farm stage of the dairy production process to engage in selective breeding for animal livestock quality.

Empirical studies from Australia where Jersey cow breed is a renowned breed for milk production, as shown over years to double the milk production, from the same population. In a study (1980-2010) spanning over decades, milk production from cows has increased by 50% in Australia. The stocking rate fell by 50% for fresh raw milk before it is sent for processing to different companies in diverse by-products. Production per hectare in Australia shows a 192% increase, with 2878litres/hectare to 8419 litres/hectare in the period between 1980 to 2010. The inclusivity of

technology and innovation in dairy farming has led Australia to achieve milk production efficiency, genetics and feed conversion efficiency, and medical examination for cows that have substantially improved the milk production capabilities in Australia.

Dairy technology comprises a mix of scientific knowledge based on theoretical and practical applications used to control the production process of milk and its conversion to allied milk products. Kanwal et al. (2004) stated that dairy technology is specifically used to treat milk altering its chemical composition, which has definitive processes that characterize milk processing. Over time, the use of equipment and machinery has perfected producing the classical milk product into groups using technologies. Technology also relates to how raw materials are used per their class, composition to be modified by specific processes to produce finished milk product quality in dairy technology (Javaid et al. 2009). It is a more process-oriented definition as the state of raw materials, and the inner molecular structure of milk is modified using appropriate process(s). It can be generic, which has both a manual process and technology-based equipment to stage the production of milk conversion to take place in large scale operations using multiple processes in terms of technology.

Figure 2.3 Technological process in the dairy industry



(Source: Ahmad et al. 2012)

To sustain the business operations of milk production, the industry point of view has monetization as a target to facilitate the supply-demand gap. However, the issue for the small dairy farmers is a challenge both economically and structurally (due to small herd size), which makes technology infusion not to be feasible (Amin and Palash, 2020). Modern machines have led to the grouping of processes, longer shelf life of products with improved plant design and innovations in the machinery in dairy processing.

Ahmad et al. (2012) explained that production processing in an industrial environment uses technology that guarantees the quality elements in the product input, processing, and output. All the dairy technology processes and sub-processes are standardized and correspond to the certification and reinforcements that add value. The modern machines and their intended processes ensure that there is loss-free utilization of milk elements. They fine-tune the improvement of raw milk to increase the shelf life missing in Pakistan dairy (Burki et al. 2004). The advent of the computer has increased the precision of mechanical and chemical actions leading to the

manufacturing of substituted products, data capture, a greater level of control, and automation of activities and sub-activities. The modification of milk and its products has led to handling multiple raw material inputs quickly.

In contrast, the introduction of packaging systems has helped to align production and supply chain management. Technology has helped introduce the biotechnology of the milk fermentation process. The introduction of enzymes at the right time and volume helps produce reliable and credible output, eliminating the possibilities of harmful elements. Irrespective of the production volume or even batch processing, continuous processing, dairy technology has improved in industrialized countries due to the need-based environmental situations. Gura (2013) stated that in countries where the weather is a factor or due to the climatic conditions, quality of milk from the herd, its extraction process is related to the consumption factor involving the end user's health, nutritional value, livestock health and type of milk. In the long run, the development of technology in the dairy sector is also related to the distribution and marketing of finished process-based output. It reaches the intended market for consumption within the perishability limits (Rehman et al., 2017).

The discussion shows that modern technology forms a key tool for improving the productivity of the sector, and dairy technology has been progressing in various environments and countries to meet the needs of dairy farmers. However, Evenson and Gollin (2003) (Sheahan and Barrett, 2014) argued that adopting ultramodern technology in the poor parts of a country often leads to disappointment and underutilization. Amin and Palash (2020) added that the challenges in a rural setting for SMEs regarding supplier inputs, processing capabilities, and utilities like electricity were key components in equipping SMEs with technology infusion to achieve output. The use of technology perspective is important in SMEs, especially to link the rural-urban gaps in demands in a national economy. For rural economies, the supply-demand gap has been increasing every year. The emergence of organized retailing format with modern procurement systems of perishable food (vegetable, meat, fish, bread), the daily consumable items is also attracting higher demand in urban areas. When it comes to new technologies, the entire domain in dairy technology is huge, as it encompasses the milk production processing capabilities and harnesses the technology related to animals.

The developed nations worldwide have shown proven use of technologies in the dairy segment, which have also been reported in transition countries to create value for the end-user. Embedding technology helps to yield higher revenues (Rhee et al., 2011). It has been often relevant for NGOs (non-governmental organizations) or even a franchisor in which innovative models of new business architecture fulfil the gaps through collaboration. The implications of the integrative approach are to bridge gaps expedited by technology found in developing economies. The issue is pertinent for Pakistan as it is a developing economy with the world's third-largest livestock population. It has very little technology transfer in the dairy value chain (Ahmad et al., 2012). While this is an opportunity to deploy technology and create more streamlined and systematic milk production in Pakistan, and the rising population demand for milk, it also poses a challenge in terms of knowledge-based transition apart from creating inclusivity of job creation important for Pakistan domestic economy.

Wajid et al. (2013) argued that the food production and supply chain arguably is most anti recessive, and hence it requires efficient technologies. The areas like animal breeding, grain production, storage require a cold food supply chain that harnesses the 'man to machine' ratio in dairy farming, embedding scientific technology in the entire process. Raja (2001) argued that any dairy development needs to bring rationality to market-based monetization capabilities. There is a stark difference in the approach and nature of technology inclusivity in developed and developing countries (Rhee et al. 2011), as most of it is driven by the market characteristics, defined by customer needs. Hence, the difference in traditional milking methods and modern equipment-based output of milk products and by-products has shaped the current dairy products. The change in lifestyle and urbanization has led to spiralling demand for milk and milk products in almost all countries. At the same time, the criticality of the technology-based production process is in demand due to the higher quality milk product (Younus et al. 2002), safe for the end-user consumption needs with adequate shelf life. The readiness of the end-users to consume diverse milk products that are packaged maintaining the health guidelines reflects the technology infusion in the developed nation's dairy sector, which is clearly defined by their level of income, or affordability factor, which is higher in developed countries over developing countries. However, the lack of knowledge for an individual family with few animals is dependent on government policy, at local city/rural level communication in a common platform that addresses animal health-breeding, production processing and storage for improving shelf life, leading to increased marketability

(Rahmat Ullah Shah and Mahmood, 2013). Therefore, the fragmented rural setup without sophisticated technology is devoid of sharing knowledge in society that impacted the last three decades of the Pakistan dairy industry and its innovation capability.

2.6.1 Genetic Technology in Animal Breeding

Since dairy involves the rearing and grazing of animals (livestock), genetics form a clear positioning regarding technology infusion in this aspect. The farming of the animals (cow and buffaloes) requires a holistic approach to breeding; as Shah (1991) argued, genetics has been progressing significantly in its contribution. The US-based firms report capabilities of genetic editing technologies, as it alters the molecular-level composition and the hereditary to make the animals retain the milk production and become resistant to diseases (like mastitis). Afzal (2010) reported that it is evident that the organizations deploying the herd of animals suffer from the downtime for non-productive animals, requires well-bred livestock animals to support the dairy sector productivity. It can be concluded that milk production is dependent on the genotype-environment factors where the owner needs to ascertain the balance of the factors of production (composition and total milk yield), as well as maintain the functional elements (livestock diseases resistance, fertility, body weight and intake of food) (Khan et al. 2008).

Wajid et al. (2013) argued that the technology in molecular genetics, therefore, optimizes the use of technology to eliminate the problems faced in conventional animal breeding techniques. The question of dairy animals breeding is pertinent as the technology-aided process against the traditional method (natural selection) is increasingly controlled in the developed nations like Pakistan (Hassan et al. 2007). Elements of breeding and functional traits of the animal with the relative milk production is of particular interest in the business world. However, this aspect mostly depends on the national level infrastructure in biotechnology, genetics, which has an adequate pool of brains to improve dairy breeding (Kakar et al. (, 2012). Atsbeha et al. (2012) stated that genetic technology had aided a wide range of issues like milk feed efficiency, reproduction abilities milking ability, resistance to disease, and calf/lamb meat production that offers better local breeding conditions existing ones. The current research focuses on the milk production traits in the animals and the genetic requirements that aids in meeting the supply-demand gaps. The small dairy farmers often do not have the freedom to engage in selective breeding. At the same time,

laboratory-based approaches are only possible with knowledge exposures and their willingness to accept new genetic technology.

The dairy fermentation process started a long time ago (9000years ago) (Akhtar et al. 2016), and the origins have been passed on to generations that have been aiding in a wide variety of milk-based products like yoghurt, curd, cheese (Rhee et al. 2011). These are based on technology resulting from accidental infection and souring of milk, where the lactic acid-producing bacteria is introduced. Kakar et al. (2012) stated that genetic technology, particularly for Pakistan dairy, is pertinent as it helps identify those genes that are subject to defects or are facing genetic disorders that need correction. Technologically, it requires an elaborate livestock gene analysis and genome scans to find traits and molecular genetic technologies implemented on breeding animals in the dairy farm (Ahmad et al., 2012). The practice in the early-stage or even in embryo stage by using technology in specific areas of DNA to induce new genetic maps eliminates the shortcomings and deficiencies of existing dairy breeds in Pakistan.

2.6.2 Dairy Processing Technology: Milking Activity

The concept of milk production technology has evolved over the years. With the hand milking procedure around the towns, cities gradually gave their way to industrialization, where automated plants processed milk pasteurization and produced milk by-products. The late 19th century saw the use of dairy processing, which presented a challenge when the numbers increased in the herd (Rahmawati and Suntornsuk, 2016). Dairy farming technology has been a part of grazing culture and agriculture for every civilization for thousands of years (Fuquay et al., 2011).

'Vacuum bucket milking' -The first milking technology is 'vacuum bucket milking' technology, which fits on the regular milk pail for each cow. Later, it led to the advanced design of surge hanging milker, where the device is strapped with the cow body as the cow stands on the floor.

Milking pipeline – The innovation in the milking in the 20th century started using milk return pipe and a second vacuum pipe which linked the milking parlour over each cow, quick seal entry points above each row (Fuquay et al. 2011). Milk is extracted through milk return pipe by vacuum, flowing using the gravity principles towards the milk house vacuum breaker leading to final storage tank. The pipeline allowed to expand as it enabled to harness larger group of cows.

Milking parlours- The Australian and New Zealand centric milking technology called milking parlours helped maximize the number of animals to be milked in a given time time per operator. It is like the assembly line, and its design focus on reducing stress on the milker, with animals elevated to a level where the milkman doesn't have to bend. Most of the commercial dairy technologies are based on this principle.

Figure 2.4 Types and Capacity of Milking Parlours

Efficiency of four different milking parlors.
1=Bali-Style 50 cows/h.
2=Swingover 60 cows/h.
3=Herringbone 75 cows/h.
4=Rotary 250 cows/h.

Herringbone parlours – this is a style of milk production that has parallel rows of cows, and the machine milks one cow in each row at a time. The role of 'milker' is to transfer the cows from the shelter to the parlour, which is a bottleneck design that leads to four to six lanes of cows. It is easy to clean and maintain the herringbone as safety and stability increase for both animals and milkmen.

Rotary parlours – The modern dairy parlours are unique, and rotary ones have a milkman at the entry point to help the cow enter the platform rotating until the last cow is done. At pre and post-activity of milking, the milkman dip the cow teats to eliminate bacteria. It can accommodate around 250 cows per parlour (Özer and Kirmaci, 2010).

Fully automatic robotic milking – the use of this machine is found in the latter part of the 1990s in the European Union. It is an end-to-end automated system that helps to eliminate the cow traffic issue, as evident in the previous methods 'parlour'. At the same time, it uses different sensors to detect health, fertility, calculate the yield and milk quality with volume recorded in this machine

(De Koning, 2010). Every cow is tagged with ID, and the production data is coded for each production phase.

The above technology deployed in the milking operation is country specific as technology started to take its due course in design, function and helped to improve and innovate on expanding on the systems. It is also using a milking routine to eliminate fatigue to the animal body. Most importantly, this technology to rescue as teat infection in dairy technology is now leading organizations to maintain a milking routine. The above types of technology in milking equipment show a variety in addressing the dairy industry needs typically prevalent in nations due to their exposure to technologies and national R&D pace (Tariq, 2013). However, the degree to which the dairy firms can adopt new milking technology or show the intention and philosophy to avoid hand milking is a clear shift in developed nations that technology inclusivity is needed. It is not just the production efficiency strictly in monetary terms, but to achieve higher levels of production volume (in litres) per day capability to meet market-based needs, safety, and hygiene in a production process that technology in milking mattered. Tahir et al. (2019) stated that this issue is pertinent for the Pakistan dairy SME sector, especially when the urban market is maturing, and the rural supply requires a faster method to harness the daily fresh milk production rate. However, the research context requires exploring the broader factors of 'milker' technology available in the nation and how extended roles of government, private players help in adopting one, which suits the rural belt of dairy farmers in Pakistan.

2.6.3 Milking Routine

A milking routine is followed, especially when the cow or buffalo is repeatedly entering the parlour that affects the health leading to animal stress, chances of contamination, leading to udder infections (O'Brien et al. 2002). The milkman knowledge about these is critical for animal wellbeing and health. The milk technician role is immense as they are enablers to the transition of the technology process activities that are taking place in the dairy location. The activities are stripping the teat, as it is important to avoid the transmission of animal-to-animal diseases. The animal affected by mastitis cannot enter the milk production but impacts the animal and its health. Hence, Hagmann (2012) argued that early detection and practices of health and hygiene are important for the animal, the small dairies, to sustain the rural model. However, the lack of milking

routine and greed to earn more is evident in the rural belt. They can only increase cows and buffalos when the milk production volume drops per animal after a continuous milking routine. The lack of milking technicians in the rural belt of Pakistan has not led the technology to aid the spread of disease, animal health and wellbeing for every household engaged in dairy milking (Tahir et al. 2019).

2.6.4 Milk Preservation Technology

Alvarez and Ji (2003) stated that the criticality of technology emerges as a necessity that increased the emergence of milk preservation strongly as the point of origin(production) and the point of consumption due to the geographical nature of demand-supply happened as urbanization happened. Secondly, the refrigeration requirement for milk preservation is primarily due to the perishable nature of milk and its properties. The traditional model of milking by hand led to the use of cans of milk for storage since ancient times. Thirdly the need for milk-based by-products has necessitated milk preservation to harness technology to extend the shelf life of raw milk.

The emergence of automated methods eliminated hands, as bulk milk cooler with a base of ice banks developed. It is a double-walled tank with sides and a bottom with refrigeration coils to remove the heat from the milk and reduce the temperature of the milk. Over the years, with technology development, the temperature-based cut-offs are used for storing huge volumes of milk in these tanks where the temperature is automatically maintained as per set conditions. Rahman (2007) argued that milk in raw form has a short shelf-life; hence quality control testing is required in multiple stages and periodically to test and ascertain if the microbiological and chemical composition has altered or not. Spreer (2017) added that routine activities like sampling and analysis of milk processing at post milking require an advanced level of technology that can detect the live composition of milk ingredients in the dairy plant, pre-storage, and post storage stages.

The implication of technology to control the food value and nutrients is more vital as the requirement of each milk-based product requires specific conditions to be appropriate for the milk by-products (Rahman, 2007). From the food science technology point of view and commercialization of milk by-products, the hazard analysis of raw milk is needed that requires technology and testing to be parallel to meet the expected outcomes. Hence, it is evident that the traditional milking process that has taste, price, convenience has now been eclipsed as consumers

do not want home-based milking (traditional) methods but is willing to pay extra, to accept technology-based milk, processed and packed to extend perishability factor (Lado and Yousef, 2002). Apart from the social impact, elements like health, safety, wellness, and well-being have been interlinked to the technology-based machines that do not comprise the quality factor. In most developed nations worldwide, the dairy sector has adopted technology creating dairy systems 'end to end devoid of human hand processing activities. Devlieghere et al. (2004) stated that essential minerals like (calcium, iodine, magnesium, iodine, potassium, phosphorous), vitamins (like A, D, K, E along with B1, B6, B3, B12) in the milk-based diet is found to be a critical driver for the consumers in accepting the processed milk and packaged milk by-products. Milk proteins like whey and caseins (alphaS1, alphaS2, Beta, K-caseins) are also important, as consumers are looking at the inherent value embedded in machine-based milk processing products. Hence technology-based milk preservation process is sweeping dairy technologies around the world.

2.6.5. Nutritional Management

Oetzel (2007) stated that nutritional requirements and management are essential for cows and buffalos engaged in the commercial milk production process. The nutritional manager is important as the animal's production volume, based on the animal's historical data and genetic makeup, which is used to ascertain the average production rate. Any indicator of being overburdened by milk production requires a balanced diet. Therefore, the role of the nutritional manager is to formulate a diet that meets all nutritional gaps to ensure adequate animal health. It is a scientific process that involves the calculation of the ingredients based on the technology. However, for the Pakistan rural dairy farmers, the preparation of the fodder with nutrient component deficiency is evident as most of them cannot afford market-based fodder for their animals which is cost-effective (Iqbal et al. 2015). A diet high in fibre must maintain minimum sustenance of animal health amidst the daily milk production stress. It is highly specialized knowledge that requires assessing the current fodder analysis, animal health, and prescribing an appropriate diet regimen, including the fibres and vitamins to make the animal robust. Hagmann (2012) argued that adopting a mass scale approach is required to reach fragmented rural dairy farmers, a team that can test - body condition, health, and nutrition.

2.6.6 Lactation Management

Cow begins to lactate after the birth of a calf. Lactation will normally continue for as long as the cow is milked, but production will steadily decline. Shamay et al. (2005) stated that dairy farmers are extremely familiar with the pattern of milk production and carefully time the cow's next breeding to maximize milk production. The pattern of lactation and pregnancy is known as the lactation cycle.

For 20 days post parturition, the cow is called a fresh cow. Milk production quickly increases during this phase, but milk composition is also significantly different from the rest of the cycle. This first milk, called colostrum, is rich in fats, protein, and maternal immune cells. Peak milk production levels characterize the next 30 to 60 days of the lactation cycle. The amount of milk produced per day during this period varies considerably by breed and individual cow depending on her body condition, genetics, health, and nutrition. During this period, the cow's body condition will suffer because the cow will draw on her body stores to maintain high milk production. The food intake of the cow also will increase. After peak lactation, the cow's milk production levels will slowly decline for the rest of the lactation cycle. The producer will often breed the cow soon after the female animal leaves peak production. The cow's food intake will remain high for a while before beginning a decline to pre lactation levels. After peak milk production, her body condition will also steadily recover. Raja (2001) stated that managing lactation is important as it directly impacts the smallholder dairy farmer’s earnings,

2.7 Reasons for Technology Adoption in Dairy Production

The dairy industry also requires technology to gain the volume-based processing power of quality milk. Quality control in the food supply chain has been a rising topic as the onus of controlling the external factors lies on the dairy owners, the point of origin (McGill et al. 2019). Though the issue has been dealt with in an institutional context, milk production institutions have evolved in different parts of the world. In farm-business, a cooperatives model is typically user-controlled, owned, and user benefits (Soboh et al. 2009) against the IOF (investor-owned firms), aiming to maximize the firm's shareholder value. Even though both of this organization structure aims to maximize the dairy production, the technology factor has been a key enabler cutting across the organizational structure, communication, quality in the new form of institutional structures

impacting the sector. Quddus (2012) argued that in many cases, it is the technology that has been used for balancing the risky ventures in different forms that have been impacting the functioning. The study set in a developing nation like Bangladesh tends to portray similar problems and issues faced by India (Basunathe et al., 2010). Mekonnen et al. (2010) study in Ethiopia in African showed a similar state of issues and problems faced by small herdsmen compared to the US, a developed nation deploying ICT based technology in dairy (Gillespie et al. 2009).

Janssen and Swinnen (2019) reported that the issue is as important as health and hygiene. In milk, procurement is mostly manual in developing countries in an Asian context, which needs a better chance. However, the functional, structural, and situational challenges that impact the dairy sector for bringing in the technology inclusivity are important for all stakeholders. The market in Pakistan is demand driven. However, it has tradition-based practices in the rural sector, a manual milking process for small herders. Ruegg (2003) stated that manual milking brings in the possibilities of the unhygienic inputs in terms of the quality dilution, external germs and dirt that are waterborne, airborne or hand contact, which impacts the final milk production. Even though the demand for milk exists in the market, the lack of institutional readiness to innovate and implement a new model for dairy processing at the structural level has not emerged strongly. Mekonnen et al. (2010) stated that technology adoption eliminates the above challenges of raw milk exposure during the milking process from different contamination sources that are a pre-requisite criterion for the saleability factor of processed milk achieving high quality.

When related to the Pakistan milk perspective, the formation of Pakistan standards and quality control authority (standards development centre) plays an important role. Under the ministry of agriculture and food division, it is the only nodal agency that plays an active role in the food laboratory, governing the ‘National institute of food sciences and technology. It has brought in testing culture in the milk production at a countrywide level, especially with the ‘Pakistan Dairy Development Company’, helping many ‘Dairy farmers association’, and associated organizations like ‘Livestock and dairy development’.

2.8 Innovation

The processor acts that lead to the organization's continuous development are typically ingrained by new ideas, new technology to bring in new products, and innovation processes. Innovation

creates efficiency, as it helps to improve the procedural approach by the deployment of innovation (Mahajan, 2010), while Phills et al. (2008) stated that it could be radical or incremental, while Nelson (1993) stated a nationwide innovation system for the country. Asheim and Gertler (2005) explained that innovation is also extended to services and business models or technologies supporting management functions. Innovation is found to be associated with the technology-based invention. Though both are different concepts, it has been linked to engineering, production, and output as well. Pavitt (2005) stated innovation as a solution-centric rather than technical and scientific nature, which has brought about improvement in different practices and disciplines like management and economics.

Knight proposed the earliest classification of innovation in 1967, where four segregation was outlined-

i) Product/service innovation – This type of innovation used an organization's product or service offerings that disrupted existing products in the market.

ii) Production process innovation – This type of innovation is related to the operations of a manufacturing or services production, which can be attributed to technological advancements.

iii) Organizational structure innovation is A structural innovation that assesses new rules between organizational hierarchy, communication, task, and rewards-based systems leading to a higher level of efficiency and output.

iv) People innovation – It is a change related to the workforce that brings about changes impacting roles, job description, ways of working, organizational culture by adopting new ideas and practices in behaviours.

The nature of innovation has been related to binary focus, product versus service, product versus process, radical versus incremental, and binary models. Trott (2005) stated that there is complexity and diversity in how innovation is defined, classified, and typified. Boer and During (2011) defined innovation as a combination of product, market, and technology impacting organization innovation. Johannessen et al. (2001) stated that anything new is an innovative product, service, or method that adds value to the context (life or outcome in operations), creating a new system in business due to the inclusion of quality movement/Total

quality management (TQM). Thus, business system innovation encompasses many types of innovation, which is a new way of organizing things and achieves something new.

Trott (2005) typology of innovation consists of the following –

Organizational innovation – This is a typical new venture with the new division, new communication system and new accounting procedure.

Management innovation is the new systems like TQM (total quality management and) BPR (business process re-engineering).

Production innovation- It consists of the adoption of new methods and practices like JIT (just in time), or QC (quality circles), or BPR (business process reengineering).

Commercial marketing innovation – The new methods adopted by the organization to make higher sales, new marketing plans, new financing arrangements like direct or e-commerce marketing adopted are innovative in the business world.

Francis and Bessant (2005) stated that product innovation could be related to the product, also involve service, hybrid innovation (mix of product and service). Secondly, they proposed process innovation at the organizational and technical levels, labelling each category through linking operations, productions, and administrative and management systems. The position innovation is defined as how a business is extended to include marketing, commercial systems to exploit a higher level of innovation in the environment. Lastly, the paradigm innovation is about a product, process, and process innovation, beyond micro-level activities, organizational level practices, and change at a greater impact in society.

However, the seed idea of innovation is also found to end user driven as typically, the need for consumer demand is often worked upon to bring in new products or new production processes that meet the changing needs of the consumers. OECD defines innovation as ‘’production or adoption, assimilation, and exploitation of value-added economic activity in renewing existing products, services or developing new production methods (Havlíček et al. 2013). The concept of innovation has a novelty factor, and the kind of innovation which is important which ushers a new way of working. Novelty is important when it is new to the firm or for the sector, as it has chances of being replicated by competitors in that country. Hence, the role of innovation in equipment and

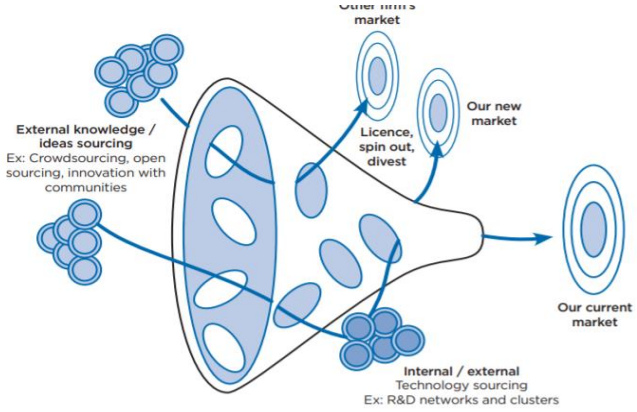
technology-based adoption in SMEs of Pakistan has happened in the past, especially in the manufacturing and farming sector. The technical and production innovations tend to overlap and complement each other bust as management, organizational help to create business system innovation and value in the supply chain (McGill et al. 2019). However, the extent of the innovation required to bring in rural milk production volume, or at Understanding the feasibility of appropriate 'milker' from a financial point of view is critical as most of the home-grown innovation in the rural dairy sector is devoid of technology in Pakistan.

2.8.1 Types of Innovation

The process elements of innovation depend on the traditional model 'closed' innovation and the new 'open innovation' methods. These are attributed to firms that operate within a social context and use communication, information processing, and technology in business to engage innovation. The idea is to make existing processes and products better qualitatively meet consumption parameters or process them less time and cost.

Open innovation is a technique that allows purposeful inflow and outflow of knowledge to initiate and accelerate innovation internally (Chesbrough, 2003). The strategy adopted is a managed information exchange process with actors within and outside the organization contributing substantially to give shape to a process, integrating existing resources and blending knowledge. Open innovation is not limited to large organizations or any sector particularly, as it can harness the knowledge through collaboration, networking, reducing time, cost, risk factors. Knowledge is harnessed from customers, suppliers, regulators, and competitors that provide cues for forming thoughts and designing a new output. However, open innovation depends on process-based crowdsourcing capabilities, as it optimizes internal capabilities with wider external capabilities challenging the traditional innovation model 'closed innovation'.

Figure 2.5 Innovation Funnel



(Source: Wheelwright & Clark (1992), and Chesbrough (2003)

Inbound open innovation – It is a situation where the external source of innovation helps to seek opportunist ideas to source technology or a component in innovation to eliminate the time, effort, and combined complexity to develop the same in-house.

Outbound open innovation – The use of purposeful strategies to externalize the innovation using a licence to other firms help the innovative product to spread the level of development. Additional changes to obtain regulatory approvals, out of licence distribution, are also found in industry practice.

Coupled innovation process – Combining both outbound and inbound innovation process methods use the resources, expertise, and firm-level knowledge to be optimized for a greater level of solutions.

Chesbrough (2003) stated that open innovation models are usually found to defend the organization's defensive reasons, to survive, reduce costs, eliminate risks associated with the product development perspective. It is also a way to show how knowledge harnessed is put to good use and leveraged to improve outcomes that industry does not possess, or competitors possess. It has been related as an 'ecosystem' where flexibility in the structural model is achieved through the network, collaboration through formal or informal methods. New forms of alliances with varied society stakeholders contribute to the open innovation process- joint R&D, cross-licensing, out-licensing, in-licensing, corporate venture capital. The criticism of the traditional innovation model

shows the limited growth and prospects of knowledge processing, leveraged within lesser internal people driving the innovation leading to lesser output. Chesbrough (2003) concluded that product complexity or process complexity in cognitive thinking requires converging knowledge inputs from various sectors. The implications of open innovation over traditional innovation are an obvious shorter time to market a product with lesser cost and risks involved. Open innovation is more fluid as the ability to accumulate cues from the environment and knowledge accumulation from diverse stakeholders helps to foster future innovations in the long-term perspective. It also helps immensely exploit outbound open innovation, leading to new market opportunities for a firm lacking in marketing capabilities, especially when the firm is small. However, Brant and Lohse (2014) argued that the open innovation model excels in harnessing the knowledge power from unexpected sources, forming and disbanding teams in collaboration, adding flexibility in a creative process against the rigidity of the traditional innovation model.

Workplace Innovation

The aspect of workplace innovation is a new dimension as it impacts the production outcomes, improving the efficiency and effectiveness of the organization capabilities (Zoghi et al. 2010). However, Mitchell-Ketzes (2003) argued that innovation comes with a cost, and the process to build upon the idea requires capital, resources, methods to be developed. Hence, innovation is an opportunity identification, as Beblavý et al. (2012) argued and converting that idea to resolve an existing problem or modify and adopt the new idea-based activities to improve the workplace needs. Høyrup (2010) argued to promote the ideas and action into outcome-based research, the policies and employee orientation are required to drive the innovation momentum forward. Though the concept of innovation is closely linked with technology, the interdisciplinary views show that the outcomes have benefitted the business and economics of the organization or for the greater good of the nation.

It is a definite comparative advantage for applying innovation in the workplace. The existence of an organization in a sector is related to how creative it is in addressing its problems. Lindahl (2004) argued that innovation from the organizational perspective had been linked to entrepreneurship. Developing the idea into a business venture is the earliest form of development the civilization has witnessed. The innovation can also be linked to the workplace context. The production consists of input; the output depends on specific processes in spatial and is critical for business output. Hence,

Anderson and Gasteiger (2007) innovative activities that can show tangible improvements in products or bring uniqueness in the intangibility in service is a relevant innovation for organizational development. It eliminates waste, improves quality, meets customer specifications, and creates more market share for the organization. Internally, innovation is bound to impact the work methods. It either brings in new ways or approaches to existing work processes, leading to using few resources using the potentiality to create more wealth. The innovation impacts the organization's capabilities. It reduces the risk of obsolescence, reengineering existing processes to create value for all actors in the value chain functions and supply chain stakeholders. Mitchell-Ketzes (2003) argued that disruptive innovation is the key to organizational success for the future. It essentially attacks the inefficiencies of the traditional organization working model, offering cost-effective solutions or enable quicker processing using technology. Hence, the systems approach apart from quality is often found to streamline the existing practices. At the same time, the organizations show their interest in the gradual and steady adoption of the technology-based institutional change process. The adoption of technology and innovation in the product (milk), process (production) requires a rethink of rural business structure, feasibility level of technology adoption, financing in Pakistan rural dairy sector is pertinent but requires rationale and initiative to eliminate traditional work methods to give way to the hygienic milk production process.

Sector innovation

Regarding technology innovation in the dairy sector, the issue has witnessed phenomenal changes in equipment-based improvement, applying cross-platform technology. Examples of biotechnology or genetics in developing improved feed for live stocks as an alternative to grass grazing or selection of perfect genes are high-level technology innovations in science. Nettle et al. (2013) stated that technology in shelter management, detecting food safety for animals, identifying feeding strategies, and zoonotic diseases that impact the animals have brought a strategic advantage to the existing practices. Thus, pre-farm technologies have a bigger role to play as they bring innovation to dairy farms worldwide. The initiatives of the dairy farmers in respective nations in the developed world have the rationality of the benefit to cost ratio worked out (Massa and Testa, 2009). Hence, any technology-based innovation that impacts the dairy sector or the dairy industry is realized regarding production gains, profits, or lesser investment in the future, animal yields rising, and lesser animals falling ill. The breakup of the investment area for the

government in bringing an all-round improvement is through the following investment areas – pasture utilization and improvement, feed use (nutrition), genetics-based animal breeding, cow/buffalo wellbeing and welfare, milking system and milk processing system, business, and human resources (Klerkx et al. 2013). The author concludes that Australia and the Dutch dairy industry have public sector support, apart from a national level knowledge wave, to bring in co-production and innovation to overcome the challenges. The nature of innovation has been closed. It refers to serving the purpose only for the Australian and Dutch country-specific needs, which has been addressed using scientific research and development impacting the dairy sector. It is critical as all countries require education (higher education) to support their national development through technology and innovation.

Technological innovation has led to easier readiness in organizations in the dairy sector to seek more opportunities to produce milk-based product systems. Nettle et al. (2013) stated that empirical studies from Australia show that the government has invested substantial well thought out programmes seeking a long-term objective for the nation. It has created RD&E (research development centres that link federal government and industry investment to create initiatives for driving the total milk production volume. This model is a structural innovation as the Australian Federal government has allowed this to research pasture production, better feeding systems, animal healthcare. This approach shows the government capabilities to engage stakeholders for driving the sector in terms of production, valuation, and counter the global threats of climate change (Anderson and Gasteiger, 2007). RD&E is showing the outcomes now after three decades with over $10billion farmer returns due to active programs in cow genetics, pasture management, supplementary feeding. The factoring of federal government benefits, statistics show that for every AUD 1 spent in 1980, the dairy sector returns benefit at least $3.30 after three decades. Modelling the R&D and innovation has been typically brought in to reduce the parity of production cost and consumer willingness to pay for milk and milk products. Some of the external drivers impacting the growth of the dairy industry are rising milk prices, increase in input costs like water, electricity, fuel, chemicals, transport, increase in wage costs of people engaged in the dairy sector, reduction of dairy production volume. Massa and Testa (2009) stated that it is evident that even in developed nations' dairy sector faced problems, which is why the application of technology and innovation has been prevalent in Australia as a case.

The development of the dairy sector has been termed as ‘intensification of the sector’ in technical language, as the concerted efforts driven by policies have led to the final impact of production. The intensification at pre-farm and farm processing using the advanced levels of technology has led to innovation in process-based outcomes (Klerkx and Nettle, 2013). The hectare yield is high, as milk has now more varieties due to automated milk processing plants (like chilled milk, flavoured milk), while the pasture-based feed has risen against the supplementary feeding. It has shown marked improvement as the mix of pasture, and supplement-based feed has improved milk production quality and keeps the animal health intact. The contribution of different organisations is DEPI, DRDC (dairy research and dairy development council), dairy research council, commonwealth government, universities, industry representation in association, and dairy research committee.

2.9 Traditional Innovation Methods

2.9.1 Internal R&D in Firms

R&D is a key antecedent for innovation as innovation results from the investment made in research and development (Berchicci, 2013). It is because R&D tends to enhance the firms’ knowledge stock and the use of this knowledge helps to introduce innovation in the supply chain process and design novel products. Likewise, several researchers (King et al. 2008) recognised R&D as a key innovation input for enhancing firms' innovative performance. As regards the role of R&D, studies carried out by researchers such as (Alcácer and Zhao, 2012) point out that internal R&D performs two core functions, namely, (i) it creates new knowledge by way of product/process innovation and (ii) it enhances the absorptive capacity of a firm (i.e., its ability to internalise the external knowledge). Therefore, R&D not only brings in the technological know-how but also takes in the knowledge spill overs from external sources. It indicates that R&D is a significant gauge for measuring the absorptive capacity of an SME firm (Bougheas, 2004). Nevertheless, R&D is a costly and risky outlay and calls for a long-term commitment to improving SMEs' innovative tendencies and competitiveness. Other studies indicate that SMEs usually undertake informal R&D (transitory R&D) by procuring resources from various departments because of the lack of technological and financial competencies.

Similarly, SMEs in developing countries such as Pakistan tend to under-invest in R&D due to higher ambiguity in continuing with innovation and information gaps between the firm and external investors. Moreover, the restricted access to external and internal finance limits the SMEs ability to utilise their in-house revenue to invest in risky innovation-led projects (Subhan, Mehmood & Sattar 2014). Sometimes, SMEs consider it less costly to imitate than to invest in innovation, as their size is correlated to the accessibility and constancy of internally generated funds (King et al., 2008). Bougheas (2004) point out that investment in R&D below the optimal level is likely to be expensive; nevertheless, grants/subsidies linked with R&D may eliminate the underinvestment in innovative activities. Czarnitzki and Delanote (2015) researched 3272 SMEs in the German context and found that R&D subsidies (government-sponsored) drastically boost SMEs' innovative capabilities and performances. In another study, Hotternrott and Lopes-Bento (2012) researched 1973 SMEs in Belgium to find that R&D subsidies speed up the investment and spending that SMEs allocate in R&D, which has a significant impact on SMEs innovative performance. Supporting this view, Bougheas (2004) suggested that financial incentives and R&D subsidies often helps SMEs to overcome the issues relating to absorptive capacity, weaker competencies, and the absence of large scale and scope of economies. Comparing this viewpoint, Bougheas (2004) examined the innovation barriers for 224 Turkish SMEs using the logit model. Their findings revealed that lack of government support in the form of lack of R&D subsidy considerably reduces the firms' innovation outlay and performance. It indicates that R&D is an imperative input for the innovation success of SMEs because SMEs gain from the knowledge generated through R&D activities which enhance their innovation output.

2.9.2 External R&D

SMEs dependency on internal R&D activities and other in-house competencies are no longer adequate to cope with the increasing costs of innovation, increasing technological complexities and shorter product life cycles (Munari et al. 2010). This kind of shift from closed innovation to open innovation models has stressed external R&D activities. Through such network activities (that is, R&D collaboration with external research organisations, educational institutions such as universities, and suppliers) may increase their competitive behaviour and performance (Berchicci, 2013). External R&D generally aims to design new products and develop new processes by cutting

down costs. In addition, the possible benefits of such external networks entail sharing costs and risks, shortening cycles of innovation, and exploiting scale economies (King et al., 2008).

Moreover, external R&D collaboration provides intangible knowledge through people-to-people contacts and strengths the marketing capabilities of each collaborating partner (Vega-Jurado et al., 2008). R&D cooperation can help SMEs overcome the challenges of resource constriction and technology transfer. In this context, Teirlink and Spithoven (2013) researched more than 100 SMEs in Belgium to find that micro-sized firms are more reliant on R&D cooperation than firms of any other size.

In addition, several pieces of research concerning SMEs financial capabilities reveal that SMEs are more financially constricted than their larger counterparts (Munari et al. 2010), implying that the internal financial resources are not sufficient to undertake R&D projects. Therefore, financial inadequacies largely constrain the innovative tendencies of SMEs. A feasible way to overcome this problem is through R&D collaboration of SMEs with suppliers, research firms, and potential competitors, which increases their R&D investment and simultaneously competitive behaviour (King et al. 2008). While resource inadequacy is a major constraint to SMEs innovative capabilities, at the same time, it is their central motive to research beyond the peripheries for the requisite knowledge and innovative concepts. Specifically, R&D alliances facilitate SMEs to internalise more technology spill overs, integrate complementary technological competencies, exploit scale economies, and control the instances of free-riding on R&D outputs (Vega-Jurado et al., 2008). In addition, SMEs can strengthen their innovation performance by gaining knowledge from external sources, i.e., by way of R&D cooperation with partner firms or research institutes.

Bougheas (2004) argue that R&D collaboration with potential competitors is likely to have an unfavourable impact on SMEs product innovation. It is major because of the increasing transaction costs, especially collaborating, administering, and controlling the R&D activities. On the other hand, Chun and Mun (2012) researched SMEs in Korea and found that R&D collaboration largely enhanced the SMEs product and process-related innovative capabilities. Strobal & Kratzer (2017) indicated that open innovation strategies in SMEs and their dependency on external R&D considerably improve their innovation performance.

On the other hand, empirical studies carried out by Fey and Birkinshaw (2005) indicate that external and internal R&D tend to have a complementary relationship at an increased level of in-house /internal R&D intensity. Meanwhile, at the lower level of in-house/internal R&D intensity, both external and internal R&D has a substitutability correlation. In particular, the trade-off between external and internal R&D has a positive influence on SMEs innovation output (Vega-Jurado et al. 2008). Likewise, King et al. (2008) researched SME firms using the linear path model, and their findings suggested that there exists a complementary relationship between the external and internal R&D. The lack of innovation due to strict organisational structures without collaboration is impacting the production, technology infusion process and quality of product/process. It is evident from the above discussion that the acts of incremental or radical innovation impact the firm's survival, and from the SME point of view, its importance is immense. Thus, the role of technology combined with innovation helps to bring about the much-needed change in the existing system. Particularly for the rural dairy sector that is devoid of modern technology, and many challenges of lack of knowledge of dairy farmers, lack of electricity in rural areas, absence of fast-food supply chain to urban areas, hence tilts towards an open innovation model over R&D. It offers more flexibility, institutional freedom, to collaborate the best and optimise for reaching the outcomes. The constraints in rural dairy farming are more as the solutions to problems is not strictly related to one stakeholder but involves diverse stakeholders. Hence, for creating a fast production process in creating a market-centric output in meeting the consumer needs of urban Pakistan, innovation is more appropriate.

2.10 Innovation in SMEs

According to Prajogo (2016), innovation, from a firm’s perspective, can be considered a complex process that involves developing new ideas, transformation, and execution, and using knowledge-based technologies, resources, and capabilities. Edler and Fagerberg (2017) explain that a firm engaged in innovative practices entails several complex strategies (for example, product innovation, process innovation, organisational and marketing innovation). Innovation plays a significant role in the progression of industries. Studies conducted by Snyder et al. (2016) acknowledge innovation as the main driver of firms’ competitiveness and the eventual source of growth and productivity. Freel and Robson (2017) argue that firms that undertake innovation through internal (internal research & development) and external (collaboration) efforts gain higher

technological capabilities to generate product and process innovation. It is because investment in innovation augments technological development and optimises the marginal cost of production. Debating on the extent of innovation in SMEs, Nordman and Tolstoy (2016) point out that adaptability, flexibility, absence of complex hierarchal structure, effective communication (internal), and quick decision-making provide them with a better competitive advantage than their larger counterparts. Nevertheless, several qualitative and quantitative studies, such as that of Poorkavoos et al. (2016; Aksoy (2017), have identified that SMEs are more financially and non-financially constrained to carry out innovation than large firms. In addition, lack of entrepreneurial and leadership capabilities, weaker proficiencies and absorptive capacity and poor scale economies make it difficult for SMEs to invest in R&D.

2.10.1 Innovation in Pakistani SMEs

Khan et al. (2015) argued that SMEs in developing countries such as Pakistan face additional constraints regarding the lack of technological investment, skill shortage, and low research and development rate. The key challenges for these SMEs are linked to promoting a culture of innovation, enhancing their innovative capabilities, i.e., radical innovation backed by R&D activities and endorsing a patenting culture for better SME performance. Meanwhile, empirical studies by Pathan et al. (2017) indicate that the use of internal R&D integrated with external R&D can help SMEs to augment innovation performance significantly.

In particular, the use of an 'open innovation model' can help SMEs innovate by integrating internal and external knowledge and technological capabilities. In this model, external technology can enter the existing system at any stage of a business venture which is better than the closed model of innovation that restricts project progress (Chesbrough et al. 2006). Even though the R&D activities emanate from the needs or improve existing operations activities, innovation is required to bring in 'radical' out of the box processes, contributing significantly to the production process. Open innovation uses both internal and external R&D typology to optimise both to adopt advanced technology. The benefits of open innovation, especially for the product development and incorporating customers in the development process, market research makes it ideal for blending capabilities internal and external R&D. However, the degree open innovation model is applicable

in the dairy sector, in rural areas of Pakistan creating new business architecture and ecosystem is dependent on many stakeholders and diverse issues.

Internal R&D is sufficient, but it limits the progress, as it relies on the internal closed knowledge system of the stakeholders. SMEs need to rely on external R&D to carry out innovation in product and performance. Other studies by Subhan et al. (2014) have also stressed the importance of internal and external research and development to foster product and process innovation. Strobel and Kratzer (2017) insinuate that external research and development (R&D alliances) helps to enhance SMEs innovative outcomes and absorptive capacity if these firms are disinclined to invest alone in R&D. To gain a deeper understanding of the innovation in SMEs, a deeper theoretical review of internal R&D and external R&D is carried out in the subsequent section. To improve the organization-centric or enterprise-based activities and R&D (research and development) is necessary, discussed in the next section.

2.11 Technical Inefficiency in Small Dairy Firms: Pakistan

In developing countries, the context of dairy farming has closely addressed urbanisation, the production system, and the supply chain contributing to the marketing system. It is evident from the study in Australia (Kompas and Che, 2006) that dairy technology is a labour-intensive sector, and the inter-linkages of activities involved in the production, processing and distribution of dairy requires the organised supply chain network to assist in consumption in cities and towns. In many instances, the strategic location of the dairy in the country, the production technology and the storage mechanism in the post-production process is a critical point for the realisation of benefits from an investment point of view (Ropega, 2011). Eniola and Entebang (2015) stated that while small dairy owners are entrepreneurial, their limited capabilities to establish or create a bigger market are dependent on their outlook and orientation of their mission.

Empirical studies show that cooperatives at the rural level bring in the power of unity in production, processing, and distribution. Still, the prevalence of the dairy model at the regional level may not fully support the framework in other countries (Lucky and Olusegun, 2012). FDI (foreign direct investment) in SMEs and mostly for a disorganised sector is unlikely to attract investors. The issue of milk collection from the fragmented industry happens with the self-collection procedure and delivery to the milk plants. Secondly, the private MNCs model owns the

dairy farmer's milk collection process in a designated region and the farmer cooperatives. Apart from the supply chain and the lack of infrastructure to process fresh milk to increase shelf life and purify impurities, the province and national government have played a bigger role (Berisha and Pula, 2015). The traditional role of rural milk collectors, lacking in the financing capabilities or forming a cooperative, starts up as an SME to challenge the bigger milk processing units in Pakistan. Hence, the level of technology to manage the herd, well-being, milk production is rudimentary and dependent on the number of hands in the family. The absence of technology as a small dairy producer with more than one buffalo or cow faces the procurement and distribution and technology infusion challenge for faster processing. Ropega (2011) argued to bring in technology for a small dairy farmer. The pre-requisites are - overhead shed and structure, animal fodder, water, straw and concentrates, and molasses added with family labour in terms of hours multiplied by the number of members engaged. Burki and Khan (2005) reports that per day per farm expenditure is around Rs. 243, and empirical study shows that most small herders cannot deal with external factors to provide quality life (inputs) to improve milk production quality.

Table 2.5 Descriptive Statistics for the variables of Frontier Production

Descriptive Statistics for the Variables of the Frontier Production Function and Inefficiency Model

Variables	Mean	Std. Dev	Min	Max
Frontier Production Function				
Output				
Milk Production and other Dairy Outputs (Rs)	88517.9	87053.1	900.2	958176
Inputs				
Shed and Structure Capital (Rs)	5713	5486.3	19.6	66220.8
Animal Capital (User Cost)	12583	10709	720	131850
Fodders (Acres)	0.81	0.7693	0.0085	9.1882
Straws and Concentrates (40kg)	62.81	118.797	5.13	2811.50
Molasses (Yes=1, No=0)	0.025	0.156	0	1
Feed Water (No. of Times Feed Water to Animals)	2.34	0.51	1	4
Family and Hired Labour (Hours)	2097	1380.70	104	7488
Technical Inefficiency Model				
Farm Characteristics				
Herd-size (Number)	3.51	2.73	1	30
Head Age (Years)	49.25	13.58	17	95
Depression (if SRQ≥8=1, Otherwise=0)	0.119	0.324	0	1
Head Literate (Yes=1, No=0)	0.447	0.497	0	1
Location Variable:				
Distance *Pucca* Road (km)	0.861	1.06	0	8
Milk Supply Chain				
Milk Supply Chain (Yes=1, No=0)	0.525	0.499	0	1
No Player (No Industry Player in *Mouza*, Yes=1, No=0)	0.425	0.495	0	1
One-player (One Player in *Mouza*, Yes=1, No=0)	0.250	0.433	0	1
Two-players (Two Players in *Mouza*, Yes=1, No=0)	0.225	0.418	0	1
Three-players (Three Players in *Mouza*, Yes=1, No=0)	0.10	0.300	0	1
District				
Sargodha (Yes=1, No=0)	0.1	0.300	0	1
Narowal (Yes=1, No=0)	0.1	0.300	0	1
Hafizabad (Yes=1, No=0)	0.1	0.300	0	1
Pakpattan (Yes=1, No=0)	0.1	0.300	0	1
Okara (Yes=1, No=0)	0.1	0.300	0	1
Muzafargarh (Yes=1, No=0)	0.1	0.300	0	1
Layyah (Yes=1, No=0)	0.1	0.300	0	1
Khanewal (Yes=1, No=0)	0.1	0.300	0	1
Jhelum (Yes=1, No=0)	0.1	0.300	0	1
Attock (Yes=1, No=0)	0.1	0.300	0	1
Sample Size	800	–	–	–

Source: LUMS Survey of Dairy Households in Rural Punjab, 2005.

They have a small herd size, high herd age, and head of the family illiteracy contributing to the technical inefficiency model. These contribute to their inability to participate in SCM (supply chain management) procurement with non-government support in rural infrastructure roads/railways connectivity, impacting smaller sized (one to three) supply chain contributors to plant procurement supply chain. The research found that variables like location, herd size, head of the literate family factor along with herd depressive disorder is impacting the production rate due to structural inefficiencies in the Pakistan dairy industry. Demircan et al. (2010) found that shed and structure capital, water and molasses, several people deployed in dairy technology are

statistically insignificant in Turkey's dairy sector. The implication is efficiency in the milk production output by volume and quality evident from the above studies.

To be summarised, in any industry, a company's ability to innovate is critical to its success. Many researchers have noticed that a company's or organization's capacity to innovate allows them to maintain and stay ahead of the competition (Lin, 2007, Kurt et al., 2013). As a result, innovation capability has become a focal point for businesses all over the world. The ability to innovate has been identified as a critical aspect in assisting businesses and translating fresh ideas and prospects into reality. The ability to innovate is a tool used by businesses to create new processes and products (Dougherty and Hardy, 1996, Darroch, 2003, Yang, 2012).

Similarly, the livestock industry is vital to a country's economy. This sector is critical for delivering adequate and balanced nutrition, generating financial flow to households, and lowering rural unemployment (Abubakar, Manzoor & Arshad, 2022). As a result, farmers' ability to keep up with these changes by monitoring their new technologies, inventions, and current advancements is critical to the livestock industry's long-term viability. The level of adoption of innovations, on the other hand, is determined by the standard of living, the organisation of society, and the economic benefit of these advances (Sezgin et al., 2010).

Pakistan is regarded as one of the world's major producers of raw milk. Unlike in industrialised nations, milk production methods in Pakistan consist of smallholdings with subsistence- or market-oriented farming followed by rural or semi-urban conventional and traditional farming methods. Historically, the dairy industry has been privately owned and operated. New projects have been launched throughout the last two decades because of the active participation of the corporate private sector. But nothing is known about technological innovation's current state that can speculate how those initiatives worked. In addition, initiatives to modernise livestock and dairy industry begin with technological advancements in rural areas. As a result, farmers should be encouraged to use innovative technologies. In Pakistan, rural dairy farming plays a significant role in terms of animal numbers and the overall dairy industry. As a result, it is reasonable to conclude that technology adoption or innovations for the development of farms in the research sector is critical. Much research on innovation uptake have been published in Pakistani and foreign context (Hassan et al., 2021; Ehtisham, 2021; Yener and Ouz, 2017). However, no detailed study on this topic has been undertaken in SMEs the rural dairy sector of Pakistan. It is also regarded to be a

significant determinant of factors influencing farmers' decisions about the adoption of innovations for the development of dairy farming in the region. As a result, the goal of this study is to uncover the elements that influence farmers' decisions about the implementation of innovations in dairy cattle farms in Pakistani SMEs. The following research question was investigated under this literature review to explain the issues indicated in the study's objective:

RQ1: What is the current state of technological innovation management, and its application play any role in the rural Pakistani Dairy Sector?

2.12 Factors Challenging the SME Dairy Sector in Pakistan

The dairy industry in Pakistan is different from its Asian counterparts, and the characteristics define the industry. The rural sector especially consists of the social structures and way of life that define the dairy sector growth and development. The traditional age-old methods of dairy processing in the rural areas are a family-based practice that has shaped the current form of practices. At the same time, its scope of growth is limited due to the exposure level of the rural population to the outside world. It implies the local production of raw milk finds its way to the rural market, and the absence of supply chain and distribution mechanism has been subjected to a lack of technology. The dairy industry in rural areas is subject to many challenges as the small families managing the small herd has low potential as a milk producer. The lack of knowledge and unavailability like existing animal health, low genetic potential in milk production, and lack of technical equipment for producing milk processed by-products have led to a multiplier effect on the management function. Even though the family-based efforts are deployed, the issues of livestock reproduction capabilities, udder abnormalities, lack of medicines available, lack of nutrition-based feed for the animals (Sarwar et al., 2002), continuous milk production stress are some of the areas that are beyond the control of the common individual engaged in this business.

The above, the Pakistan small rural dairy farmers can produce over 48 million tonnes of milk which is quite high in developing countries. The single reason being the contribution of the small dairy farmers is the aggregate engaged in home-based rural dairy practices. Self-care at home impacts the levels that can be labelled as low productive animals due to neglected health and small herd size. It can produce high volumes of small dairies throughout the rural areas of Pakistan are high in number and scattered throughout the rural regions. However, Nazir and Khan, 2009) stated

that high rural yields are insufficient as Pakistan still imports milk-based products (milk powder, cream, whey, yoghurt, cheese, and butter). The market has evolved as the needs of urban Pakistan consumers have matured while the rural areas' inability to convert raw milk is still at a nascent stage. Bilal et al., (2006) study show that over Rs1.1 billion amount is spent in 2005-06 of last decade that is a burden on the economy due to the consumer habits that has been changing the milk-based consumption and market trends. Some of the factors that are worth considering which is impacting the rural dairy sector in the form of challenges that is beyond the capabilities of the poor dairy farmers are-

2.12.1 No Availability of Nutrients for Dairy Livestock

The rural animal livestock suffers from low milk productivity, primarily attributed to the knowledge factor, no development in rural areas to produce capabilities of nutritional feed. In the entire value chain, starting from the quality and quantity of the livestock feed, the rural areas have been lacking considering the Pakistan grazing topology. The country with the harsh climate has limited green grass for grazing and has crop stubbles, shrubs, Agri-industry wastes to be provided for the animals in rural regions. The figures estimated shows that for green fodder/crop residues, grazing/rangelands, post-harvest grazing, cereal by-products and oilcake/meals, the animal can obtain 51, 38, 3, 6 and 2%, required nutrients (Hanjra et al., 1995). This study confirms the research of Hasnain (1983), who stated that feeds with nutrition are required to improve the milk production in the existing genetic breed available in the country, as the grazing grass alone is not a single source of nutrients to the animals in rural areas. The research found that 95% of the Pakistani animals are dependent on nutrients based on the forages that Bulla et al. (1977) found. The structural inability to produce quality feed is national level competitiveness, and hence the policies at the industry or SME level is important to note.

The role of industrial manufacturing capability in developing agriculture seeds for better crop production on the input side has helped Pakistan. The same for the animal feed industry has failed to take off. The issue is related to technology usage in the dairy sector needs to be addressed either through domestic capabilities or borrowing of feed technology from developed nations. Atsbeha, Krstofferson and Rickeertsen, (2012) stated that the knowledge about feed technology is also closely linked to policymaker awareness in framing development plans for the nation. The

traditional food source for animals has been typically an age-old knowledge that has been in practice that has become the transition from the existing form of conventional knowledge feeding to nutrition-based feeds that require an industrial setup is a technology-based approach. In the rural sector of Pakistan, due to harsh weather and the absence of grazing lands compared to Australia and New Zealand for the dairy industry, the rural sector of Pakistan must rely on post-harvest agriculture remnants. The rotational crop production and variety help the conventional feeds be a mainstay source of feed for livestock animals. However, Atsbeha, Kristoffer, Rickertssen, (2016) argued that it does not compare to the nutritional value while the production cost impacts the feeding cost for the animals that questions the affordability. The above discussion highlights the issues impacting animal health due to the absence of quality fodder in Pakistan rural areas. Over the years, the lack of nutrition in the feed has worsened rural animal health, ability to fight diseases, milk production.

The study by Crowder (1999) showed that 29 and 56.5% is the number of nutrients that the livestock is about to get in the fodder provided to the animals. This research shows that the existing practice has been affected due to the type of food. At the same time, the component of DCP (digestible crude protein) requirements for the animal livestock is 39.41% less (Akram, 1990), that Hanjra et al. (1995) supported, stating that to equip the dairy animal for high milk production, around 63.2 million tonnes of TDN and 5.53 million tonnes of DCP is required. The lack of technology is evident as the animal feed is not being exploited towards better utilization and marketability in Pakistan compared to the developed nations in the west. The criticality of the animal feed to be improved with research and development requires central government involvement, and industrial development policies have not paved the way to contribute to the inclusivity of technology. It is a strategic issue for the dairy sector and national importance, especially it is an important input factor for the dairy industry. The lack of awareness and orientation towards developing quality feed for animals has a long list of implications, like the low productivity of animals in Pakistan. The issue has adversely impacted the rural small dairy farmers as milk production per animal per year decreased. It can be attributed to the nutrients available in conventional fodder given to the animals engaged in the small rural household in Pakistan. However, the development aspect rests on taking the scientific route to identify the deficiencies and then develop an appropriate formulation suited to Pakistan dairy animals. It requires a

localized solution of the requirements and nutrients formulation characteristics, livestock health, breeding, and milk production in Pakistan.

2.12.2 Deterioration of Grazing Range in Pakistan

The dairy industry, especially the animals being dependent on grazing the grasslands, is an important factor in why the dairy industry in Australia and New Zealand has flourished. The rangelands are the reservoirs of nutrients that are found in the valleys of the green mountains. These are available at around 38% for Pakistan, far away from the rural villages where the dairy industry in every household has flourished. The second resource found in Pakistan is the fodder crop residues as an outcome of the agricultural process. Currently, the input factor for the Pakistan dairy animals is restricted to fodder crop residues that contribute to around 51% of the supply to the animals. However, the Pakistan geographic topology is diverse. With riverbanks offering grazing lands while mountainous areas and deserts forcing the dairy farmers to think of alternate feeding strategies, the national-level policy is important. The agricultural practices that are related to converting the arid regions, wastelands require national agricultural policy to convert these into productive usage (Raziq et al., 2010). The challenge to create range vegetation in those areas of Pakistan is also facing the deforestation rates rapidly. Agriculture is a great input factor for the rangelands as it requires the Forestry department to reforestation strategy and coordinates with the livestock and dairy development.

The input factor of grazing lands for the dairy industry animals is critical for animal survival. It is not strictly a technical point but is a critical factor for the aggregate animal livestock population to survive and sustain in the dairy industry of Pakistan. The quality of livestock health is dependent on the availability of resources like grazing land and Agri based fodder. In contrast, the chances of technology-based nutrients in feeds for long-term animal health have been absent, showing a gap in Pakistan's practices.

2.12.3 Livestock Health Issues in Pakistan

Animal health is a core requirement when the productivity of dairy animals is concerned. Animal health comprises breeding, fatigue due to the production of milk, and diseases that infect animal well-being. The countermeasures are the animal health done by the vaccination process, ensuring

dairy animal health in its entire life cycle. However, even though it is mandatory, not all the dairies in Pakistan get access to this exercise, with Iqbal and Ahmad (2002) stating that 10% of the livestock population gets it done.

The diseases that strike the animal population have shown a very high rate of spread, leading to a high rate of mortality and morbidity. There are cases of endemic in the country as evidence of haemorrhagic septicaemia (HS), foot and mouth disease (FMD), a black quarter (BQ), rinderpest has been reported many times. Apart from that, diseases in sheep and goat-like sheep pox, anthrax and enterotoxaemia have also been found. In the cattle population, identifying the disease and then treatment requires investment which is important for the small dairy farmers. Most of these are uncontrollable as they are external to the issue, but the parasites inherent in these problems require science and technology to control them. The traditional practices in the dairy industry require the use of technology to bring in development, and animal wellbeing requires a community-based approach to resolve the spread of the diseases. The economy loses a big impact on the Pakistan economy just as the small dairy farmers lose the animal due to the loss in milk production and inability to address the issues related to disease death (Nazir and Khan, 2009). The national infrastructure in assessing the damage to the dairy animals annual is a critical point for understanding and developing an approach to develop measures to avoid the diseases which take endemic form. The above discussion shows how the lack of technology to diagnose animal diseases occurs and spread in Pakistan, requiring government and provincial government intervention. It requires setting up surveillance using a team of veterinary doctors, as the income potential of small dairy farmers is affected that indirectly impacts the milk consumption in the Pakistan population.

2.12.4 Milk Production and procurement Leading to Processing for Distribution Challenges

The milk is a perishable liquid and has a limited shelf life, so it must be consumed within the time frame. The rural dairy model produces fresh raw milk in small home-based dairies to be locally distributed. The dairy sector's marketisation process depends on how the dairy farmers can procure the milk using milking process activity. The traditional knowledge in the home level diaries is family-based and passed onto the next generation in the families. The rural processing of the milk is hand-based extraction of raw milk from the animal udder. This extraction process is followed

by the storage and distribution supply chain to the rural localities. The above discussion shows the predominant problem of traditional methods and storage that restricts raw milk from being transported far away and consumed locally. The practice has not changed for centuries, which is also evident from the lack of technology to extract milk faster and lack storage solutions and milk processing capabilities.

The challenge for the rural dairy farmers is to gain the capabilities to control the deterioration of the raw milk quality post-extraction till the consumers consume it. The implications are the economic point of view, where the dairy farmers can use technology to preserve the milk to get the monetary value. It is estimated that rural dairy production is small production pockets that cater to customers' rural catchment. However, as the aspiration of the small dairy farmers increases to breed their animals to increase the milk production for greater economic prosperity, the challenge is to overcome the manual labour for each animal, raw milk storage, and transportation to the respective customer houses. (Aziz and SIivia, 2008) Around 20% of the aggregate rural milk production are wasted in Pakistan, mostly in the rural areas, due to a lack of hygienic practices, storage solutions and processing capabilities.

It can be implied that the home-based start-up venture of the dairy industry dotting the rural areas of Pakistan suffers from the lack of technology-based practices. The milk has been commoditized in Pakistan as the marketable value is higher only when it is subject to a standardized processing system as per FAO and WHO guidelines. At the same time, it stands only second to wheat in terms of value that the nation can produce for consumption. The herd segmentation that produces milk has 54.4% rural area production that lacks the marketing efforts to wider areas beyond the rural areas. Only the peri-urban area dairy milk production has access to markets in urban areas that helps the raw milk production be sold to demand centric markets. The total production of milk, being 26.2 million in Pakistan, finds its way with only half of the amount to the market for consumption while the rest is channelized to make milk-based by-products and part of it is for calf feeding (Aziz and SIivia, 2008). The Pakistan milk industry and its production capacity is dependent also on the import of dry milk products consistently over the years in pre-2000 and post 2000 years. The estimated foreign exchange which the Pakistan government spends is over Rs1213 million

In terms of milk and milk-based by-products, the domestic market of Pakistan is a food segment that virtually has no substitutes. It is a powerful driver of creating a market for milk and milk-based products in those rural areas dairy farmers can participate. The opportunity of milk using appropriate processing as per global standards require milk processing plant, milk packaging plant and harness all the milk producers to be a part of the cold supply chain. It can create new avenues and utilise milk usage where diverse stakeholders play the role to market it. Traditional rural dairy processing is a manual milking method that cannot transfer raw milk faster due to informal agents in the milk supply chain (Jalil et al., 2009). Compared to the west, the Pakistan model in the rural dairy industry is still in the nascent stage as the concern of traditional rural methods is still a widely accepted norm and practice in the local market. Even the prices that rural consumers buy is low that meets their expectation set. However, short supply chain and local transportation to customer homes and low cost of raw milk production is a way of life. The rest of Pakistan, especially for the urban cities, does not hold, as the market has evolved to accepting dry milk powder when the demand (need) outstrips the supply. The middleman in the Pakistan milk business, who usually procures milk from the rural farmers at low cost and sells at high prices, is also a part of the entire system. The involvement of the middleman has led to the mixing of water which is malpractice in the milk business. Not only it raises the volume, but it dilutes the quality as the fact of adulteration happens as the agenda is to maximize their buying and selling practices (Hasnain and Usmani, 2006). Raziq et al. (2010) stated that despite municipalities fixing the milk per litre costs, the factoring of the actual cost of storage, processing and transport charges is not added into it. It has led to a higher power in the hands of the middleman, who sets the price of the milk based on the rapport with the urban and semi-urban client. The above discussion shows the evolution of the rural market, the transition towards catering the urban market by middle and the urban market that consumes packaged milk which sets new standards in milk quality consumption.

2.12.5 Lack of Dairy Processing Centres in Pakistan

The entire milk processing in the rural context has undergone significant changes in how it is processed. The development factor in milk production and processing in the traditional method is that all hand-based and direct transfers to localities serve the purpose. Dairy is a profitable industry; however, it cannot access the modalities to get prime attention even though rural small dairy farmers are the largest milk producers in Pakistan by volume. They lack the essential skills to

process the raw milk extraction process without technology. The current traditional milking practices run the risk of adulteration, hand-based contamination, and germs mixed before the consumption phase. The technology development in the dairy industry in the west has ushered along with the phases of industrialisation. Pakistan too has around 23 milk processing plants which private players mostly hold. Financed by ADB (Asian development bank), the Pakistan experience has shown that during the 1990s, the high cost of investment cannot match the projected returns by processing milk. The consumer demand for the processed milk 'pasteurised' was less as the price was quite high, which impacted the demand levels and sales. However, the market has matured with a retail revolution in urban cities. The exposure to a wide range of milk-based products has changed consumer tastes towards the packaged form of milk as a commodity (Sarwar et al., 2002). The inclusion of the higher varieties of milk with flavour and colour options has led to market maturity and includes those who avoided drinking milk. The Pakistan experience shows that even though the packaging facility was set up to process processed milk, the high cost in the UHT process in the pre-2000 era was not well received. It is believed that transition from the raw milk to processed milk led to a substantial jump in the cost (Iqbal and Ahmad, 2002). The entire strategy to market packaged milk and its non-acceptance by the Pakistan population with lukewarm demand affected the sector. The search for healthier options in the milk options has been previously accomplished with the 'pasteurization' (Anjum et al., 1989) in the Punjab province promoted as a hygienic version.

2.12.6 Institutional Non-Participation as a Constraint

The Pakistan government and the ministry in charge lay down the guiding point for bringing growth and development. However, the plan of action depends on the successive governments and their ideologies that have helped to shape the dairy industry in Pakistan. Hasnain and Usmani (2006) argued that the rural sector, especially dairy, has been ignored. Despite national-level institutions contributing to the nation has not been able to apply the research outcomes at ground level show development. At the central and the provincial level, the government has not invited dairy farmers to a comprehensive dialogue. Neither has set up block development covering several villages that reach the rural area to understand the situational problems to be comprehended (Hasnain and Usmani, 2006). The institutional help in Pakistan, especially in loans, micro credits, for SMEs has not favoured the rural sector, as the mechanisms and procedures were not well

developed. The issue impacted the rural farmers both in agriculture and dairy, which has proved to be a discouraging situation for the concept of financial institution impression. Raziq et al. (2010) stated that in the rural areas, The lack of knowledge and facilities not available in rural countryside is a structural problem, while the process-centric challenges like training related to the transfer of new knowledge to the rural area have not happened. The evidence in the lack of growth in the local economy, technology, and productivity depends on the quality of knowledge the rural population can assimilate. The non-availability of the technical staff in any sector resembles that development is non-existent. The rural sector is stagnant due to a lack of structural and institutional help missing in the system. It is only the human health services found in rural areas, while animal health and well-being, as an extension from the central hold of power in urban areas of Pakistan, are absent.

2.12.7 Low Milk Productivity of Pakistan Dairy Livestock

The rural milk production in the home-based dairies is localized and based on the traditional milk extraction process. The economic activity related to the animal-like meat buying and selling or wool from lamb, preparing by-products of milk. The sustainability of the rural economy is typically dependent on the range of activities that decide the lifestyle consumption demands. The earliest study of (Dahlin 1998) stated that each rural countryside was predominantly engaged in agricultural production to sustain the local and national economy during pre-industrialisation. Evidence is found in most civilisations showing that the progress or development factor in the nations worldwide is hinged on how they harnessed technology factor. In particular, the dairy sector has been dependent on animal capabilities to produce milk, where the genetic breed is considered an important factor. The second issue is the breeding and reproduction cycle, which affects the animal and the commercial production of milk that stresses the animal mental and physiological health. A comparative study shows that one dairy animal of Australia or New Zealand is equivalent to around three animals in Pakistan, animal milk production in Germany, and the US is around six animals production capabilities (Garcia et al., 2003). The milk production capability in the developed nations compared to the developing nations is wide in terms of animal capabilities. It can be attributed that a range of factors is impacting the animal milk production (by volume), which is dependent on the genetic makeup and technology-based infusion to crossbred better quality animals that are higher in productivity and disease resistant. The difference is significant in cross-country comparison analysis, as (Hasnain and Usmani, 2006) found that the

number of animals being increased in small dairy farmers in developing countries compared to high productive animals that use technology and limited animals. The question in the rural context is important as the higher number of small dairy farmers is using the strategy to increase their herd size to increase their milk production volume. It is evident that traditional practices of animal maintenance, breeding, and milk extraction take up manual labour engagement in each family, labelled as unproductive. While technology can be attributed to a lack of progress to bring in all-around development, the picture at the national level in Pakistan is predominantly the same. As a nation, the differentials of breeding technology rests on the amount of scientific and technological research or national level innovation that has been accomplished to design high productive animals for breeding. Demircan, Binik, and Zalauf, (2010) argued that the higher milk production at the cost of the addition of animals is dependent on the ability and access of the small dairy farmer at the rural level. Lack of technology and innovation has not revolutionised rural milk productivity at the animal or processing level. It has a greater impact on feeding management and animal well-being than most family-based helpers in the milk business. No rural small dairy farmers in Pakistan can get quality fodder or grassland to feed the herd to add value to higher milk quality. Animals deprived of good feed input are missing the power to serve the small dairy production over a longer time in Pakistan that is financially depressing for the small dairy owner. Iqbal and Ahmad (2002) added that using technology in breeding and feeding reduces the management and wellbeing of the animal health activities significantly that Pakistan small dairy farmers are unable to achieve. It is a design fault and majorly related to the financial inabilities, government mechanisms concentrated to few hands that adversely impacted the growth and development. The non - availability of information and communication about existing technologies is one of the major factors in rural areas of Pakistan that impacts the entire local and national milk productivity levels (Farooq and Qudoos, 1999).

2.12.8 Poor Livestock Health Support Services

The Pakistan rural villages are cut off from the urban areas as the transport and communication are rudimentary. The lack of supply chain and the transport infrastructure from the remote rural areas of rural areas to the urban or semi-urban centres has been evident. It is also important for the national economy, as the animal health services provided by the government through the veterinary help keep the aggregate health issues to attend. Hasnain and Usmani (2006) argued that the strategy

is most effective when the animal-based diseases spread quickly throughout the geography. However, the statistics show that actual numbers reach rural animal care that is a fraction of what has been planned as per the program. The extension of health services for the dairy animals is the breeding insemination services that in Pakistan has not been able to achieve 3% of all aggregate rural areas as per studies Usmani and Shah (1986) (Usmani and Shah, 1986) and Khan (1994) in the last century. It has led to limited scope to infuse biological technology in the dairy sector in the rural areas of Pakistan and eliminate the prevalence of germplasm (Bilal et al., 2005). The support services in genetic technology require specialized knowledge and technicians to disseminate the practices at an appropriate time in specific rural areas. The power of genetic procedures is immense as it helps boost milk production in the small business or rural areas, ward off the animal diseases that impact the community of animals impacting the rural production of milk. However, the strategy in planning and execution has seen a vast difference, which has made development in technology perspective stagnant. The implications for the rural dairy farmers is lack of knowledge, orientation and access to genetic technology in improving dairy breeds and adopt breeding practices to be spread in the rural areas of Pakistan. Hasnain and Usmani (2006) highlighted another alarming issue: the prime female buffalos are slaughtered for meat in the peri-urban areas of Pakistan due to its economic value and consumption needs as part of Pakistan food habits and lifestyle. Bilal et al. (2005) stated that the major cause of the destruction of good buffalos with higher productivity is lost in the meat consumption that can be used in processing artificial insemination. The progress has been slow as identifying the rural areas and the requirement of selected bulls, transported to the respective bringing in the success in output in Pakistan. The study of (Afzal and Naqvi, 2004) found that muted efforts in synchronizing rural dairy farmers' needs and the initiatives undertaken by the government have been accomplished with limited success. The mechanism involved the transportation of the mating animals to the nearest location, which is a standard procedure in Pakistan's 'Lumbardari' scheme. The strategy entailed the village head to allocate a bit of land to accommodate the bull for mating in that village brought from outside for breeding (Afzal and Naqvi, 2004). However, the entire experimentation programme has been moderately successful, and now it stands discontinued.

Technology adoption aids in the reduction of workload, the enhancement of farmer quality of life, and the improvement of farm productivity (Anjum et al., 2021). Whereas use of such technology has gone up dramatically, the dairy industry has been sluggish to accept it in comparison to other

industries (Asghar et al., 2021; Russell and Bewley, 2013). Investing in dairy farming technology entails overcoming several obstacles. The reasons for investing or not investing (Steeneveld and Hogeveen, 2015), technological efficiency (Gul et al., 2021; Steeneveld et al., 2012), and economic ramifications (Bijl et al., 2007), among others, must be considered. A significant element that hinders investment is a lack of analysis of the individual conditions and demands of farmers (Luvisi, 2016).

Innovation capability is an abstract trait that benefits businesses in a variety of ways. The development of emerging countries is also aided by increased innovative potential (Ates and Bititci, 2011, Camelo-Ordaz et al., 2011, Yu, 2013). Those that were more inventive had higher income and productivity than countries that were less innovative (Fagerberg, 2004). Many scholars believe that the ability to innovate is the only way for a company to survive and succeed. Various intangible elements that influence innovation capability have been found in the literature. Firms' ability to innovate, for example, can be improved by good human resource procedures. Employees can generate and share new ideas thanks to good training and development (Shindina et al., 2015). The literature portrays that several empirical studies have been conducted to study the factors that can influence dairy sector technology adoption (Katungi and Akankwasa, 2010; Akuduguet al., 2012; Loevinsohnet al., 2012). Farmers' decisions regarding whether and how to accept new technology are influenced by the dynamic interaction between the technology's qualities and a variety of settings and circumstances (Loevinsohnet al., 2012). Mainly these studies fused on economic and socio demographics factors in western countries. Despite the efforts to promote adoption of innovative technologies by the Government and international development projects, the adoption rate among farmers has always been low in Pakistan (particularly in rural settings) . Therefore, this research aims to fill this gap by investigate the determinants of farmer’s decisions to adopt technology in the rural dairy SMEs in Pakistan.

There is a scarcity of data on dairy producers' adoption and usage of technology in developing nations (Janssen and Swinnen, 2017). This includes Colombia, where a lack of information may be contributing to the country's poor technology adoption rate (Gul et al., 2021; Masih et al., 2021; Barrios et al., 2019). As a result, it's crucial to investigate how dairy farmers in this country implement new technology. The findings could help to improve decision-making and productivity in a sector that is still developing in terms of organisational challenges and management (Afzal et

al., 2021). The goal of this study was to determine the elements that influence dairy agribusiness's adoption of new technologies. The findings could help research and policy-making organisations fund extension projects more effectively. Despite the significance of dairy farms in agrarian-based economies (such as Pakistan), there seems to be no conceptual framework that can capture the elements that influence dairy farms' ability to innovate.

The dairy industry has also seen a rise in production and consumption, and can be described as a globally connected, diverse, and fast-changing food production sector. Economic prosperity, rising population, rising urbanisation, and other factors have all contributed to increased demand for dairy products. Milk and dairy products are becoming more popular because of a growing middle-class demographic with more disposable income, customers seeking healthy options to fit on to a more active social life, and an emphasis on natural ingredients. Currently, the dairy industry serves about 7 billion people and supports 1 billion people who work on dairy farms. Hence, based on this critical review the study tries to close this gap by attempting to analyse the factors affecting the technological adoption in Pakistani dairy sector as postulated in following research question.

RQ2: What are different factors impacting the rate of technological innovation in the rural dairy sector of Pakistan?

RQ3: What framework can be suggested for Pakistani Dairy SMEs to manage and apply technological innovation in rural areas?

2.13 Pakistan new Initiatives in the Dairy Sector

The Pakistan government has initiated an experimental basis to address the problems and issues related to the livestock sector. The total outlay earmarked was Rupees 8.8billion, promoting milk, health and hygiene, marketing of processed milk, and knowledge about production systems that can drive distribution systems. There are seven projects in different parts of Pakistan that were created to provide the extension of services at the rural level that predominantly aimed to reduce the deficiencies in knowledge, practices that aim to improve productivity. However, this development programme requires a range of technology-based solutions routed through the veterinary doctor to one or more rural villages in Pakistan. Muhammad et al. (2014) added that the programs were small and met their intended targets, which prompted the second phase of the ‘Milk collection and dairy development programme’, which distributed over 150 milk cooling storage

tanks. The other initiative found in Pakistan is military dairy farms, where the model of genetic embryology was carried out based on the rural model experimented earlier. The aim was to create a pool of highly productive dairy animals for the Pakistan soldiers to sustain their daily needs. Under the guidance of the Centre of Excellence, the Okara firms developed genetics while buffalo semen production was started in Renala in Punjab province. The above development shows a replication of an experimental output applied in a military context that is limited in nature against the demand at the national level.

Staal et al. (2008) argued that the level of technology is beyond the reach and comprehension of the small dairy farmers in rural Pakistan. Science and technology require niche expertise of high calibre to engage in genetics, embryology that helps to build and sustain dairy productivity. The control measures to stop epidemic and disease spread within dairy livestock animals in rural Pakistan led to the creation of ‘’ “National Disease Reporting and Epidemiology System (NDR & ES); in 2010. The decentralization of power and wider reach to access the rural village dairies was initiated with at least 40 surveillance (regional surveillance units RSU) teams and RRT (rapid response teams). Around 66 of them were created. The strategy is to use the distributive leadership model with guidance and framework to benefit the rural dairy farmers. The above initiative shows a mix of technology and structural design in society and organizations that aim to create future sustainable models (Staal et al., 2008). It also aligns the rural area deficiencies with the milk production capabilities using technology and innovation from the central government. It harnesses smaller nodal agencies to extend the services at the village level. The new Govt. initiatives show shifting structural frameworks like institutions, individuals engaged with multiple stakeholders, especially when it is a low-income market or a developing nation (Michelini, 2012).

2.13.1 New Government Initiatives

The structural development for the nation is generally charted out by the Pakistan government each year with the declaration of the budget for each sector. For the dairy and livestock sector, which contributes to the economy, the setting up of MTDF (medium-term development framework) was done. The goal of MDTF was to achieve the goals, meat (0.5%), milk (8%) production in the rural areas, which contributes to the consumption-based Pakistan economy (Staal et al. 2008). However, this approach showed a market-based orientation strategy from the government to develop the

local pockets of home-based, small-scale production related to dairy, meat, milk products to get a boost. The structural approach to regularise the market and consumer demand has been done through PSDP, which is meant for the greater good of the citizens of Pakistan. Cain et al. (2007) stated that when expanded, it means PSDPs (Public Sector Development Programmes), which aims in developing the processes of the central and provincial government for the dairy sector, livestock sector, genetic breeding involving crossbreeding, embryos, and semen availability. Compared to the past initiatives, the approach is more holistic, as the government of Pakistan with foreign exchange reserves can also allow people or institutions to import high productive foreign buffalos and cows (Michelini, 2012). It is followed by the initiatives to adopt modernization of scientific and technology-based R&D (research and development) equipment supporting biotechnology-based research on animal genes. The challenge is to adapt the scientific and technology processes to identify the types of diseases and strains specific to the Pakistan rural areas in dairies. It also led to the mechanization of the dairy equipment, as it allows to achieve the faster speed of processing of raw milk. Muhammad (2014) found that the entire nation has been shifting and evolving as the import of powder milk as a substitute to meet the national demand has increased. Ishaq et al. (2017) found that the internal strategy to adopt technology and develop processing capabilities required gestation time that impacted the dairy industry, especially at the rural levels as consumers' preferences towards traditional and modern channels of milk production are shifting. The health of animals, both mental and physical stress due to milking, the calf mortalities, and breeding challenges using high productive embryos and semen, have found their way to limited rural areas. However, all the developmental work in this sector is subject to a time-based gestation period to achieve the outcomes. The Pakistan market demand and production capabilities did not match in Pakistan.

2.13.2 Workforce and Woman Skilling in the Dairy Sector

The predominant male dominant industry, the home-based dairy industry, faces including women in production. However, as a family entrepreneurship model in Pakistan's rural sector, the small-scale home-based start-up is driven by the families' knowledge. The family-based entrepreneurship model divides animal well-being, animal grazing, and milking activity to be part of a home-based model's daily dairy regimen. Amin et al. (2010) argued that with small herd size (1-3) or (4-6), the role of females in the household to distribute the load of aggregate dairy is essential, while it is the

females who tend the entire cattle herd in the rural families. The male-dominated dairy sector in the rural sector needs hands (additional) to expedite the activities that are interlinked with one another daily and the role of females. Children in rural households cannot be ignored during grazing, feeding the limited herd size. The manual method of dairy practices prevalent as a family-based knowledge held for generations also requires the female to join the workforce to distribute the time-based manual labour for everyday animal health and upkeeping (Amin et al. (2010). The aim is to reduce the time of all the activities and multi-task the man and female roles in dairy practices at home to manage the productivity rate better. The limited participation of Pakistani rural woman folks in terms of entrepreneurship and ownership of a dairy and restraining to engage in the dairy sector is a challenge in Pakistan as they do not have access to finance, technology and social support for milk production and its access to adopt industrial level capabilities (Amin et al. 2010).

2.13.3 Genetic Technology and Dairy Improvement in Pakistan

Genetic technology is a critical part of how animals can improve their future off-springs. Genetic technology is a boon, but it requires scientists to engage and address the rural dairy needs of Pakistan. The challenge at the central government of Pakistan is to develop solutions for catering to differential needs of genetic technology for improving the dairies (Khan et al., 2013). The strategy adopted shows a socio-economic development angle. It aims to equip the rural areas across geographical areas of Pakistan to understand the range of genetic buffalos and cows available in Pakistan. Most of the genetic makeup of the animals in rural dairies require to be studied to understand the gene traits and identify the low milk-producing strains, upon disease-resistant to improve. Abdullah (2004) argued that technology also should be cost-effective for adoption, especially at rural levels, the access to be easy to benefit the plenty. Genetic technology changes the molecular makeup and requires specialised knowledge and advanced level laboratory equipment technology to support the development strategy. The national-level importance of genetic technology to be included in the dairy sector issues to test progeny, improve the genetic makeup, apply the new strains of genes in Sahiwal and Nili-Ravi cattle has been conducted but with limited success. The amount of work needed to be conducted at the rural level to cover Pakistan is still huge. In terms of genetic makeup, ‘Kundi’ buffalos and the ‘Red Sindhi’ cow, Azakheli is still left. The ability at the national level to decode the makeup of genes is critical for

the Pakistan scientific community and dairy sector (Staal et al., 2008). While it requires time to conduct the genetic mapping and coding programme, the limitation is specialised knowledge that rural dairy farmers cannot be of part. The slow penetration of identifying the wide variety of animals in the rural dairy sector is important in gene pooling as the animals are commercially used for milk (dairy) and meat (beef Halal certified) usage. The innovation in Pakistan cattle population is dependent on how quick the cattle breeds are identified, the challenges of diseases, low milk productivity is traced (phenotypic characteristics) (Shafee et al. 2013).

It shows the technology has been a mainstay of the development of genetic technology, which impacts the dairy industry of Pakistan in a long-term strategic perspective (Khan et al., 2013). To equip the nation with the best quality genes in the dairies across the rural belt, the initiatives shown is moderate in terms of progress, as the effects of genetic technology realisation of benefits are only possible when the mapping of all types and variants of the dairy cattle, livestock is mapped across Pakistan rural villages. Hasnain and Usmani (2006) argued that the 'National Breeding policy' developed in the last decade has been instrumental in driving the crossbreeding facilities, the laboratories, and technology to be disseminated to rural level dairies. Even though it is a knowledge transfer and practice are being learnt by technicians, then replicated to other areas of Pakistan. However, the complexity of technology and the nature of innovation to be brought out in the genetic mapping to improve dairy production of milk in cattle is case-specific and requires specialised knowledge.

2.13.4 Pakistan macro–Business Environment

The development of the Pakistan economy has been based after its creation and the subsequent national development plans to build the nation post-partition from India. The focus has predominantly been on the larger industrial establishments, not on the SMEs in the first phase and the development of nation, building industries and sectors requiring interventions, action plans based on proposed schemes (Venkatesh and Bala, 2008). The challenges were plenty, and the central or federal government plans to set up the structures and systems to run, mobilising the resources to establish factories to sustain the economy, and using SME model and entrepreneurship schemes to support dairy farming (Afzal, 2008). Hence, the development approach largely relied on developmental aid toward larger industries in Pakistan. However, the scope of rural dairy

volume remains underutilised, and consumer tastes are shifting with knowledge (Ishaq et al., 2017). There is a clear distinction for the large enterprises in terms of financial loans and approvals for laying the foundation of Pakistan.

2.13.5 HRM

The significance of HRM practises and their influence on organisational success is generally acknowledged among small-to-medium-sized businesses (e.g., Wiesner et al. 2007; Teo et al. 2011; Coetzer et al. 2007; Barrett and Mayson 2007). However, most of these investigations have been undertaken in non-agricultural contexts. There has been little empirical research on HRM practises and performance linkages in small enterprises operating in agriculture and its sub-sectors, such as dairy farms. Prior research in small firms in the agricultural environment has focused on individual HRM practises such as recruitment and selection (Maloney et al. 1993), compensation (Billikopf 1995, 1996; Howard et al. 1991; Fogleman et al. 1999), and employee retention (Billikopf 1995; Nettle et al. 2011).

The nation figures are very poor in the HDI (Human development index) by the UN, which can be related to the rising unemployment levels in the nation over the years. The basic education infrastructure being generic, setting up education for all, and establishing higher education institutions are important pillars for society and economic development. The issue in the context of SMEs is relatively important as this sector requires quality employees to survive and sustain their business model (Khan et al., 2013). The SMEs are financially insecure as their business model is dependent on frugality. SMEs in the Pakistan context is mostly engaged in manufacturing which makes the model skewed towards one direction (Staal et al. 2008). However, the same for the dairy sector has not been an accepted model as most Pakistan families in rural countryside manage a home-based small herd of small businesses with limited catchment area for business. The context of education in these rural pockets is limited to rural education as for higher education; people must relocate to urban areas of Pakistan. The nature of dairy technology and the associated nature of the domain knowledge like genetics, biotechnology, veterinary are specialised courses that have been out of reach for most of the rural villagers. Hence Khan et al. (2013) findings show that the role of these institutions and in equipping the workforce in Pakistan with adequate skills that aid the dairy technology, using a cross-disciplinary approach is critical for success. The world over,

the models of dairy development has shown the proof of the value-added manufacturing that has altered the technology inclusivity and the education helping this sector evolve and bring on innovation. The resources factor largely relates to the knowledge acquisition and application of dairy practices for which training at rural areas for scaling up technology and innovation mechanism is needed (Khan et al. 2013). Pakistan, in this context, has limited research capabilities within engineering to develop dairy equipment that is scalable to address the rural dairy issue, which is a research gap.

2.13.6 Access to Finance

The take-off for a start-up venture or a traditional small business wishing to grow and develop requires capital for expansion. The issue is important considering the external environment, the market, and the potentiality that the business model is likely to succeed in. The banks' requirement for financial assistance to set up a business or capital expansion plan has different parameters to be fulfilled before it is approved. Hence the rural dairy farmers context, the small size of the business, with limited buffalos and cows, daily production and customer base has not appealed to the financial institutions. The SMEs in Pakistan has had had a bad experience in financing the SMEs, while Berchicci (2013) stated that the inability of the SMEs to pay off the loans has a discouraging stance. Staal et al. (2008) acknowledged that the banks and even micro-credit institutions in Pakistan perceives the dairy sector as a cottage industry due to the fragmented nature of the small home-based dairies. At the same time, there is no integrative force which Staal et al. (2008) found in India white revolution in dairy development, to build a credible force driving the SME requirement in small dairy farmers. The authors concluded that the singular attempts of a home-based small dairy farmer also do not qualify for an SME loan, require social structural support, and stakeholders like the government can leverage institutional help, technological support to bring in innovation in dairy development. The structural failures include lack of evidence of the family-based business, cash-based model of income, very few animals (1-3) or (4-6) to sustain a repayment model for the huge loan required to set up a milk processing plant. Though there are three types of SMEs –

Greenfield –can finance an idea with adequate investment options leading to long term fixed asset financing support.

Early-stage – this is for the capital expansion for the SME that is wanting to grow after successful operations of 2years based on working capital calculations.

Established business loans- The large enterprises procure loans either through equity route or through business expansion plans that require capital from medium to large.

The above discussion shows a gap in the research. The dairy industry is still not the preferred sector to obtain a loan for investing in the technology-based equipment that aids in milk processing and production in a rural economy.

2.13.7 Low Level of Technology in SMEs

The SMEs sit between a large industry and a small enterprise, which shows the capabilities of the entrepreneurship orientation to the business idea and plan. Entrepreneurship has been one of the key drivers of the economy, with numerous examples around the world. However, in most cases, these entrepreneurs had to rely on home-grown apparatus or equipment that has impacted the growth and development progress. There is an option to borrow technology from different sectors and adapt it or from a nation with strong technology capabilities. The SMEs suffer from a low level of technology inclusiveness that is a characteristic trait across sectors as mostly they rely on innovation (Michelini, 2012). It has led to more sector-specific innovations that have helped to usher in industrial automation, computerisation and, much later the artificial intelligence (Venkatesh and Bala, 2008). The SMEs often cannot adopt the R&D (research and development) initiatives as there is a cost attached to the entire innovation, even though the SMEs understand that benefits outweigh the investment cost.

On the contrary, entrepreneurship has led to establishing a new business genre like Coca Cola, KFC in the USA that has used technology to innovate and is a trade secret for generations. Therefore, the purpose and orientation of the business venture are important to understand the direction for the strategy to find a way towards shaping a new venture, as Scholten and Dugdill (2016) research found that grants and funds for dairy development from western nations are traps. However, the Pakistan rural dairy business has lacked the technology as the traditional form of dairy business is devoid of that, while innovation has been very rudimentary, and the financing model is too weak.

2.13.8 Inefficient Management of Pakistan Institutions

A grey area in the context of national development, the issue for Pakistan has been relevant as it has not addressed the sector-specific challenges. The efficiency of the government in handling the institutions that are pillars of science and technology is a piece of evidence that the centralisation of the output of innovation has not reached the intended purpose.

Management is a key dimension of a well-performing firm, and management styles dictate the success and profitability of corporations and firms worldwide (Michelini, 2012). However, the SMEs sector doesn't possess a strong managerial structure, which is an obstacle to its smooth performance and success. The managers don't possess the necessary skills and expertise in running the affairs of the business and often lead the business towards failure. In Pakistan, the opportunities of skills training and vocational education are a handful that further aggravates SMEs' predicament. The sector doesn't enjoy a high influx of funds, and the minimal finance they have is spent on core operations of the business, which diminishes the chances of training and education for employees. MacRae (1991) found that senior managers' education, training, and experience are major differences between high growth and low growth SMEs firms. Several the study revealed that the economic performance of SMEs in Pakistan is badly affected by insufficient managerial skills, especially small firms (Aftab and Rahim, 1986).

2.13.9 Lack of Automation of the System in SME

The existence of non-commensuration laws has created several complications for the SMEs sector. It's not easy for the commoner to understand those procedures, and the cross-cutting aspect is complicated to be comprehended by the people, due to which the performance in the sector has remained sub-standard. These laws create time-consuming processes combined with excessive paperwork, which creates further hurdles for the SMEs, rendering them unable to produce optimum results.

2.13.10 Market Constraints: SME

A typical SME in Pakistan caters to the domestic private sector, and their activities are mostly concentrated in some specific regions. SMEs have less access to information and communication

channels; they face difficulties complying with labour and attracting them, environmental, social regulations, and international standards in production processing; therefore, they operate in limited markets (Berchicci, 2013). Access to domestic and international markets plays a key role in enhancing SMEs' value chain breadth, which is not feasible for Pakistan. At the same time, they import dry powdered milk from abroad.

All the above apply to the dairy sector. The typology of the discussion shows more of the country's national policies and agenda that has been unaddressed for years. However, the dairy demand-supply gaps are noticed markedly in urban areas (Afzal, 2008).

Even though a sectors development approach was adopted in 2005, Pakistan signed an agreement with USAID, Pakistan Initiative for Strategic Development (PISDAC), to develop a few priority sectors in Pakistan. SMEDA being the official counterpart on behalf of the Government of Pakistan, facilitated the process. The strategy level process was primarily led through private sector engagement in a Strategy working Group (SWOG). The sector development process resulted in the creation of five sector development companies: Pakistan Stone Development Company (PASDEC), Furniture Development Company, Pakistan Gems and Jewelry Development Company (PGJDC), Pakistan Dairy Development Company (PDDC), Pakistan Hunting & Sporting Arms Development Company.

However, this process was not adopted continuously despite the many achievements in the shape of sector development companies. This strategy development process should be adopted on a continued basis. Through private sector consultation, priority sectors and detailed diagnostic studies may be undertaken (Staal et al., 2008). The priority sector may include Minerals, Tourism, Logistics, ICT, Gems & Jewellery, Horticulture, Construction, Fisheries, Dairy & Livestock, Textile, Leather, Engineering, Energy.

Lack of institutionalization and establishing of cooperatives with the government, local (city level) authorities is not resulting in designing of outlays for developmental programs for the nation, impacting the SME sector. Ishaq et al. (2017) stated that the dairy sector, particularly, needs an urgent structural and institutional need-based framework supported by Pakistan government policies absent in execution phases.

Empirical studies show how the Asian SMEs are progressing-

Subcontracting

Automobile and electrical industries consist of MNEs and foreign or joint venture subcontractors in the first tier in many Asian countries. As production volume increased in the Thai automobile industry, MNEs and foreign or joint venture subcontractors in the first tier began to procure components and parts from local companies. Local SMEs in the second and third tiers are formed to supply parts to the subcontractors in the first tier connected through informal channels (Muhammad et al., 2014). At this stage, technology is transferred from MNEs to local companies efficiently, and agglomeration effects become useful.

Business Environment

MNEs are being strict at selecting subcontractors in ASEAN countries. Only a small number of local SMEs have the chance to be selected as subcontractors in the second tier. Hence, SME promotion policies, simultaneously, should improve the competitiveness of existing non-subcontracting enterprises. Moreover, policies should consider the private sector's initiatives and improve business environments rather than being directed to meet the specific targets defined by the government.

Networking

Both China and India have experienced dynamic and rapid economic growth, giving them economic power to invest in bigger nation-building projects (Staal et al., 2008). Since domestic markets are expanding, subcontracting systems involving local LEs and SMEs have developed. Coordination and exchange of information among SMEs are very important to activate the agglomeration effects of industrial clusters. Moreover, SMEs can play an important role in absorbing the increasing labour force and thereby reducing unemployment problems.

Networking and Clustering

The development of SMEs often requires effective clustering and networking, which are developed and made accessible by conscious, effective government assistance programmes such as industrial incubators, industrial parks for SMEs, and industrial apartments (e.g., Kogyo apartment in Japanese). Muhammad et al. (2014) stated that an effective cluster environment might create synergy and adequately compensate multifarious serious shortages of resources often faced by

SMEs. In many countries, central governments are taking the initiative of planning and implementing SME policies. Often, the critical role of local authorities and relevant agencies are absent or negligible. Effective implementation of SME policies must be undertaken and monitored by local governments, agencies, and organizations with adequate funding and support provided by national governments.

Afzal (2008) added that local, provincial governments could play a critical role in creating SMEs' databases and set up a forum of SME owners and local governments. The issue for the dairy industry is pertinent for Pakistan as the structural policies and approach were taken by the government does not state the use of developmental stance to boost the dairy sector to generate jobs, create more industrial productivity and output contributing to Pakistan national economy. The structural mechanisms in organisational collaboration have an initiative centre lacuna in Pakistan compared to most developed nations and developing nations around the world in dairy technology. Even though the policies are there, the government initiatives to earmark a dairy centric area for the development of the sector-specific park is missing in Pakistan. In most of the nations that have automated, dairy technology has progressed far ahead in terms of volume of processed milk production as the advent of technology in respective nations has been adopted at some point in time. Each of the technology-based applications has streamlined the equipment centric mechanical challenges that plagued the industry as most of the earlier technologies looked at the functional side of purifying the raw milk to be processed as per food processing technology fit for consumption. The next wave of technology expanded the issues for processed milk storage, followed by machine-based equipment that helps produce milk by-products variants. Lastly, developing a food supply chain for dairy products as organised retail pushed each country's demand. The above discussed generic approaches differed in terms of dairy development, where technology played an instrumental role in eliminating human manual labour, eliminating physical contact with the animals in a dairy firm, resulting in an ecosystem for sustainable dairy in the long run. Therefore, most developed nations accepted technology-based dairy farming methods, which can be termed industrial processing.

2.14 Supporting Theories

Dependency theory and Appropriate Technology has been selected for particular emphasis here. Dependency Theory arose as an alternative to the modernisation and development ideas created and promoted by Western and Marxist researchers. Of course, it includes a harsh critique of both constructivist and Marxist theories. The Dependency Concept originated with an investigation of the colonial impact on aboriginal socio-economic and political structures, then seeks to analyse the features of the new socio-economic system, and finally strives to discover its advancement about internal and external changes in the world capitalist economy.

The Dependency Theory examines the internal dynamics of developing nations and connects them to their places in the world economy. It also investigates the relationship between interior and exterior structures. It explains Third World underdevelopment regarding the socioeconomic-politico-cultural dynamics that connect these nations to industrialised countries. The developing nations are regarded as the peripheries, while the developed countries are regarded as the centres, and it is held that the nature of social manifestations in the boundary can only be understood and analysed concerning the global capitalist system, which the developed centres control.

The essential argument of the Dependency Theory is that the nature of social phenomena in Third World nations is dictated by the process of underdevelopment that defines these countries and is the product of World Capitalism's growth. Furthermore, the process of underdevelopment is inextricably linked to their reliance on others. In reality, nearly all dependency theorists believe that foreign dependence, particularly on capitalist nations, causes underdevelopment.

Appropriate Technology, on the other hand, is concerned with what kinds of decisions should be taken regarding technology in developing countries. The rise of Dependency Theory may be seen as a necessary response to the increasing inability of conventional theories to explain various issues that emerged in the context of underdevelopment. For example, technological diffusion, urbanization, and industrialization had not made significant improvements in the socio-economic conditions in the periphery and in many ways had increased the inequalities. Dependency theory is primarily an economic and social development concept that explains worldwide inequity via the rudimentary manoeuvring of third world countries in the hands of wealthy nations. However, there are several elements for which Pakistan is reliant on the core nations. However, the primary reasons for Pakistan's reliance on the core nations are intrinsic enforcement, worldwide marketing,

economic development dependency, and population control policies, as well as intellectual. As a result, the researchers used this theory based on the current literature. The central argument made by Dependency Theory is that the present condition of the developing countries must be re-examined in the context of the historical evolution of an international economic system, and the changing nature of the political, economic, and technological relationships between the advanced and the developing countries. Such an analysis suggests that the earlier forms of political-economic dependence which prevailed under colonialism have given way to financial and technological dependence wherein the techno economic structures, institutions and dynamics of the developing countries are dependent to a large extent on those of the advanced countries, thus limiting the range of technological options and activities that are possible in developing countries.

In the Appropriate Technology approach, the needs, and resources of the country in which a technology is to be implemented become significant. The central argument is that different technologies are suitable to different environments and that technologies which have been developed in advanced countries to the extent that they have been developed in response to the needs and conditions of the.se countries, are not necessarily suitable to the factor endowments (e.g.: capital scarcity, labour abundance) and sociocultural attributes of the developing countries. The need is therefore expressed for more "appropriate" technologies that address the urgent needs for employment creation, capital saving and demand for essential goods in the developing countries. The basic arguments of the Appropriate Technology School are:

- That there is more than one way of manufacturing a particular product.
- That more than one product can satisfy a particular need.
- That alternative techniques and products can be developed and should be evaluated according to some social cost benefit criteria instead of the private profit maximization criteria. Thus, for example, it is argued that Appropriate Technology should be labour intensive, energy saving, small scale, use local skills, manufacture mass consumption goods and conserve on scarce raw materials.
- To the extent that the development and use of Appropriate Technologies essentially involves the development and use of appropriate criteria for the selection of techniques, the problem of choice of techniques is at the core of this concept.

Dependency theory and Appropriate Technology has been jointly selected for particular emphasis here because:

- Both deals explicitly with the problem of choice of techniques in developing countries.
- Both are relatively recent theoretical movements in development research and to some extent represent opposing perspectives on the problem of development.
- Taken together, they address, or allow being addressed, the range of issues that are raised by the research questions outlined earlier.

It should be noted that neither Dependency Theory nor Appropriate Technology are formal, coherent, and unified theoretical perspectives. Each represents a trend in thinking rather than an unambiguous position with respect to the problem and there are many internal debates and sub trends in each perspective. It is useful to think of each as representing a range of perspectives which are closely interrelated and are in consensus as to the major problems that are being addressed. Thus, Dependency Theory, for our purposes, is primarily concerned with the causes and consequences of technological decision making in developing countries in terms of its implications for the overall process of development and underdevelopment.

However, it is important to recognize that the problem is not one of merely developing a new set of hardware which is more suitable to the developing countries but that there are a host of other factors, including problems relating to implementation, evaluation, social and political barriers, availability of skills, and administrative techniques, which need to be considered before Appropriate Technology becomes meaningful in a practical sense.

Appropriate Technology is basically concerned with the development of a prescriptive model for the choice of techniques in developing countries Unlike Dependency Theory; it pays little attention to the political and historical dimensions of underdevelopment. Its value lies in the fact that it has contributed to the expansion of the microeconomic model of technological choice by recognizing the need to incorporate a larger set of factors in the choice process. Although each of the approaches described offers powerful insights into the problem of choice of techniques in developing countries, there are still several issues and questions that are left unaddressed or unanswered.

2.15 Chapter Summary

The above literature review shows that development per se has mostly been driven by government initiatives as a central policy. At the same time, it has also led to rolling down the action plans over a time frame, as the demand from the population grew steadily. The mode is not prevalent in the

Pakistan government for bringing in national-level economic development centric initiatives. The role of nodal agencies at the central government to identify the public or private players for setting up dairy plants to harness raw milk processing shows a gap at the policy and framework level. The nature of governance requires more decentralisation of power that addresses the population demand for fresh milk consumption. It also shows how evidence of a gap in networking between various institutional stakeholders in Pakistan has been ignored. While the prevalence of networking to resolve disaster management, or in construction, IT sector is evident, the same for SME dairies in the rural sector of Pakistan is a structural gap in resource utilisation at the macro level in the Pakistan economy. The traditional nature of milking methods in the small family-owned business has been devoid of technology, exposure to information. These are widening gaps in industry application that have led to few stakeholders in the dairy supply chain have realised the value in raising the dairy program to the next level leading to the concentration of power in few hands. The implication leaves a gap in the missed opportunity of tapping the roadmap to revive the rural dairy farmers, SME culture, use of technology and innovation to usher momentum in economic development.

3. CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

According to Bresler and Stake (2017), the term research methodology has been identified as the process used for collecting relevant information and data for making business decisions.

This chapter discusses the research methods used to address the research question. According to Rajasekar (2013), a research methodology is a systematic approach to issue solving. It is a science that studies how research should be conducted; to some extent, this approach determines the specific instruments that the researcher chooses. A researcher must develop a technique for a specific research topic. It is the essential component of any research effort since it is used to determine the investigation's validity (Cooper, 2018). It defines the study approach by establishing a logical relationship and rationale. As a result, how a research study is carried out must be very clear and exact.

Furthermore, research methods aid in the investigation of a solution to an unstudied research topic by using a suitable sample, data, statistical, and data analysis tools. Furthermore, methodology aids in the verification of dependability and validity. Whereas dependability indicates that if the research is redone several times, the study's conclusions will remain the same, demonstrating consistency. In contrast, validity refers to the procedures used as though they had measured for what they were meant to measure (Bell et al., 2018). The nature of the research problem, on the other hand, primarily determines the research methods, techniques, approach, and strategy to be used for a specific research project. The type and form of research questions and objectives serve as the foundation for methodological development (Cooper, 2018).

3.2 Method Outline

As evidenced by Attia and Edge (2017), the section of the ***method outline*** describes the ***procedure*** and ***participants*** clearly and concisely through which the research can be completed. The respective section of the method outline is generally concerned with two sub-sections, such as ***procedure*** and ***participants***. Participants provide knowledge regarding the number as well as the

type of experimental participants. On the other hand, the procedure seems to be the chronological description conducted step by step for experimental events. The present research has explained the methodological approach by introducing the overall ***approach*** to the study.

Here, the study synthesizes the use of quantitative and qualitative methods and a mixed approach, which can help investigate the research questions. On the other hand, a description of the data collection methods has also been provided, and the analysis and justification and evaluation of the methodological choices. It evaluates the surveys, experiments, existing data under the quantitative method; however, focus groups and interviews and participant observation are evaluated, which falls under the qualitative method (Clandinin*et al.*, 2017). Hence, the respective section of the study employs legitimate ways for testing the methods by providing an outline for the overall research that needs to be conducted.

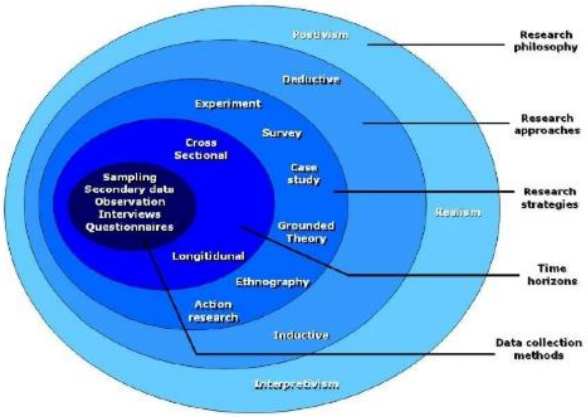


Figure 3.1 Research Onion

Source: (Saunders *et al.*, 2009)

3.3 Research Paradigm

The essential stance of every investigation is the research paradigm. It is "the fundamental collection of beliefs that directs action" (Guba, 1990, p.17). These ideas impact every step of the research process, from deciding on a study issue to analysing and interpreting data (Johnson & Onwuegbuzie, 2004; Mertens, 2009). For a better comprehension of the research paradigm, which is explained in the next part, it is vital to comprehend the research's ontological and epistemological viewpoints.

3.3.1 Ontology

Ontology, defined as the study of "being," is one of the fundamental fields of academic philosophy (Holden and Lynch, 2004). It is often referred to as researching the nature of social entities and the organisation of social reality (Crotty, 1998). As a result, ontology's principal purpose is to address the essence of truth (Saunders et al., 2009). All study starts with ontology, then moves on to epistemological and methodological components, which serve as the foundation for researchers to seek new knowledge through research (Grix, 2002). Subjectivism and Objectivism are the two major competing disciplines of ontology, the science that debates whether animals are subjective or objective (Saunders et al., 2009). According to subjectivism, social phenomena develop from the perceptions and actions of the social actors who are concerned with their presence (Saunders et al., 2009). Objectivism is the concept that components exist apart from the social actors who are concerned about their presence (Saunders et al., 2009). Objectivism and subjectivism, according to Jonassen (1991), have separate principles because knowledge inquiry as to the researcher's active interpretation and growth of personal knowledge.

According to Jonassen (1991), Objectivism maintains that the essence of the present is objective and that researchers explore and analyse these objective realities that act as a mirror. The ontological standpoint of this research is Objectivism, which holds that social reality exists outside of people's brains. There are two main grounds for adopting an objective ontological approach for the present research. For starters, this point of view allows the author to analyse social events and explain their implications in a way that is possibly independent of the wills of social players. Adoption and intents about technical innovation in the dairy sector are considered as social realities in this study, and dairy farm owners are viewed as social participants. Even though all players have changed or been replaced, the acceptance and usage of technology in dairy has not changed (true). In other words, none of those social members is free to change, alter, or terminate their usage of technological innovation in the dairy industry (reality). This study necessitates an objective perspective to understand a distinct and genuine reality to evaluate this objective social entity. Because Objectivism typically involves collecting and analysing quantitative data to give solid evidence to explain the occurrence, it is regularly utilised in the current literature and achieved through quantitative research methodologies (especially questionnaire surveys) (Orlikowski and

Baroudi, 1991). Consequently, Objectivism was chosen as the ontological paradigm for this investigation.

3.3.2 Epistemology

According to Saunder et al. (2009), the definition of epistemology is concerned with what constitutes adequate knowledge in a given field of study. According to Grix (2002), epistemology is one of the essential philosophical sciences dealing with exploring social reality through research methodologies, hypothesis verification, or other ways. Furthermore, Orlikowski and Baroudi (1991) distinguished two critical stages in research epistemology: positivism and interpretivism. The positivist approach is an essential method in information systems research, and it is linked to both qualitative and quantitative analysis (Galliers and Land, 1987). Three epistemological approaches are explored below to choose the most effective and acceptable method for this study.

3.4 Research Philosophy

Research philosophy generally deals with the ***"nature; source and development of the knowledge"***. For the present study, it indicates a belief about the ways where data for a phenomenon should be ***gathered***, ***used,*** and ***analysed*** as well—addressing the respective section of ***research philosophy*** for the research involved to be aware along with the formulation of the assumptions and beliefs of the researcher (Cuervo-Cazurra*et al.*, 2017). Furthermore, it highlights the term ***epistemology*** that is ***"what is known to be true",*** which is opposed by the term ***doxology ", which is believed to be true"***. It tends to encompass different ***philosophies*** for the ***research approach***. According to Kaplan and Kaplan (2018), epistemology relates to the link between reality and the researcher, whereas ontology refers to the reality that a researcher study. According to Saadi (2019), in the realm of social sciences, ontology refers to the basic principles and norms that individuals have regarding the problems under inquiry; hence, the ontology is the researcher's belief system. According to Healy (2016), addressing research questions entails defining the ideas that a researcher follows as they strive to make sense of the social environment.

The philosophy chosen for the current research is Pragmatism which supports mixed methods, i.e., following quantitative and qualitative methods in the same study. Pragmatism discards the claims that two alternative approaches or methods cannot be followed research. Pragmatism also rejects

the principle of using complete objectivity (positivism) or subjectivity (interpretivism) in a single study and relies on more human actions (Aithal, 2017). Such actions consider it necessary to maintain flexibility in data collection, using different approaches and methods that help collect relevant, extensive data to find concrete answers to the research questions. Maintaining the worldview 'pragmatism' helped the researcher follow 'mixed methods', eliminating each method's inert weaknesses and building upon their strengths. Positivism relies on observation and objective reasoning and scientifically considers researching as natural science (Saunders et al., 2009).

Positivists usually collect quantitative data that can be put to statistical testing to reach objective-based conclusions. Positivism was considered weaker for this research because the requirement was to understand the technological challenges faced by dairy SMEs in Pakistan. This understanding could be not gained by fully relying on positivism. It was necessary to understand the experiences of human subjects (Owners/managers of SME dairy firms) regarding the use of current technology and the need for innovative technology.

It required the researcher to follow interpretivism to interact with the SME owners/managers, ask questions, probe them, clarify issues, build rapport, share emotions, and obtain subjective views to understand the problems in-depth. However, it was feasible to rely completely on interpretivism because the research questions could not be resolved based on the subjective views of the human subjects. Therefore. Both positivism and interpretivism were used in the current study to conduct qualitative and quantitative research, respectively, as supported by Pragmatism. Pragmatism helped to align two contrasting philosophical views, i.e., positivism and interpretivism, in a single study. It was a key requirement of this study, as interpretivism helped to collect qualitative data by interviewing the research subjects to know the existing situation, i.e., current technological capabilities of dairy SMEs, technological gaps, what kind of technological innovation is required to ensure the sustainability of the dairy industry.

On the other hand, positivism helped to test the effectiveness of the current technology and validate the necessity of innovative technology. Positivism helped collect quantitative data by surveying the employees, managers and owners of the dairy firms using structured questionnaires. The findings helped to test the concepts, variables, and constructs studied in the literature. The use of both positivism and interpretivism was made, rather than used singly in the current study.

Positivism

"Positivism research philosophy" seems to adhere to the view based on factual knowledge obtained by observation involving the measurement. However, positivism mainly depends upon ***quantifiable observations*** that lead to ***statistical analysis***. The respective term is used for describing an approach of the society for the study, which relies particularly upon scientific evidence like statistics and experiments for revealing the true nature depending on how society operates. This study did not rely entirely on positivism because this philosophy supports quantitative research and statistical/scientific data testing to test theories, especially when research problems are fully clear. However, partial reliance on positivism was maintained to test the effectiveness of various technologies relevant to the SME dairy industry in Pakistan.

Interpretivism

According to Goldberg *et al.* (2017), ***interpretivism research philosophy*** includes the researcher for interpreting the elements of the study, which can integrate the human interest within the research. ***Interpretivism*** is associated with the ***philosophical position*** based on ***idealism*** and is known for grouping the diverse approaches altogether. This research did not solely rely on interpretivism because it entirely rests on subjective views of the human subjects and the researcher's judgment, which increases the possibility of bias. However, partial reliance on interpretivism was made so that the SME owners/managers of Pakistan dairy firms could be probed regarding the present technological capabilities, feasibility in operations, and the need for innovative technology that requires asking open-ended questions in an interview.

Realism

The respective ***philosophy*** tends to rely on the ***"idea of independence"*** based on reality through the human mind. It is related to the assumption for the ***scientific approach*** for knowledge and development. Realism might be divided into two categories such as ***critical*** and ***direct***. ***Direct realism*** is considered as naive realism indicates ***"what you see is what you get".*** For instance, it portrays the whole world with ***"personal human senses"*** (Hickson, 2016). On the other hand, ***critical realism*** is known to argue about the experience of humans about the sensations and images based on real-world which might be deceptive, and these never portray the real world. Realism

was not followed because it is like positivism yet assumes that the objective world is independent of the human mind.

Pragmatism

Pragmatism research philosophy is known to accept the concepts for being relevant while supporting the action. It has been considered a "problem-oriented philosophy" that considers the view about the best methods regarding the research, which can help in efficiently answering the research questions. As per the use of ***"pragmatism research philosophy",*** the ***research question*** has been the most significant determinant for the ***research philosophy. Pragmatics***, in this case, can combine both the interpretivism and positivist positions in a single research scope as per the nature-based on research question.

3.4.1 Justification for the choice of Pragmatism

The choice for a particular research philosophy can be impacted through practical implications. For the present research, ***pragmatism research philosophy*** has been most appropriate. ***Pragmatism*** is a paradigm that can underpin the ***mixed research method***. It seems to be a ***problem-oriented philosophy*** taking the view for applying the best methods for the research, which can eventually help answer the research questions (Tobi & Kampen 2014). However, the use of these respective philosophies consists of both benefits and limitations for the present research.

Table 3.1Benefits and limitations of Pragmatism Research Philosophy

Advantages	**Disadvantages**
Pragmatism philosophy is responsible for overcoming the ***scientistic tendencies*** within ***contemporary analytic philosophy***.	The use of pragmatism philosophy has been criticized for focusing upon the practical results and ignoring the theory and philosophy.
By emphasizing natural phenomena, Pragmatism can provide a helpful correction regarding the	It is unable to convince people who do not share their fundamental values.

metaphysical tendencies within continental philosophy.	
Pragmatism philosophy also presents recognition based on the metaphysical divide within the natural and cultural entities and an appreciation for cultured, constructed, and artificial nature for self.	The use of pragmatism philosophy tends to be confined to itself for philosophical theory instead of being fully engaged (Ndlovu-Gatsheni, 2017).

(Source: Developed by Researcher)

3.5 Research Approach

The research approach is referred to as a ***procedure*** or ***plan*** composed of steps related to broader assumptions for ***detailed data collection methods***, its ***interpretation*** and ***analysis***. According to Basias and Pollalis (2018), this seems to rely on the nature of the respective ***research problem*** required to be addressed.

3.5.1 Justification for following the Abductive Approach

Like Pragmatism, the abductive approach integrates two opposing poles, i.e., inductive approach and deductive research. The Abductive approach was considered feasible for this research because no single approach, i.e., inductive, or deductive, could have helped find concrete answers to the research problems.

The Abductive approach implies moving forward and backwards between the inductive and deductive approaches, i.e., collect in-depth information to build new knowledge and simultaneously testing data to validate the knowledge through scientific testing.

The followers of the deductive approach mainly assume the positivist position of theory-testing, using the quantitative data collection and analysis technique to arrive at objective-based results (Zalaghi and Khazaei, 2016). On the other hand, researchers following the inductive process usually assume the interpretive mindset and conduct qualitative data collection and analysis to

form subjective reasoning and knowledge development. While inductive and deductive approaches are two distinct schools of thought, these approaches can be followed simultaneously in a particular study by pragmatic researchers opting to test existing theories and add value to existing knowledge (Zalaghi and Khazaei, 2016).

While the deductive approach informed by the positivist standpoint helped to test theoretical concepts and variables discussed in the literature review, the inductive approach helped to fulfil the theoretical gaps by developing new knowledge based on empirical findings to explain the nature of innovative technology that is needed in the Pakistani SME dairy sector.

It is mainly divided into two groups: the ***"approach of data analysis and reasoning*** and ***approach of data collection'***s well.

Table 3.2 Components of the Research Approach

Source: (Almalki, 2016)

The relevance based on the hypothesis has been the major point within ***"inductive and deductive approaches"***. ***The deductive approach*** is known to test validity based on assumptions, whereas; the use of the ***inductive approach*** seems to contribute to quite a few new theories. On the other hand, ***an abductive approach*** generally starts with some ***surprising facts*** along with the ***research progression,*** which has devoted the explanation of a detailed understanding of the types of research approach has been mentioned below:

Deductive approach

As per the views of Haydon *et al.* (2018), deductive research approaches begin with a theory by the development of a hypothesis through that theory along with analysing and collecting the data for testing the hypothesis. Making use of the deductive research approach indicates taking the steps that are described earlier regarding inductive research as well as reverse their order. It helps conduct a scientific investigation and is mainly concerned with the ***"development of a hypothesis"*** as per an ***existing theory*** and then ***"designing the research strategy for testing the respective hypothesis"***.

Inductive approach

The ***inductive approach*** is also considered inductive reasoning that starts with an observation, and the theories proposed for the end of the research process result from the observations. The ***inductive approach*** includes a specific search pattern through observation and development based on explanations (Dougherty *et al.,* 2017). Hence, it collects ***data*** and analyses the data patterns along with theorizing through the respective data. It highlights the main ***difference*** between ***"deductive and inductive research approaches",*** where the ***deductive approach*** is known to be concerned with ***testing theory***. In contrast, ***the inductive approach*** is concerned with developing a new theory emerging through the collected data.

Abductive approach

The Abductive approach is also considered abductive reasoning, which addresses the weaknesses related to both the ***inductive and deductive approaches***. More specifically, deductive reasoning tends to be criticized through the lack of clarity for how a theory can be selected for being tested by the formulation of a hypothesis. On the other hand, inductive reasoning has been criticized as there is no amount based on empirical data that can necessarily enable the building of theory (Fletcher *et al.,* 2017). Thus, the abductive approach being the third alternative, tends to overcome all these weaknesses by adopting a pragmatist perspective.

Table 3.3 Abductive Reasoning

Source: (Camprubí, *et al.*, 2016)

Table 3.4 Advantages and Limitations of Abductive Approach

Advantages	**Limitations**
Alase (2017) opined that abductive reasoning allows inferring as an explanation for the present research, which eventually enables the precondition for being abused through the consequences.	Abductive reasoning has been considered as an incoherent, weak, and non-existent approach.
The use of the abductive approach covers both the application of inductive and deductive reasoning.	The problem based on the articulation of clear inference in abductive reasoning has been due to the difficulty of clear interpretation.
While explaining the facts related to the study, an abductive approach allows the researcher for	Applying abductive reasoning can be challenging for the first time due to its

combining both ***cognitive and numerical reasoning***.	cause-and-effect relationship (Bengtsson, 2016).

Source: (Developed by the Researcher)

3.6 Research Design

Research design is the framework associated with the research techniques and methods which the researcher has selected. Almalki (2016) stated that this highlights a close relationship between the research method and design as an effective research design assures the obtained data, which can help in efficiently answering the research questions. However, different types of research design are mentioned below:

The current study was exploratory research that helped to understand the various problems faced by the Pakistani SMEs (dairy firms) regarding technology and the emerging requirement for innovative technology that could ensure its sustainability. The exploratory design was feasible because the research problems were not clear at the beginning of the study, and further enquiry was needed to identify the actual problems. Exploratory design helps to follow a flexible, informal enquiry and collect information from multiple sources to reach the depth of the problems.

Exploratory research design is mainly conducted for a specific problem that has not been researched well earlier. It helps in generating operational definitions which demands priorities along with providing a model which has been better researched. Using exploratory research design helps resolve the best method of research design for data collection and selecting the subjects. It is meant to collect descriptive information and provide an enhanced understanding of the respective research study.

Exploratory research helps to understand 'what the actual research problems are?', a pre-requirement of this study. Moreover, inadequate, and insignificant research in Pakistani SME firms, especially dairy firms and the technological challenges made it necessary to follow the exploratory design so that investigation could be carried out from a very basic level.

Other research designs such as explanatory design was considered weaker because explanatory studies mainly aim to establish the causal/fundamental relation between the variables. Also known as causal research, the purpose of explanatory research is to conclude how the research variables, independent and dependent variables, are associated with each other and with the key research problems (Tobi and Kampen, 2018). The use of explanatory research in this study would have meant understanding the relationship between 'operations in Pakistani dairy SME industry', 'sustainability of SME dairy firms' as dependent variables and 'technological innovation' as the independent variable. However, lack of clarity about each of the variables, i.e., the nature of operations carried out by Pakistani dairy SMEs, their current technological capabilities, sustainability requirements (as dependent variables), made it difficult to establish the relationship with technological innovation (independent variables variable).

Moreover, the researcher's objectives were not to identify how each of the variables is linked to each other, rather understand the existing nature and type of each element, identify the problems, and conduct a further enquiry to discover the need for technological innovation. Finally, the descriptive design was also considered inappropriate for this study because descriptive studies mainly follow a formal, inflexible, and structured approach to data collection and analysis. Descriptive research has a formal set of clearly defined aims and objectives, and questions since the beginning of the study when full clarity of the research problems is there. Statistical analysis is conducted to find concrete answers to the identified problems (Turner *et al.*, 2017). Therefore, descriptive research is often termed statistical research because it involves a large sample size that mainly takes part in quantitative data collection, such as surveys to yield voluminous data. Such data is subject to statistical testing. Therefore, descriptive research was not considered suitable for this study because the scope for rigorous data testing was not there. The researcher had full clarity about the problems at the preliminary stages of the research.

Hence, discarding the explanatory and descriptive designs, the exploratory design was followed to discover something new at different stages of the study, throughout the research, and find out the need for technological innovation and what effect it could have on the operations, performance, and sustainability of the Pakistani dairy SME firms.

Descriptive research design

Descriptive research is considered for measuring and observing without any manipulative variable. It can identify the trends, characteristics along with correlations as well. Hence, the use of descriptive research design helps identify a research method that can describe the characteristics based on a phenomenon that can be studied. As evidenced by Rahi (2017), it mainly emphasizes the description of nature for demographic segments without analysing the cause of a particular phenomenon.

3.6.1 Justification for the Choice of Exploratory Research Design

Nevertheless, the use of explanatory research design is also comprised of several benefits and limitations, which are mentioned below:

Table.3.3. Advantages and Disadvantages of Exploratory Research Design

Advantages	Disadvantages
The exploratory design allows deeper insight into the study, bringing more facts supported by the study.	The use of this research design can provide qualitative data that can result in being difficult for interpretation.
It can help in increasing the proper understanding of the researcher for a specific subject.	It cannot provide any conclusive result due to the lack of statistical strength.
Based on the views of Kogan *et al.* (2019), it helps in deciding about the exploration of the configuration, testing the philosophy, and gathering strategic information as well.	Most of the data that is collected through secondary sources can also be outdated.

Source: (Developed by the Researcher)

3.7 Research Strategy

The ***research strategy*** is considered as a ***step by a step action plan*** which provides a direction to the efforts and the thoughts related to the study that eventually enables the research to be conducted systematically. Research strategy helps in producing quality results persisting with detailed reporting. Consideration of research strategy while conducting the study can enable the researcher in staying focussed, enhancing the quality, reduce frustration, and save resources and time (Tarrant, 2017). These are the bolts and nuts of the application for describing the rationale of the research study and the experiments that need to be performed to accomplish the desired goals.

Figure 3.2 Research strategy

Source: (Avella, 2016)

The researcher must devise a plan for the ongoing study. Research questions that have previously been developed must be addressed, and the methodological part assists in locating the answers to research questions. As a result, it should be objective, and the responses are generated from examining the data produced for the research project. Data collecting approaches and constraints such as time, financial resources, access, and many others may impact the strategy used to complete the research (Easterby-Smith et al., 2018). ***Research strategy*** covers the ***research questions*** concerning quantitative ***surveys***, ***qualitative interviews***, ***action research*** and ***case studies***. It also consists of different phases; for instance, it is emphasized upon the ***inventory of***

the research. It is used to identify targets of the research for both the feedback criteria and customer segments. ***Quantitative surveys*** focus on objective measurements, mathematical, statistical, and numerical analysis based on the collected data and the help of surveys, questionnaires, and manipulating ***the pre-existing statistical data*** by ***computational techniques*** (Harrison *et al.*, 2017).

On the other hand, ***qualitative interviews*** focus upon participant observation, focus groups and in-depth interviews. Each of the methods is suitable for obtaining a particular type of data. However, a ***case study*** is such a ***research strategy*** that investigates a phenomenon according to its ***real-life context***. These are generally based on an in-depth investigation for exploring the underlying principles of causes. Nevertheless, ***action research*** handles the problem related to the real world within collaborative, participatory, and cyclical ways to produce both the action and knowledge. It is referred to as a particular research methodology that works for a change, whether professional or social. This study, being mixed method survey-based research, is a combination of case study, explanatory, and descriptive type of research where the researcher aims to explore the current technological status of the Pakistani dairy sector, identify the factors affecting technological innovation in Pakistan rural dairy sector and suggest a framework to develop technological innovation I dairy industry of Pakistan.

3.8 Research Method

According to Abutabenjeh and Jaradat (2018), a research method is a systematic plan to conduct a research study. The research method includes specific techniques adopted for the research process to assemble, collect, and evaluate data. It has been found to define those tools used to collect relevant information within the research study. The qualitative and quantitative and mixed methods are considered as the min researcher techniques.

The primary distinction between quantitative and qualitative research is based on the nature of knowledge and the world's perception (Creswell, 2013). On a distinct level of discourse, data gathering techniques and data analysis distinguish between quantitative and qualitative methodologies. Numbers, graphs, or statistical data are used in the quantitative technique. It is used to validate or test hypotheses and assumptions. This form of study may be utilised to discover generalisable truths about a subject. These approaches are commonly employed to investigate

natural occurrences in the realm of natural sciences. On the other hand, qualitative methods are dependent on words or narrations. These strategies are used to comprehend ideas, thoughts, or experiences. This form of study provides in-depth insights into areas that are little understood. A qualitative technique is commonly employed in social science to assist researchers in investigating social and cultural issues (Saunders et al., 2009).

The qualitative method based on exploratory investigations considers informal and rigid research in areas that have not been thoroughly investigated (Saunders et al., 2009). As previously stated, one of the significant differences between quantitative and qualitative research is the ability of the former to produce objective-based statistical results. Simultaneously, a descriptive, thorough explanation of social phenomena is often done using a later technique. Mixed-method research relates to a pragmatic research paradigm in the middle of these two separate approaches.

According to Allwood (2012), neither qualitative nor quantitative research techniques are superior to others; the reasons for selecting research methods typically depend on the context, nature, and aim of the study. Choy (2014), on the other hand, concluded that researchers today prefer to use a mixed methods approach to capitalise on the strengths and advantages of both quantitative and qualitative research while removing the flaws associated with each.

3.8.1 Justification for the use of mixed method

For the present research, the use of *mixed methods of data collection* has been considered appropriate as it considers the use of both *QUALITATIVE and QUANTITATIVE methods.* The validity and reliability of any research project, among other criteria, are largely dependent on the systematic process of collecting data and evaluating it in an acceptable manner utilizing proper methodologies. While the type of the research study aids in defining research techniques, research strategy, design, and overall research pattern because the type of research questions and goals serve as a foundation for research technique and research design (Cooper, 2018). According to Easterby-Smith et al. (2018), any approach or combination of methods can be employed based on nature, circumstances, and conditions. Moreover, Chi Squared Test for independence is applied to assess the association among the nominal variables. The Chi-Square test of independence is used to determine if there is a significant relationship between two nominal (categorical) variables. The frequency of each category for one nominal variable is compared across the categories of the

second nominal variable. Mixed methods helped collect quantitative data through surveys, while qualitative data was collected through interviews. It helped in better triangulation as the findings obtained from the quantitative research could be backed up and cross-examined with the help of elaborate qualitative information obtained from the quantitative research. Pragmatism supports mixed methods and the abductive approach followed in the current study, and each method helped to discard the weaknesses present in the other.

The author used the Mixed Methods technique in the current investigation for a variety of reasons. To begin with, by combining qualitative and quantitative methodologies, the shortcomings of each methodology may be mitigated, while the strengths and benefits can add value to the findings. Second, this integration will help to consolidate the results. Furthermore, mixed methods are particularly useful for analysing inconsistencies between quantitative and qualitative results. The participants' points of view are reflected. This method provides study participants a voice, ensuring that study results are grounded in the experiences of the participants, and encourages intellectual involvement. Finally, triangulation, as used in the current study, will improve the credibility of the final findings since one methodology might result in overcoming the drawbacks of another method.

3.9 Data Collection Techniques

Data collection is considered a method for gathering and measuring information upon the ***variables*** based on interest within an established systematic fashion (Levitt *et al.*, 2017). It enables the study to evaluate the answers to the research questions; evaluating outcomes and test the hypothesis. The methods for data collection can be divided into three categories: ***"primary; secondary and mixed data collection methods"***.

3.9.1 Primary Data Collection Method

Primary data collection is collecting the data through ***surveys***, ***questionnaires, interviews, field observations*** and ***experiments.*** These methods might be contrasted with the source of ***primary data,*** which can be considered as the ***first-hand collection based on the data*** for a specific purpose. The primary methods of collecting data can be categorized as ***quantitative data*** and ***qualitative data***.

3.9.2 Quantitative Data

According to Ridder (2017), quantitative data is considered based on counts and values expressed as numbers. The quantitative data is referred to as the data regarding numeric variables. Thus, this data collection method emphasizes the objective measurements, along with, ***mathematical; statistical and numerical analysis*** based on the gathered data with the help of ***questionnaires; experiments and surveys.***

Experiments

Experiments are done on a group of people who are asked to complete different tests that help measure their cognitive abilities. The main purpose of conducting experiments is not to judge the people and measure the so-called intelligence rather for looking at the relationship within performance and similar other factors. While using the computers, it needs to be conducted in such a way where previous knowledge of computers is not necessary. Here, the behaviour and reaction of the people are observed after and before practising the intervention. The controlled group of people are not exposed to this type of experiment or intervention (Meredith *et al.*, 2018). It allows the researcher to compare the results of both the groups and determine the impact of the intervention.

The research found this method unsuitable for the present study. Because, under such rigorous variable restrictions, the data may become distorted and erroneous. It may cater to the research's unfavourable conditions. Variables can sometimes be controlled to derive desired or altered data outcomes. The research findings might be separated from the real-world setting. Moreover, the experimental investigation provides a conclusion by allowing the hypothesis to be accepted or rejected. In an essence, the answer is either yes or no. However, there is no clear explanation for the study. Therefore, this method is a constrain in the way of study which is conducted to suggest a problem-solving framework.

Questionnaires

Questionnaires are identified as the best way to obtain information through a larger sample of individuals who might not possess much time for attending the interview process. The researcher maintains confidentiality about the questionnaires, enabling the participants to answer the questions privately (Leighton and Nielsen, 2020). For the present study, the research questions comprise multiple-choice questions along with close-ended and open-ended questions. This method of questionnaires enables all individuals to have an equal chance of participation within the research. However, as opposed by Ketchen *et al. (2019), participants can provide biased answers that are socially acceptable, leading to a low rate of response. People are not forced to answer all the questions*. It can result in forming false conclusions for the interpretation of the study while analysing the data. Hence, the researcher needs to encourage the participants to provide honest answers for avoiding false interpretations through the respective study.

Survey

Surveys: A survey is typically used as a data-gathering instrument in "nonexperimental" descriptive research to investigate and characterise reality (Bhattacherjee, 2012). A survey, for example, can be used to determine the frequency of any specific ailment. Surveys may be used to collect data and knowledge about human behaviour and attitudes in a similar fashion. According to Kumar (2014), traditional experimental design explains these concerns by randomly assigning participants or subjects to either a control group or an intervention group. However, either practically or morally, it is argued that survey participants are not assigned to specific interventions at random. According to Creswell (2014), identifying a "control group" or randomization may be impossible because the procedure is challenging to complete. A census refers to the inclusion of all populations in a survey. However, for cost-effectiveness and practicality reasons, a survey is often conducted on a representative group sample and then applied to all populations (Creswell, 2014).

In comparison to questionnaire, creating a survey, which is often arranged for a professional or academic purpose, may take long, and takes significant attention. They are research approaches that can supply us with valuable information. Incorrect data collection or interpretation might

affect the validity of the findings. As a result, the whole survey becomes a useless. Surveys are expensive to do, so getting everything right is critical.

3.9.3 Justification for the Choice of the Quantitative Data Collection Method

Quantitative data is numerical, and it helps to measure the variables included in the study on a specific sample. It helps to collect measurable data that can be put to scientific tests and reach objective-based conclusions. Quantitative data can be collected through experiments, surveys, and questionnaires; however, each strategy has its strengths and weaknesses.

An experimental study is a quantitative data collection strategy. The independent variables are mainly tested; however, they may be manipulated to measure any independent change variables. However, experimental studies make it difficult to capture research participants' perceptions on a wide range of scales.

A questionnaire is used for collecting, interpreting, and analysing various views of the people through a specific population. However, this also increases the probability of receiving biased answers from the participants leading to false interpretation. Nevertheless, it can help increase the knowledge within the fields like demography and social research.

The survey is widely used as a quantitative data collection strategy that helps to reach a large sample and collect voluminous data. However, the survey needs to be assisted by structured questionnaires to collect quantitative data. However, the use of semi-structured or unstructured questionnaires may be used to collect qualitative data.

Undertaking a survey is also cost-effective and a faster method of collecting primary data than experimentation and observation (Harwell, 2011). The main advantages of surveys are that they can be carried out online and through the physical distribution of questionnaires, allowing flexibility (Newman, 2014).

The main disadvantage of surveys is that respondents may not seek clarification about the questions if they are not understandable unless a pilot study is carried out. The possibility of biased responses and providing erroneous information is high if the respondents fail to understand the questionnaire.

Justification for conducting a survey

The survey was considered most feasible to collect quantitative data in this research because of the cost-effectiveness, extensive reach, and convenience to collect voluminous data from a large sample size. It does not require the researcher to physically interact with the participants as it can be done online. Therefore, a survey was supplemented by using closed-ended, structured questionnaires designed to address the research questions formulated in chapter one and collect data to fulfil the research aims and objectives.

Questionnaire design for a survey –

The questionnaires were carefully designed for the survey after a deep synthesis of the concepts and variables studied in the literature review. For instance, it sought participants' perceptions about the use of genetic breeding technologies, molecular genetics technologies, and the requirement of technology equipment that could impact both structural and functional change and emergent need for innovative technology as used by dairy firms in developed countries. Therefore, the theoretical knowledge, concepts and variables studied in the literature review were incorporated within the questionnaires so that the responses and subsequently the findings validate the same. The questionnaires were mainly designed using the five-point Likert scale, which made it possible to capture the extent of agreeability or disagreeability of the participants concerning using a specific technology.

In the quantitative analysis, the internal reliability was checked by measuring Cronbach's alpha. The composite Cronbach's Alpha of the construct was measured to ensure reliability. At the same time, the researcher performed KMO and Bartlet tests to examine sample adequacy and sample sphericity, respectively. Descriptive analyses were applied for the verification or falsification of the questionnaire statements (percentage and mean score

3.9.4 Qualitative Data

As per the views of Alavi *et al.* (2018), ***qualitative data*** is referred to as the data that characterizes and approximates the information provided through the participants. These data can be recorded and observed and are ***non-numerical*** within nature. The data is known to be collected by the

methods based on ***observations***; ***face-to-face interviews*** consisting of the conduct for ***focus groups*** and similar other methods.

Focus groups

A focus group is an entirely qualitative data collecting approach that entails group interviews. A group of individuals with similar interests or traits gathers in an organised setting to present their perspectives and thoughts on a discussion agenda (Qu & Dumay, 2013). It must function as a facilitator to guide the group discussion, regulate the process, and guarantee that all participants have an equal opportunity to express their opinions.

The focus group was deemed inferior for the current study because the potential of organising a location and asking a group of people to engage in a group discussion with a subjective character of the issue was scarce. Moreover, focus groups, when compared to individual interviews, are less effective in covering a specific problem in depth. One downside of a focus group is that participants may not communicate their honest and genuine ideas regarding the issue at hand. They may be cautious to share their opinions, especially if their opinions differ from those of another participant.

Case study

A case study is useful when the need is to inquire about a phenomenon in its real-life context, particularly when the boundaries between the research phenomenon and the problem are unclear**.** The versatility related to the method is described in applying the respective method along with its analysis for both the complex and simple subjects. One of the benefits of using this method can be its judicious use through the combination of collecting qualitative data for drawing proper inferences.

The research also found the case study method unsuitable for the present research. One of the main drawbacks to use this method was that the data collected cannot necessarily be generalised to the wider population. This leads to data being collected over longitudinal case studies not always being relevant or particularly useful. Additionally, every resource has an unconscious bias that shapes their actions and decisions. Because of its emphasis on collecting facts, the case study approach may find outliers that counter a hypothesis rather quickly, but it is up to the researchers to select

what material qualifies for this distinction. If the case study approach yields unexpected results or contradicts the opinions of those who participated, there is still a chance that the information will be inaccurate.

Action research

As stated by Windsong (2018), ***action research*** is also renowned as ***participatory action research. T***he ***reflective process for progressive problem solving*** is led by people who work with other groups as part of a ***"community of practice".*** This helps in improving the process of addressing any issue along with solving the problems as well. The main steps associated with the action research process of data collection are concerned with the ***identification of a specific topic*** for studying; ***gathering data*** that are related to the respective study; ***interpreting and analysing*** the gathered data and ***executing the action plan*** that represents the ***application*** of the ***results*** for ***action research***.

Content analysis was also determined inappropriate for this study because of the constraint of published materials. In addition, it does not deliver any space to interact with the research subjects to probe and cross-question them about the current situation.

Interview

It is the most common method of forgathering data for ***qualitative research*** due to its approach. In this method, the interviewer tends to collect the data immediately from the participants on a ***one-to-one basis***. The process of the interview can be either ***formal or unstructured conversation***. It comprises questions that are mostly ***open-ended*** with an impulsive answer from the interviewee.

3.9.5 Justification for the Choice of the Qualitative Data Collection Method

For the current study, the interview method's application has been considered appropriate to collect qualitative data. According to Teut (2020), this can enable the researcher to use structured and unstructured interviews, where structured interviews seem comparable to a questionnaire consisting of similar questions for a similar order composed of multiple-choice answers. It implies that the use of semi-structured interviews was followed to collect qualitative data.

Using the respective method for collecting data allows in maintaining an accurate screening due to face-to-face interviews and can also enable the researcher to capture both non-verbal and verbal cues. It helps maintain focus for the participants, and behaviours and emotions can also be observed and captured for the present study. However, the cost is considered a major limitation for conducting interviews as personnel costs are required. On the other hand, administering the interview also opts for entering the data manually or creating an audio-visual interview process, increasing the project cost. Most importantly, it tends to limit the sample size of the participants as interviews cannot be conducted for a larger sample size.

Table 3.5 Plan for data collection in mixed research

Quantitative Method				
Strategy	***Instruments***	***Participants***	***Sampling***	***Sample size***
Survey Questionnaires Online and offline surveys	Close-ended questions	Dairy entrepreneurs and suppliers in Pakistan	Probability or random process of sampling	100 participants
Qualitative Method				
Strategy	***Instruments***	***Participants***	***Sampling***	***Sample size***
Interviews	Open-ended questions Structured interviews	The target audience are the owners of rural small and medium-sized dairy organizations and research scholars of dairy industry.	Non-probability or non-random process of sampling	8 participants

Source: (Developed by the researcher)

3.9.6 Qualitative Data Analysis

The type of analysis for qualitative study was crucial to plan. Here, the researcher examined the themes, which is called thematic analysis (Benner, 1985; Leininger, 1985; Taylor & Bogdan, 1984) because there is a lack of sufficient literature for this research approach in Pakistan. Although the process for doing thematic analysis has not comprehensive literature background, the researcher has carefully followed Braun and Clarke's directions (2006). The researcher collected the narratives of participants through semi-structured interviews. The researcher created the codes and themes from IQs, the most frequent method of qualitative technique (Chenail, 1995). The themes and codes were generated using MAXQDA, which is a qualitative data analysis software. The thematic analysis looks for discernible themes which arise from participants' answers or narrations from participants.

Table 3.6 Steps Involved in Thematic Analysis

Phase	Description
1. Becoming familiar with data.	The interviews were transcribed. Reading and rereading the transcripts is the initial stage in any qualitative study. The data was extracted in an analysable format to familiarise the researcher with the whole body of acquired data.
2.Generating initial codes.	The data was organised in a logical and orderly manner. During the first coding, extensive data was reduced to little chunks of relevance.
3. Searching themes.	The preliminary codes were compiled into probable patterns (themes) that convey something significant about the study topics.
4. Reviewing themes.	The identified themes were evaluated and adjusted such that they made sense and were closely connected to the initial codes and research questions.
5. Defining themes.	The identified themes were interpreted, and subtopics were investigated to see how they connect with the primary themes.

3.10 Population and Sampling

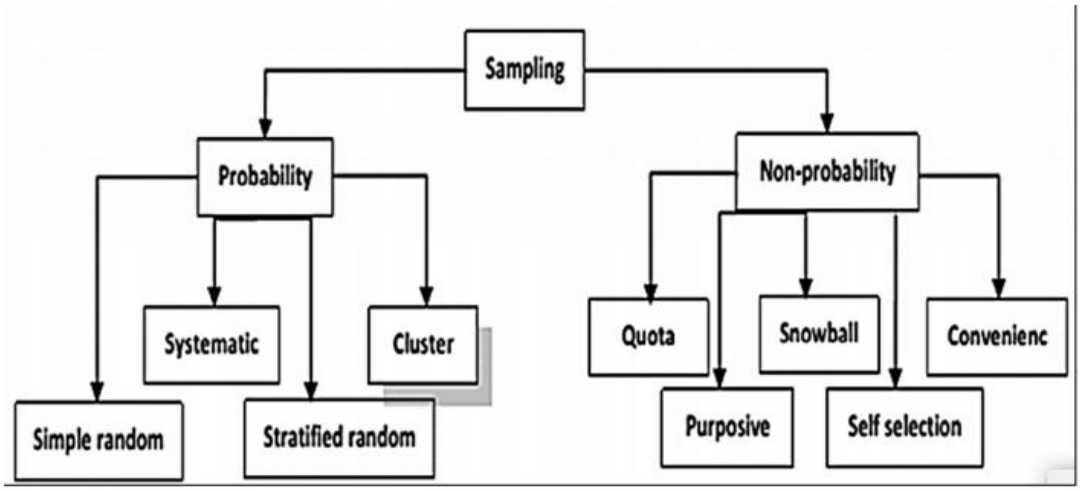
As put forward by Hussaini *et al.* (2019), a population is the complete set based on individuals through specialized characteristics. On the other hand, a sample is the subset of that population. Hence, population and sampling seem to be the process for taking a subset based on the participants who are representatives of the total population. The population of the present study are the

entrepreneurs and suppliers from Pakistan dairy industry. The sample for the research needs to comprise of adequate size to ***warrant the statistical analysis***. Sampling techniques can be categorized into two types such as ***probability sampling and non-probability sampling***. These are also considered ***random sampling and non-random sampling techniques***.

Non-probability sampling: The sampling technique is concerned with the members based on a population that does not have a similar chance of being selected. It may not be safe to assume the sample representing the target population (Ghosh and Guchhait, 2020). In this case, it considers the possibility of the researchers deliberately choosing the people who can participate in the respective research.

Probability sampling: In this respective sampling technique, every individual within the entire population consists of an equal chance of being selected as the respective subject of the research. The method is known to guarantee the process of selection, which has been completely randomized without any biases.

Figure 3.3 Sampling Techniques



Thus, for the present study, the use of ***both probability and non-probability sampling techniques*** have been appropriate. ***Probability sampling*** is considered for the quantitative method of data collection for conducting survey questionnaires. On the other hand, ***non-probability sampling*** has

been considered for the interview process in qualitative research. In qualitative research, purposeful sampling is commonly employed to identify and choose information-rich instances linked to the phenomena of interest. Although there are several deliberate sampling techniques, criteria sampling appears to be the most often employed in implementation research (Palinkans et, al., 2015) In the qualitative portion of the present study purposive sampling (which is a type of probability sampling) is used to collect the qualitative data through interviews. According to Palinkans., (2015) purposive or judgmental sampling gives more insights of research problem, and the participants have the clear knowledge about what they are being asked.

Furthermore, maximal variation sampling, in which individuals were chosen to have a varied viewpoint on core phenomena (Creswell & Clark, 2011; Flick, 2009), was used to generate a high-quality study that yielded multiple perspectives from participants on the same issue. This was accomplished by selecting individuals with diverse origins, occupations, education levels, business location, business size, cattle type and so on. Furthermore, the length of time spent carrying out dairy business provided an insight of their thoughts on procedures and operations. Furthermore, participants in the qualitative phase differed from those in the quantitative study in order to have additional perspectives (Creswell & Clark, 2011; Creswell, 2014). Hence, the sample size is known to be 100 participants for dairy entrepreneurs and Pakistan's suppliers. However, 8 participants are considered for being the target audience for rural small and medium-sized dairy companies and research scholars from dairy sector.

3.11 Ethical Considerations

Ethical considerations are specified as the most significant parts of the respective research. It considers the accumulation of principles and values which addresses the questions for whatever is right and wrong. According to Locher and Bolander (2019), this also makes a difference in the research's good and bad. Different ethical considerations for the present research have been mentioned below:

Informed consent: This is referred to as the major ethical issue while conducting the research. It means that an individual voluntarily as well as intelligently manifests the way for providing their consent. The present researcher ensures information about the overall research to the participants and the purpose for conducting the research.

Confidentiality: The issue based on anonymity and confidentiality has been closely connected through the beneficence rights and the respect for fidelity and dignity (Navalta*et al.*, 2019). Thus, in this research, it has been ensured about maintaining confidentiality for the data that has been collected through the participants. It is concerned with the management of private information for protecting the identity of the subject.

Approval: This typically ensures to take the participants' approval before researching and take permission from them and the organizations where the research needs to be conducted. It requires us to disclose the purpose and importance related to the respective study.

3.12 Summary

To summarize for the present chapter has highlighted the process and techniques that have been used for conducting the present research. The method outline for the respective chapter has described the use of every methodological approach that needs to be addressed. Significance for each of the layers composed by the research onion has been highlighted in the above discussion. However, proper explanations about research philosophy, approach and design have been emphasized in the present chapter, along with the justification for each aspect. Alternatively, both the use of the research strategy and research method has been mentioned highlighting each of the methods concerned with the research. Significance based on data collection techniques has also been evaluated in the above chapter with a special focus upon the use of mixed research methods that have been concerned with both primary and secondary research methods. Nevertheless, the sample size for the present research has also been discussed for interviews and surveys, along with the ethical considerations that need to be maintained while conducting the present research study. Hence, this chapter can lead to critically evaluate the ***validity and reliability*** of the study.

4. CHAPTER 4

FINDINGS AND DATA ANALYSIS

4.1 Introduction to the Chapter

This Chapter presents the findings from the gathered data, analyses the data collected and covers the results of this data collected from respondents. This section logically organizes the data. The main data source for this research was collected data from survey questionnaires (quantitative) and interviews (qualitative data). Data was edited for accuracy and completeness, after which analysis was performed using the Microsoft Excel Version 2020 and SPSS 20. Data were coded, followed by data entry, and subsequently, appropriate statistical tests were run that made it possible to have the results presented in tables and charts.

The researcher did data analysis in two parts: the first part pertains to quantitative data analysis, while the second part contains the qualitative analysis of respondents' answers to the interview questions. The quantitative data were analysed using the Microsoft Excel Version 2020 and Statistical Package for Social Science (SPSS) Version 25. The researcher used Cronbach's alpha to assess the reliability of qualitative data. The KMO test and Bartlett's Test (KMO) measure Sampling Adequacy (MSA) and Bartlett's Test of Sphericity determine content validity) were ran to assess the validity of quantitative data. For qualitative data analysis, the researcher chose the thematic analysis approach. MAXQDA was used to generate the relevant themes and codes from the interview transcripts.

4.2 Quantitative Analysis

The researcher performed the quantitative analysis to answer the first (RQ1) and research question (RQ2). The data was analysed in SPSS for pre-test examination (Reliability and Validity. After that, data was analysed in MS Excel to answer the (RQ1 and RQ1). The researcher used Chi Squared Test and descriptive statistics (percentage) to confirm or reject the research hypotheses.

4.2.1 Reliability

Validity and reliability of included items in a measure are ensured by test-retest reliability and Cronbach's Alpha. Here the internal reliability was checked by measuring Cronbach's alpha. The composite Cronbach's Alpha of the construct was 0.602 for the 20 items. It exceeds the cut off value of 0.60, as suggested by Nunnally (1978). Hence, the qualitative data collected in this study is reliable for further statistical analyses.

Table 4.1 Cronbach's Alpha

Cronbach's Alpha	N of Items
.602	20

4.2.2 Validity Test

The KMO test and Bartlett's Test were applied in this study. KMO was used to measure Sampling Adequacy (MSA), and Bartlett's Test of Sphericity was run as it determines content validity. Bartlett's test of sphericity indicates the satisfaction in results. Kaisen (1974) recommend 0.5 as a minimum (acceptable), values between 0.7-0.8 as acceptable, and values above 0.9 as perfect. In this study, the value of KMO (0.540) is greater than the threshold value of 0.5. Thus, it is acceptable and shows satisfaction in results. At the same time, the value of Bartlett's Test of Sphericity is significant at 0.000, which is less than 0.5 indicating the suitability of analysis. Table 4.2 shows these values.

Table 4.2 KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.540
Bartlett's Test of Sphericity	Approx. Chi-Square	287.600
	Df	190
	Sig.	.000

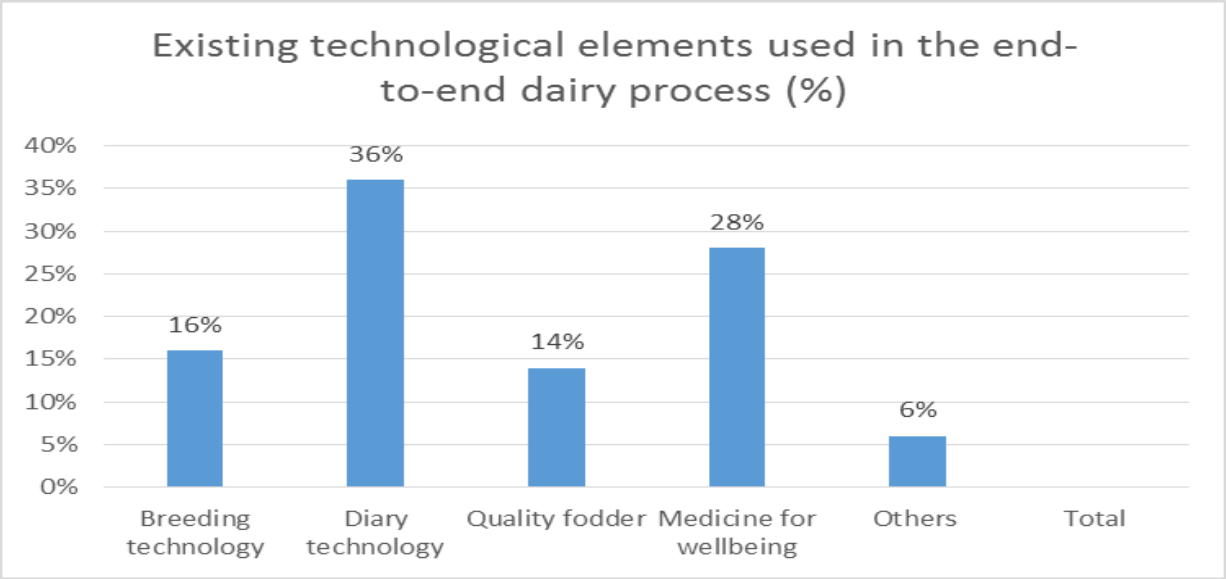
4.2.3 Descriptive Analysis

Q 1. What are the existing technological elements you are using in the end-to-end dairy process?

Table 4.3 Existing technological elements used in the end-to-end dairy process

Options	**Response (%)**	**Response (n)**
Breeding technology	16%	16
Dairy technology	36%	36
Quality fodder	14%	14
Medicine for wellbeing	28%	28
Others	6%	6
Total		100

Figure 4.1 Existing technological elements used in the end-to-end dairy process



Findings:

Most of the participants in the survey (36%) choose 'dairy technology' as the existing technological element used in the end-to-end dairy process. In comparison, 28% emphasise medicine for well-being and 16% on breeding technology. Therefore, different dairy farms and milk processing units use different technologies in the end-to-end dairy process, which is likely to be according to their SMEs business model, the extent of technological know-how and affordability they possess.

Discussions:

The above responses are mixed. The small rural dairy farmers in Pakistan face reality with four thrust areas with a technology perspective: animal well-being, animal breeding (genetic technology), quality fodder, and automation in milking stores and packages. The rural practice is daily milking and daily intake for consumption, short supply chain using traditional dairy technology. The main pillars for technology-centric penetration are dependent on manual work and lack of orientation, education, and knowledge in the dairy sector. The above responses show a non-focused approach impacting the dairy growth to stagnate, as meeting the basic infrastructural support for the animal shelter and upkeep animal health that failed. Dairy technology has progressed within the manual labour predominance and related activities. Neither the technology

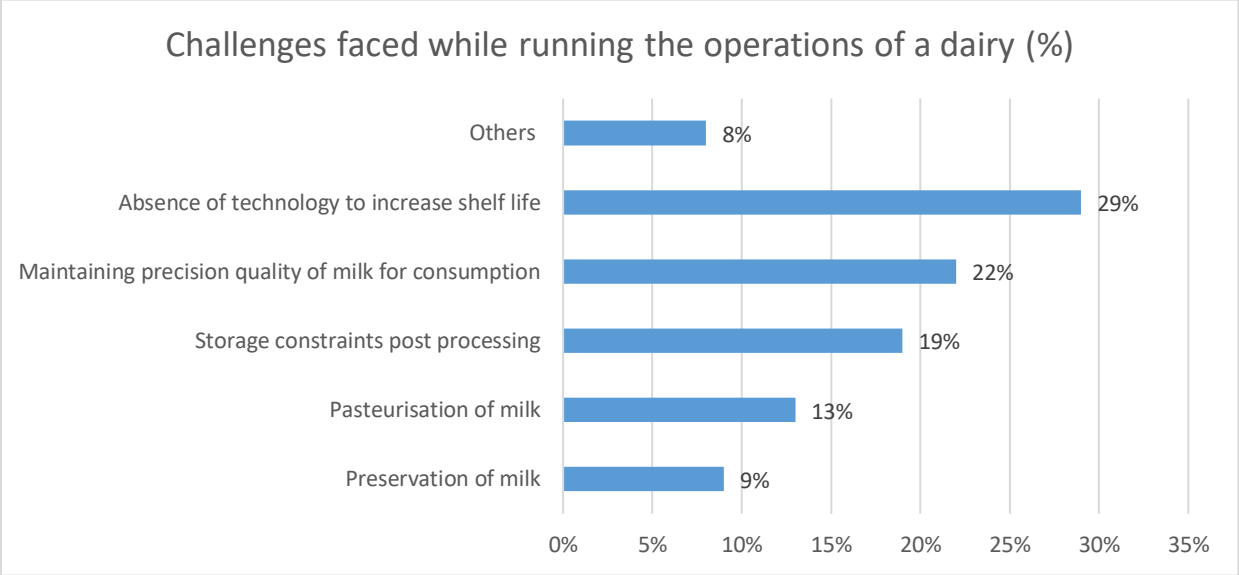
in genetics for selective breeding in Pakistan has been achieved as a headway confirmed by (Younus et al. 2002) research study. The daily feeds for the animals with specialised nutrition are not widely available in rural areas, neither the medicine for animal well-being. The above results are indicating that little progress has been made in terms of technology inclusion for the Pakistan rural dairy sector as SME based initiatives for production processing of raw milk is being explored. However, with lack of improvement in the storage and variety of milk products due to technology absence of rural market but not automated and mechanised which has challenged the development of innovation in the small dairy farmers to enter the business environment of marketability that has been confirmed by (Burki et al. 2004). The farmers reporting the inability to match the industrialised methods in terms of home-grown innovation is a technological deficiency that rural sector dairy farmers in Pakistan are suffering.

Q 2. What are the key challenges you are facing while running the operations of a dairy?

Table 4.4 Key challenges faced while running the operations of a dairy

Options	**Response (%)**	**Response (n)**
Preservation of milk	9%	9
Pasteurisation of milk	13%	13
Storage constraints post-processing	19%	19
Maintaining the precision quality of milk for consumption	22%	22
Absence of technology to increase shelf life	29%	29
Others	8%	8
Total		100

Figure 4.2 Key challenges faced while running the operations of a dairy



Findings:

Varying responses were received regarding the key challenges being faced while running the dairy operations, wherein 29% emphasised the absence of technology to increase shelf life. In comparison, 22% chose to maintain the precision quality of milk for consumption. 19% considered storage constraints post-processing as the main challenge, while for 13%, the key challenge was the process of milk pasteurisation.

Discussions:

The above results show that the post milking stage's activities have technology embedding in the rural sector of Pakistan. Not many respondents stated that dairy technology availability in rural areas could increase raw milk shelf life, deal with milk ingredients (composition), or overcome the storage constraints. These three are the major challenges that rural dairy farmers face that have no concrete solution in terms of technology-centric application that has been confirmed by Rahman (2007) research. The implications show that rural dairy farmers have no provisions to start up as an entrepreneur due to financial blockages in the system, while technology (internal R&D) is too out of reach in the current circumstances for a small dairy farmer as innovation requires knowledge to process as per Rahman (2007). The dairy processing conditions as technology have not been able to add value to milk processing for rural small dairy farmers, leading them towards

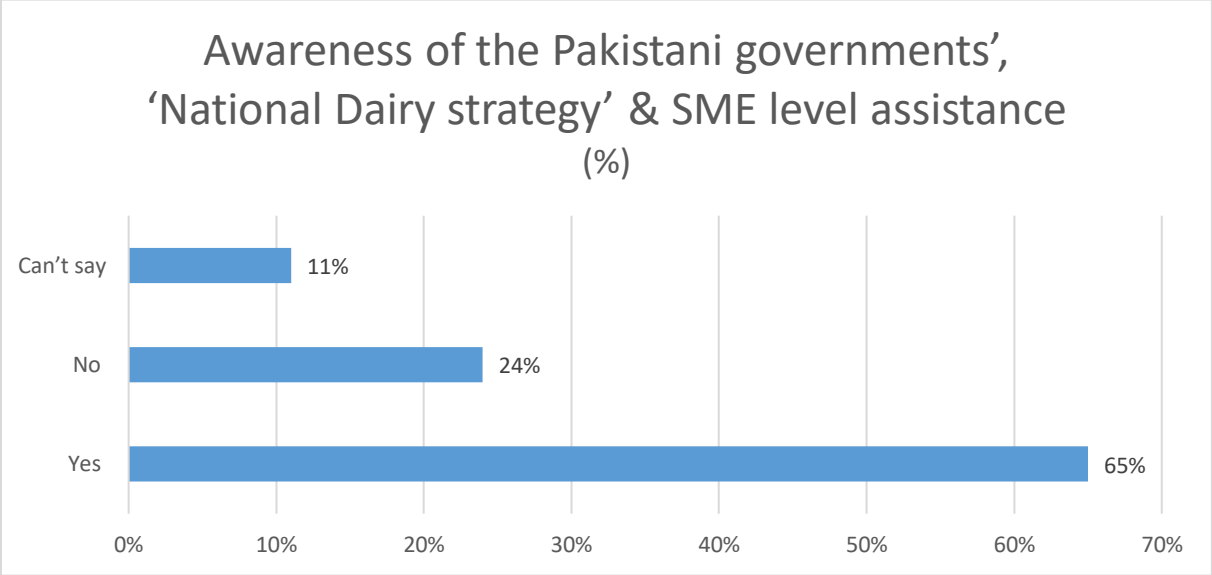
industrialisation (starting with SME small and medium enterprises) post-Independence in Pakistan. Thus, the national-level technology inclusivity in each sector and national innovation embedding has been very rudimentary that has not addressed the rural development for small dairy farmers, echoed by Khan et al. (2015) in a literature review. Compared to the west in the Pakistan dairy sector, the aspect of technology has not been able to make product improvements or process improvements, as the level of innovation requires SME level adaptation to the local milking process. It has failed to address the sector-specific challenges that are evident for dairy, where the investment requirement is huge when technology is required to change existing rural manual methods of milking the animals. Alvarez and Ji (2003) argued that the lack of awareness and exposure of the people engaged in the trade is also a factor in their orientation to avail financing and adopt institutional models through united methods. It confirms elemental, rural, and individual level challenges that are still missing in large rural patches throughout Pakistan in the dairy milk sector.

Q3. Are you aware of the Pakistani governments' 'National Dairy strategy' and SME level assistance to start-up technology inclusive dairy production?

Table 4.5 Awareness of the Pakistani governments', 'National Dairy strategy' & SME level assistance

Options	Response (%)	Response (n)
Yes	65%	65
No	24%	24
Can’t say	11%	11
Total		100

Figure 4.3 Awareness of the Pakistani governments', 'National Dairy strategy' & SME level assistance



Findings:

The majority (65%) shared a positive response about their awareness of the Pakistani governments', 'National Dairy strategy' and SME level assistance to start technology inclusive dairy production. In comparison, 24% did not affirm the question.

Discussions:

Even though it ranks third in milk production globally, the government schemes in the dairy production technology that addresses the future strategies announced in 2007 have not shown results. The model of growth to aid the small dairy farmers to scale up towards SME has failed due to the carefree attitude of the Pakistan government, centralised power against the much-needed decentralised approach for rural thrust in dairy industry growth. It also missed the allocation of funds for a cash cow sector, capable of driving Pakistan GDP higher with the evolving lifestyle needs of Pakistan urban population ready for consuming packaged milk and a variety of milk products. The current businesses in rural, urban, and peri-urban are privately held is therefore not able to meet the demand (aggregate) as localisation of technology at SME level failed to take up and procure raw milk production processing to be packaged for a higher level of market acceptance in urban cities of Pakistan. The above responses show that awareness about the scheme and policy from the dairy farmers exists. The daily manual operations and raw milk finding its way to the

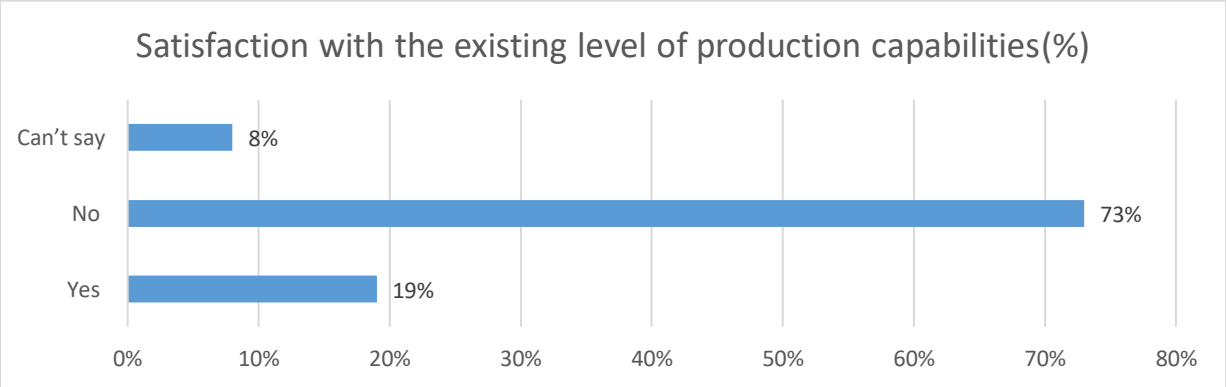
local markets are part of the operations. However, a national-level strategy and its impact are not felt by the dairy farmers. There is no visible infrastructure support, financing support that substantiates the policy framework to be a reality. Even though Pathan et al. (2017) in the literature review raised the issue, pan Pakistan rural areas are affected by a lack of information at the central and provincial government. It shows how the small dairy farmers with livestock as an asset is dependent on the Pakistan government sector-specific investment budget, which counters Subhan et al. (2014) argument of home-based innovation rate to be too low against the state-sponsored R&D external in nature distributed to wider locations to spreadhead innovation level as discussed in (Munari et al. 2010). It is a high-level strategy requiring the central authorities to direct local, provincial authorities to assist the policy-based actions in benefiting the dairy farmers develop 'absorptive capacity' or adopt transitory R & R&D as per Bougheas (2004) Pakistan national territory.

Q4. Does existing rural milk production technology in the Pakistan dairy market can meet market-based demand-supply requirements?

Table 4.6 Satisfaction with the existing level of production capabilities

Options	Response (%)	Response (n)
Yes	19%	19
No	73%	73
Can't say	8%	8
Total		100

Figure 4.4 Satisfaction with the existing level of production capabilities



Findings:

As opposed to the previous response, the majority (73%) of the participants shared a negative response expressing their dissatisfaction (lack of satisfaction) with the existing level of production capabilities when the Pakistan dairy demand supply is widening.

Discussions:

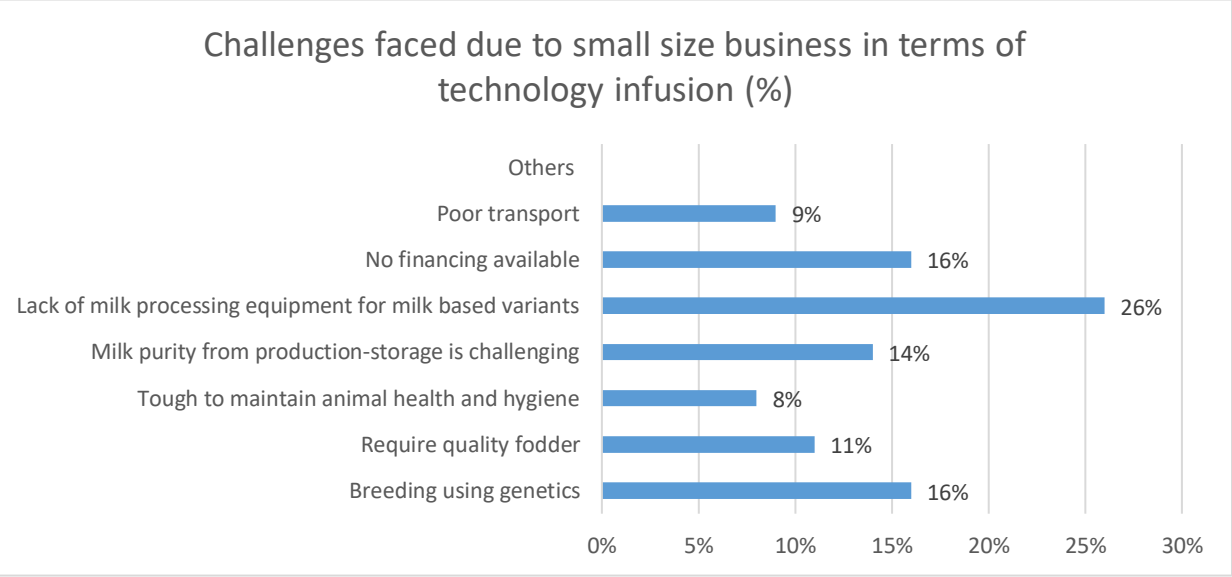
The respondents in rural areas of Pakistan, mostly family held dairy businesses, reflect the satisfaction dissatisfaction equation. It reflects the perception of a specific segment of the population, the dairy farmers who are small and is missing out on the marketability of their daily output due to lack of infrastructure, technology and innovation that is lacking. The rural setup and methods of manual milking, which is a predominant practice in small dairy farmers, has not progressed. It suffers from the lack of efficiency and stresses the effectiveness of resources (hands in the family) used for milking. Hence it is limited to increasing the number of animals in the family-based entrepreneurship, milking manually, storing for a short time till it is sold in the local community, which is already discussed by Ropega (2011) that Pakistan is unable to show over the last seven decades post-independence development. The evident dissatisfaction arises from the small dairy farmers, most of whom are in rural areas detached from urban locations where the conditions in research by (Sarwar et al., 2002) in biological and medicinal, while expenditure documented by Bilal et al. (2006) at the macro level has no policy-based strategic action plans to boost rural milk production volume. Fresh milk cannot find its way to the urban markets for immediate consumption. Neither have they possess the technology of pasteurisation and storing facilities in rural areas to increase the shelf life of raw milk. It is a productivity loss in almost all the small dairy farmers how to possess (2-3), (4-5) animals as they carry on rural entrepreneurship in Pakistan. It also illustrates how the institutional strategy based on national policies has not reached out to the specific target market (dairy sector, small dairy farmers) and address the shortcomings or lay down the future development strategies intended as per policy implementation.

Q5. What challenges are you facing as a milkman with a small business in technology innovation in the dairy sector?

Table 4.7 Challenges faced due to small size business in terms of technology infusion.

Options	Response (%)	Response (n)
Breeding using genetics	16%	16
Require quality fodder	11%	11
Tough to maintain animal health and hygiene	8%	8
Milk purity from production storage is challenging	14%	14
Lack of milk processing equipment for milk-based variants	26%	26
No financing available	16%	16
Poor transport	9%	9
Others		0
Total		100

Figure 4.5 Challenges faced due to small size business in terms of technology infusion



Findings:

The key challenges faced by SME dairy firms in Pakistan due to their small size terms of technology infusion in the dairy sector relate to various aspects as given in the options. The dominant one is the lack of milk processing equipment for milk-based variants, as confirmed by 26%. Other participants consider other challenges as crucial such as breeding using genetics (16%); likewise, lack of financial availability (16%), milk purity from production-storage is challenging (14%), and the absence of quality fodder as depicted by 14%. Therefore, the challenges are varying are affect the operations of different dairy SMEs constraining the extent of technological infusion.

Discussions:

The respondents in the dairy profession stated that the lack of milk processing equipment at the SME (small and medium enterprise) level is one of the key challenges. The manual milking of the animals for fresh milk and the absence of a milk processing plant in rural areas has affected the aggregate growth and development of the small dairy farmers. It is also supported by the fact that there are no easy financing as most dairy processing plants are privately held in Pakistan. The lack of ability as a small dairy farmer has also affected the genetic composition of the herd, as the scope of selective breeding being absent is impacting the future generation of buffalos and cows to be less yielding (milk by volume). Iqbal and Ahmad (2002) study confirmed this, which is still the same that shows an absence of penetration level of innovation (genetic) to benefit common rural livestock farmers in Pakistan. Nazir and Khan (2009) based fodder for livestock is absent, which makes the affordability factor an issue for the small dairy farmers in rural areas, impacting their capability in quality milk production, disease handling capabilities, nutrition for animal health and lifecycle development still a rudimentary process as evident from above. The lack of technology-based health support systems for the livestock is held by various small farmers, impacting the long-term consequence of milk production, milk quality, and animal health in the long run. The small farmers unable to set up dairy at the SME level are suffering to improve the quality of milk purity and storage challenges. The above factors and the response criteria show a lack of structural process to devise a solution that addresses the SME dairy industrialisation in rural Pakistan, which is evident from the lack of transport that corroborates the fact that (Raziq et al., 2010) has researched. There is a lack of government infrastructure provisions that have slowed down the

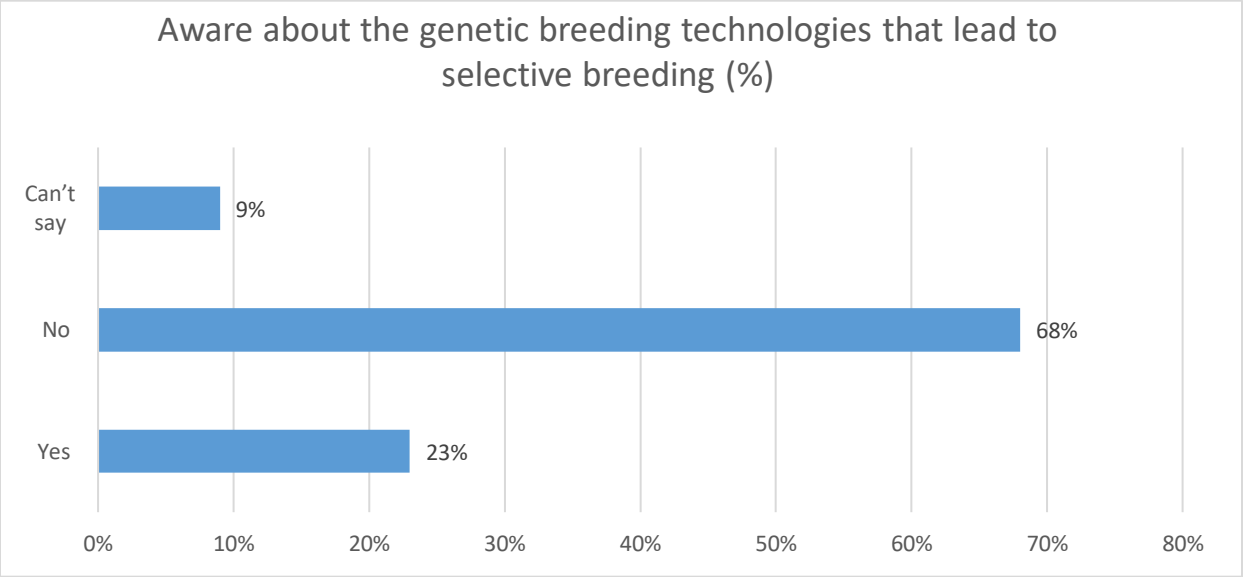
dairy development industrialisation process and have not seen the possibility of converting arid land suitable for grazing pastures for rural animal livestock. SME level development model to suffice the rural dairy sector planning for Pakistan. The above discussion on the factors brings about the dimensions that miss the holistic approach regarding the development of the dairy sector in the context of small dairy farmers of Pakistan. The range of issues facing has made them dissatisfied as there is no viable SME structure to support rural dairy farmer's potential capabilities of raw milk production as documented in (Aziz and SIivia, 2008). They are also facing knowledge-based challenges, barriers in setting up biotechnology-based innovations for their livestock or processing plant at the SME level, which shows that it has missed project planning and scheduling, diversion and channelising the funds to develop small dairy capabilities in Pakistan.

Q6. Are you aware of the genetic breeding technologies that lead to selective breeding for better cattle progeny creation impacting the Pakistan dairy sector future?

Table 4.8 Aware of the genetic breeding technologies that lead to selective breeding

Options	Response (%)	Response (n)
Yes	23%	23
No	68%	68
Can’t say	9%	9
Total		100

Figure 4.6 Aware of the genetic breeding technologies that lead to selective breeding



Findings:

According to the derived response, it was surprising that 68% of the participants are not aware of the genetic breeding technologies that lead to selective breeding for better cattle progeny creation impacting the future of Pakistan's dairy sector. Meanwhile, only 23% indicated their awareness of the fact.

Discussion:

The responses indicate that most of the small dairy farmers of Pakistan are not aware of how to engage generic breeding for selective output of the livestock progeny. The current Pakistan dairy industry is suffering from the fact that lack of medical facilities is impacting the health of the animals. It also impacts the breeding quality and linkages with the total animal population for a given rural area that has been grossly overlooked. However, not everyone has the knowledge that is an opportunity for the government of Pakistan at central and provincial governments to make their awareness about the awareness, and facilities available for vaccination of livestock from Pakistan government as per Iqbal and Ahmad (2002) study. Thus, the knowledge creation to drive the innovation has been not met from policy realisation and implementation. The responses indicate that government level initiatives to bring technology innovation in aiding a sector depends on knowledge dissemination. The knowledge gap has been a key steppingstone towards a policy-

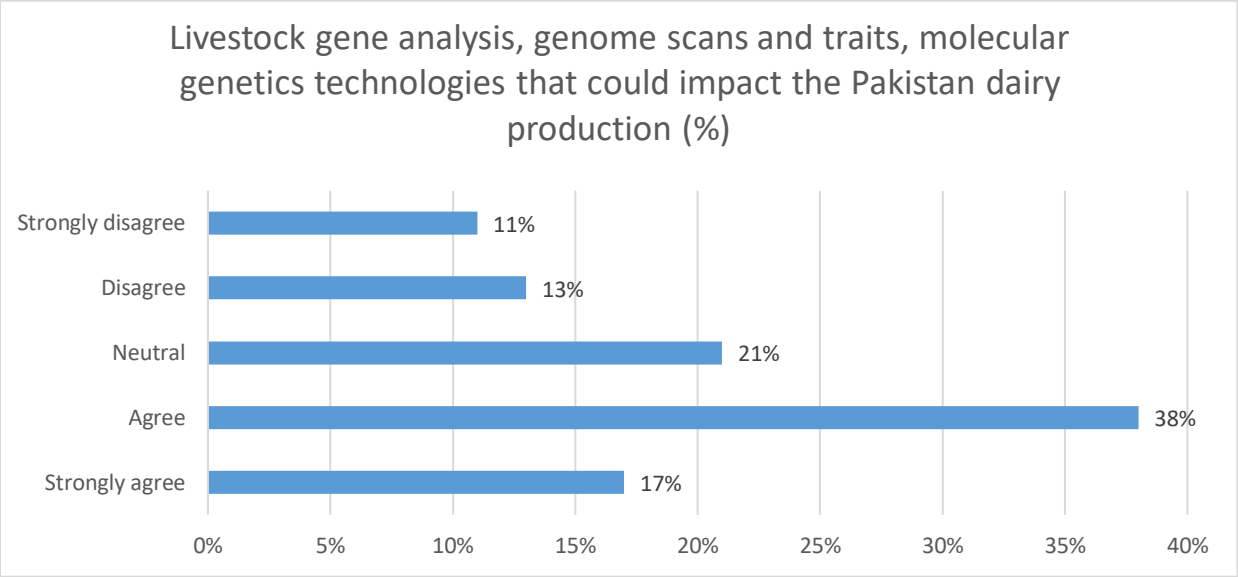
based action plan to plug the central government's targeted goals gap. The government has one gene bank with 25 research labs, not enough to cover the community work of all provinces in Pakistan. It has adopted technology to preserve semen, assisted technology for genetic improvement through 'in vitro fertilisation laboratory' and 'hormone analysis', all of which is limited to the laboratory setting. The widespread rural community training on techniques (scientific) for artificial insemination through polytechnic institutions leading to reproductive efficiency is limited to urban areas. Thus, failing the strategy of deep penetration of strategy in pan Pakistan rural areas to disseminate state of the art reproductive technology of food animals has failed its mission reflects the study of Sarwar et al. (2002) that proves development rate in bringing structural changes is still a developmental lacuna. Though laboratory technology has been perfected, its implementation requires infrastructure requirements at the rural site, which is not set up in a rural perspective. It implies a closed innovation model that requires adopting an open innovation model, as Iqbal and Ahmad (2002) researched. It also shows the lack of institutional failure, political willingness in terms of linkages to share technology diffusion at a mass level that has not benefitted, rural small dairy farmers.

Q7. The livestock gene analysis, genome scans and traits, molecular genetics technologies would impact the Pakistan dairy livestock production to be strategic for the future?

Table 4.9 Livestock gene analysis, genome scans and traits, molecular genetics technologies that could impact the Pakistan dairy production

Options	Response (%)	Response (n)
Strongly agree	17%	17
Agree	38%	38
Neutral	21%	21
Disagree	13%	13
Strongly disagree	11%	11
Total		100

Figure 4.7 Livestock gene analysis, genome scans and traits, molecular genetics technologies that could impact the Pakistan dairy production



Findings:

The above results indicate that 55% (17% strongly agree + 38% agree) that livestock gene analysis, genome scans and traits, molecular genetics technologies would impact Pakistan dairy production in future. Contrary to this, a smaller percentage, 26% (13% disagree + 11% strongly disagree), shared a negative response.

Discussions:

It is a missed opportunity for the Pakistan government as this issue is more strategic and related to improve the aggregate animal (cow, buffalo) health in Pakistan. The dairy industry adversely impacts animal health, which reflects in lower milk production over the years for any Pakistan small dairy farmer. Genetic breeding is a national issue that is likely to impact the productivity of the dairy sector animals and the sustenance of the small dairy farmers in Pakistan in future that has support from Afzal and Naqvi (2004) for a muted action plan. Also, Hasnain and Usmani (2006) have a missed opportunity for genetic breeding as female buffalos are slaughtered. The mixed responses show that Pakistan scientific research and technology can be brought into a constructive process to address the dairy sector needs, especially for the small dairy farmers in Pakistan. Genetic technologies are a competitive advantage for the dairy sect, especially to make future animal

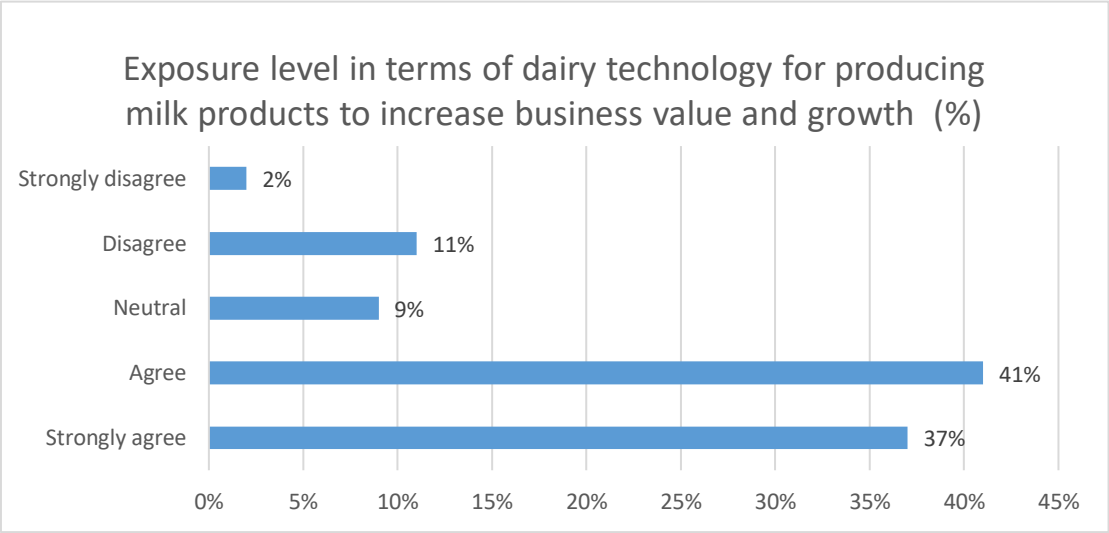
species requiring a fundamental change to build genetic profiles resistant to diseases and low milk production. Hence, national innovation led by technology in the genetic domain can program animal breeding to have a selective approach. The 'Lumbardari' scheme in key areas of high milk production is missing Afzal and Naqvi (2004) research and even now. However, people who have limited knowledge and partial knowledge have mixed responses that show that small dairy farmers are not aware of the benefits of the whole programme, which can be beneficial for small dairy farmers missed in pan Pakistan rural areas. The variation in the knowledge about genetics impacting the breed of animals is uneven due to lack of exposure to appropriate institutions in Pakistan or media sources that otherwise have failed the entire livestock capabilities for future quality milk production for the nation.

Q8. Knowledge exposure level in terms of dairy technology for producing milk products would increase your business value, growth, and direction?

Table 4.10 Exposure level in terms of dairy technology

Options	Response (%)	Response (n)
Strongly agree	37%	37
Agree	41%	41
Neutral	9%	9
Disagree	11%	11
Strongly disagree	2%	2
Total		100

Figure 4.8 Exposure level in terms of dairy technology for producing milk products to increase business value and growth



Findings:

Whether the exposure level in terms of dairy technology for producing milk products would increase the business value, growth and direction, a major section of the sample,78% (37% strongly agree + 41% agree), shared a positive response. On the other hand, only 13% (11% disagree + 2% strongly disagree) shared a negative response.

Discussions:

The dairy technology in Pakistan has been not comprehensively facilitated by national-level policies, which has not focussed on geographic distribution, leading to development to concentrate on few private enterprises. The issue is important from an SME perspective and setting up industrial level milk processing capabilities, with Pasteurisation technology that impacts raw milk's shelf life against the existing practices. Automated milking process against the hand based manual milking processing is also an efficient method to gather faster raw milk. The absence of technology has also led to keeping open the risks of milk contamination intensity, probability of adulteration frequency very high in the food supply chain, making the higher consumption demand lev subject to be unfit. Knowledge has been a key source for technology and innovation to disseminate through the network of people engaged directly and indirectly in the business. The source of knowledge that is technology-related in dairy products, dairy processing using

'Pasteurisation' depends on the Pakistan government institutional facilities and support. At the same time, it has media communication that has led to the spread of news. Muhammad (2014) research highlighted the same as 'National Breeding policy' cross breeding facilities, the laboratories, and technology to be disseminated to rural level dairies is established. Muhammad et al. (2014) research in the literature review proves milk cooling storage tanks in 150 places exists. However, it is minuscule compared to the pan Pakistan rural dairy firms at the home level. It failed to be spread in actual development figures in a higher number of provinces or rural pockets. It neither showed the policy-based support for open from the centralised closed innovation model adopted by the Pakistan government, leading to a greater level of adaptation of technology to drive the localised solutions in small dairy farming. Technology application is a step to inch towards industrialised dairy practices. Shunning manual methods where defined process of milk pasteurisation and milk packaging is an important step towards fulfilling consumer demand for hygienically processed milk. However, the responses indicate that majority of the Pakistan small dairy farmers have expressed their opinion about the technology factor in dairy linking the elemental knowledge that can bring in more innovation (efficiency and effectiveness) for the manual effort put in daily. The respondents acknowledge that knowledge accumulation from diverse sources is necessary to support the formation of a decision and the setting up of a credible goal. The responses indicated that the literacy factor in the domain of dairy business is essential, and the absence of it for most small dairy farmers in the rural belt has been drastic for development.

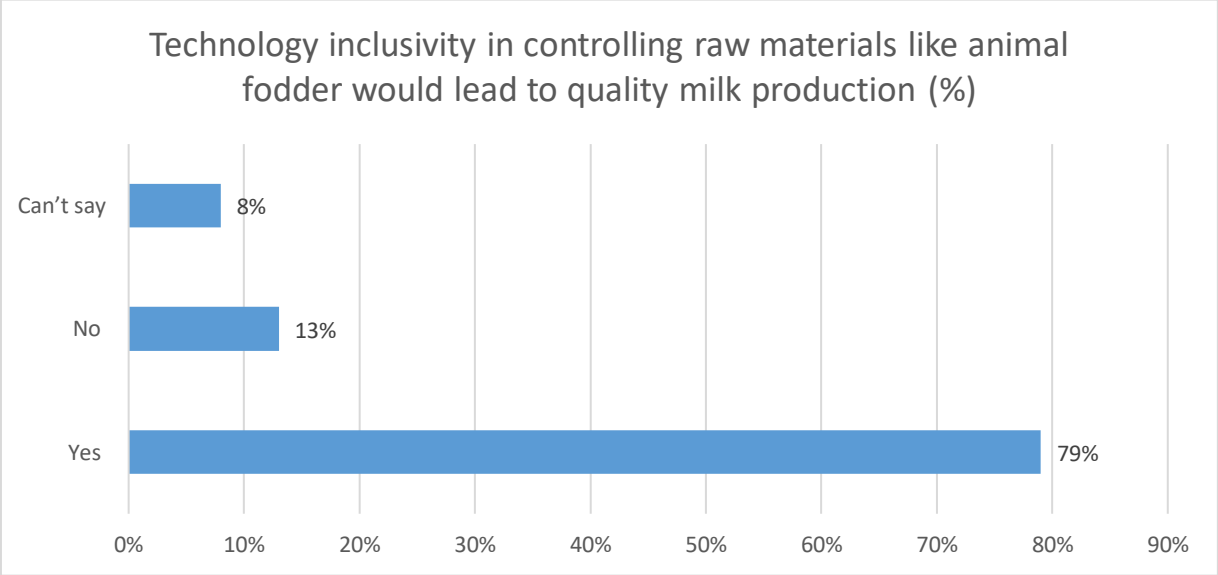
In contrast, the government has been hesitant on conceptualising an absorptive knowledge model. The result also indicates that knowledge is a value add for the small dairy to get a direction towards the future. Still, lack of exposure acted as a barrier for the Pakistan dairy industry to become more mature in its lifecycle curve.

Q9. Do you feel that technology inclusivity in controlling quality in animal fodder would lead to quality milk production per FAO standards?

Table 4.11 Technology inclusivity in controlling raw materials like animal fodder would lead to quality milk production

Options	Response (%)	Response (n)
Yes	79%	79
No	13%	13
Can't say	8%	8
Total		100

Figure 4.9 Technology inclusivity in controlling raw materials like animal fodder would lead to quality milk production



Findings:

A majority, 79%, shared a positive view that technology inclusivity in controlling raw materials like animal fodder would lead to quality milk production; however, a very small percentage, 8%, did not feel that technology inclusivity in controlling raw materials animal fodder would lead to quality milk production.

Discussion:

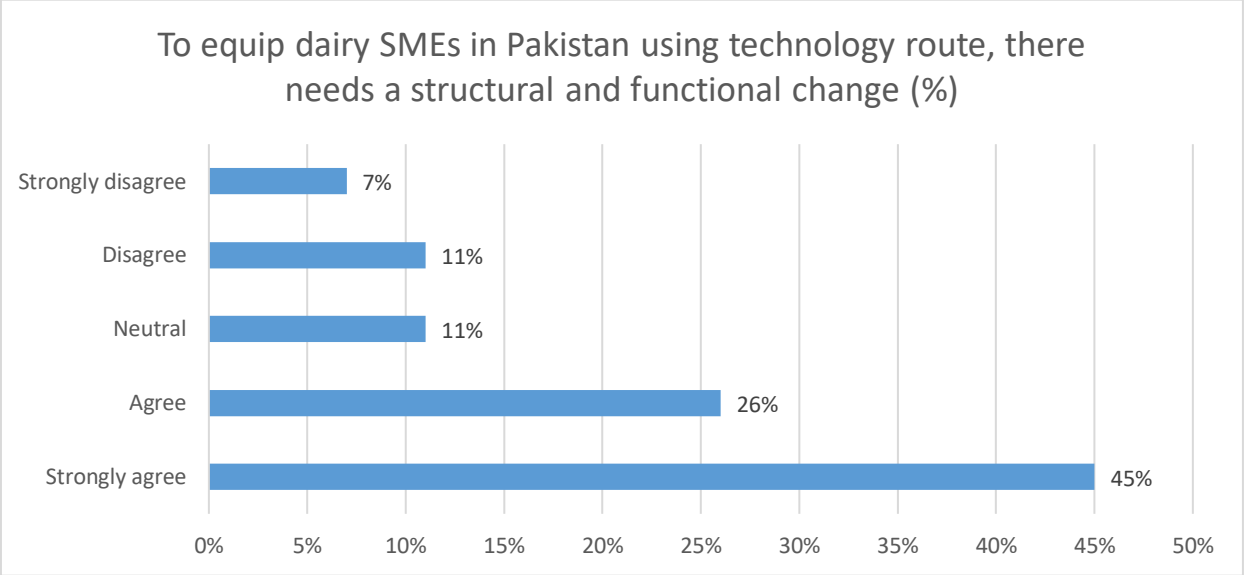
The small dairy farmer understands the criticality of quality fodder for the livestock animals. The response indicated that most of them support quality fodder, as rationality impacts animal well-being (health), milk productivity (volume), and output parameters. However, the awareness of the small dairy farmer towards fodder for their animals shows that they understand the criticality of quality fodder which impacts animal health and milk productivity. The poor farmers know fodder for animals, eliminating the need for grazing in-ground, improving the productivity in milk production. However, they feel that technology is one of the key drivers for improving animal food quality, which is the core issue in delivering quality input factors. The non-availability of technology to produce local fodder for the buffalos and cows is evident. It requires a large-scale industry to mix the ideal composition for preparing animal premix fodder. It is evident from the Bulla et al. (1977) research (Hanjra et al., 1995). As per FAO standards, fodder is scientific as it has all essential food ingredients, which make it ideal for animal health and milk production in the long term. The lack of technology and lack of SME based industrialisation has not ushered commercial production of fodder for animals in the Pakistan rural areas. Compared to developed nations like Australia and New Zealand, it is an important aspect of providing nutrition due to the arid region. However, Sarwar et al. (2002) reported that conventional feeding practices are still prevalent in the research. Therefore, the rural farmers did not show a cluster-based united cooperative to fuel enterprise-level initiatives for local procurement of the food nutrient supplies. It has not got technology-based help from the government as the fodder of advance grade production is limited to private firms. On the contrary, the Pakistan rural farmers do not have production facilities or innovation capacities for fodder production at a local rural level, a cavity in the entire system. The lack of SME level innovation in manufacturing animal fodder in the rural sector is a gap in Pakistan that impacts the long-term animal health and milk production capabilities.

Q10. Do you believe that to start SMEs dairy in Pakistan requires technology equipment that impacts both structural and functional change in activities?

Table 4.12 To equip dairy SMEs in Pakistan using the technology route, there needs a structural and functional change

Options	Response (%)	Response (n)
Strongly agree	45%	45
Agree	26%	26
Neutral	11%	11
Disagree	11%	11
Strongly disagree	7%	7
Total		100

Figure 4.10 To equip dairy SMEs in Pakistan using the technology route, there needs a structural and functional change



Findings:

A major section of the participants in the survey, 71% (45% strongly agree + 26% agree), shared an affirmative response that to equip dairy SMEs in Pakistan using technology route, there needs

to be a structural and functional change in macro and micro elements in the socio-economic level in Pakistan. As opposed to this response, 11% disagree and 7% strongly disagree.

Discussion:

The SME is a small-scale industry that sets up a new method of mechanical or automatic provisions of the task done manually earlier. The inclusivity of SME equipment in the dairy sector requires financial support and, most importantly, the ability to adapt to rural farmer requirements to process the small volume of raw milk (2-3) (4-5) from the cows or buffalos. However, the manual milking method adopted by the rural small dairy farmers has no technology and uses the hand-based milking method, age-old practice. The above responses show that they are aware that technology imparts efficiency and effectiveness in any process that holds for the milk production domain. The problem of the rural sector in Pakistan not being able to scale up to SME level for dairy milk production is dependent on two factors – technology and innovation. The lack of both has led to a profound impact on the small dairy farmer production in the rural areas as it uses traditional folklore and beliefs to process milk.

Conversely, it also reflects a lack of direction and development in the SME industrialisation perspective that the dairy sector in Pakistan has been deprived of during successive government rule. It is evident that the nation has lacked in constituting a low scale dairy technology setup fit for SME, or home-based dairy setup as Alvarez and Ji (2003) research warranted the technology to be used to exploit time, cost-based efficiency. The bargaining power of the rural farmers from the Pakistan government has been limited as local economic impetus is an issue. It is beyond the control of the power of small farmers who have limited economic capabilities, which is why technology has not found a place in daily dairy activities like milking, storing milk or produce by-products in the rural countryside. The negative responses show that some rural farmers believed that they do not need sophisticated automation in milk production technology but require knowledge to fit for SME level (low level) consumption-based technology. The localisation of technology and knowledge has not happened in the Pakistan rural areas, leading to a lack of technology in animal breeding, milk production plant, animal fodder, medicines areas. The viability of commercial production in the rural setting for the farmers is not possible. Rahman (2007) research highlighted in literature reviews supports that the issue of the fragmented location of the small dairies has posed to be a problem for Pakistan, which is why the SME based model is

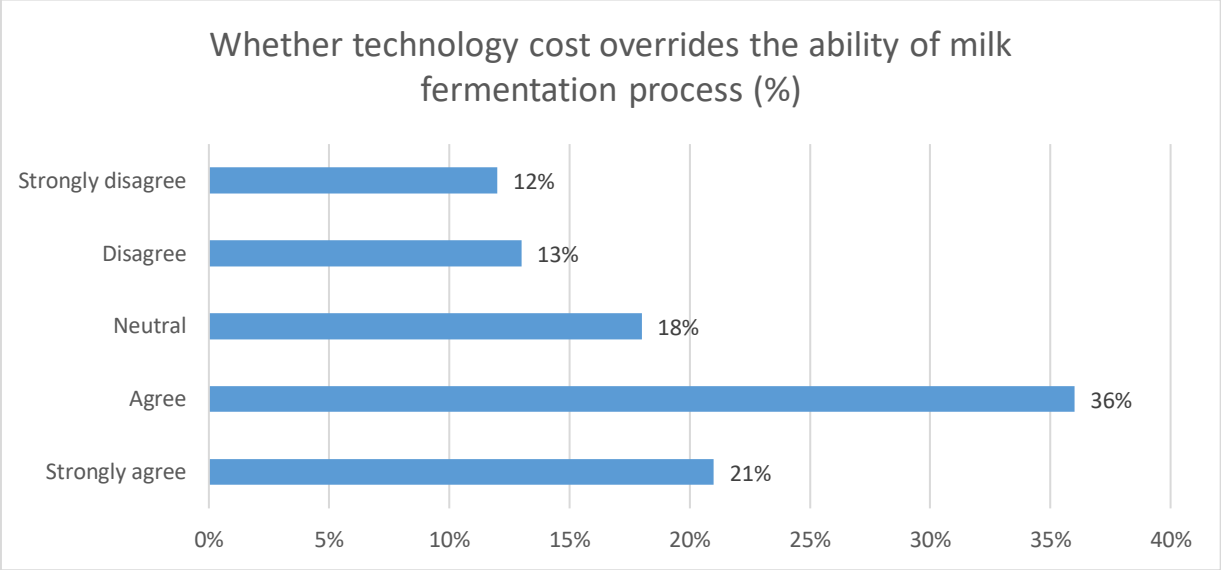
rural Pakistan has feasibility but failed to initiate technology-based implementation to cover a wide area. The inclusivity of technology and innovation in the rural sector in dairy has had limited development and success, which has failed to address the surplus milk production in Pakistan rural areas forced to be wasted. When applied in the Pakistan rural sector, the self-sufficiency economy theory has failed to achieve local level sustainability, as bio security measures and developing an ecosystem in rural dairy requires technology and innovation to adapt to rural conditions, which is a tailor-made solution (against the standard technology equipment).

Q 11. Do you believe that technology cost overrides milk processing, storage, fermentation process, acts as a value function for the end-user (fit for consumption)?

Table 4.13 Whether technology cost overrides the ability of the milk fermentation process.

Options	**Response (%)**	**Response (n)**
Strongly agree	21%	21
Agree	36%	36
Neutral	18%	18
Disagree	13%	13
Strongly disagree	12%	12
Total		100

Figure 4.11 Whether technology cost overrides the ability of the milk fermentation process



Findings

Regarding whether technology cost overrides the ability of milk fermentation process, milk by-products as a value function for the end-user, the responses were varying in nature. However, 57% (21% strongly agree + 36% agree) shared a positive answer while 25% (13% disagree + 12% strongly disagree) shared a negative response to the idea. It is noteworthy that 18% preferred to remain neutral.

Discussion:

The use of technology and innovation in the dairy milk production and food supply chain is intensive, while the same is absent in rural areas of Pakistan. The fragmented location of the small dairy farmers in the have unique requirements, and local and national constraints have impacted the growth and development of rural dairy farmers in Pakistan. The barriers from the lack of aid in Pakistan, with private players allying/Joint ventures with MNCs, have led this gap to increase over the years. The nature of rural dairy production being scattered throughout the satellite towns around the urban cities in Pakistan has shown the demand. However, the above responses show the infrastructural absence, technological absence, or even the local knowledge not being spread for creativity has led to a lack of localised innovation. The challenge of converting large-scale milk production systems, like QC of raw milk every day as per Spreer (2017), needs technology at pre-

and post-processing stages. Technology and innovation require to be scaled down to rural Pakistan needs at an SME level, which has failed to strategic overtures and policy-making lacunae to address the dairy sector problem. Due to the nil level of dairy innovation, rudimentary technology application in milk processing technology and failure to manage issues in rural area specificity. There are no good farming practices in Pakistan, which shows a lack of FAO adaptation to the local level compliance of SPS. The food security issue of the rural supplying hub to the major Pakistan cities lacked a food supply chain that fails the self-sufficiency theory of economics. The technology in national level biotechnology laboratories in Pakistan and its dissemination of good genes to rural farmers is a failure of capacity building capabilities of good breed of livestock (buffalos, cows). Thus, it is technology and innovation that reduces the cost of a transaction, the volume of effort needed, application of resources in existing production methodologies that has been a failure in infrastructure, processing, creating institutional support connecting rural and urban milk demands. The evidence of cost, time, and quality-based output using technology and innovation, is clear from the examples of the private players in milk processing (Nestle Pakistan). Lado and Yousef (2002) confirmed that the government of Pakistan and it's outlay of finances, policy-based outlook towards the rural dairy sector is inactivity. It is evident from responses that policies have been stiff and slow, making the open innovation model unfit for initiation and adaptation in the rural areas. The small dairy farmers have not progressed from the point of technology inclusiveness. Innovation is limited to the advantage of family labour, missing out on a higher volume of milk production. The perishability of milk is a concern, and technology-based solutions for processing, storing in rural areas requires small scale setups missed in Pakistan.

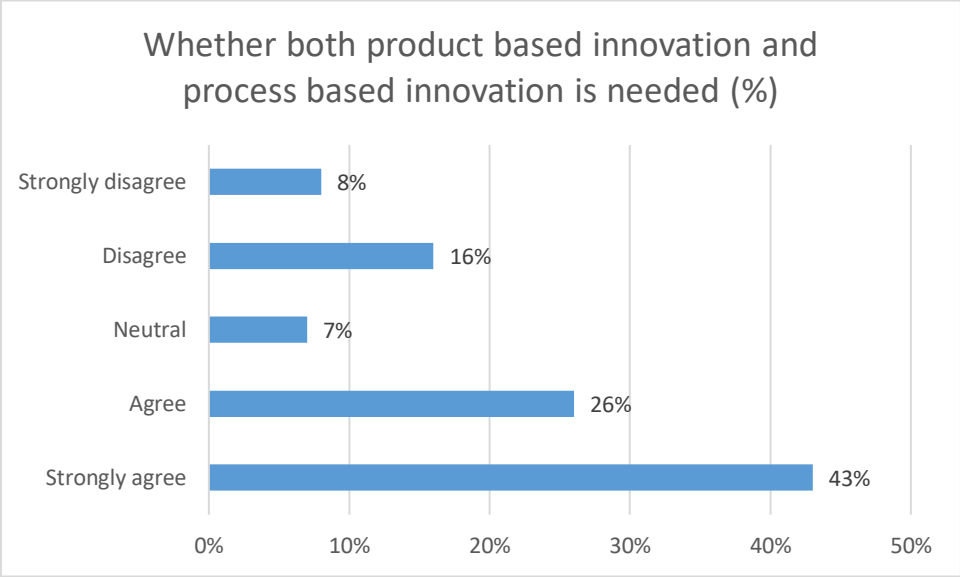
Q 12. Do you believe that both product-based innovation and process-based innovation in dairy technology are needed to meet Pakistan's demand-supply gap?

Table 4.14 Whether both product-based innovation and process-based innovation is needed

Options	Response (%)	Response (n)
Strongly agree	43%	43
Agree	26%	26
Neutral	7%	7
Disagree	16%	16
Strongly disagree	8%	8

Total		100

Figure 4.12 Whether both product-based innovation and process-based innovation is needed



Findings

Regarding the question that both product-based innovation and process-based innovation in dairy technology are needed to meet the demand-supply gap in Pakistan, a significant 69% (43% strongly agree + 26% agree) shared a positive answer. On the other hand, 24% (16% disagree +8% strongly disagree) did not feel that product-based innovation and process-based innovation in dairy technology is needed to meet the demand-supply gap in the country. However, the responses were varying, and all participants were not on the same platform.

Discussions:

The existing issues impacting the rural dairy farmers in Pakistan are the lack of small and medium enterprise milk processing units. As per international standards (FAO guideline) standards, the lack of systems and structure for the rural dairy farmers in producing milk processing capabilities, as per international standards (FAO guideline) standards, is evident. The lack of knowledge and availability of technology on a small scale adversely affects the dairy farmers in Pakistan. Rural milk is not processed due to the absence of technology-based options to produce various milk-based by-products. It is a gap in the capability as the fermentation process of raw milk, which leads

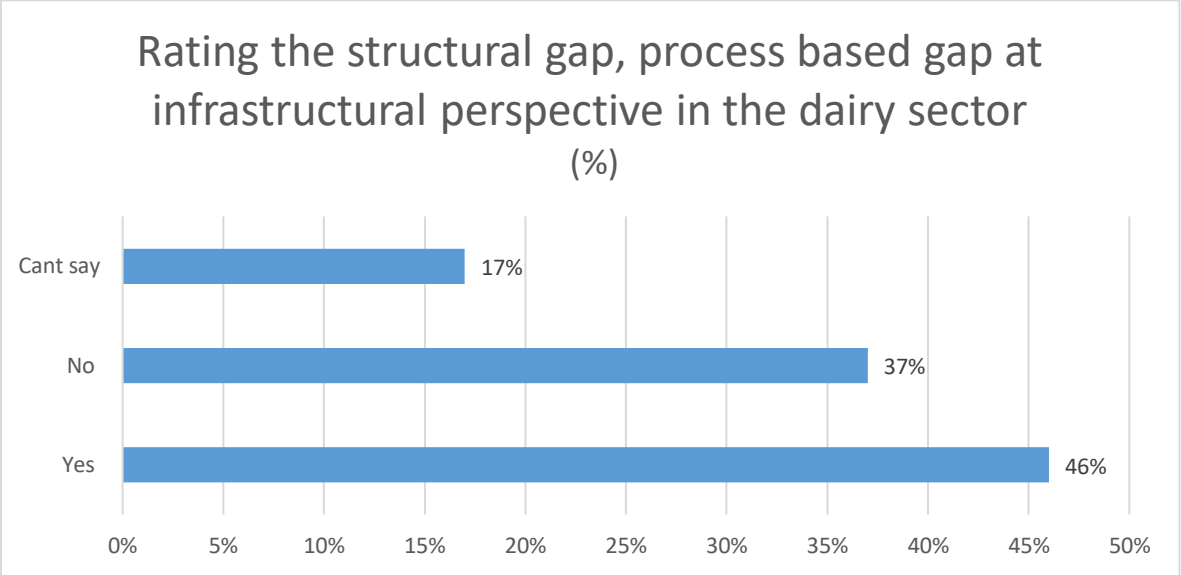
to many other products like yoghurt, cottage cheese, butter, cheese, is missing in the rural small dairy farmers. The possibility of the product, which has a ready market as consumers in urban areas are ready for consumption, is a fact that increases the viability of the milk production laden with technology. The equipment-based approach that involves automated procurement of milking helps the product 'raw milk' be more marketable from rural areas. However, it is a cost and requires knowledge proficiency in managing the dairy plants, which requires to be adapted to low rural volumes at the SME level. The lack of knowledge and technology in the traditional milking process is a key factor that impacts the development and growth of the rural dairy sector. The rural farmers in the dairy sector cannot adopt industrialised practices that are automated, leading to a wide range of milk-based varieties like yoghurt, butter, cheese, cottage cheese, buttermilk, all of which have a ready market acceptance in Pakistan. Oetzel (2007) study in the literature review shows that product innovation at the rural level is needed to assess the market demand before it is commercially produced. For Pakistan rural farmers, daily milk production progressively recording low volumes requires a nutrition-based animal diet that is not available. There is no government-based framework, support infrastructure to contribute to nutrition management, and lactation management for livestock support, which is consumed daily. Hence, it does not allow the rural farmers to market is beyond their locality or store it. The lack of innovation is due to the absence of technology exposure in dairy knowledge at the rural level and the inability of innovation at the national level to scale down the large-scale dairy processing plant to meet the small rural volume of milk production. Alvarez and Ji (2003) research discussed in the literature review on the process-based innovation is also absent as the capability to innovate at the national level is based on the knowledge creation and co-creation by involving rural dairy farmers as a strategy lacking direction. The knowledge is limited to home-based milk preparation and not the mechanised process where multiple milk by-products are possible.

Q 13. After all your experience, do you rate a structural gap, process-based gap at infrastructural perspective in Pakistan dairy sector to drive SME sector growth?

Table 4.15 Rating the structural gap, process-based gap at infrastructural perspective in the dairy sector

Options	Response (%)	Response (n)
Yes	46%	46
No	37%	37
Can't say	17%	17
Total		100

Figure 4.13 Rating the structural gap, process-based gap at infrastructural perspective in the dairy sector



Findings:

A mixed response was received regarding rating a structural gap, the process-based gap at infrastructural perspective in Pakistan dairy sector to assist SME sector involvement, as 46% supported the idea. In comparison, 37% did not confirm the notion.

Discussion:

The institutional approach to resolve the dairy sector issues (of the rural dairy farmers) has been ignored for a long, as private players are serving the entire market. The rural dairy farmers lack economic support, knowledge, and structure. Their dispersed locations make it difficult for milk

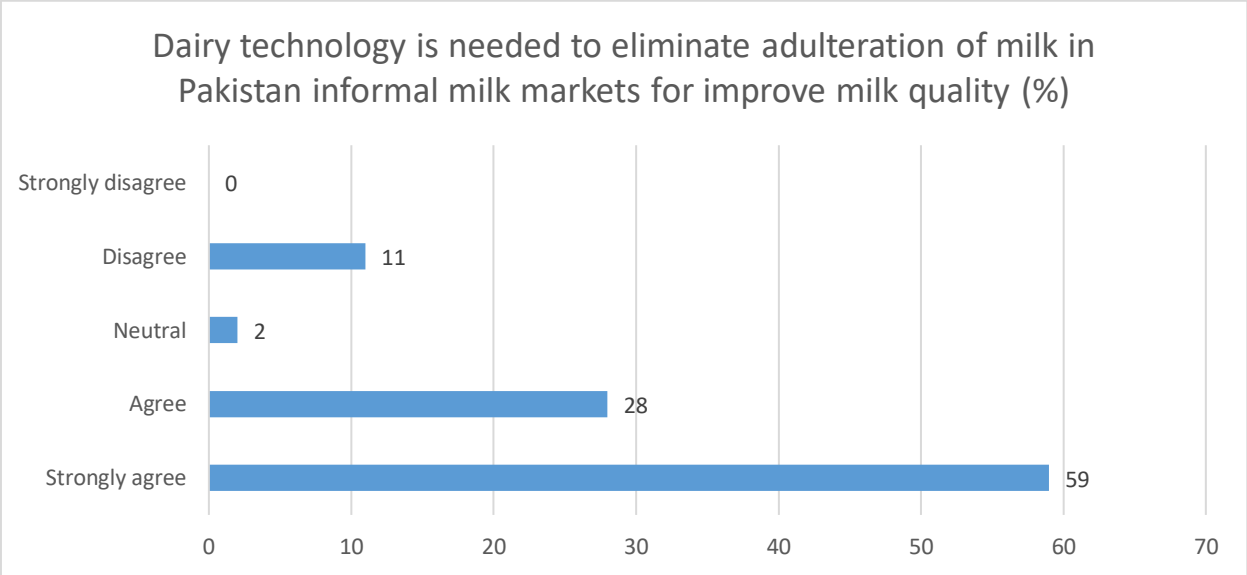
collection from small pockets to be processed in a central location and then distributed for marketability. The factors involved and evident from the responses is a structural gap in institutions not converging their goals and mission to address the issue of the dairy farmers problems. The responses show that the lack of genetic laboratories non-coordinating at the rural level impacts the genetic technology, in the long run, to reflect national milk volume production and aggregate animal genetic makeup. The lack of veterinary support at the grass-root level is absent is failing to address the animal health, the stress of calf birth that impacts the herd and the estimated milk production not meeting the targets. The analysis supports the. Quddus (2012) study as the risk of a venture due to the absence of knowledge assimilation, financing, or process-centric abilities is failure to implement technology to devise SME level milk production capabilities in rural pockets and storing them for longer shelf life is missing that impacts the rural dairy farmers not able to deliver fresh milk fast to urban consumers missing the national domestic market supply-demand economic benefits. The process-based lacune that is evident is the family-held businesses, do not have technology to take care of animal health, breeding, milking process, storage, producing capabilities for diverse milk products, milk products packing, and faster transportation is what similar structural challenges every country faced as per Mekonnen et al. (2010) study in a literature review. All the development process is based on an open innovation model and are mostly interdisciplinary and involves two or more institutions with knowledge. The lack of initiatives in launching a scheme and rural farmer training systems, economic support to spread the good practices for national-level adoption borrowed from the agricultural sector in Pakistan has been missing over decades. The same being missing is a process to help the rural dairy farmers and enhance their abilities to exploit the scope of urban Pakistan milk demand, milk by-products (variety) demand to be marketed fresh.

Q 14. Do you agree that dairy technology is needed to eliminate adulteration of milk in Pakistan informal milk markets for improving milk quality?

Table 4.16 Dairy technology is needed to eliminate adulteration of milk in Pakistan informal milk markets for improving milk quality

Options	Response (%)	Response (n)
Strongly agree	59	59
Agree	28	28
Neutral	2	2
Disagree	11	11
Strongly disagree	0	0
Total		100

Figure 4.14 Dairy technology is needed to eliminate adulteration of milk in Pakistan informal milk markets for improving milk quality



Findings:

The responses show that over 59% of states strongly agree, and 28% agreeing to the dairy technology as a key force to eliminate the existing problem of adulteration of milk. While there are only 2% being neutral, and 11% stated that technology could not eliminate adulteration, it brings out the knowledge-based perspectives of a business situation.

Discussion:

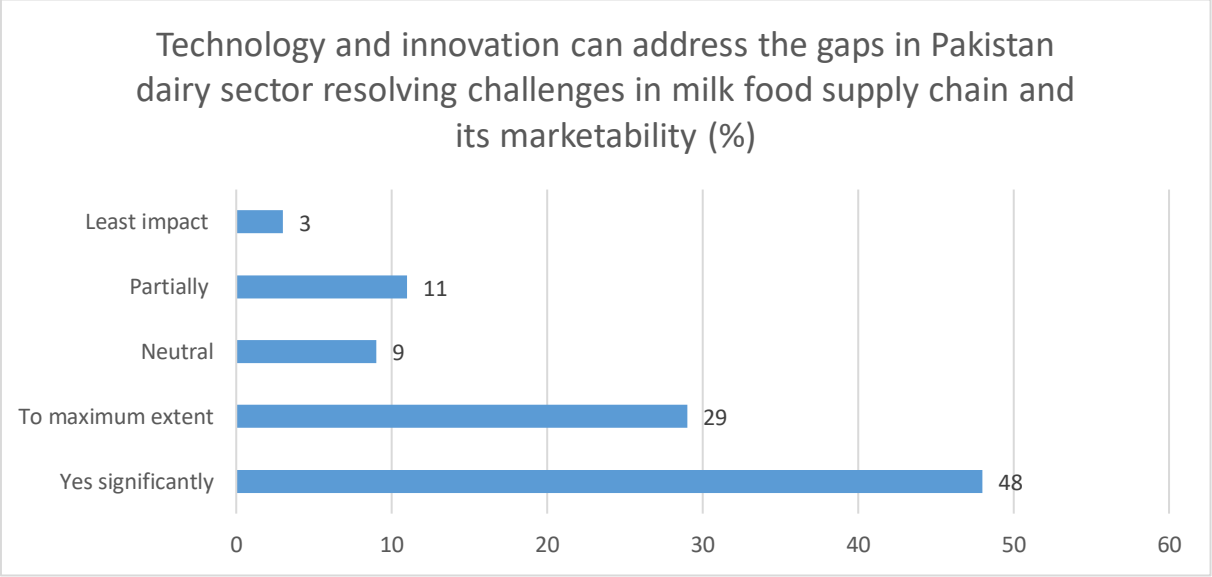
The rural dairy farmers stated that dairy technology is the critical point for resolving the adulteration of milk which is a practice in Pakistan. There are informal markets of adulterated milk which is a risk to the mainstream food supply chain of the country. Pakistan government has minimal control as the stakeholders (producers, traders, distributors, transporters) forms the part of activities from the point of origin (raw milk) to the consumers' consumption activity. The use of technology as an integrated measure in dairy technology has been supported due to the vested interests of the small dairy farmers. The technology is a leveraging factor here, as it plays a role that surpasses the ability of the small dairy farmer, institutional (public/private) capabilities and returns a higher value to contribute to the dairy sector as per the research of Johannessen et al. (2001) is pertinent here. This process is critical and adds value while recognising the product, process requirements and developing mechanism is a capability that defines development or innovation rate. Issues like milk adulteration is a threat that is not in the control of the small dairy farmers and to gain greater control over the probability and possibilities and uphold the small dairy fraternity business overcoming adulteration loopholes. The response pattern shows that small dairy farmers are concerned and seek ways to counter the challenges of adulteration, bypassing it, by applying the technology element in each activity. The role of SMEs in Pakistan undertaking a strategic mission to improve the milk quality from small farmer's perspective ranges from genetic breeding, dairy processing plant for small scale dairy farmers, technologies like the packaging of fresh milk that is linked to keeping the originality of milk within Pakistan milk supply chain connecting rural areas with cities support the Schumpeterian view of 'hard to achieve' amidst existing practices. The lack of technical knowledge is also a barrier to adoption or starting an initiative through entrepreneurship in the dairy sector of Pakistan. Rural areas have slowed down innovation levels due to constriction of knowledge flow (Chesbrough 2003) research mentioned in a literature review. The low level of knowledge due to lack of information dissemination from the industry associations, lack of integrated approach for dairy production, transportation and supply chain has left the gap in addressing the rural milk production capabilities in eliminating adulteration. The issue is important as the 'fit for consumption' is applicable as rural milk producers require defined processes, methods of milk collection, packing and distribution to keep consumer's consumption.

Q 15. Do you feel that technology and innovation can address the gaps in the Pakistan dairy sector, resolving challenges in the milk food supply chain and its marketability?

Table 4.17 Technology and innovation can address the gaps in Pakistan dairy sector,

Options	Response (%)	Response (n)
Yes significantly	48	48
To maximum extent	29	29
Neutral	9	9
Partially	11	11
Least impact	3	3
Total		100

Figure 4.15 Technology and innovation can address the gaps in Pakistan dairy sector, resolving challenges in the milk food supply chain and its marketability



Findings:

48% of respondents said yes significantly, while 29% thinks to some extent. 9% remained neutral and 11% believe Technology and Innovation can partly play its role. Only 3% believed it will have very less effect.

Discussion:

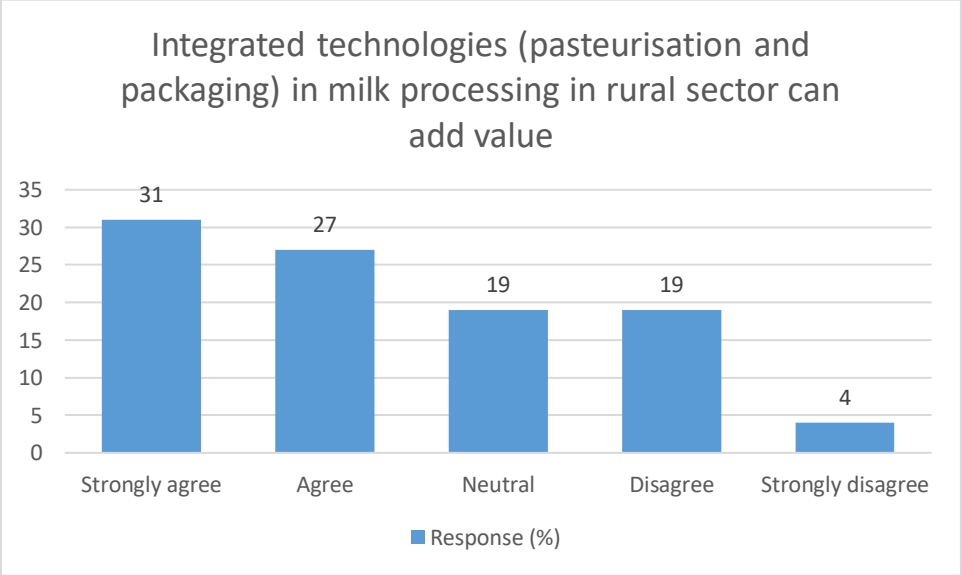
The responses show that the small dairy farmers have perceived the combination of technology and innovation to bring in a change in the sector. The issue is pertinent as the small farmers' realised technology alone could not resolve all issues for the dairy sector in Pakistan. Hence, the adoption of incremental innovation bringing in improvement in the output, is necessary. Most of the respondents' support this, as they perceive a combination of these two to work for addressing the challenges in the Pakistan small dairy sector. The respondents' emphasis on using both is an indication method validating practices followed at a large scale and addressing the small dairy sector problem through sharing and collaboration, which Beblavý et al. (2012) required to re-adapt to the scenario. It requires solutions to adapt to address the relevant needs of the stakeholders. The negative responses imply the unsure nature of the responses expressed about technology and innovation due to their lack of technical knowledge and education level. However, much of their traditional practices are dependent on the information flow. The overall discussion shows that small dairy farmers are likely to adapt technology to improve the milk (product) and dairy processing (methods) to attain Pakistan government-certified standards that add value to their identity. It also makes them more recognisable in terms of milk quality standardisation perspective, as they follow the standard procedure laid down by the PDDC. It is a step that small dairy farmers are seeking to achieve small holder subsistence and be more market-oriented, trying to come out of the rural label and be more peri-urban in addressing the systems prevalent in this sector. However, as they seek solutions, Høyrup, (2010) research supports that workplace innovation is typically the use of common sense, as they adopt or modify activities or sub-activities differently. Their perception is also a reflection of why and how they want technology innovation to combine and assist the rural commercial milk production system in challenging the stronghold of private players in Pakistan. Still, with limited exposure, they cannot do development in individual or rural countryside to solve dairy SME establishment structural gaps. They are essentially seeking to improvise local solutions either by scaling down (urban milk processing model) or scaling up the dairy integrated processing for meeting rural challenges in the dairy sector of Pakistan. However, the lack of innovation in rural areas lack of knowledge has affected the growth and development pace, putting a barrier to the entrepreneurship opportunities for rural dairy farmers.

Q 16. Do you agree that integrated technologies (pasteurisation and packaging) in milk processing in the rural sector can add value?

Table 4.18 Integrated technologies (pasteurization and packaging) in milk processing in the rural sector can add value

Options	Response (%)	Response (n)
Strongly agree	31	31
Agree	27	27
Neutral	19	19
Disagree	19	19
Strongly disagree	4	4
Total		100

Figure 4.16 Integrated technologies (pasteurization and packaging) in milk processing in the rural sector can add value



Findings:

The strongly agreed is about 31%, with 27% agreed, and 19% neutral. The respondents who disagreed are 19%, strongly disagreed at 4%.

Discussion:

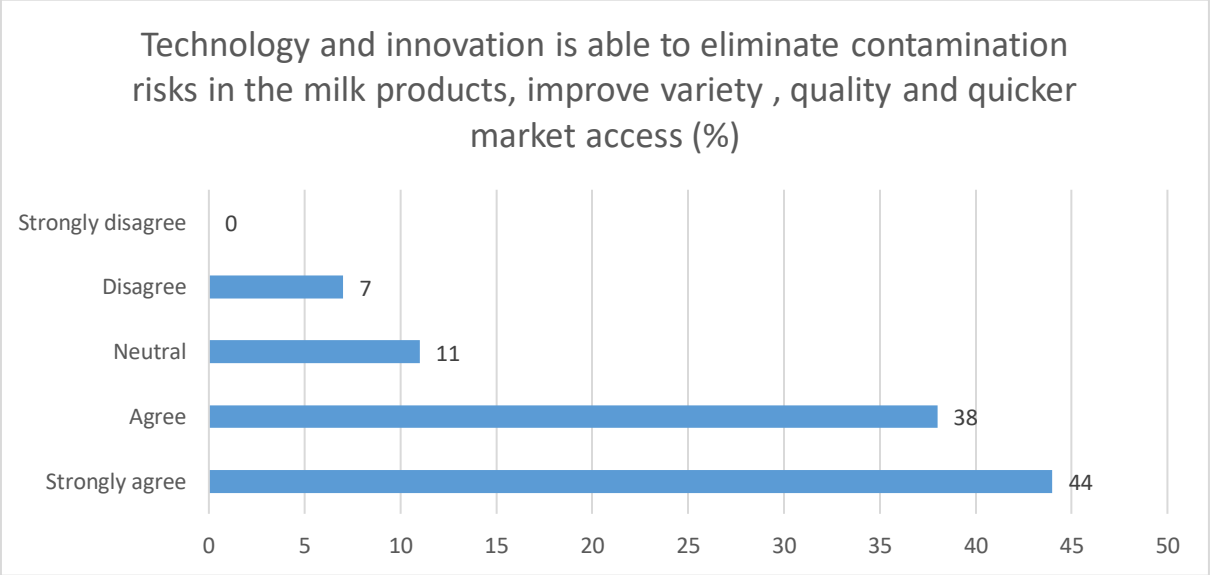
The small dairy farmers seek to shift from their manual methods of milking and limited animals in their family business selling locally. The above responses indicate that market awareness and knowledge is existent that is showing the small dairy owners to look out for SME scale of milk production processing units that fits their rural model. The private players in Pakistan are market leaders and use integrated raw milk processing and packaging, which small dairy farmers cannot achieve. Their responses in the majority show that they agree and strongly agree, which is a mental readiness, and they are trying to seek ways to improve using local innovation methods. Thus, they intend to adopt commercial technology to their rural needs scaled-down version of the technology, which adds significant value to the vast population of small dairy owners. It also shows the lack of government institutional help and support missing, which has failed to address their needs to process milk in their home start-ups containing limited animals (2-3) (4-5) in a family. Therefore, the integration of both technology and innovation is a competitive advantage and the only way to upgrade and adopt pasteurisation and packaging with improvisation at the local level. However, they are standard procedures prevalent in commercial large dairy enterprises in Pakistan. Nettle et al. (2013) research in the literature review falls short in Pakistan as animal health requires integrated technology to address mass scale issues and yet penetrate a rural area. The milk processing uses automated plants for milking and processing it (pasteurisation) for enhancing shelf life (storage). It also paves the way to use processed milk to be packed for consumption through distribution networks in the markets. However, all the technologies needed are an integrated feature to advanced industrial milk processing capabilities, which starts with milking the package milk products that require technology in infrastructure and processing innovation. Klerkx et al. (2013) supported this strategy of cost-benefit analysis to assess the risk of start-up or transition to a new wave of practices, procedures needed to upgrade the existing knowledge base. In Pakistan, bringing an all-around improvement in product and process need stakeholder involvement to infuse technology and innovation to embed in the everyday activity of the dairy sector. The need for makeshift replicated small scale dairy model instead of large-scale equipment requires product R&D, while govt initiating the integrated method uses automation and requires non-human touch operations that impact milk quality and reduce the chances of adulteration supply-demand mismatch. The innovation in local rural milk procumbent process and the technology of manual to automated has not been able to add value which makes this a gap in the existing situation.

Q 17. Do you think that technology and innovation can eliminate contamination risks in milk products, improve the variety, quality, and quicker market access?

Table 4.19 Technology and innovation can eliminate contamination risks in the milk products, improve the variety, quality, and quicker market access

Options	Response (%)	Response (n)
Strongly agree	44	44
Agree	38	38
Neutral	11	11
Disagree	7	7
Strongly disagree	0	0
Total		100

Figure 4.17 Technology and innovation can eliminate contamination risks in the milk products, improve the variety, quality, and quicker market access



Findings:

The responses show that most of the rural small dairy farmers believe that technology and innovation are integral in eliminating the contamination risks in milk product processing,

improving the variety, quality, and achieving quicker market access. Around 44% stated strongly agree, and 38% agreed, with 11% responding neutral 'unsure' and only 7% disagreed.

Discussion:

The small dairy farmers in the rural areas expressed their opinion on the aspect of technology inclusivity in the milking, processing the raw milk, can eliminate human or external contamination. Their observation is based on their traditional milking practices and that of the large enterprises which process millions of litres of milk in a single day. This aspect of knowledge and orientation shows their willingness to adopt the technology-based solution as per their knowledge. However, no SME level smaller equipment for rural areas has been available. Their orientation also reveals that the technology element improves the user's access to produce a higher variety of milk-based by-products in high volume. It also is a process where the mechanised inputs and outputs can achieve food-grade processing and hygiene that is absent in the traditional milking methods, which impacts the final consumption willingness in customers. The small dairy farmers also realised that the technology needs to be adapted to the rural situations and needs. The conditions are much different with the inclusion of institutions (like SMEs with operations that of a cooperative) to blend technology and innovation in the process. Khan et al. (2015) acknowledged all these are constraints in Pakistan, as wider stakeholder involvement is needed, while traditional innovation in dairy is limited for rural dairy farmers. The rural dairy farmers have a small herd size, low volume of milk production from the animals unsuitable for automatic mechanised plants that can only process higher volumes in (millions of litres) gallons. Their response also indicates that technology and its adaptation to rural conditions require innovation, that is a capability small dairy farmer do not possess right now. This gap is addressed by King et al. (2008) research discussed where the author cited to avoid linear path model of innovation, and impact on, not sufficient milk volume yields is evident as per discussion of Nazir and Khan (2009) in the literature review. The indication of technology to provide nutritional management to processing milk by-products, The speed and efficiency of achieving the processing power in automated equipment is an advantage for the rural dairy farmers as it allows to convert raw milk into by-products quickly and reach the market using cold supply chain that is again embedded with technology and transport. Raziq et al. (2010), in a literature review, stated that national policy implementation needs dairy linkages to sustain and survive as directly and indirectly these structural gaps in the national system require

support from other sectors. The realisation divides the opinion clearly as technology inclusivity in milk production. Its processing is absent, which is a much-needed development Pakistan requires to harness the daily production limits.

4.3 Hypothesis Testing

The Chi-Square test of independence is used to determine if there is a significant relationship between two nominal (categorical) variables. The frequency of each category for one nominal variable is compared across the categories of the second nominal variable.

Table 4.20 Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Existing Technology * Operational Challenges	100	100.0%	0	.0%	100	100.0%

Table 4.20 depicts the case processing summary of the test of independence between Existing Technology and Operational Challenges. According to the table all the cases are valid and there is no missing value in both variables. The n ext. step is cross tabulation. This test is applied to test the association between two categorical variables Technology and Operational Challenges. Following hypothesis are designed to test this association.

$H1_o$: Use of the technology by farmers is not associated with the operational challenges faced by them.

H1a: Use of the technology by farmers is associated with the operational challenges faced by them.

Table 4.21 Existing Technology * Operational Challenges Crosstabulation

Count		Operational Challenges						
		PC	PAC	SC	MQ	ISL	OTHER	Total
Existing Technology	BT	0	0	0	0	8	8	16
	DT	9	13	14	0	0	0	36
	QF	0	0	0	14	0	0	14
	MED	0	0	0	8	20	0	28
	OTHER	0	0	5	0	1	0	6
Total		9	13	19	22	29	8	100

Table 4.21 displays that only 16 of the respondents use the breeding technology, out of these 16 respondents 8 are facing the challenge of increasing shelf life and other 8 are facing the other challenges. According to the table total 36 respondents are sing diary technology (e.g., automotive milking, preservation etc.). The reason of the use of this technology are preservation, pasteurization, and storage technology. Only 14 of the respondents are using quality fodder to maintain the precise quality of the dairy products. Only 6 respondents use the other technologies who are facing the challenges of storage and increasing shelf life of their products. Cross tabulation displays a substantial association between the different technologies used by the farmers and the operational challenges being faced by them. Furthermore, chi squared statistics are used to confirm the statistical association between them.

Table 4.22 Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.994E2[a]	20	.000
Likelihood Ratio	199.355	20	.000
Linear-by-Linear Association	1.834	1	.176
N of Valid Cases	100		

According to Table 4.22 p-value (sig.) of the Pearson Chi-Square and Likelihood Ratio is less than 5%. This indicates the statistically significant association between the variables. Thus, the null hypothesis. (**$H1_o$)** is rejected and the alternative hypothesis **(H1a)** is supported.

Table 4.23 Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Existing Technology * Awareness of NDS	100	100.0%	0	.0%	100	100.0%

Table 4.23 displays the case processing summary of the test of independence between Existing Technology and Awareness about National Dairy Strategy (NDS). According to the table all the cases are valid and there is no missing value in both variables. The next step is cross tabulation. This test is applied to examine the association between two categorical variables Existing Technology and Operational Challenges. Following hypothesis are designed to test this association.

$H2_o$: Use of the technology by farmers is not associated with their awareness about National Dairy Strategy.

H2a: Use of the technology by farmers is associated with their awareness about National Dairy Strategy.

Table 4.24 Existing Technology * Awareness of NDS Crosstabulation

Count		Awareness of NDS			
		Yes	No	Not Sure	Total
Existing Technology	BT	15	1	0	16
	DT	8	26	2	36
	QF	0	14	0	14
	MED	9	13	6	28
	OTHER	2	1	3	6
Total		34	55	11	100

Table 4.24 shows that only 34 of the respondents are aware about the National Dairy Strategy. Out of these 34 respondents 15 are using Breeding Technology (BT), 8 are using Dairy Technology (DT), 9 of them are using medicines for wellbeing and only 2 respondents of them are using other miscellaneous technologies. 55 of the respondents does not know about the National Dairy Strategy and 11 respondents are not sure about their awareness about NDS. However, they are also using the different technologies. Cross tabulation shows a statistical association between the different technologies used by the farmers and their awareness about National Dairy Strategy. Furthermore, Chi-Squared statistics are used to confirm the statistical association between them.

Table 4.25 Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	54.380[a]	8	.000
Likelihood Ratio	56.651	8	.000
Linear-by-Linear Association	14.106	1	.000
N of Valid Cases	100		

According to Table 4.25 p-value (sig.) of the Pearson Chi-Square and Likelihood Ratio is 0.00 (less than the maximum recommended value of 5%). This indicates the statistically significant association between the variables. Thus, the null hypothesis. (**$H2_o$)** is rejected and the alternative hypothesis **(H2a)** is failed to reject.

Table 4.26 Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Existing Technology * Satisfaction with Current Production	100	100.0%	0	.0%	100	100.0%

Table 4.26 demonstrates the case processing summary of the test of independence between Existing Technology and Satisfaction with Current Production. According to the table all the cases are valid and there is no missing value in both variables. Further, the cross tabulation is applied. This test is applied to test the association between two categorical variables Existing Technology and Satisfaction with Current Production. Following hypotheses are designed to test this proposed association.

$H3_o$: Use of the technology by farmers is not associated with the Satisfaction with Current Production

H3a: Use of the technology by farmers is associated with the Satisfaction with Current Production.

Table 4.27 Existing Technology * Satisfaction with Current Production Crosstabulation

Count		Satisfaction with Current Production			
		Yes	No	Not Sure	Total
Existing Technology	BT	9	7	0	16
	DT	7	25	4	36
	QF	1	12	1	14
	MED	1	25	2	28
	OTHER	1	4	1	6
Total		19	73	8	100

As per Table 4.27 most of the respondents (73 out of 100) are not satisfied with their current production. Majority of these unsatisfied respondents use Dairy Technology (25 out of 73) and Medicines fir wellbeing (25 out of 73) to increase their production level. This group is followed by the 19 respondents who are satisfied with their current production level majority of them is using Breeding Technology (9 out of 19) and Dairy Technology (7 out of 19). Only 8 respondents are not sure about their satisfaction/dissatisfaction with the current production level half of these respondents are using dairy technology. These statistics are showing a clear division of the satisfied and unsatisfied farmers for the selection of the technology. Furthermore, Pearson Chi-Squared test for independence is applied to examine the association between these categorical variables.

Table 4.28 Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.865[a]	8	.005
Likelihood Ratio	21.247	8	.007
Linear-by-Linear Association	9.532	1	.002
N of Valid Cases	100		

As per Table 4.28 p-value (sig.) of the Pearson Chi-Square and Likelihood Ratio is 0.005 and 0.007 respectively (less than the maximum recommended value of 5%). This indicates the statistically significant association between these variables. Thus, the null hypothesis. (**$H3_o$)** is rejected and the alternative hypothesis **(H3a)** is supported.

Table 4.29 Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Existing Technology * Challenges as Small Farmer	100	100.0%	0	.0%	100	100.0%

Table 4.29 is the case processing summary of the test of independence between Existing Technology and Challenges Faced due to Small Size business. According to the table all the cases are valid and there is no missing value in both variables. The n ext step is cross tabulation. This

test is applied to test the association between two categorical variables Existing Technology and Challenges Faced due to Small Size business. Following hypotheses are designed to test this association.

$H4_o$: Use of the technology by farmers is not associated with the Challenges Faced due to Small Size Business.

H4a: Use of the technology by farmers is associated with the Challenges Faced due to Small Size business.

Table 4.30 Existing Technology * Challenges as Small Farmer Crosstabulation

Count		Challenges as Small Farmer							
		BUG	RQF	MAH	SC	LPE	FC	OTHER	Total
Existing Technology	BT	4	1	0	1	4	5	1	16
	DT	5	2	5	6	8	6	4	36
	QF	1	3	1	3	3	3	0	14
	MED	4	5	2	3	9	2	3	28
	OTHER	2	0	0	1	2	0	1	6
Total		16	11	8	14	26	16	9	100

Table 4.31 depicts that majority of the respondents (26 out of 100) is facing lack of processing equipment challenges (LPE). Out of these 26 respondents 9 respondents use the medicines for wellbeing, 8 respondents use dairy technology, 4 respondents use breeding technology, only 3 respondents of them use quality fodders and only two of them are using other miscellaneous small technologies. This cross tabulation is not much explanatory about the choice of technology based on the challenges faced due to the small size business. Furthermore, Pearson Chi-Squared is u\implied to assess this association.

Table 4.31 Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.170[a]	24	.687
Likelihood Ratio	23.940	24	.465
Linear-by-Linear Association	.482	1	.487
N of Valid Cases	100		

As per Table 4.31 p-value (sig.) of the Pearson Chi-Square and Likelihood Ratio is 0.687 and 0.465 respectively (more than the maximum recommended value of 5%). This indicates the statistically insignificant association between these variables. Thus, the null hypothesis. (**$H4_o$)** is supported and the alternative hypothesis **(H4a)** is rejected.

Table 4.32 Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Existing Technology * Awareness about Genetic Breeding	100	100.0%	0	.0%	100	100.0%

Table 4.32 is the case processing summary of the test of independence between Existing Technology and Challenges Faced due to Small Size business. According to the table all the cases are valid and there is no missing value in both variables. The next step is cross tabulation. This test is applied to test the association between two categorical variables Existing Technology and Awareness about Genetic Breeding. Following hypotheses are designed to test this association.

$H5_o$: Use of the technology by farmers is not associated with the Awareness about Genetic Breeding.

H5a: Use of the technology by farmers is associated with the Awareness about Genetic Breeding.

Table 4.33 Existing Technology * Awareness about Genetic Breeding Crosstabulation

Count		Awareness about Genetic Breeding			
		Yes	No	Can't Say	Total
Existing Technology	BT	16	0	0	16
	DT	3	28	5	36
	QF	1	11	2	14
	MED	2	24	2	28
	OTHER	1	5	0	6
Total		23	68	9	100

As per Table 4.33 majority of the respondents (68 out of 100) are not about the genetic breeding at their impact on production. That is why none of these 68 respondents is using breeding technology (BT). On the other hand, 23 respondents out of 100 are aware about the breeding using genetic technology and its impact on production, based on this awareness 16 out of these 23 respondents (who have awareness about breeding using genetics) are using breeding technology for increasing their sustainable production. However, only 9 respondents out of 100 are not sure about their awareness, therefore, these 9 respondents are confused in the selection of appropriate technology. Furthermore, Pearson Chi-Squared is u\implied to assess this association.

Table 4.34 Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	65.902[a]	8	.000
Likelihood Ratio	62.389	8	.000
Linear-by-Linear Association	13.256	1	.000
N of Valid Cases	100		

As per Table 4.34 p-value (sig.) of the Pearson Chi-Square and Likelihood Ratio is 0.00 and 0.00 respectively (less than the maximum recommended value of 5%). This indicates the statistically significant association between these variables. Thus, the null hypothesis. (**H5o) is rejected and the alternative hypothesis (H5a) is supported.**

4.4 Qualitative Data Analysis and Interpretation

This part includes the analysis and insights derived through communicative, comprehensive, and unambiguous interviews with various dairy industry-related persons and institutions in Pakistan. A thorough analysis was conducted by sharing the interviewees' opinions, expressions, and perspectives to make sure the analysis is reliable, practical, and associated with the research goals and objectives, and responses were analysed and compared with prior research works given in the literature review chapter.

The third or last research question of the present study (mentioned in section 1.9.3) requires the in-detail answer. There is no considerable literature and measurement model available, that can help to investigate this question quantitatively. Therefore, the researcher used qualitative data analysis to answer the third research question (RQ3) to get the clearer insights of identified research problem. The interview has been divided into small dairy SME owners, government representatives, and academic dairy technologists from Pakistan. The data was analysed in several stages, involving coding, classifying, and summarising, to ensure that it was appropriately converted from raw to usable and meaningful form before being analysed (Malhotra et al., 2008). The topic of thematic analysis was explored by the researcher (Benner, 1985; Leininger, 1985; Taylor & Bogdan, 1984). Despite the lack of a comprehensive literature base for thematic analysis, the researcher followed Braun and Clarke's (2006) guidelines in the methodology section and used MAXQDA, a qualitative data analysis programme.

The opinions of the participants were acquired through digitally recorded semi-structured interviews. After that, the responses were attentively listened to, translated into English, and turned into transcripts. This method required contemporaneous participation in data collection and processing and allowed for a back-and-forth approach. The interview guide in the interview guide was updated because of the pilot case research. The method of reiterative procedure is adopted. By gradually moving from raw narrations to themes, MAXQDA facilitates the production of consistent stories. The data was analysed until theoretical saturation, also known as theoretical density, was reached. The following are key themes derived from the interview data; each theme, along with its sub-themes, reflects a research topic and is compatible with the data obtained. To accomplish the research objectives the researcher went through the following stages,

Step (I)

The first step in theme analysis is to become familiar with the whole data set, which necessitates consistent and purposeful reading of the data (Braun and Clarke 2006). Interviews are included in the present study's data collection. At the same time, it may be tempting to begin coding data and find patterns immediately; familiarizing yourself with the entire data set first provided the researcher with critical exposure to raw data and served as the foundation for all subsequent stages.

In the initial stage, all data representing narrations from dairy business owners and dairy sector research researchers were imported into MAXQDA as inputs. These sources were further classified by assigning relevant attributes, such as dairy company owners and dairy research scholars. It also helps determine and evaluate the impact of these features on the interview data. Furthermore, the classification gave the freedom to classify, comment, and establish links or comparisons between the sources. Following that, the research went on to the next phase of developing first-order themes to begin the analytical process and get insights into specific sources.

Step (II)

As the first analytic phase of the procedure, coding aided the researcher in arranging the data at a microscopic, exact level. Following the familiarization process in step 1, researchers began collecting notes on future data items of interest, queries, linkages between data objects, and other preliminary thoughts. Phase 2 is the beginning of the coding process. Rather than themes, the researcher created codes throughout this stage. According to Boyatzis (1998), A code is an essential portion, or component, of basic data or information that may be meaningfully assessed in connection to the phenomenon. The initial codes in this inquiry are sufficiently well-defined and delimited to not overlap with other codes and fit coherently within a larger coding paradigm or coding pattern known as coding guidelines.

When the analytic process began, individual data sources were coded. Data from all sources was manually coded to produce the codes. They include substantial derivations from sources relevant to a topic. Data from interviews has offered deeper insights into various topics, including entrepreneurship, innovation, and technology.

This first-order theme generation aided in systematically confirming the thematic approach and measuring the issue from several perspectives to provide a comprehensive picture.

Step (III)

The final process analyses the coded and aggregated data extracts for potentially more important themes (Braun and Clarke 2006). If your whole analysis is considered as a building, individual codes are the bricks and tiling, while themes are the walls and roof, according to Braun and Clarke (2012). The topic identification method – the building of those walls and roofs – is largely an active and interpretive one. Themes in this study are not derived from the data; rather, the researcher constructs themes by assessing, merging, comparing, and even graphically mapping how codes link to one another.

Using the inductive technique, researchers extract themes from the coded data, culminating in themes that are more closely connected to the original data and representative of the entire dataset (Braun and Clarke 2006). While constructing and arranging themes, thematic maps are useful for graphically illustrating cross-connections between notions and between core themes and subthemes (Braun and Clarke 2006). The figures below illustrate thematic maps from the current inquiry. The researcher ensured that the Themes were individually significant while also 'collaborating to construct a whole coherent story.

In step III, all the subthemes (produced by the first-order themes) were linked together to better comprehend the patterns and concreteness. Assessing the connections and linkages between these topics aided in discovering and grouping common themes. The grouping was done to cope with the intricacy of many topics systematically and to simplify the analysis. The diagram below explains why some of the topics must be grouped on common grounds.

Step IV

In stage 4, the researcher used Braun and Clarke's two-level analytical technique (2006). To ensure proper fit, the researcher reviewed coded data placed inside each topic at the first level of analysis. Next, the researcher examined all appropriate codes and data snippets under each subject to ensure that each theme had adequate supporting data. Is the information provided consistently in its support of that theme?

Most of those themes in the interviews overlapped or shared similarities with other subthemes, while others differed. As a result, the themes were evaluated and grouped based on their interactions, links, correlations, and intrinsic character. The surveys revealed nine overlapping or similar themes within the replies from various sources. While overlapping themes expand the researcher's knowledge base with direct information from participants, unique themes allow for a deeper understanding and development of a suitable solution to the researcher's issues. The figures below demonstrate how the many overlapping concepts were eliminated or consolidated into a common subject.

Step V

After finishing the first level of analysis, the researcher was certain that the revised thematic map adequately encompassed all the coded data to be utilized in the final analysis. The researcher made detailed notes, or memos, on his thought processes. Such memos assisted researchers in connecting subjects while also producing an audit trail, which boosts the legitimacy of their findings.

MAXQDA aided in the management and organization of data within these major areas. This allowed us to go forward with the investigation and ask questions based on the facts more effectively. As a result, each of these categories is analyzed and addressed below, summarizing the grouped themes and their interrelationships, as well as the takeaways and major challenges regarding the Pakistani dairy business. Each category's material has been analyzed, and it is designed to show the essential components therein, the learnings from these categories, the difficulties that need to be addressed, and the prominent gaps. The final codes, together with their themes and sub-themes, are shown below.

Figure 4.18 Theme 1 Thematic Map

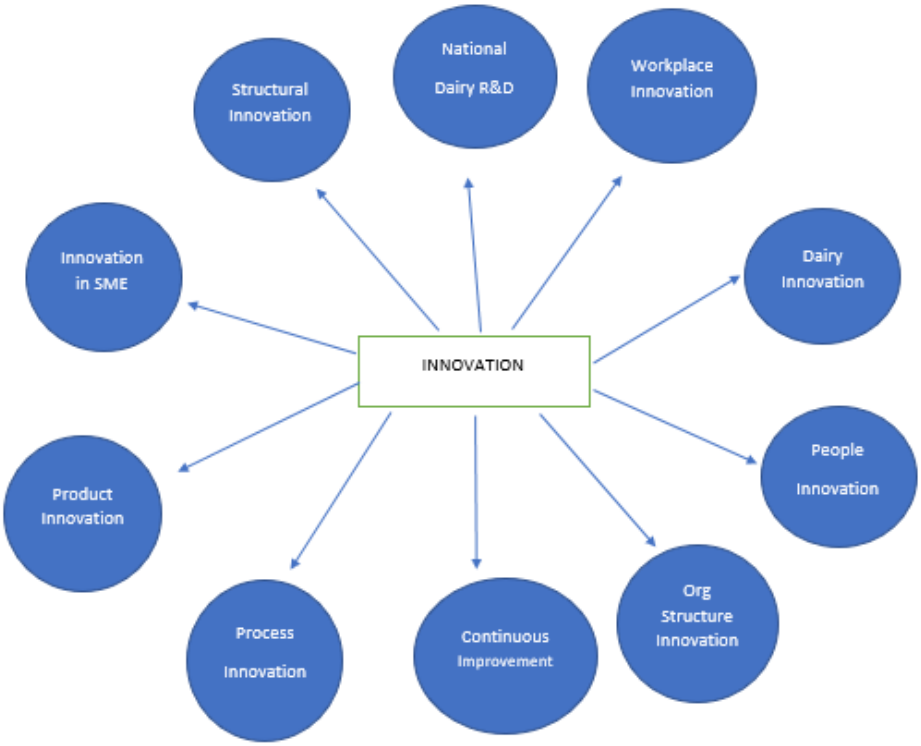


Figure 4.19 Theme 2 Thematic Map

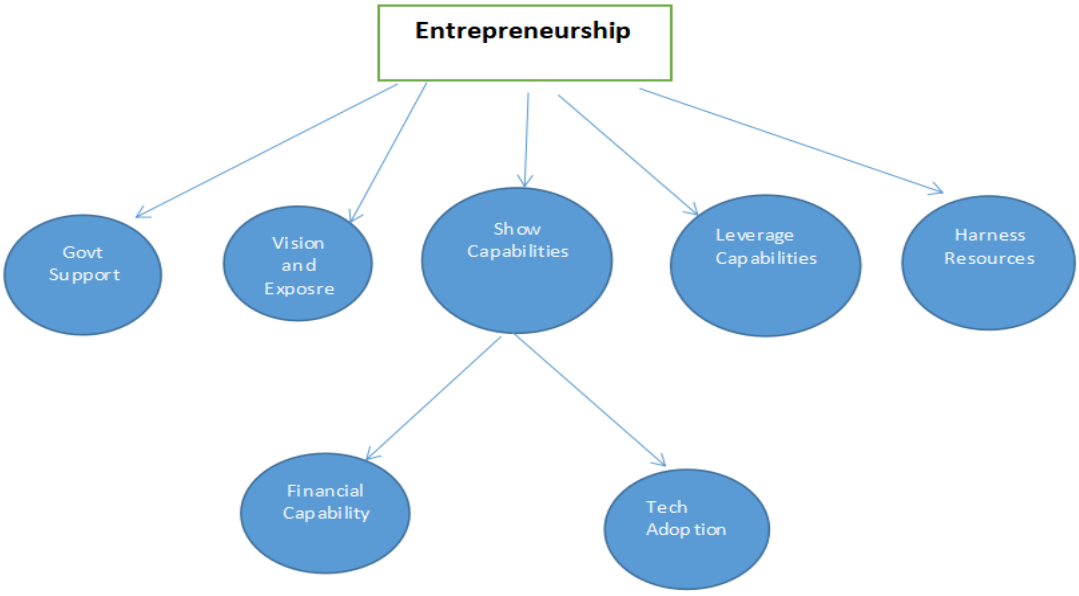
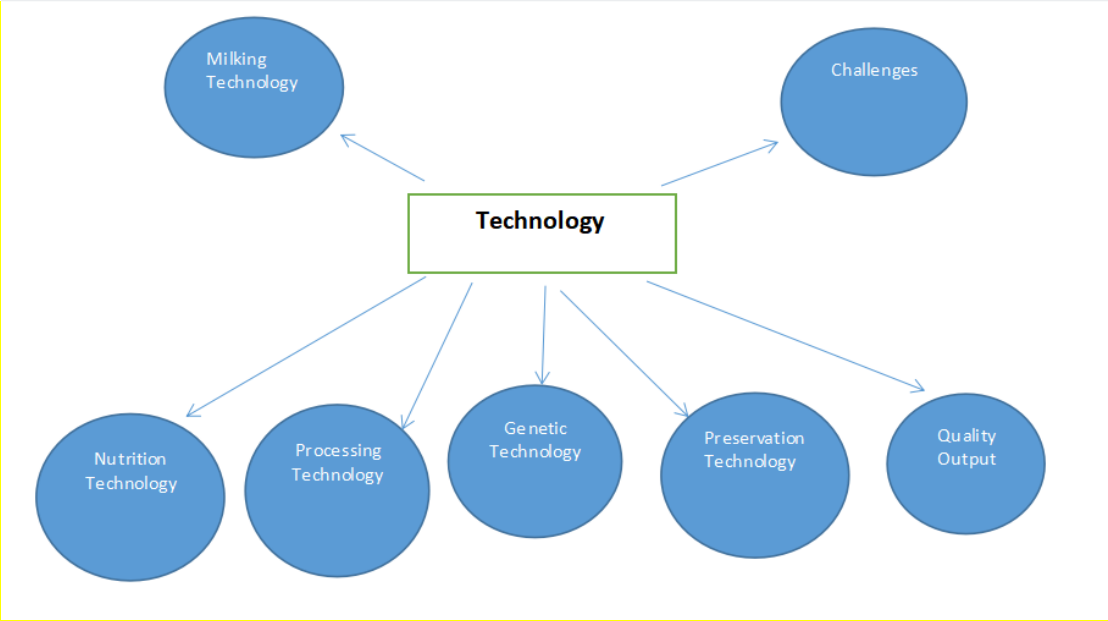
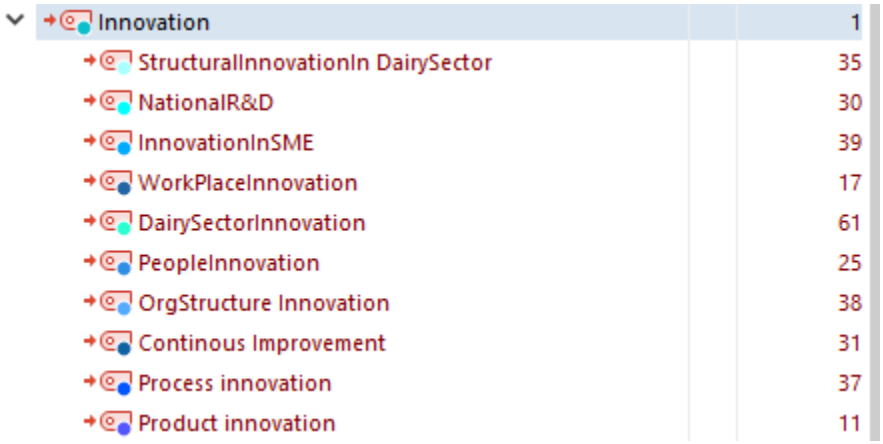


Figure 4.20 Theme 3 Thematic Map



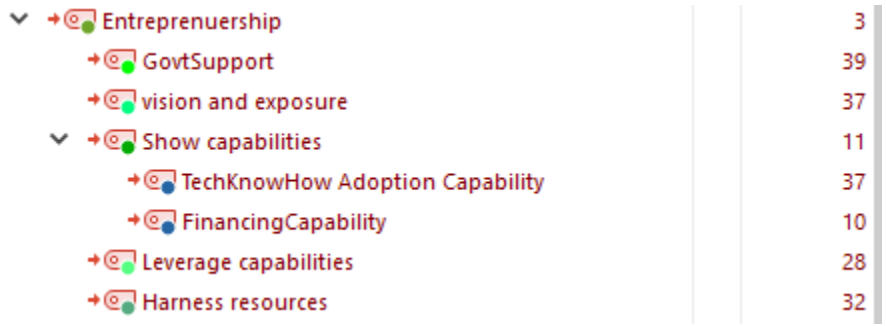
The major codes are innovation which has sub codes as – structural innovation in the dairy sector, national R&D, innovation in SME, workplace innovation, dairy sector innovation, organisational structure innovation, continuous improvement, process innovation, product innovation.

Figure 4.21 Theme 1: Innovation



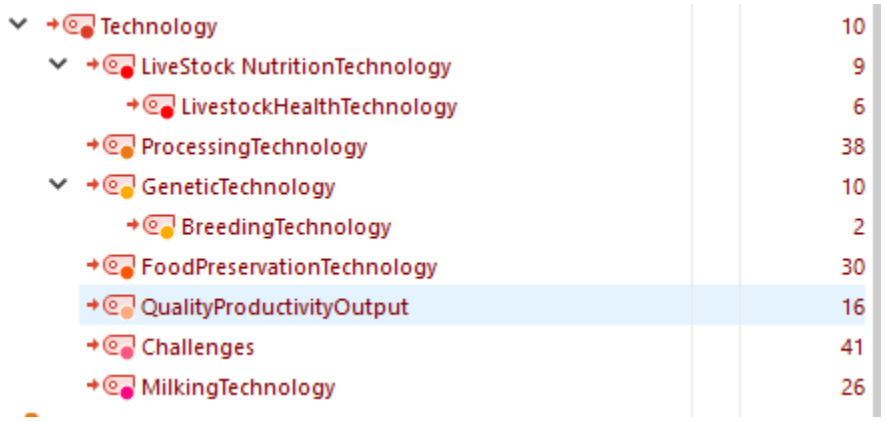
The second code is entrepreneurship in rural dairies in Pakistan, which has major influencing factors like Govt support, vision and exposure of entrepreneurs, leverage capabilities, show capabilities, and harness capabilities.

Figure 4.22 Theme 2: Entrepreneurship



The last code for the research is the 'technology' factor, with a wide range of dimensions associated with various stages of the entire dairy milk industry. The technology in milk and the herd of animals range from milking technology for extracting milk, processing technology, food preservation technology, challenges, quality productive output, livestock nutrition, and health technology.

Figure 4.23 Theme 3: Technology



From the above analysis using codes, the key variables identified in the lexical analysis of the transcripts are

The '*structural innovation in the dairy sector* refers to the absence of a new form of enterprise or organisation, which in the interview has been related to as a 'viable model' initiated by the Pakistan

government balancing the stakes of both rural dairy farmers of both other stakeholders. The innovation here is structural as this new form boosts the prospects of rural dairy production to find effective ways to be processed in automated milk processing plants against the prevalent hand-based milking system. The structure of home-based small herd practice would boost the small dairy farmers' access to technology within an enterprise; otherwise, that is financially, technologically out of reach. When referred to the literature review, the new structure in dairy processing shows developed nations in the west (USA) and even developing nations like (India) both adopting a 'milk cooperative' structure to drive the mission. However, the above structure centric challenges are dependent on the existing power relationships in the rural and urban institutional model in Pakistan, where it is 'lack of infrastructure development and centralised development of Pakistan' due to lack of decentralisation strategy. The new form of the dairy enterprise 'cooperatives" releases the power, equally distributes in the cooperative model of organisation to facilitate the growth of rural dairy farmers, processing plant to get its profit share. However, most importantly thrust the rural-urban economic model towards a consumption centric milk products market in Pakistan heading towards maturity. The second issue in a new organisation structure is the fact, '*application of technology is indeed a solution, but it is also a cost that nobody is willing to invest in, '*that requires a solution, as *'institutional support is missing that is evident from banking for entrepreneurship loans'* is missing.

As one of the interviewees argued, *"Lack of technology inclusiveness in rural setup in terms of breeding, setting up the provisions of dairy processing plants at SME, animal health and wellbeing against diseases, storage provisions to increase shelf life of processed or raw milk are key symptoms of lack of technology and innovation in dairy sector of Pakistan.* Lack of knowledge to procure loans at rural towns, absence of technical knowledge about dairy processing stages, establishing an organisation registered with employees is a huge challenge.*"*

Another participant added, *"structural problems are prevalent which is setting up SME level dairy which are barriers that shows stakeholders and financers to be non-cooperative about dairy sector opportunities. The small dairy farmers therefore suffered from the psychological and behavioural discouragement around them about setting up SME level dairy processing unit in Pakistan. It is a systems failure in terms of technology penetration in dairy sector, lack of comprehensive national*

level plan rolls out and localisation of resource to boost the economic activity as a missed opportunity."

The need for technology and a new organisation structure aids in milk procurement from rural small farmers and uses it to gain recognition in SME or industry, for a loan from banks. Structural change in bringing the small rural dairy farmers under one roof offers to harness their potential to contribute to daily produce, ready for processing in an automated plant. Therefore, the criticality of forming an organisation that recognises rural small dairy farmers, the power of small dairy farmer contribution to rural and urban economy rests largely on creating an appropriate entity. The literature review also refers to the aspect of '*open and closed innovation models. After analysing the responses, its applicability in this research shows that the open model is better suited for Pakistan'*. Studies from the west (developed) and developing nations in the dairy sector has shown trends to break the rigidity in a dairy model that holds on to knowledge within limited boundaries, few stakeholders and benefitting the only handful while the opposite should have been true. The *'cooperative'* organisation aligns the gap in knowledge in small dairy farmers, entitles them with power and recognition, removes the barrier about the inability to get loans, inability to process raw milk scientifically, inability to expand beyond the rural market that the new organisation can change and bring a new dimension in the milk market. This structural theme has emerged from multiple factors which are not materialising for small rural dairy farmers.

The second code or variable in consideration set is 'National R&D' as the Pakistan government has brought in series of reforms in successive governments that have ruled the country. Their strategy and economic policies are important to shape each sector and bring in the nation's economic development. Science and technology form the backbone as their contribution to the industry are immense, with infrastructure, metals and mining forming the early signs of national development. However, the level and rate of national R & R&D in areas of the dairy industry have a wider range of responses, with respondents linking the herd's health as an important facet.

As a participant gave his opinion, *"There are key technologies that is not possible though internal R&D, and hence relying on external R&D is appropriate. For a country like Pakistan which is in developing state, it holds true as the policies framed also requires, allocation of funds in each sector, that has potential to serve the population and contribute to GDP."*

Another Interview Felt, "*There is lack of equipment based dairy production that is a challenge for small dairy farmers, to market their milk output for supplying to the high demand areas (urban). The maximum small dairy farmers are in the rural sector which not able to use the resources, the dairy sector progress to contribute to consumption centric economy leading to economic benefits."*

This viewpoint supports that any animal herd is an asset for the nation but depends on R&D in areas that help look after its health, breeding, and nutritional supplements. It supports human consumption in daily lives, across different markets (rural and urban), across socio-economic classes. The national R&D is an area that the government forms to boost growth and development, bringing technology transfer from advanced nations. It is a national capability when looked at internally, as it helps to drive projects in specific areas where gaps exist. While in this research, the development level has been perceived as '*slow*' in Pakistan for the '*animal herd health, milk processing equipment, nutrition management as overdependence in foreign firms is perceived*.' The literature review confirmed that the progress in genetics and breeding to harness the gene-pool is being conducted in Pakistan to preserve animals' strain from extinction. It also showed how selective breeding is being done in select areas.

On the other hand, the respondents stated that the national R&D involvement is 'too centralised', which is concentrated in '*few laboratories'* and pertains to genetic engineering. Small rural farmers in Pakistan wants equipment-based innovation through local R&D that Pakistan national-level R&D lacks.

As an interviewee showed his concern, *"Technology in dairy requires investment and R&D at internal level is not possible due to lack of knowledge. The quantum jump in the dairy technology in Pakistan in terms of dairy equipment is restricted to bigger dairy enterprises concentrated in the hands of few and located in urban cities. The lack of technology penetration for small dairy farmers in Pakistan is an opportunity missed in national development of this sector. The industrialisation of dairy sector therefore did not happen, as compared to other sector, due to the fragmented small dairy farmers in rural locations. This has led to widening the milk demand in urban rural divide, as technology based cold supply chain is not there, neither raw milk production processing at rural sector exists, and zero provision of huge milk storage facilities at the national geography level.*

It is a cross-disciplinary field that requires engineers in Pakistan and food processing technology to collaborate in R&D for meeting the needs of small-scale milk processing equipment designed for small rural dairy farmers. "Lack of systems', and 'centralised' form and nature of R&D in Pakistan presents a problem as the system of identifying the problems, its feasibility and viability to come up with a solution still are very nascent. The national R&D is concentrated in few areas around the laboratories in genetic breeding; even though the responses show that '*they do have access', 'for many small dairy farmers, it is a lack of knowledge that R&D happens in the dairy sector awareness about its existence*. Implications for the role of national R&D, which restricts the development to itself and does not conduct surveys to understand the nature of innovation required to be researched, is itself a gap in the national policy and its action-based programs. The national R&D need to visualise the small dairy farmer requirement of processing raw milk at home' *pasteurisation, distribute animal vaccines to every rural pocket, support genetic breeding and devise new equipment* using 'biomedical engineering' discipline as the respondents referred these in their responses significantly when processing technology, harnessing resources and technology is considered a gap. It applies to all "*large, medium and SMEs are operating are not able to grow and rise to their full potential"* as the large dairy industries privately held rely on western technology while the small rural dairy farmers require national R&D mission to aid in technology-based innovation.

The third factor is *'innovation in SME'*, which states the nature of the sector and surrounding factor that influences its growth and development. The role of SME is directly the next step in the dairy sector, when 'home based rural dairy' is a traditional the civilisation has grown up with.

As an interviewee commented that, "*The lack of industry support in development SME based model through entrepreneurship is evident in the rural areas did not take off, due to lack of political interest while urban development happened in selective areas. The failure to understand the dairy industry as an inclusive consumption economy for Pakistan as a nation has been prevalent over the years. This has impacted the rural development in terms of technology and innovation that is centralised in the Pakistan failing to comply policy based distributive model for greater good."*

'Small players in the rural geographies have limited animals and engages in a typically small family-based business', is relevant for the rural belt, as it caters to the rural market only, meeting

needs of the local rural household. The transition from home-based entrepreneurship, typically a '*family held business'*, suffers from '*lack the knowledge*. The 'rural sector is not aware neither the institutional policies support their entrepreneurship venture', and lack of awareness is restricting the rural small dairy farmers from migrating to the SME model. IN GENERAL, the SME sector, particularly in Pakistan has been neglected, though arguments supporting the mainstream sectors have been perceived. SMEs depict a higher level of power to negotiate with the bank, an entity that delineates from home-based entrepreneurship, making the business model of dairy official." process of funding for a new business start-up shows a great level of economic mismatch of existing business model and projected venture" is a trend that is hard to ignore as SME sector trend and banking rules for the dairy sector seems to be different. It has been evident from the banking and financial institution which is not willing to grant financial help to the small home-based family dairy business, but can honour the same for SME, proves the cavities in the Pakistan SME model." *model to suit the rural areas, as such as the SME lacks thrust in Pakistan.*

In contrast, the owners of small-scale dairy production plant, the ownership, the profit percentage, financing the entire venture is still a grey area", show that the risk of financing overlooks the rural dairy model of business particularly when the home-based start-up is trying to transform to become an SME in the dairy sector. "*Pakistan banks lean-to manufacturing lending, and not towards dairy sector"* is a core issue that failed dairy entrepreneurship to take off at rural areas. However, dairy has never been considered a sector regarding ROI (return on investment) by financial institutions addressed in the literature review. In contrast, the unorganised nature of rural small dairy farmers has been a point that financial institutions try to ignore. SME as a structural entity requires many small enterprising dairy farmers to unite with a financial contribution. Examples in the literature review show' lessons from the western world show a mix of planned development with the public, private and PPP (public private partnership) working in the dairy sector. However, the question remains open as the level of innovation to assist the development of milk processing in the SME sector requires an institutional model-based approach in real-life testing before actual implementation due to uncertainty in SME sector survival in this domain.

The fourth factor is 'workplace innovation', which pertains to the small dairies in rural settings that use home-based methods and techniques to find localised solutions. The families involved in the traditional method of hand-based milking of raw milk daily are likely to find solutions to the

challenges at the processing level. The evidence in the '*rural farmers lacks as a home-based institution to provide solutions for milk that is commoditisation, in the market' implies that raw milk finds its users only in a rural setting.*' Lack of innovation due to limited knowledge at the workplace faces a challenge due to lack of technology inclusion and awareness compared to *'modern milk factories operating in Pakistan*.' While it is also evident that humans seek efficiency, the two most important factors that strongly emerge in shaping the future of rural dairies of Pakistan are – '*lack of milk processing technology and absence of packaging makes their effort in rural side unviable to market their products,* and '*absence of supply chain capabilities to urban markets of Pakistan'*. These falls back on the rural farmers' inability to meet national dairy demand (volume, type) parameters, which workplace innovation is unable to meet. The above factor is closely linked to knowledge and technology infusion at a small scale, directly impacting the 'rural infrastructure needs, entrepreneurship provisions with easy financing from the banks'. The respondents stated that '*demographics of rural using traditional practices and methods in all their professions to sustain the living portrays a stark difference'*, which points out the gap in the rural-urban knowledge, awareness connect in the dairy domain. It also shows the negligence from surrounding stakeholders to consider dairy a livelihood to be" rural professions like dairy and agriculture is very primitive due to manual methods.

On the contrary, the rural dairy farmers require, 'fragmented rural dairy farmers milk production requires the support of village-level aggregated milk procurement and processing 'pasteurisation' to increase the shelf life of the milk. Therefore, the home-based solution or workplace innovation falls short in technology perspective or innovation perspective that links the national level R&D inclusivity for all in the dairy industry. This factor has a lesser reference in responses as respondents are aware of their home-based innovation capabilities related to dairy, proving that traditional methods are still being used.

The fifth factor is '*dairy sector innovation'*, as Pakistan has large dairy manufacturers, with both public and private (Nestle) existing in the market. The responses show a higher level of mentions, and its relation to other factors in innovation is extremely important to bring about all-round development. The responses clearly distinguish larger established dairy enterprises and the unorganised small dairy farmers in dairy sector innovation. The technology used in automated dairy equipment is limited to larger firms, even though the volume of aggregate milk from small

dairy owners in Pakistan is the highest. The irony of non-processed raw milk and its consumption dynamics related to small dairies' markets is a limited function. The absence of new techniques in milking, milk preservation in rural dairy shows the prevalence of the traditional methods in the 21st century, as the folklore of the family held methods are followed. The adaptation of new methods in the dairy sector requires a 'vision and exposure levels', and knowledge linked to other important factors like 'harnessing capabilities, leveraging capabilities that show rural dairy capabilities'. Though it cannot be linked to technology, non-technical methods without equipment refer to 'processing technology' referred to as a '*challenge'* by almost all respondents in this research. It helps us conclude that the sector has rural milking technology and large enterprises modern milk processing technology that sets the two extreme perspectives in Pakistan even today. It also shows the research direction to identify it as a gap and assess the current parameters required to close the gap. The institutional model show, *'rural voice as a small dairy farmer did not echo the government, financial institutions* and became a muted voice over the years. It is one of the reasons why the rural dairy sector has failed to take off. The reference of Pakistan government schemes is important for discussion here, as evidence like *'inability to engage in a consensus and network management to align similar thinking small dairy farmers'* shows both sides cannot connect. The responses of '*the policy frameworks and inaction due to paucity of the funding model that has resulted in the concentration of dairy technology few private players'* bring up the reality of the dairy sector, which is a structural issue followed by action plan implementation failure. The issue is hard to resolve as principal stakeholders like *'Government feigned ignorance'* and apathy towards developing an enterprising structural model for pan Pakistan economic development in the dairy sector has been missed. This issue is particularly about the literature review, which shows the total volume of daily raw milk production from small rural farmers. The marketisation opportunity is huge (demand and supply gap). It is also related to enterprise-level innovation, national R&D, structural level innovation required for rural dairy sector associated factors to grow and benefit rural farmers, Pakistan's economic model towards sustainability. It has emerged as the most important theme from the response frequency, as both micro-level (rural areas) and macro-level (national economic support) dairy play a critical role, which the stakeholders in power have ignored for a long time.

The sixth factor is 'people innovation' with a score of much less, as it links the 'vision and exposure' of the rural small dairy farmers to be absent. The role of technology and innovation is critical, but

it depends on people's minds and perceptions about innovation acceptance in the dairy sector. The picture presented by the respondents in Pakistan shows linkages to organisation structure innovation, continuous improvement, and workplace innovation. The people innovation factor can be linked to the theories of innovation mentioned in the literature review, open and close innovation options. While this is a critical point, the contribution of traditional practices at workplace innovation does not suffice, as the culture-based practice is considered appropriate, unless the technology (innovation) brings in more efficiency than that of current practices. The people innovation is limited as the practice is socially known and shared. The aspect of factor' *techno know-how adoption capabilities'* at the dairy sector in rural Pakistan is limited, as the opposing force of 'manual old methods of dairy practices are age old' looms large. The relation is evident from the matrix of these two factors. Still, it is also important for manual milking, raw milk processing, milk shelf life, or even herd (cattle) health from the future of rural dairy potential implications. The economic participation led by *'people'* based movement, cattle herd as an asset has not gained momentum, which Pakistan national policymakers have missed linking due to stiff structures and policies failing to develop a model created, scaling up in one area, replicating in another pan Pakistan location, neither conduct nationwide consumption centric economic analysis to achieve sustainability.

The seventh factor is '*organisational structure innovation',* which relates to the family-based loosely integrated model, perceived as unorganised by the established stakeholders of the society (financial organisations particularly). The factor shows the need for improvement '*structure of innovation in dairy sector' that relates to the form factor required for institutional level innovation to benefit the current unorganised form of rural dairy sector*'. Secondly, it also shows the need to support the *'open innovation'* format that is beneficial for increasing the level and rate of innovation at *'national R&D'* institutions. Responses like '*Dairy sector is dependent on many stakeholders and not finding the support from the critical sectors like financing options, govt support, transportation has failed the development in the long run'* seem to confirm that the presence of a unitary model of organisation that serves the interests of rural dairy farmers is now imminent, as it can leverage the demands of small rural dairy farmers. So, 'from critical institutions like laboratories, medical health department, industry associations for SME' require a force to create a new structure in the rural dairy sector for small herdsmen. Literature review relates this movement in every sector that has had happened in civilisation as industrialisation has led to automation, that

is evident from large enterprises using milking technology, processing technology and food preservation technology. '*Lack of entrepreneurial support for the rural farmers'* is a deadlock while the argument of" *requires the knowledge and technology expertise that is an application* is also true. The extent to small dairy farmers can relate to the '*new organisational structure model'* is low as a gap of traditional and modern methods of milking has huge strides in technology, which has been echoed as *'technology and not highly advanced automation in milk production, which will be beyond their control'*. The organisation that sits between small rural farmers procuring daily inputs of raw milk and the processing using food preservation technology is ideal. It helps to keep value and cost factoring to produce output that can find acceptance in Pakistan urban society. Maintaining the rural sustenance model, '*rural consumers who are attuned in consuming the raw fresh milk'* could see, '*allows the raw milk to undergo pasteurisation that is fit for storage and safe consumption'* as a welcome change was beyond their control as an individual small dairy farmer. The new entity of organisation guided by government in a cooperative model (successful in USA, India and elsewhere), overcomes *the 'awareness, lack of knowledge challenges' and monetising opportunities' limited knowledge to produce milk by-product variants'*. The 'new organisation structure' ushers the *'entire operations of milking, animal well-being and management, food and breeding require technology-based infusion'* integrating rural and village level economic development, bridging the economies with enhanced *'rural infrastructure needs, entrepreneurship provisions'* as per respondents.

The eighth factor as a code is 'continuous improvement', as it has been found to impact the dairy sector innovation, people innovation, process innovation (other coded variables). The respondents stated this mostly as 'stagnant' and are linked to '*challenge'*. It has been referred to as 'common challenges for the rural population is the same, and the government has not been able to resolve with institutional help, for farmers, rural dairies. While some of the respondents argued that 'technology-based knowledge in a rural area' also impetus it as gap, help government formulate policies, and announces socio-economic development schemes. 'Continuous improvement' however, faces default challenge from the people innovation, as all of the rural farmers are limited to lack of awareness, traditional practices referred to as" *overindulgence in manual methods of the milking process, traditional breeding, is perceived as the existing experience of rural farmers that is very basic".* Another perspective that emerges strongly is that being an *informal, unorganised sector impacts the progress." At the same time,* respondents also referred to 'The inability to engage

in a consensus and network management to align similar thinking small dairy farmers', which failed to garner momentum at the elemental rural level of entrepreneurship. Adopting technology requires individual learning pace and willingness to unlearn old and take up new. Hence the inability of farmers to develop consensus and take the initiative to adopt new technologies' *small dairy farmer is deprived of knowledge as their outlook and orientation are small'*, practices for milking, milk processing, or entrepreneurship are those challenges that ultimately led to a dairy process to adopt 'continuous improvement'. It is evident that failing to continuously develop, '*bigger disadvantage for small dairy farmers as rural-urban divide presents supply chain transportation challenges especially when milk is perishable'* that is hurting the rural economy, rural dairy sector and its people in Pakistan even though they are over 50% aggregate milk producers by volume.

The code 'process innovation' is related to the different processes involved in the milking technology, which is the entirely traditional method of hand milking practice. It was referred to in close connection with the dairy technology mostly as the respondent conversation hovered the importance of changing from manual to automated (without hands). The dairy technologist in academia stated the chances of contamination. At the same time, it has been mentioned several times as a 'challenge' for small rural dairy farmers due to limited 'tech-knowhow and adoption capability. Process innovation is also figured in '*process technology'* semantic analysis as milk extraction (milking technology) is one manual task that keeps the whole family busy in rural dairy. While it needed to change *'leveraging'* automated processing plants, the technical challenge of addressing the small volume of a dairy farmer found a barrier in the 'continuous improvement' quest. No appropriate machine exists for home processing, while the market demand for 'processing technology pasteurisation of milk', packaged is rising (demand perspective) in urban Pakistan. The inability is expressed as '*vision and exposure'* in the qualitative code semantic analysis. Challenge is only in *'process'*. None of them wants to change traditional milk against modern practices, a process innovation that ensures visible, tangible benefits and output (efficiency and productivity) at a home-based setup.

The 'product innovation' code discussion prompted many of the respondents to express inability in terms of know-how for small dairy farmers at a rural level as options and choices for adopting the advanced automated milk processing plant are nil. The '*lack of technology and the challenges of*

adaptation in rural settings require innovation' in the product as well, as it sells only milk. At the same time, respondents showed market demand evolving to milk products that require automated processing to produce variants in the milk products. The realisation amongst the respondent group is strong '*does not own any technology to produce a wide variety of milk product variants, neither any storage solutions nor packaging facility to meet the urban market trends'*. Product innovation at the national level relates to Pakistan's capability to create dairy equipment to cater to the needs of the small dairy farmers in a rural area that faces '*challenge*' and over-dependency on western machinery in dairy processing.

'Entrepreneurship' is a major factor considered a variable in the dairy sector in Pakistan. The dairy model is a mostly traditional home-based start-up or a family business for ages. In the semantic analysis, it has been found support in associated factors in aggregate responses like govt support, vision and exposure and capabilities (harness, leverage, and show). Firstly, the aspect of subfactor of government support has been reflected across all responses. The codes weightage diagram draws correlation in issues like structural innovation in the dairy sector, national R&D, dairy sector innovation, organisational structure innovation, and dairy sector innovation. Thus the *'role of small dairy producer falls short in terms of the spirit of entrepreneurship, as the individual capability to take home-based dairy to the next level (SME) has failed'.* The implication is '*small herd size (1-6) manual milking and upkeeping of the health of animals, that misses the opportunity of higher productivity.* The challenges in dairy sector entrepreneurship are high, as it fails to be recognised as bankable, mostly fragmented, unorganised, which financial institutions do not prefer. From a policy perspective, the government's intervention has resulted in the centralisation of power and infrastructure, while rural entrepreneurship has not found a place of consideration in their decision making. In four areas, govt support has failed, the dairy sector in rural areas development, failing to create a new organisational structure to gain power for rural entrepreneurship model, national R&D to aid the technology, equipment, cattle health defining a new structural innovation dairy sector.

The aspect of '*vision and exposure'* for the stakeholders in the dairy sector has been identified as the key issue here. In most of the rural areas, lack of communication shows limited exposure of rural with urban. Therefore, the aspects of modernisation of dairy technology plant or its availability as an SME (small and medium enterprise) model showing capabilities to process the

lesser volume of milk (million tonnes) per day has not happened. While vision and exposure have found mention in dairy sector innovation in a rural context, the power of rural dairy farmers fell short in financial perspective, mostly to arrange the funds showing the viability of the model for rural economic development or specifically dairy sector. It has been mentioned in *'is a viable model that the past and current Pakistan government has ignored for long, as the economic inclusivity of the milk consumption in rural areas cannot reach the emerging urban population'*. At the same time, the literature review reflects how the government role has brought forced direction and choice in developed nations for adopting new model (structural) balancing entrepreneurship, monetisation, bringing in dairy sector evolution. The policy and implementation-based failure are referred in all respondent groups. However, *'limited development of vision, has found genetic laboratories for cattle gene preservation while it falls short in health (veterinary doctors in rural areas), nutrition-based technology for cattle fodder.* The consequence has been referred 'development is limited to increasing the herd size, with manual breeding, manual milking, and the biggest challenge of the volume of milk production dropping gradually over the years, that shows how Pakistan rural milk production is likely to drop due to absence of vision and exposure of both central government and provincial government.

The *'capabilities'* is an action-oriented term, as developing them in the context of the research topic shows 'harnessing capabilities' that identify and allocate resources. The rural dairy to bring in '*dairy sector innovation'* requires outside influence, people and knowledge related to science and technology. Their power to relate to stakeholder management was insignificant as banking institutions failed to recognise their need for an SME dairy unit encompassing many rural areas and their dairy herdsman. As stated by an interviewee, *"For a country like Pakistan which is in developing state, it holds true as the policies framed also requires, allocation of funds in each sector, that has potential to serve the population and contribute to GDP. P5 argued that domestic consumption of milk and demand of milk products is increasing every day, which restricts the small rural dairy farmers due to their incapacities."*

Failing to recognise the power of milk as a commodity and changing trends of packaged processed milk in urban consumer markets is a failed '*leveraging'* capability on the rural farmer's behalf. Thus, the initiatives and the intent to expand the capabilities to produce more milk in automated systems have faced a 'structural challenge' in the dairy sector as the associated 'people-based

innovation' in rural practices is too primitive. The sub-factors like '*show capabilities'* are divided into '*tech-knowhow adoption capability'* as an '*entrepreneur*' and '*financing capability'*. The first sub factor' *tech-knowhow adoption capability'* has found a lack of dairy sector innovation, people innovation and guided vision from external sources like government falling through. '*Rural farmers, therefore, is not able to harness technology (preservation, packaging) or innovation to aid the capabilities of the home-based milking methods'* is a response that shows the basic knowledge, awareness level and scientific-technological knowledge *'involve family members into the high-level technology is a significant technological leap'* seems to be a huge gap for adoption.

The last factor about the research topic is 'technology' that has been divided into subcodes (variables) like – livestock nutrition technology, health technology, genetic technology/breeding technology, processing technology, food preservation technology, milking technology (extraction), and '*challenges' with 'quality production output'*. The semantic analysis of the most cited word in the respondent shows' *processing technology'* as it has been found to link to 'dairy sector innovation' and '*process innovation'*. Discussions show a demand for a change in rural level voiced by respondents. At the same time, the *'gap of policies outlined and implemented is stark as the benefits are not reaching out to the small dairy farmer every household'* is a reality. The aspect of '*lack of infrastructure development and centralised development of Pakistan genetic breeding technology containing the strains of best buffalos and cows is in the hands of respective ministry'* shows that power is not in the hands of rural dairies while government policies and approach towards technology dissemination to benefit wider masses or dairy sector has been ignored. As an interviewee referred, "*the National level policies in dairy sector and added that it failed as the approach failed to leverage the technology-based infusion in dairy sector to boost the economy. The government failed to mobilise the resources using technology to transform the rural dairy sector contribution the Pakistan economy. Much of it is due to non-friendly policies for family-based herdsman, fragmented small farmers, inadequate cold supply chain to urban cities from rural towns in Pakistan, absence of processing plants scattered in different locations that reduced the chances of feasibility of dairy industry investment."*

Technology domain, therefore, is more related to '*knowledge inadequacy impacts the ability of rural section of the population to accept and adopt technology in the dairy sector as the advancement'* against the other viewpoint that 'SMEs are operating are not able to grow and rise

to their full potential due to mix of technology and innovation. It is evident that 'lack of technology does not allow to store, a process that the modern milk factories are capable of' is a rural-based lacuna. However, the contrary viewpoint shows' *Pakistan urban market is now using dry milk imports from the western brands, with MNCs manufacturing milk products to meet the increasing demands.* The implications are clear as the government fails to recognise technology inclusivity in all-around development for Pakistan, particularly to address '*lack of milk processing technology and absence of packaging makes their effort in rural side unviable to market their products*. It is perceived that the 'concentration of power and development in Pakistan is limited to the urban cities, which is why the rural areas lack the readiness to accept and adopt technology' is a core issue as development and emphasis on sectoral allocation of funds has been emphasised been too partial. Respondents showed evidence of '*The level of investment, inclusivity of technology has been high, in the urban areas, that is opposite in the rural areas*, and most importantly the 'rural professions like dairy and agriculture is very primitive due to manual methods' requires massive investment which requires the structural approach of new organisation model to distribute technology and support stated in an interview '*the need is to set up a structural system that has government stake, and it benefits the small dairy farmers in a particular region.'* The inclusion of three or more rural villages of Pakistan procuring milk every day is a new dairy model which has undermined the '*capabilities of technology adoption in rural small dairy farmers to achieve operational efficiency of an automated production system.*' Academician as a dairy technologist has mentioned, '*economic viability of maintaining the herd and growing the strength to meet entrepreneurship level requirement in Pakistan'* requires technology and innovation to suffice the needs of a small-scale milk processing plant. The government has failed *'lack of the integrative scientific research in technology and innovation rate'* to take up the 'challenge' of 'rural dairy industry is scattered which means that in geographically mapped results it is more fragmented with pockets of the population who has been engaged in the family business and is prevalent in every village.

5. CHAPTER 5

DISCUSSIONS

5.1 Introduction

This chapter underlines the responses from two data collection methods, quantitative and qualitative. The former is administered to small dairy farmers of Pakistan, while the latter is about an open-ended theme-based approach adopted to elicit opinions from SME dairy owners, political representatives, and academia. The plan is to get an all-around opinion about exploring the problem plaguing the small rural dairy farmers, the opinion from the policymakers of the Pakistan government, and lastly, as a consultant to the academia in the dairy technology field.

The criticality of this chapter rests on the discussions that attempt to understand the reality and aim of the research to be fulfilled in the current context. The respondents' claims and opinions are free-flowing and capture their past experiences through the open-ended interviews conducted with three different stakeholders related to the research topic. The respondent group that has used surveys is large in number. Hence, distributing a closed-ended questionnaire has been adequate to capture the diverse responses regarding the topic variables discussed in the literature review. The demographic characteristics of the respondents are mostly aged rural people with basic schooling literacy, engaged in a business which is a family-owned start-up or business that their forefathers established, lives in an extended joint family. The above characteristics of the quantitative survey group of respondents show that irrespective of the nature of business, background and education, their ability to understand the issue and explore the options that positively contribute to the research study. The outcomes of the qualitative and quantitative research questions are synthesised with the previous research accomplished by the researchers already discussed in the literature review.

5.2 Discussions

5.2.1 The current State of Technological Innovation in Pakistani Dairy Sector

Most of small dairy farmers of Pakistan responses show a distinct trend of being deprived of the technology. They are tuned to traditional milking practices, milk preservation and creating a market that meets local demand-supply volumes. It is the outcome as there are developments in laboratories for genetic testing and breeding, milk contamination testing centres but not available at pan Pakistan locations in rural areas. Therefore, the national policy towards bringing in the force and momentum of 'continuous improvement' has not benefitted the rural dairy farmers due to implementation inadequacy. The sector has been ignored from an institutional point of view, as it requires a new approach, 'organisation structure innovation' in the Pakistan dairy context. Findings show the low power of rural smallholder dairy farmers against the institutional forces of technology providers like the government in terms of reach and access.

5.2.2 Factors Affecting the Technological Innovation in Pakistani Dairy Sector

Most importantly, financing rural dairy businesses presented an immense challenge. Applying the Schumpeterian viewpoint, the ability as a nation to develop depends on the technological and innovative capabilities, and in Pakistan, the grassroots level development lacks in rural areas. The basic amenities of education, electricity, water supply, health and hygiene have shown muted progress in rural Pakistan, compared to urban areas, which is why bringing in innovation (open) need to break free from the bureaucratic (closed) innovation model. The amalgamation of technology and innovation in the socio-technical dairy sector innovation model would require people and processes to make production happen at the SME level.

Firstly, rural dairy farmers' orientation depends on their existing practices learnt from generations and exposure through education about new practices in the dairy sector. The rural setting of most family-based small dairies, however, limits the scope of education and knowledge about the latest dairy technology practices that have evolved over the years around the world. People innovation is mostly traditional practices that impact product innovation and process innovation directly. There is a processing technology to be scaled down to SME level dairy processing, need technology and innovation to have experimented, which will happen with resource harnessing.

The rural farmers, government (central and provincial), and institutions adopt organisational structure innovation to adopt new technology and processes in rural settings. Examples of developed and developing nations like the USA and India show national policies to be supported by the government, develop approaches for 'tech knowhow' adoption capabilities, and achieve 'absorptive' capabilities in rural dairy farmers based on traditional dairy technology knowledge.

The rural dairies of Pakistan cannot access the following technologies that significantly impact the quality of fodder for the animals as the grazing options in harsh climates are not available in Pakistan, unlike Australian dairy animals. The absence of technology and the rudimentary milking practice by hand and involvement of the whole family make this model viable only in the rural sector context in Pakistan. 'Processing technology' at small rural dairies with limited herd size is a challenge. Hence, the entrepreneurship to scale up required it to develop (scalable model) to benefit the thousands of rural dairies. This factor requires greater involvement in understanding the dairy technology and social process in rural areas to scale up and scale down and meet rural farmer needs. The value is still unexplored as the capability of rural farmers being nil requires understanding the rural farmer's needs, explore and exploit the rationality of milk processing plan investment in an area. These are structural changes that are needed that is evident from the responses, though bringing in the solution requires greater institutional, technology and innovation collaboration to overcome the challenges. The systems approach is needed in managing the stakeholders, inputs-processing, and outputs to be adopted as a new social model.

Secondly, the growth prospects of rural dairy farming are limited to the increase of animals in the herd in the family-owned business in rural countryside, as the milk production waned over the years. The rural dairy farmers do not have access to advanced level selective genetic breeding technology as the urban-rural divide and national policies are not conducive enough for rural penetration. The availability of medicines for all the animal diseases at the rural level is not available that hampers daily milk production, and rural dairy farmers must rely on traditional animal health and well-being methods. Responses from political representatives have corroborated it as a structural failure to address the woes of rural small dairy farmers. It also shows the missing link of economic development at local villages that have been missed largely on account of infrastructural and communication development not happening. It also confirms the responses of the small dairy farmers of Pakistan, who stated similar challenges in terms of policies that have

not made any difference in their dairy sector, leaving no alternative solution. Still, it continues its traditional method of hand-based milking. The concept of growth or development has not been reported at any stage of dairy processing units in the rural areas of Pakistan.

Thirdly, the absence of technology in milk production and processing has affected downstream processing like packaging, storage, and transportation. The challenges are processing inability for the small dairy farmers as the traditional model has forced to shorten the shelf life of raw milk. Lack of storage technology with temperature control does not enable the rural dairy farmers to use the cold food supply chain to market the output in Pakistan's urban areas. There has been acceptance of the fact that powder milk from west imported is flooding the market. At the same time, people prefer traditional milk as a consumer, stressing the absence of a supply chain for production to consumption value add to happen. Thus, dairy value chain connecting the rural producers and the urban consumers is still an unexplored area in Pakistan. This issue links the movement of the flow of milk at one point to other. Technology is a significant factor in the know-how, as awareness is built on exposure and impacts processing capabilities. The existing practice-based approach is devoid of processing speed due to a lack of innovation in rural dairy. The innovation to increase it brings in faster-processing speed; neither the processing methods have a healthier approach to eliminating contamination. It is important as a manual method of processing stages like milk extraction requires eliminating human contact in the traditional method. The absence of the above technologies has impacted Pakistan's rural sector to be dependent on traditional mode of practices that has been relied on for generations. The state of art processing capabilities in modern dairy plants in Pakistan, specifically in the urban areas, are owned by MNCs and private players that empower them to market milk by-products. Both academia and political officials have acknowledged that it shows a skewed growth towards manufacturing SMEs, ignoring the potential of rural milk supply to meet the growing demand for milk and milk-based by-products. However, small dairy farmers expressed process-based challenges in ushering modern methods through entrepreneurship in rural areas.

Fourthly, the situation in the rural sector is challenging as they do not have access to technologies that allow small dairy farmers to engage in the pasteurisation of raw milk. Their inabilities in knowledge are also one of the reasons, SME level start-up has not been able to penetrate for establishing a venture. They also do not have access or learning skills to adopt technology in the

everyday milking process. To process milk in SME scale equipment, they need the knowledge to maintain and store the milk has not happened for that model to be replicated. Again, their orientation of mind towards the aspect of quality that defines the factor' safe for consumption is a challenge. Due to the absence of knowledge and traditional practice prevalence, even the financial institutions are unwilling to disburse the loan to rural dairy owners. All the above is dependent on technology knowledge, while traditional practices are too basic. Learning about new practices involving technology at various stages of dairy processing would take time to adapt and assimilate. The elements of technology in the local milking process in rural areas of Pakistan did not have exposure to modern methods of milking, electricity-based processing, as maximum rural villages are not electrified. It can be concluded that much of the traditional milking methods, milk processing, suits the rural way of living; the ability to produce milk-based sweets as by-products depends on the traditional method of practices followed for ages. SMEs in the dairy sector against the other industry sectors have been looked down upon, though the developed and developing nations have embraced SMEs as an organised model to finance dairy initiatives and development.

The fifth factor is that all stakeholders have expressed knowledge about the aspect of national dairy policies by the successive governments in Pakistan. It raises the question of the level of assistance in policies, budget outlays, and action plans to penetrate deep inside the rural areas of Pakistan has been missed. Policy-based inaction in scheduling activities, developing strategies to support the dairy sector can be concluded as the absence of technology in the entire rural dairy sector is evident. While this has been rudimentary, the responses showed that, even though the small dairy farmers have tried to venture as an entrepreneur to increase the family-owned business is limited to increase animal strength in the total herd. The stress on milking regimen on the animals impacted long term health, as local practice and even breeding is not scientific, resulting in a steady decline in the volume of milk. The rural farmers engaged in the dairy sector are aware of the national dairy strategy of Pakistan, as the initiation from the central government at the Federal level shows a policy-based framework that is already in place for years. The policies have been modified as per the current situation in the nation, and initiatives to push the home-based industry in the dairy sector have been neglected as development in terms of technology or innovation at the local level has not happened. It can be concluded that policies not being actioned by the provincial government to reach rural areas have stagnated the development rate. Even the option of home-based dairy activities to shift towards SME (small and medium scale enterprise) has not happened.

The issue has been countered by views expressed by politicians as cooling tanks are provided. In contrast, embryo transfer has been done, along with establishing animal disease reporting and epidemiology with dedicated response team's setup. However, only in few provinces like Punjab deprive the rest of the rural areas in Pakistan.

The sixth factor is that the rural dairy farmers are aware of the policies, though that is evident at the central and provincial government levels. Rural dairy farmers cannot realise the benefits due to a centralised form of power that failed to provide rural thrust in action-based outcomes. The rural customers' rural needs are localised, supported by the existing traditional methods, practices, and knowledge. The lack of milk production technology for a small dairy farmer operating in a small village has limited their growth, and innovation is too basic at the rural level. The supply chain is short, with fresh raw milk being supplied to the local household in milk cans. This traditional method of milking by hand and can base delivery to rural homes does not require technology. It is their way of life and propagated as family-owned knowledge for centuries. The issue about business venture initiation and training availability about processing knowledge has an evident gap. As per the political representative, the lack of breeding knowledge shows that initiation from the government has been done in distributing embryos in select provinces as an experimental basis to the livestock farmers. The same model replicated in 7 rural areas has been extended for veterinary health services for the animals, as an extension of service, leading to service improvement like quarantine. The implications of development in those rural villages of Pakistan have not been extensive, as there is a cavity in the animal fodder, especially when nutritional management domain for the rural dairy owners, neither any initiative from the government is evident in the lactation management keeping them free from the stress of daily milking regime.

The seventh issue is that most dairy farmers in the Pakistan rural hinterlands are scattered in their geography and are using the above methods to serve the rural population. The government attitude towards the sector is limited to the development concentrated in the urban areas. While SMEs are the drivers of growth for the economy, it is skewed towards the manufacturing arena. The dairy sector, perceived as a cottage industry serving rural customer needs, has been neglected on the development radar. The national-level strategy for the dairy sector or SME initiatives in the rural sector has been stagnant. The visible support in terms of infrastructure and training has been

absent. When the concept of development and growth is discussed, most of the small dairy farmers in rural areas are looking to expand the home-based business. The responses show the structural gap of the rural dairies in Pakistan against the planned outlay and the achieved status that has missed continuous development paradigm through the provincial states. The evidence shows that dairy is an ignored sector, where the economics of devising a plan to boost the local economy has been a missed opportunity. The small dairy farmers have been facing numerous challenges, ranging from establishing SMEs, financing options from banks, availing technology to develop capabilities in processing at a rural level has not materialised. Even though small dairy farmers aligned their output to the market-based demands, the use of technology to expedite processing qualitatively or quantitatively in dairy volume has not reached rural areas. There is a stark divide in urban milk plants in Pakistan with private money and MNC technology that has met the market-based demands in urban areas. However, the existing rural milk production by volume and quality is unable to meet the international standards or 'safe for consumption due to manual milking methods. Lack of efficiency due to technology has been evident as a structural gap in rural dairy firms, even though the statistics show that fragmented owners in rural Pakistan account for around 50% of the aggregate volume of milk production. The responses from both the owners of small dairies in Pakistan rural belt and the factors that have been challenging them to adopt technology-based solutions have also been echoed by the academia and small dairy owners. It shows that in the Asian context, where the dairy farmers mostly have a small herd, it is important to devise a model organisation that acts as a nodal body. The responses from the academia stated that experimentation at the rural level with a nodal enterprise offering breeding (genetic) technology, automated milking system, processing of milk (pasteurisation), veterinary doctors to serve at least three villages is an ideal model. The discussions about forming cooperatives, an example of milk cooperatives from the USA, a developed nation, and a developing nation like India, have been cited, which has met with success in the dairy sector.

The strategy adopted for growth and development in rural small dairy farmers is increasing the herd size. Even the stress of milking regimen daily impacts animal health and well-being. The lack of support in terms of herd medical help for the unexpected infections in buffalos is a cost to the farmers in Pakistan, especially in rural areas which do not have easy access. The responses typically show a lack of orientation at knowledge level and awareness. In some cases, the access to such technologies for the rural farmers in Pakistan is a challenge. In the entire spectrum of dairy

enterprises, the segregation of animal breeding, well-being and health is important, along with milk extraction and processing capabilities into various milk products. It can be concluded that rural farmers have none of these, as all of them require to learn new distinct processes based on one or more (interdisciplinary) studies based on research. It translates to the level of technology embedded in the scientific research and the technology domain and the rendering efficiency and effectiveness in overcoming a previous practice method. There is evidence of an adequate amount of technology like Pakistan's programme in isolating specific strains of the gene of buffalos which are of high yielding variety or disease resistant. It is cross-disciplinary research undertaken at the highest level by scientists of genetics, biotechnology. Milk extraction systems and milk processing systems are prevalently used in large scale enterprises in Pakistan. Again, the availability of medicines and fodder with nutritional management for animal health is also prevalent. The respondents showed a mixed overview of their perception of strategies which has been deployed. While owners stated that an actionable plan was never implemented, not even adopting an SME-based model for addressing woes of rural dairy farmers, experimental models in 7 rural villages of Pakistan have not been rolled out either.

Most importantly, small dairy owners and government initiatives as powerful initiators have faced structural challenges in bringing technology into existing practices. Even though the market has moved towards a higher maturity curve, the usability of the rural milk produce in contributing to the national milk consumption of Pakistan requires a tremendous amount of transformation. There are world standards to be maintained in milk processing composition to make it 'fit for consumption' and end-to-end technology-based devices to achieve 'safe for consumption. Both the parameters are missing in the rural milk production process as human touch in traditional milk extraction methods is prevalent, increasing the risk of contamination. The rural dairy farmers at the individual family level cannot access technology, impacting their marketability of huge aggregate volume of milk to lose its significance in Pakistan consumption economy. It is pertinent as urban consumers consume a variety of milk products as the life cycle curve has matured, due to the presence of a wide range of milk by-products from the manufacturers. Dairy technology domain academics have raised this issue as the gap between traditional processing, and technology-based processing is huge, and providing nodal enterprise handling problems of rural dairies will not suffice. The reason is the individual level learning curve challenged with the aspect of practices to be adopted, all of which are technology centric. It is a challenge for the rural farmers,

and hence participation from the government in training is needed to keep the model viable and support rural dairy causes. It is pertinent in equipment maintenance, animal welfare and breeding that requires guidance while it also helps in identifying gaps in adulteration in the rural milk supply chain in Pakistan. The criticality of a model enterprise in a catchment area of rural villages needs to be economically viable. The government respondent stated a strategic location to be ideal for the technology and innovation to be disseminated. The training led technology transformation over time is ideal as the rural dairy farmers need time to assimilate practice-based knowledge at a functional level. Innovation in milk procurement from nearby villages requires storage cans to reach the nodal unit to engage in pasteurisation.

5.2.3 Suggestions for the Sustainable Technological Development:

The above challenges of technology and adaption to the rural area requires innovation. It is a capability based on technology and knowledge that the urban milk processing companies have harnessed to access the markets in urban areas. The lack of awareness and prevalence of traditional methods of processing milk in rural areas aligns with the rural nature of milk-based by-product demand that does not require technology. However, both the federal government and the rural dairy farmers are oblivious to the increasing demand for milk due to population growth. At the same time, animal productivity decreases annually due to milking regiment stress. Thus, a solution to overcome the vast range of challenges at the socio-technical level is important as it is tough for rural home-based dairy farmers to understand the range of technology and their applications in existing practices. The dairy farmers suffer from an SME based support which can process a rural level small volume of milk processing requirement 'pasteurisation'. It is an intensive and automated technology, but lack of knowledge to obtain SME license, financing, technology to produce variants of milk by-products also require the market readiness to accept it. The responses show that both sections of government representation and academia support a cooperative or inclusive cooperation model. The rural level innovation to overcome the challenges is the improvised version that depends on activities' role, the intensity of involvement of small rural dairies to adopt new ways of processing, and technology to be modified slightly to achieve the operational goals.

The question of end-to-end processing capability with technology is critical when rural milk supply meeting quality and hygiene standards are packaged and is deemed fit for urban consumption. It

is a supply chain value addition in exploiting the rural dairy sector contributing to the supply of the unmet needs of rising urban consumption levels. It is a sudden transformation of rural milk producing capabilities using technology to reach a new market. However, to maintain the milk processing quality, sustainability to the rural economy that the federal government has missed focusing. The issue is pertinent as rural production at the aggregate level requires an extensive end to end technology infusion to enable better processing. The role of the nodal agency that process pasteurisation for the catchment area of 'n' number of villages requires to be educated about the milk preservation techniques in transit and at home with approved vessels. As per an academic dairy consultant, it is important to issue training on milk adulteration and its acceptance in urban markets of Pakistan.

Linking the capabilities of the rural sector, resources available and marketing the output for acceptance is an innovation in value chain and marketing. The emphasis of finding an appropriate approach to process the entire spectrum of dairy-related activities having been missed can be structurally addressed with collaboration between the stakeholders. The rural orientation to adopt best practices for improving milk quality, from milking to packaging, requires a fundamental change. It needs to meet the qualitative parameters of standardised milk packaged for urban milk consumption requirements, which helps the small dairy farmers adopt a process to reach bigger urban markets in Pakistan and sustain the process over time. It is creating inclusive consumption avenues with the local economy (domestic economy) that aids in employment creation directly and indirectly through the model's viability depends on a bigger issue of procuring technology to aid and assist at every stage of the dairy industry. The dairy technology's academic assistance and consultation asserted that the government official failed to refer to this model. It shows the gap in the thinking as the best practices model around the model shows the government-based assistance, to the dairy sector in rural and town, countryside as an evolutionary model for almost major countries which has focussed on dairy output to feed the national population. Barring Australia and New Zealand, which have abundant grazing land and high productive jersey cows, many nations have adopted routes with localised innovation and technology adoption to benefit and achieve national strategy on the dairy sector. When challenges are immense, collaboration is the best model to harness resources.

In contrast, the rationality of the scaled down version of the SME dairy model needs financial justification that requires a higher volume of milk to be processed for nearest rural villages. This structural positioning would also help distribute genetic technology breeding practices, nutrition in fodder, health, and hygiene of cattle herd to be addressed in the collaboration model. It structurally disintegrates centralism in the existing approach and distributes knowledge (technology, innovation) to provinces and rural areas, easily acting as a hub.

It is critical for overcoming the challenges identified in the responses in small dairy owners and has been suggested by the thematic qualitative responses from academia. The absence of the power of fragmented rural dairy farmers is evident, as the lack of dairy SME flourishing in Pakistan is seen. Forces act on the small dairy farmers, as development or growth is synonymous with the investment factor. The lack of access to technology like selective genetic breeding for the best productive buffalo strains is a big support for milk production's failing yield. The lack of Pakistan's government and provincial government failing to address the rural dairy farmer's woes has been evident from responses of the interview that acknowledge the inability to harness technology-based solutions for this sector. As reported by the dairy technology academic, the level of innovation required is open as it requires the involvement of the diverse stakeholders as the rural landscape of the small dairy business dotting Pakistan requires much more than the standard solutions. The academic responses stated to adopt rational practices and add value to the existing practices, learning curve and embed technology, which is the final goal. In the interview, the small dairy owners expressed their experiences that serve as a guiding point for bringing in the change. Thus, it is not only the structural element of establishing the nodal organisation to serve a wide catchment of rural diaries in Pakistan villages but the longer goal of the operation that involves milk extraction, milk storage, milk handling in transport to be standardised as per available options to prevent adulteration and contamination.

Though the range of problems in rural areas of Pakistan is typical and distinct to the geographic location of the village in the province of Pakistan, there has been no overture to resolve these at the elemental level in a rural perspective. The use of innovation in thinking and exploring the models of other developing nations, budgeting by the central authority of Pakistan has not been accomplished and echoed by the government official, small dairy owners and dairy technology academic the solution to use technology outsourcing from diverse stakeholders who are directly

and indirectly associated to rural sector dairies. The responses show that the government failed to take a leaf out of many real-life examples from developed or developing nations and follow different models of dairies available globally. It lacks policy-based implementation or inability to focus and mobilise mechanisms favouring rural areas, SME sector, and dairies that are small fragmented from the Pakistan government. It can be concluded that even though the federal government assumes central authority, it is unable to use power and establish a solution to boost rural or develop the dairy sector as an industry. Education's role in bridging the knowledge gap also requires showing how technology is a critical driving factor in changing the business operations pattern.

The traditional milking practices must be unlearned, and the adoption of new methods of milk processing with the nodal agency serving as a common point for all the small dairy farmers of multiple villages require a greater level of communication. The provision for aid and support to all the small dairy farmers in every rural village of Pakistan is a solution if milk producers are involved in finalising the nature of vested powers, interests, economics of operations and outcomes in terms of benefits. It requires innovation as it is not a company registration that can accomplish the purpose but through creation of a cooperative model that brings in social participation and equality of ownership in the entire venture of the dairy business. The issue is important for the above research outcomes as the ownership of business, income, and contribution is subject to discussion by the stakeholders. The small dairy farmers' response shows the government's apathy, but they, the institutional head, have access to technology, power to influence to innovate a model organisation. The response of the government official in dairy stated that experimental basis work has shown moderate success in breeding, animal health, fodder and is yet to bring nationwide innovation in adopting technology for rural level dairies.

The responses have echoed the existing demand supply mismatch in rural and urban divide show that small rural dairy's opportunity to participate in supplying to urban Pakistan aggregate milk needs is still there. It is a cash cow sector, as changes in lifestyle demand packaged milk and milk-based by-products that small dairy farmers in rural areas contribute to national milk production volume (over 50%). Unfortunately, the responses from the small dairy sector show the inability at the structural and functional level to meet the national demand for milk due to a range of practices, particularly lack the direction to execute the strategy as per the national plan. Not many are aware

of the government level experimentation of the nodal organisation serving seven villages amongst thousands in Pakistan. The outcome of this model has not been replicated with the problems and issues addressed for the pan Pakistan rollout. The academic dairy technology stated that innovation in bringing in practices, processes for technology inclusion in the rural level of operations, have too many challenges as SME level automation in pasteurisation is not the answer. It requires creating assisted solutions for home-based dairy farmers to enter the cold food supply chain, add value through pasteurisation, and eliminate all human contact activities in the milking process. The dairy technology academia has raised the issue to initiate incubation of real-life problems to be resolved in higher education (universities of Pakistan) and develop a solution based on research and development.

The problem is complex. The solution is not straightforward, as the diverse perspective in the responses has opened debates on the possibility of solutions. The location-based disadvantage for the rural small dairy farmers is a structural issue that requires an innovative solution both in terms of using technology and its adoption for benefitting a larger catchment of small dairy farmers. The challenge which respondent stated both government official and dairy-based academia is to engage traditional people with traditional practices in the dairy sector to adopt modern tools and practice with the rationality of each step. Respondents have referred to it as a structural gap in infrastructure and the process-based gap that the Pakistan government displayed. As per political respondents, the challenge shows that the rural dairy sector is fragmented can be resolved by providing incentives to modify their milking practices, which are traditional. However, academic dairy consultants argued that and scattered throughout Pakistan as each of these home-based start-ups is catering to its local catchment of customers. It can be attributed to the lack of technology and innovation that cannot equip small dairy farmers in the rural sector to achieve milk production volume and enjoy higher economic benefits. The lack of milk processing technology like pasteurisation at small-scale home-based family businesses is missing, while larger issues of end-to-end automation starting from milking process to packaging of milk impacts quality and marketability requires systems structures and support to make it a success. It is a cavity inherent to rural milk-based businesses. The range of technology needed to define rural development and growth to achieve a world-class manufacturing standard is impossible unless all relevant stakeholders contribute. The solution has to aid the process-centric issues challenging both the small dairy farmers scattered all over Pakistan and the government support to penetrate deeper in

rural areas. From the response pattern, it is evident that two forces identified in the rural dairy sector are rural farmers do not have the power to influence. In contrast, the government does not have sufficient infrastructure to create a framework for national-level development and adoption of technology.

The requirement that emerges is more process-centric innovation at the social level, which can add value and sustain the structural and functional (process-based incapability) capabilities of rural aggregate milk production. However, the experimentation in Pakistan rural areas is restricted to veterinary support, genetic embryos distribution activities, which shows both short term and long-term benefits to the small dairy farmers. However, this model requires changing and adapting the cooperative system with inputs of small dairy farmers in terms of raw milk. At the same time, the nodal organisation train small dairy producers to adopt best practices in milking, storing as they do pasteurisation. The modalities of the economic viability of the processing require the government, small dairy farmers, genetic laboratories, fodder manufacturers, veterinary doctors, equipment manufacturers, and HE (higher education) R&D to collaborate holistically. Though it has been a priority in terms of the requirement but has not been proposed by any of the interview respondents, the model organisation serving a particular catchment area requires to be scaled up in terms of its offerings in Pakistan. The rolling out mission of the government with the best practice examples around the world show preference in the cooperative model for all the added services offered to the small dairy farmers. It is evident from the context of the present business condition in a rural and urban context. The greater concern is unlearning the traditional practice of the manual method of milking practices in rural areas of Pakistan is adulteration that is also an issue going out of hand for the nation. The stakeholders like milk producers, the middleman who transports the milk, the processing organisation, packaging organisation and the customers are shifting towards a market in Pakistan that is accepting processed and packaged milk and milk by-products that rural dairy farmers are unable to find a solution to the capabilities of rural dairy farmers to be harnessed. The end-to-end milk production that includes technology is equipment centric, while the evolution of practices and activities to be adopted by the small dairy farmers in rural areas are acts of innovation. Behavioural level change to accept the transformation is more important to make the functional outcomes contribute to the long-term objectives.

In contrast, the structural evolution in innovation requires the active role of the government's key organisations to adopt a distributive model in operations rather than centralising it. The respondents' affirmation of existing conditions and practices and cross-verification through the interviews have resulted in findings showing policies and inactivity. It also shows that small dairy farmers are deprived even though their initiatives to obtain funding for an SME level milk processing plant have failed most of the time. The overall situation shows a lack of knowledge for home-based small dairy owners unable to manage livestock efficiently. They try to address the low milk productivity issue that plagues their business over the years. These responses indicate a need for a revamped systematic approach with the failure of the government policies and a holistic model for developing rural dairy. Best practices worldwide to sustain milk production show not increasing herd strength but focussing on technology and innovation in Australia. The Pakistan dairy sector, particularly rural areas, age-old use practices, and improving milk production capabilities require structural and functional approaches to resolve the problem.

5.3 Research Questions Revisited

As mentioned in section 1.3, the basic objectives of the present research project were to examine the status of technological innovation in Pakistan’s dairy sector, factors affecting the adoption of technology and finally to suggest a framework of technological innovation management and its application in Pakistani rural dairy SMEs. These research objectives were achieved based on the Dependency Theory and Theory of Appropriate Technology applying the mix method approach. The research questions along with their accomplished answers are briefed below.

5.3.1 Research Question (1)

The first research question was about the status of technological innovation in the dairy sector of Pakistan. The present analysis revealed that, most Pakistani small dairy producers' comments reveal a clear pattern of being technologically disadvantaged. Traditional milking procedures, milk preservation, and building a market that satisfies local demand-supply volumes are all priorities for them. It is the result of improvements in laboratories for genetic testing and breeding, as well as milk contamination testing centres, which are not available in rural areas across Pakistan. As a result, due to inadequacies in implementation, the national policy of bringing in the force and momentum of "continuous development" has not benefited rural dairy producers. In the Pakistan

dairy environment, the industry has been disregarded from an institutional standpoint since it necessitates a new approach, 'organisation structure innovation.

5.3.2 Research Question (2)

The second research question of this dissertations relates to the factors affecting the adoption of technology in Pakistani Dairy industry. The analysis revealed a range of factors that measure the adoption of technology in dairy SMEs in Pakistan. To begin, rural dairy farmers' orientation is influenced by their existing methods, which have been passed down through generations, as well as exposure to new dairy techniques through education. The rural environment of most family-owned small dairies, on the other hand, limits the scope of education and information about the most up-to-date dairy technological methods that have emerged around the world over time. People innovation consists primarily of traditional methods that have a direct impact on product and process innovation. There is a processing technique that can be meant to reduce to SME level dairy processing, but it will take time to experiment with technology and innovation, which will arise with resource harnessing. To embrace new technologies and processes in rural settings, rural farmers, government (Federal and Provincial), and institutions use organisational structure innovation.

Moreover, as milk output has declined over time, the expansion prospects of rural dairy farming are confined to increasing the number of animals in the herd in the family-owned enterprise in rural countryside. Because of the urban-rural split and national policies that are not conducive to rural penetration, rural dairy producers do not have access to sophisticated level selective genetic breeding techniques. Because there are no treatments accessible for many animal ailments in rural areas, daily milk production is hampered, and rural dairy producers must rely on traditional animal health and well-being approaches. Political responses have confirmed that it is a structural failing to solve the problems of rural small dairy farmers.

Subsequently, the lack of technology in milk processing and production has had an impact on downstream processes such as packaging, storage, and transportation. The obstacles for small dairy farmers include processing incapacity, as the conventional paradigm has compelled them to lower the shelf life of raw milk. Rural dairy producers are unable to use the cold food supply chain to promote their products in Pakistan's urban areas due to a lack of temperature-controlled storage

technologies. MNCs and private companies own state-of-the-art processing capabilities in contemporary dairy plants in Pakistan, particularly in metropolitan areas, allowing them to market milk by-products.

Fourth, the situation in the rural sector is difficult since small dairy farmers do not have access to technologies that allow them to pasteurise raw milk. One of the reasons that SME level start-ups have not been able to penetrate for creating a business is due to their lack of information.

The final point is that all stakeholders have expressed interest in learning more about the national dairy policy of Pakistan's successive administrations. It begs the question of how much aid has been neglected in terms of policy, budget outlays, and action plans to reach deep into Pakistan's rural areas. The sixth reason is that rural dairy farmers are familiar with the policies, which is visible at both the federal and provincial levels of government. Due to a centralised style of power that failed to offer rural impetus in action-based outcomes, rural dairy producers are unable to reap the rewards. The needs of rural clients are localised, and they are supported by existing traditional methods, practises, and knowledge. For a tiny dairy farmer working in a small community, the absence of milk production technology has hindered their expansion, and rural innovation is too basic.

5.3.3 Research Question (3)

The third research question of the present study intends to suggest a framework for the adoption of technological innovation in Pakistani Diary SMEs. The findings imply that , small dairy producers and government programmes, in particular, have experienced structural hurdles in integrating technology into established methods. Even if the market has progressed to a higher maturation curve, the rural milk produce's potential to contribute to Pakistan's national milk consumption requires a significant degree of transformation. To reach 'fit for consumption,' there are world standards in milk processing composition to be maintained, as well as end-to-end technology-based devices to accomplish safe for consumption.' Both characteristics are lacking in the rural milk production process, as traditional milk extraction methods rely heavily on human touch, raising the danger of contamination.

As a result, a solution to overcome the wide variety of socio-technical issues is critical, as it is difficult for rural home-based dairy farmers to comprehend the breadth of technology and its uses in current practises. Dairy farmers are harmed by a SME-based support system that can only process a modest volume of milk that requires 'pasteurisation' at a rural level. It is a labour-intensive and automated technology, but it requires market preparedness to embrace it due to a lack of understanding in obtaining a SME licence, financing, and technology to make variants of milk by-products. The responses reveal that a cooperative or inclusive cooperation paradigm is supported by both government representation and academia. The improvised version of rural level innovation to overcome problems is dependent on the role of activities, the intensity of involvement of small rural dairies in adopting new processing methods, and technology that must be slightly adapted to reach operational goals.

5.3.4 Summary

Most Pakistani small dairy producers' comments reveal a clear pattern of being technologically disadvantaged. Rural farmers' orientation is influenced by their existing methods, which have been passed down through generations, as well as exposure to new dairy techniques through education. There is a processing technique that can be meant to reduce to SME level dairy processing, but it will take time to experiment with technology and innovation. To begin, rural dairy farmers' orientation is influenced by their existing methods, which have been passed down through generations, as well as exposure to new dairy techniques through education. MNCs and private companies own state-of-the-art processing capabilities in contemporary dairy plants in Pakistan, particularly in metropolitan areas, allowing them to market milk by-products.

Rural dairy farmers do not have access to technology that allows them to pasteurise raw milk. One of the reasons SME level start-ups have not been able to penetrate for creating a business is due to their lack of information. Small dairy producers and government programmes, in particular, have experienced structural hurdles in integrating technology into established methods. Dairy farmers are harmed by a SME-based support system that can only process a modest volume of milk that requires 'pasteurisation' at a rural level. To reach 'fit for consumption,' there are world standards in milk processing composition to be maintained, as well as end-to-end technology-based devices to accomplish ‘safe for consumption.

6. CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The previous chapter on discussions summarises the findings based on the responses obtained from surveys and interviews. The survey consisted of small dairy farmers of Pakistan, and the interview was conducted on dairy owners, government officials and dairy technology academics of Pakistan. This stage of the research has now reached, where the findings need to be revisited concerning the research objectives set at the beginning of the research. The objectives of the research set at the beginning of chapter one was – to invest the range of technological activities and the existing state of rural dairy in the context of Pakistan. The second objective was to identify the factors that led to technological innovation and the challenges faced in the rural dairy sector. The third objective is to suggest a framework for bringing in technological innovation management in rural dairy SMEs. These objectives are formed based on the gaps identified in the literature review and exploring the given options, existing infrastructure, and work accomplished in this rural dairy sector of Pakistan. Each objective is linked to the respective research question as it tries to explore the literature review underpinnings to the research variables. Thus, the context of rural dairy farmers and their small scale of home business with the availability of technology and innovation has been answered with the wide-ranging traditional methods and modern methods used. The extant literature draws the comparison of the best practices elsewhere in the world, in the end-to-end dairy processing activities and the wide range of stakeholders who are directly and indirectly associated with the dairy sector in rural areas. The state of the Pakistan small dairy farmers is then related to the research topic that sets the tone of the research as to how much technology has been inclusive in their daily life of dairy business activities in the rural areas of Pakistan. The second question tries to understand the range of technological innovation that impacts dairy activities, and particularly why it is important to manage them for the dairy sector. The issues are explored in the context of Pakistan, especially what individual small rural-based dairy farmers can achieve when development and growth are the contexts of the research. The literature review draws the comparisons of the private sector, the role of government and how the small rural dairy farmers perceive technology and innovation while facing the challenges to grow and develop their existing

home-based dairy model. The last research questions focussing on the gap of the existing processes and practices in the rural small dairy farmers, the government policies and action-based framework, explore the options at hand. The attempt is to understand the current practices addressed by surveying the rural small dairy farmers, followed by an interview of SME owners, government officials in the dairy sector, and dairy technology academic professors to find a holistic solution for overcoming the challenges.

6.2 Linking of Research Objectives with the Findings and Conclusions

- **Objective 1-** To investigate a range of state of technological innovation and current state in the rural dairy sector of Pakistan

The situation for the small dairy sector has been discussed in the literature review showed that it involves animals, equipment, procedures that constitute the daily activity. While most of it in small rural dairies in Pakistan follows a traditional model that has been continuing for ages, the use of hand-based milking, home environment and family members engaged in animal well-being. The evidence showed rudimentary use of technology in Pakistan rural villages in dairy perspective as the owners' awareness and exposure is limited. Their central goal is to increased milk yield for the total number of animals in their herd, which usually ranges from 1-6 animals at the most. From activities like breeding, fodder for animals, animal diseases, the milk extraction process, storage of milk technology in rural areas of Pakistan has been almost non-existent, which is a huge gap in the current situation. Evidence of experimental agencies in 7 rural areas for genetic breeding, veterinary doctors to assist and support animal health has been reported, which helps to conclude that initiatives till now has been very slow and not focused if technology perspective is considered in dairy development in rural areas. The perceptions of the rural small dairy practitioners follow a traditional method used for generations and the critical importance of technology to be induced requires adaptation due to the existence of large-scale dairy processing equipment to SME level. Implications for the use of technology is speed, efficiency and effectiveness. However, most of the rural sector in Pakistan is without electricity and consumes raw milk in rural localities devoid of milk processing capabilities. It also implies that local innovation in the existing dairy practices in rural Pakistan has not progressed as the supplier matches the demand characteristics of rural

consumers. The rural diaries serve specific rural catchment areas in and around the village, which does not allow them to store raw milk due to its perishability. Neither has they shown any evidence of technology to produce a wide variety of milk by-products for human consumption. The limited activities are manual and intensify the risks of milk contamination and adulteration due to the absence of technology and innovation in Pakistan's rural dairy sector. It impacts the falling milk production yield, animal well-being and healthcare, nutrition and lactation management, milk extraction and preservation to be negligible in existing traditional methods in rural areas of Pakistan. It has been cited by (Ahmad et al. 2012), who acknowledged that very little technology from developed nations to developing nations in the dairy sector had been transferred, while (Rhee et al. 2011) argued it is the approach in adopting technology which is built on the awareness that matters. It also supports (Younus et al. 2002) findings as the market matures and criticality of technology in rural areas is important when demand increases for high-quality milk (devoid of human touch, contamination, adulteration). However, the responses bring out (Rahmat Ullah Shah and Mahmood, 2013) findings which show that the family-based home-based rural dairy farmer is not able to access or source technology as most of it is specialised that has a huge cost involved, requires knowledge to maintain, especially in health-breeding, production processing and storage stages of the dairy process.

- **Objective 2-** To identify different factors that can measure technological innovation and its management & challenges in the rural dairy sector

The use of technology in the dairy sector is a critical force in bringing about changes in dairy processing capabilities. The small herd size for family-based owners in rural areas (1-6) animals do not follow milking routine, milk preservation technology, animal fodder nutritional management, lactation management. The non-availability of technology is plenty with awareness, education, from environmental surroundings, is evident. The role of influencers like the Pakistan government at the central and provincial level has shown evidence in policymaking initiatives, having the capabilities of infusing technology like genetic technology in breeding, fodder with nutrition, medical support through a veterinary doctor for animal health and well-being is important from the functional perspective of development. The institutional role of the technology enabler rests on the government, who are providers of structural help and support to develop any sector in Pakistan. However, communication of national policies not having scheduled action-

based initiatives and stagnant outcomes is evident from Pakistan's small rural dairy farmers' perspective. The lack of process-based innovations due to lack of technology has led to limited milk-based by-products, reduced shelf time and smaller reach of food supply chain reaching to rural market only. Lack of technology has propelled the probability of raw milk being exposed to contamination (from germs, air, and water), dirt in handling due to lack of storage technology and transportation that implies an absence of standardised practices based on scientific research. The organisations like Dairy Farmers association bargaining on technology access from government, Livestock and dairy development schemes, or the involvement of Pakistan dairy development company has not culminated into any positive development. When analysed, the responses show the inability to meet the OECD definition of adding value for innovation to be absent, as per Havlíček et al. 2013), while the cost factor Mitchell-Ketzes (2003) also showed a lack of tangible improvement in existing dairy activities using technology. The literature review discusses world over, development of dairy is based on the use of biotechnology, genetics, equipment-based solutions that rural sector of small dairy farmers could not access due to financial inability, institutional bargaining power to devise a working model for a small-scale cost-effective solution to overcome challenges and adapt to rural area needs.

- **Objective 3-** To suggest a framework of technological innovation management and its application in Pakistani rural dairy SMEs

The use of technology in the entire spectrum of dairy processing is wide. The stakeholders on the supply side, small rural dairy owners, seek help in financial loans for entrepreneurship initiatives. The institutional model of structural help to aid the processing capabilities of rural dairy farmers has been evident in developed and developing nations in the form of a cooperative that balances the needs with its ability to procure technology providing equitable ownership. Outcomes of the responses show gaps in the system, from inability of Pakistan government to reach every rural area and limited support (veterinary and genetic embryos), which has been experimented with in seven villages. Rural setting in Pakistan presents many challenges with SMEs not perceived as ideal and financial institutions viewing dairy not as an ideal economic model in terms of viability to succeed. The reasons for traditional milking methods and limited market in catchment area, lack of technology access to store, inability to defeat perishability and milk shelf life, produce varied milk-based by-products, and food grade quality standards are reasons stagnancy. Urban Pakistan has

matured in lifecycle and consumption parameters presents an opportunity to harness the power of aggregate, raw milk production by small dairy owners of Pakistan. Understanding the deficiencies at the structural, functional level is facing the traditional practices embedded in the behaviour of small rural dairy farmers. The inclusivity of technology depends on localised adaptation capabilities, which is innovation for overcoming rural challenges. The responses show a pattern of SMEs leaning to manufacturing and dairy sector still a cottage industry that financial institutions failed to recognise and explore the economic opportunity. The government contribution to policymaking has limited benefits for small rural dairy farmers. The suggestion from a dairy technologist academician shows the creation of a nodal organisation that balances the power equation of demands and supplies. Technology is a rural disruption of traditional practice that requires establishment and maintenance based on the use of equipment for raw milk processing (pasteurisation). It requires training to enhance knowledge for small dairy farmers to extract milk, supply genetic embryos, quality fodder at a reasonable price for nutritional management, support services for animal health with medicine and lactation management. While all technology-based initiatives are specialised skills, knowledge transference to rural areas requires building over time and eliminating human contact, germ and dirt contamination in the milk supply chain.

Additionally, the packaging option further creates a marketing sustainability model for Pakistan's rural dairy home-based businesses. The strategic location of the nodal organisation covering three villages in a rural area would help penetrate, provide pasteurisation support for the volume of milk, and increase the animal health management and nutrition management, which is technology embedding scientific methods in existing manual practices of dairy management. The unclogging of inflexible policies and frameworks is a process-based innovation that the nodal organisation requires to achieve. The success depends on the ability to show rural focus and extend the marketing output of milk by-products in urban Pakistan. As suggested, this model offers local economy to contribute to the national (domestic) economy of Pakistan and create a sustainable model provided procurement of raw milk, is processed (by pasteurisation), is packed and handled food-grade material, stored inappropriate storage, transported through the cold supply chain to urban areas of Pakistan.

6.3 Implications

6.3.1 Theoretical Perspective

Many academic researcher and entrepreneur leaders that are dealing in the part of management as well as innovation are paying significant attention for enhancing technological innovation and searching for the factor that increase technological innovation. This dissertation is the first of its kind to evaluate the status of technological innovation in Pakistani dairy sector, investigate the factors that affect technological innovation and suggest a framework to rural dairy owners to enhance technological innovation. The outcomes of this dissertation offer literature that will serve as a conceptual framework for future studies in this research area. The present findings are also useful because they highlight recent trends and theoretical advancements in the areas of technological advancement and innovation in dairy sector.

6.3.2 Practical Perspective

Recent Rural Development plans and strategies emphasise the need of an effective domestic agricultural commodities system in promoting and sustaining growth and development in the food and agriculture sectors (Khan et al., 2013). The policy states unequivocally that the prospects for economic growth are dependent on effective transformational advancement of the agricultural system in providing better economic incentives for thousands of poor small - scale farmers to take part in the domestic food and agricultural market centred extension as commercialised and demand driven producers. Dairy product producers all around the world are innovating new products and processes, and efforts are being made to increase the industry's overall creative capability. However, there is opportunity to increase the industry's innovation performance by concentrating on the direction and pace of the innovation processes (Lamprinopoulou et al. 2014; Hekkert et al. 2007). Realization of this objective now necessitates development practitioners being able to either evaluate their initiatives to enhance dairy technology, therefore enhancing farmers' livelihoods, or create fresh insights for more dairy sector progress. This research would aid them in the future design of development projects or programmes targeted at assisting smallholder farmers. Governments would receive support from the research findings as well because they need micro-level information to formulate appropriate policies, such as justifying whether increased necessary

support or allocation of funds is required in this sector, quantifying the status of farmer adoption, and identifying major factors that influence uptake of improved dairy technologies as well as its impact on inefficiency. This study's findings might potentially be utilised as a reference for other related regions and as a benchmark for future research. In general, the study is anticipated to produce grass-roots information for many stakeholders to support well-informed research and sustainable development plans that mitigate their drawbacks and other difficulties in this study. The current state of technical innovation in Pakistan's dairy business, as well as the factors driving it, have received little attention. The employment of technology in the dairy business is a driving factor in changing dairy processing capacities. Because of the small herd size for family-based owners in rural regions, animals do not adhere to milking routines, milk preservation technologies, animal fodder nutritional management, and lactation management. The lack of availability of technology is abundant with awareness, education, and environmental surrounds. The role of influencers such as the Pakistan government at the central and provincial levels has been demonstrated in policymaking initiatives; having the capability of infusing technology such as genetic technology in breeding, fodder with nutrition, and medical support through a veterinary doctor for animal health and well-being is important from a functional perspective of development. The government plays the institutional function of a technology enabler since it provides structural assistance and support to any industry in Pakistan. The results generated this study will help the policymakers to improve the factors that positively predicts the technological innovation in dairy sector of Pakistan.

6.4 Contributions

6.4.1 Theoretical Contributions

The present study is the first among the academic studies that contributed to applying Dependency theory and appropriate technology model in the context of the Pakistani rural dairy industry. These models conventionally pay attention to the need for technological adoption in developing countries and its applications in sector development. Whereas, based on these models very little research work is done in Pakistan, particularly in the dairy industry. The authors provide a theoretical contribution by discussing the present state of technology utilisation in Pakistani dairy SMEs, as well as the critical factors influencing technological adoption. Furthermore, extending the theory,

this study provides a realistic procedure for rural dairy owners and regulatory agencies to collaborate on technical improvement in the industry to assure a large supply of hygienic dairy products for increased profitability, poverty alleviation and foreign exchange through quality export.

6.4.2 Practical Contribution

The thesis creates a more consistent and comprehensive picture of the present level of technology adoption in Pakistan's rural dairy industry, as well as the impediments and key drivers for technological adoption that were found, debated, and integrated. On the one hand, scholars and practitioners can identify the most significant barriers to adopting new technology that the dairy sector now confronts. On the other hand, proper infrastructure of dairy industry technologies taken and analysed in front-runner countries (discussed in literature) can be used by practitioners in lag markets to learn from the experience of mature dairy markets and be motivated to develop measures (e.g., new policies or business strategies) in their countries. The study indicates that the Pakistan Government's dairy strategy provides a policy-making instrument that informs the identification of systemic challenges and the implementation of interventions to promote system innovation in small and medium-sized dairy firms. The study also adds to our understanding of how hierarchical frameworks are applied. It ensures that the root of the problem, interconnections with other tools, and the contextual character of the context in which it is embedded are reflected in the development and implementation of the framework and policy instruments. However, additional framework applications are required to draw judgments on the theoretical function of policy instruments in the system implementation.

6.4.3 Social Contributions

As mentioned in the sections above, 65% of the Pakistani population is attached to the agriculture sector, most of which is the middle class surging with the least disposable income. Hence, a practical application of the present study in the dairy industry can play a game-changing role in developing the sector. This sector development will subsequently create jobs, circulate money, and help the government alleviate poverty.

6.5 Recommendations

The following recommendations are suggested based on the gaps identified in the research analysis. It is divided into three stages in chronological order, and each is fulfilling the previous stage.

i) Rural Identification

The emergence of diverse inputs from different themes in the interviews supports the plight of non-inclusive growth of small dairies in rural Pakistan, and recommendations are based on Asian dairy experiences. Addressing the structural reorganizational challenges, Pakistan can draw heavily from the Bangladesh model. The classification of dairy firms in rural areas as per animals in each family household are:

Farm type	Number of cows/farm	Ownership
1. Household dairy Milk produced for home consumption and surpluses of milk are converted into market sales	1–3	Usually large- and medium-sized households
2. Dual-purpose cows (draft and milk) Seasonal surpluses of milk are converted into market sales	2–6	All types of household as secondary activities
3. Small dairy farms Milk and milk products are converted into market sales	2–5	Small- and medium-sized livestock households (mostly with government incentive, NGO or co-operative support)
4. Medium dairy farms Milk and milk products are converted into market sales	6–25	Medium-sized household/private small commercial dairy farm (mostly with Government incentive, NGO or co-operative support)
5. Large dairy farms Milk and milk products are converted into market sales	26 and above	Private commercial dairy farms

Thus, the above classification segregates the owners and their capabilities considering the low cost of raw milk in rural areas. It is evident that government structurally identifies the different small dairy farmers, creates an identity base, genome mapping of animals, tracks animal health with ID, and adds a technology-enabled dashboard. This initial screening at the rural level helps the financial income, business size, production volume, diseases trend, and the scope of creating an institutional model covering three or more rural villages under government care. It paves the way

for the groundwork pending for rural small dairy farmers', animal, and health and genetic databases to be created.

ii) Localisation of the Technology-Centric Development Plan

The second recommendation is to identify the clusters of rural villages that would be catchment areas for receiving the government initiative of a one-stop solution. The single window help for animal veterinary, artificial insemination of semen, curing animal diseases, tracking milk production volume, and fodder requirement at a low price is ideal for gaining economies of scale in distributing services function to the rural areas in Pakistan dairy development. This strategy looks after animal health, with an immediacy and urgency model serving many small dairies (30-60) and total animals (80-110). The team constitutes the mix of representatives (technicians) for genetic mapping, semen donator, milk quality controller, veterinary doctor. It is a micro-level structural approach to distribute and disseminate the specific requirements. It is the key to leading the development using the right mix of technology to address the small dairy farmers' challenges.

iii) Process and production innovation

The third and final stage is built on the first two recommendations. It involves creating a PPP model or a cooperative dairy unit that harness three or more rural villages to procure a considerable amount of raw milk at the input. It is processing criteria, and hence data of aggregate rural village(s) help ascertain a minimum quota to process raw milk for pasteurisation is achieved. The processing plant output is stored and packaged for urban consumption and distributed to rural villages at a slightly higher price for value-added offerings. The packaging facility leads to distribution identifying high demand urban centres of Pakistan, helping to establish a cold supply chain. The urban products stamped and dated would require covering processing and transportation costs for each province of Pakistan that is subject to add to the mark-up price. The option of using milk for producing by-products is the last stage of processing development using advanced level technology. It would only come into force when the urban markets have picked up the consumption volume from these rural processing centres (PPP or cooperative). The power and control over operations are from the provincial government liaising with different science and technology institutions that contribute directly and indirectly to dairy technology.

6.6 Limitations of the Study

This study has certain shortcomings that should be addressed in future research. The limits are highlighted in this section from three perspectives:

To begin, the current study is a cross-sectional study since the data was collected during a specific and restricted time to address the research objectives. As a result, the detected impacts and responses cannot represent the variation in responses from individuals at another time point. Longitudinal study, on the other hand (based on data collected over time) might aid in determining changes in technological innovation and its determinants.

Furthermore, data is gathered from dairy sector businessmen and Pakistani authorities. As a result, the current study's findings may not be generalizable to other geographical regions since the study's findings are in accordance with the status of technical progress and variables influencing technology adoption in Pakistan's rural dairy industry and SMEs. The view and reaction to technological growth may be different in various regions of the world.

In addition, the researcher changed the survey questionnaire utilised in the current study to obtain appropriate replies from the respondents. This survey questionnaire, however, is not commonly utilised and has been verified by studies in the dairy business. As a result, the researcher's self-administered questionnaire expertise is restricted in measuring the variables under inquiry.

Furthermore, keeping market circumstances in mind, a quantitative survey with a sample size of 100 surveys was undertaken. Due to a lack of time, resources, and the COVID-19 outbreak during the research period, the researcher was limited to a sample size of 100 respondents in the quantitative survey questionnaire and only ten interviewers in semi-structured interviews. The small sample size may limit the accurate representation of the population. The poll was done online due of the covid-19 epidemic. As a result, those without internet access or who are not in contact with the researcher or survey facilitator were unable to participate in the surveys and interviews.

6.7 Scope of future research

This section proposes ideas for future research on technical innovation in dairy SMEs after acknowledging and condensing the current study's shortcomings to add to the existing of knowledge.

The research involves an issue that encompasses the role of government, small dairy farmers, financers, and institutions (genetics, embryology, veterinary, food) related to the animal/livestock in the dairy sector. Future studies can try to determine the level of genetics and embryology that has led to an increase in milk production in select small dairy farmers who are recipients of the embryo. There is scope to find out the feasibility of setting up a processing unit for milk pasteurisation and calculating the cost per litre, access of total volume of milk, and development feasibility of raw milk procurement to the processing centre for rural villages in Pakistan. All this future research would contribute to establishing testing the infrastructure model to show processing efficiency due to the inclusion of technology sustaining the rural dairy model and test marketability to urban areas.

There are some other shortcomings of the present study that can be addresses in future studies on same research issue. To begin, future studies may be conducted out as longitudinal research to solve the time-horizon issue of the study, since the longitudinal study can be used to examine the intention changes of men across different time periods. As a result, longitudinal research will be more useful in gaining a comprehensive perspective on Pakistani guys. Second, because to the Covid-19 breakout and restricted time and financial sources, the current study's sample size is quite small. A bigger sample size should be used in future studies to provide a more realistic representation of the research population.

Third, many additional elements, according to the research, can influence technology acceptance, innovation, or practise. As a result, the future investigation may generate a few distinct factors. Furthermore, the current study used primary data to assess the various dimensions (quantitative surveys are based on dairy owners' perceptions). A future study could take a different approach by combining data from nutrition experts, veterinary and livestock experts, and other relevant sources. Finally, the current study is being undertaken in Pakistan. Therefore, the findings are applicable throughout Pakistan. A subsequent investigation should be carried out in a different geographical region to corroborate the findings in other cultures.

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8. Appendix: Transcripts

THEME 1: Respondent from Pakistan dairy industry/firm owners(small)

Q 1. What kind of challenges did you face in bringing dairy technology that drives the operational capabilities of your set up? Is this technology innovative enough to drive sustainability? Please elaborate.

P1 stated that the dairy industry in Pakistan still faces the commitment from the government as enterprise level set up requires higher participation level of the associated organisations to aid poor herdsman. P1 stated people who have less than 10 animals or even less than 5 face immense challenge in terms of financing a dairy plant alone. P1 also added lack of knowledge to procure loans at rural towns, absence of technical knowledge about dairy processing stages, establishing an organisation registered with employees is a huge challenge. Lack of technology inclusiveness in rural setup in terms of breeding, setting up the provisions of dairy processing plants at SME, animal health and wellbeing against diseases, storage provisions to increase shelf life of processed or raw milk are key symptoms of lack of technology and innovation in dairy sector of Pakistan. P1 stated that help in the locality in terms of breeding technology to increase better offspring of calf or the use genetics is not within their range and control. The lack of support in crucial technologies and its availability for the small dairy farmers has been evident that Government of Pakistan is ignoring. Hence this is a gap as setting up of infrastructure in the rural sector where most of the cows, buffalos are concentrated. This is a technology which needs the appropriate scientific knowledge, as it cannot be a home-grown innovation by the farmers. The Pakistan existing dairy firms are also not able to get access to uniform distribution system of dairy technology which is more of centralised to few pockets in urban cities. The government strategy to adopt technology in dairy sector requires a more penetrative approach where the maximum concentration of small dairy farmers live which is rural area. The power of central government and its concentration has not reached the rural pockets where small dairy farmers are located. Neither the SME level dairy technology that is affordable for the small dairy farmers of Pakistan has been brought in the market to render a 'big push' to rural based small dairy farmers. There is no institution at rural level which helps dairy farmers end to end for improving milking, milk processing or its storage issue especially for the rural conditions. The current level of challenges is to harness all small dairy

producers to unite, process milk and explore milk by-products which is not happening in the reality. Banking finance for the rural population is limited and mismatch of milk-based entrepreneurship and home-based dairy farming business is a big challenge for starting up in Pakistan. The market is ripe for different milk products consumption while Pakistan government imports milk powder that overlooks the capacity of the rural economy providing sustainability and growth to the local economy.

P2 stated that the structural problems are prevalent which is setting up SME level dairy which are barriers that shows stakeholders and financers to be non-cooperative about dairy sector opportunities. The small dairy farmers therefore suffered from the psychological and behavioural discouragement around them about setting up SME level dairy processing unit in Pakistan. It is a systems failure in terms of technology penetration in dairy sector, lack of comprehensive national level plan rolls out and localisation of resource to boost the economic activity as a missed opportunity. There is lack of technology in existing milking process, breeding methods, and animal health care that misses the sector sustainability thrusts. P2 stated that institutional abilities in addressing the Pakistan dairy issues and problems from the government has been weak. The small dairy farmers do not have SME level technology to adopt entrepreneurship that aids in increasing the quality, quantity of the milk production volume. Hence, inaccessibility of animal medical care and welfare has been a part of national innovation culture, which Pakistan dairy sector suffers from. The result of national innovation policy and technology centric R&D in dairy sector has been more of limited to laboratory that required to develop the solutions for the rural sector of Pakistan. The inability to sell the excess raw milk to the demand side requires technology and innovation to adhere to market based food grade processing and process centric knowledge is a major challenge for the milk suppliers. The unity of the dairy sector is tested here, as the progress requires technology and investment to harness the total milk production by volume, process in real time, to supply to the urban cities. This is a huge gap as the dairy industry is still in its nascent stage, missing the industrialisation wave where the inclusion of technology and innovation helps to automate the process of milking process. This is a power which the small dairy producers in Pakistan are missing right now, missing the national food sustainability agenda. The fragmented small dairy farmers with lack of knowledge and technological knowhow to set up the dairy processing production plant at a small scale is failed attempt due to localisation of technology requirements with innovation at several stages that is essential for the development and growth of

the dairy in rural sector. The lack of industry support in development SME based model through entrepreneurship is evident in the rural areas did not take off, due to lack of political interest while urban development happened in selective areas. The failure to understand the dairy industry as an inclusive consumption economy for Pakistan as a nation has been prevalent over the years. This has impacted the rural development in terms of technology and innovation that is centralised in the Pakistan failing to comply policy based distributive model for greater good.

P3 found that few banks are having agriculture and farming loans but their perception about total number of animals as asset is a critical factor that decided the loan amount. P3 stated most of them have either (1-2), (3-4) or (5-6) cows or buffalos that is not enough in procuring a loan, as the cost of setting up dairy in rural locality is much higher. Hence the social and policy-based mechanisms from the Pakistan government and their financial capability from existing dairy business did not suffice the model of venturing a start up in dairy technology. The technology leading to efficiency in the rural dairy processing capabilities and meeting the growing Pakistan urbanisation demands is a fact that is a missed opportunity in steering the nation towards food sustainability. P3 stated that technology in dairy requires investment and R&D at internal level is not possible due to lack of knowledge. The quantum jump in the dairy technology in Pakistan in terms of dairy equipment is restricted to bigger dairy enterprises concentrated in the hands of few and located in urban cities. The lack of technology penetration for small dairy farmers in Pakistan is an opportunity missed in national development of this sector. The industrialisation of dairy sector therefore did not happen, as compared to other sector, due to the fragmented small dairy farmers in rural locations. This has led to widening the milk demand in urban rural divide, as technology based cold supply chain is not there, neither raw milk production processing at rural sector exists, and zero provision of huge milk storage facilities at the national geography level. Being small dairy producers, it is financially not viable to establish dairy plant and hence, regional, or rural town level dairy processing infrastructure from the government could have sustained domestic consumption closing supply demand gaps. The failure of the sector to put in concerted efforts to bring in innovation in dairy products, dairy processing capabilities as SME level is a lacune which is exposed. There are also institutional drawbacks as it is not able to distribute the technology and innovation in Pakistan for greater good of nation, that is evident from the rural areas. The manual method in agriculture, dairy farming shows that urban rural divide in adoption is dependent on the industry outlook, provincial government aid to support the rural areas and revive the economy. The economics of rural area

capabilities in terms of population engagement and production output to be fruitful to the Pakistan national building process has been ignored for decades.

P4 argued that bigger investments attract latest dairy technology but the issues like small dairy farmers with low count of animals serving a locality is not substantial enough in meeting the loan approval parameters. The lack of Pakistan town level infrastructural support from the Pakistan government is a key barrier to address the sustainability movement in dairy sector failing to monetise, breed, set up enterprise, to process milk and supply to emerging urban cities of Pakistan. It missed out the rural dairy production to contribute and meet the urban Pakistan milk product needs, failing to create a holistic sustainable model due to the fragmented small dairy farmers not getting realistic help. Thus, the central policies and neglected rural dairy sector is evident as common people without specialised knowledge is unable to engage into scientific breeding of cows and buffalo that increases milk production from the current low yields. The government perspective of aid ideally should have been not a financial one, but of technologies that persists in the western world. For boosting the milk production (volume) assistance in breeding, medical help along with milking equipment to safeguard the quality factor has been ignored. There is no solution for small dairy owners as well, if they want to engage into entrepreneurship idea and market their raw milk. Currently they are unable to expand their current level of small business not just due to finance, but absence of structural policies of dairy sector which could have helped to harness the power of raw milk processing using government based dairy production processing and storage facilities. Innovation at rural is subject to age old knowledge of how to convert the milk to variety of milk products but not in industrial scale of operations. The lack of this approach is creating a lot of stunted growth in dairy sector in the rural sector of Pakistan. P4 stated that innovation is not something they can create in-house or borrow from neighbours as most of the advancement in dairy sector is a scientific and requires intensive technology-based approach. The rural population has been ignored in terms of economic development from finance (micro credit) against the home-based start-up

P5 referred to the National level policies in dairy sector and added that it failed as the approach failed to leverage the technology-based infusion in dairy sector to boost the economy. The government failed to mobilise the resources using technology to transform the rural dairy sector contribution the Pakistan economy. Much of it is due to non-friendly policies for family-based

herdsman, fragmented small farmers, inadequate cold supply chain to urban cities from rural towns in Pakistan, absence of processing plants scattered in different locations that reduced the chances of feasibility of dairy industry investment. It is evident that lack of exposure has been a common cause for dairy farmers, while academia, industry research and development lacking in Pakistan, high set up cost of enterprise level dairy processing systems has posed as a challenge for the development of dairy technology. P5 felt there are key technologies that is not possible though internal R&D, and hence relying on external R&D is appropriate. For a country like Pakistan which is in developing state, it holds true as the policies framed also requires, allocation of funds in each sector, that has potential to serve the population and contribute to GDP. P5 argued that domestic consumption of milk and demand of milk products is increasing every day, which restricts the small rural dairy farmers due to their incapacities. The use of technology-based solution is ideal for the small dairy farmers to change existing hand-based milking process or seek institutional dairy processing through cooperative model and utilise raw milk processing through appropriate technology making it marketable. There is lack of equipment based dairy production that is a challenge for small dairy farmers, to market their milk output for supplying to the high demand areas (urban). The maximum small dairy farmers are in the rural sector which not able to use the resources, the dairy sector progress to contribute to consumption centric economy leading to economic benefits.

P6 stated that lack of support in terms of technical knowledge in the dairy sector in rural location is missing in Pakistan. As a small dairy farmer, the family has faced challenges in terms of basic up-keeping of animal health, breeding techniques, milk storage and develop capabilities to produce milk by-products. The absence of technology has impacted their growth and dreams as lack of awareness to sustain the dairy technology and inclusivity in the existing dairy farming at rural town level has stunted the growth of this industry. The innovation in the dairy sector in Pakistan is a faraway dream as most of it is out of reach of most of the small dairy farmers. Much of it the progress in technology and innovation embedded in the dairy industry is based in the awareness creation in knowledge perspective that Pakistan industry, ministry has not been able to disseminate. The sectorial thrust in terms of development has not been able to channelize the relevant inputs at the right time at right place. The nature of dairy farming in Pakistan geography is fragmented and concentrated in rural pockets, while the high demand for processed milk is in urban areas. This is a gap as it requires government-based intervention at structural level as small

dairy farmers neither have technology-based solution nor innovate to attain high yield variety animal, capability to process and store food grade milk quality that is fit for preparing milk products. The Pakistan industry association also have not able to address the cold supply chain issues to enable small dairy farmers to supply to urban high demand areas. This is a problem, that majority of dairy farmers faced, while inadequate infrastructure to store the milk, processing raw milk at industrial scale, lack of technology to produce milk by-products, no proper transportation and logistics to ensure perishable factor, have eliminated the possibilities of creating an inclusive consumption culture contributing to the Pakistan domestic economic sustainability.

Q 2. What are the conditions that impacts the extent of dairy technological innovation, for improving the Pakistani dairy sector (SMEs)? Please elaborate.

P1 stated that Pakistan government and associated organisations in research and development is not able to use technology-based innovations at right places to improve the sector. The sector is being targeted not as important though milk being a part of staple diet in Pakistan lifestyle. The absence of surrounding environmental conditions in the environment, has impacted the business motives and its monetisation capabilities. P1 referred it more of inflexible and stiff structural policies that fails to impact the societal progress and creating more economic avenues using the dairy sector as a key platform. The lack of institutional knowledge sharing, and lack of coordination is evident from the present operations in Pakistan. There is lack of national development in technology for each sector and being a developing nation, it relies mostly on western imports of machineries and equipment. The impact on the rural sector, SME level development hence is slow and subject to government intervention. Not much private public partnership (PPP) or cooperative model in organisation has been seen in the industrialisation perspective that has impacted the dairy sector in Pakistan. These are mostly structural constraints that is impacting the business environment, national innovation development level in Pakistan. The lack of inter organisational linkages, in the rural environment has been missing which could have assisted end to end support to the dairy processing industrial development. Even the local government support for the animal health and medical check-up periodically is a sustainable strategy to keep them free from the diseases. The support for genetic breeding of selective traits of cows, buffalos is a scientific technology which is beyond the capability of common rural individual in Pakistan has been ignored. There is no collaboration neither there is cooperation between

organisations with an agenda, that drives the growth of dairy development. Therefore, the role of universities in dairy technology domain and its linkage to usher the technology inclusivity in the dairy sector has not taken place. Thus, the support from the scientific development linking technology has not helped the Pakistan dairy sector small players, SMEs (small and medium scale enterprises). This reflects a poor national level approach and orientation of the issues that is impacting the dairy sector innovation as academia and industry related problems are not incubated in promoting R&D within Pakistan business environment. This is overtly evident strategy in Pakistan, is causing greater dependency on the external imports due to lack of indigenisation approach to develop solutions that require customisability. The inflexibility of the Pakistan government programmes that is directed towards equipping SME sector; easy financing schemes has been not benefitted the dairy sector small farmers. The national level strategy lacked the focus on dairy sector, for a comprehensive plan of development addressing the concerns of small, fragmented Pakistan dairy farmers. They needed technology to counter the diseases that affects buffalos, production processing of raw milk at SME level, avail storage and transport logistics to market milk-based products in Pakistan urban cities.

P2 expressed extreme frustration pointing out the fact that being a small-time farmer the power of unity has also not able to create private partnerships, or form cooperatives where they could have exploited the opportunities. This a lag in terms of institutional structure, flexibility in creating awareness, mobilise the resources, influence other institutions like banking institutions to facilitate the progress of the industrialisation of rural dairy processing in Pakistan. The political approach towards dairy development is not all round in Pakistan while most of the associated institutions have not been able to integrate their efforts to create incremental progress. The gap between the political decisions in a national level policy has failed to take place through an appropriate strategy. This missing action-based outcome has left the fragmented pockets of dairy farmers in Pakistan to increase their animal strength. However, lack of innovation in dairy farming has caused, no progress especially in the rural sector. There is no culture within the institutions to reach out a town/village level for driving technology-based innovation, in the dairy farming sector where knowledge dissemination would have created more opportunities for the problems faced by the stakeholders. This is a single most barrier while the dairy farmers themselves are not educated enough to handle the advanced equipment for dairy processing. The lack of education and exposure to dairy processing technology therefore is also rudimentary which is why the innovation factoring

in rural set up has not happened in the dairy business. Even though the stakeholders are understanding it and is aware about it, that developmental approach is required in rural setting, but its initiation and visualisation for the nation has been ignored. This is a one of the reasons as to why the SME level incremental innovation in dairy sector has failed to happen, due to inflexibility of policies and its outcomes. There is too much development around the urban areas, while the rural sector has been ignored when it is about infrastructure, communication, and transport-logistics development. This has over the years, undermined the progress of dairy sector in rural sector grossly, overlooking the local economy needs and deviating from the sustainability goals. There is lack of purpose and communication from the national ministry level and the policy-based interventions at ground level. The technology-based revolution also requires financing and to address this issue at the rural village level for promoting entrepreneurship or build SME level dairy production unit requires a comprehensive coordination, collaboration to design a forward-looking framework. The central and local government authorities also could not lay down the plan of action for a budgeted amount to create a platform that helps in rural raw milk production to find markets or infuse technology in processing for increased marketability. Innovation from providing better animal feed, animal health, increase yield of milk, or SME based milk processing units' requirements to be met. The nation needed a customised solution that fitted the gaps in the regional level, sector level thrust of dairy processing plants for small dairy farmers. However, lack of innovation at national level has not led to any substantial growth or direction towards improvement. This in entirety is a missed opportunity for the nation as raw milk production and consumption at domestic level and the capabilities of diverse milk products from raw milk only increases the value in the entire process and economic push.

P3 referred that though the country is a developing nation, it is not able to match the progress of a developed nation in terms of technology infusion. The lack of technology in this sector is due to national level slow progress in dairy segment, and overt reliance on the western equipment which are best costly. P3 explained that to enable dairy processing enterprise at rural level in a SME level operation, also required substantial amount of financing, internal R&D, importing world-class processing that failed due to lack of public or private institutional level integrative approach in resolving dairy sector issues. The general environment in the rural sector of Pakistan seeks an all-round development which is evident from the infrastructural point of view. However, the mainstay of the rural economy is through the agriculture and dairy products that is consumed fresh by the

local population. The development of the rural economy towards sustainability requires the government to identify the potential sectors which are profitable, leads to mass level sustenance. The dairy as a sector is an important contributor to the daily consumption and lifestyle that makes the local Pakistan economy to create sustainable solutions for employment. Though not much has been achieved at rural business opportunities, the dairy is one such sector which required to transform towards betterment. The rate of innovation in the rural sector is slow as the technology dissemination has been slow in terms of industry establishment. The dairy sector is an opportunity and a missed sector as the only way it has to progress in terms of improvement is through the technology innovation. The major role to be played for bringing in the innovation is the government who uses its power and relation-based approach to link key institutions to work concertedly in bringing an all-round innovation The dairy will progress from the manual mode of activities only when the technology is infused that is

P4 stated that the economy is not at good shape and lack of fund allocation in the national budget has not helped the dairy sector much. The association of the industry officials and their contribution to dairy sector could have resulted into a systematic development of progress to adopt technology in dairy production and processing. However, the lack of knowledge of technology availability in this sector at rural Pakistan, entrepreneurship abilities, R&D abilities or even in the suburban towns around the urban cities has not been able to capitalise the opportunities to create monetising of milk production. The dairy industry is an inclusive sector where the local population using local resources can create production of raw milk that is consumed by the local population is creating a sustainable local economy. However, the dairy in the rural sector of Pakistan is very slow in every sector. This has affected the dairy sector adversely as the institutional involvement, and the political influence to aid the sector in actionable outcomes has failed. There is vast potential of the SME level entrepreneurship opportunities as most of the small dairy farmers have increased their holding of animals (cows, buffalos) to increase their income. This reflects the nuances of entrepreneurship at elemental level but due to lack of specialised knowledge, the population at the bottom of the business entrepreneurship is unable to progress to the next level of industrialisation stage. The possibility of building the business requires the inclusion of innovation in both process and product where the raw milk production is processed in a plant. However, the affordability of the small dairy farmers in the Pakistan rural communities is limited. The prospect of small dairy farmers uniting to form a joint venture, or a cooperative was found to be very weak as most of the

initiatives as SME find it very difficult to get financing from financial institutions. The lack of credit line for first start up fund, and political highhandedness in initiatives, failed as the comprehensive government action plan has not been able to address the rural problems. The lack of provincial governments and the central government relationship, allocation of budget, has also failed in funding enterprises in SME sector due to lack of appropriate implementation mechanisms to boost local industry. The technology inclusion level is very low in rural which is one of the reasons the environment for the innovation has not contributed to Pakistan economy from all corners in development perspective. The market is fragmented and overcrowded with small players of dairy farmers dotting the geography far away from the urban markets in Pakistan required more of a structural and infrastructure centric approach to resolve the development of dairy sector in the country.

P5 explained that the over the years of experience, the development of dairy sector is only existing as a policy while credible proof of government of Pakistan for the smaller dairy farmers is clearly absent. Being a small dairy farmer the affordability to range of technologies that impacts the production rate, volume, animal health which is a critical part of staying the business has been individual contribution. The government level support to spread breeding practices using genetic medication is a developed country practice which increases milk yield per animal. The sustainability goal of this sector is missed as technology-based efficiency in creating safe for consumption of milk has been missed in rural Pakistan. The linkage of the financial help to include technology in the progress of the dairy sector has therefore failed due to lack of national level consensus or emerging model that helps to fuel developmental approach in addressing growth using technology as its base. The lack of knowledge about business models, the possibilities of the new methods of organising resources and establishing new enterprises as a SME requires innovation. This is more of a socially driven wave of ideas through collaboration when the expected help from the Pakistan central government or the provisional government being myopic about opening the dairy sector innovation has not met the future projected demand from the market. It also reflects the lack of a focussed strategy, which has not spawned the home-grown dairy industry in the rural sector to be established as SMEs. Therefore, the Pakistan government contribution in driving the variety of technology for animal wellbeing, dairy production technology adapted for SME level has been ignored, eliminating the chances of potential of setting up progressive enterprises that is in sync with meeting urban milk consumption demands. There is no

evidence of larger dairy production processing plant that can create SMEs in dairy sector to offer low-cost model which leads to in-house R&D for custom solutions. This has been largely missing as the business environment in Pakistan, as it is embedded with the market constraints which is impacting the innovation rate, in the institutional cooperation and collaboration perspective in Pakistan. The result is lack of development, process-based innovation within organisations, lacking in the business environment which is impacting the ground level impacting the small business owners including the dairy sector.

P6 stated that the focus of the stakeholders in Pakistan dairy is more individualised towards personal gain rather than the issues of greater good to the society. The evidence of policy-based action roll out is absent in Pakistan as the local government authorities have not been able to address the sector specific issues in the dairy sector of Pakistan. The perspective of non-technology-based progress has been slow and is far away in adopting newer methods due to approach towards national policy treatment and innovation. The result is lack of direction in national innovation policy and absence of technology has created an environment that is non-cooperative and non-collaborative in nature. The conditions for promoting innovation in the rural sector in Pakistan dairy context is remote. The lack of institutional progress and development to address SME level capabilities in the dairy sector has been impacting the country. It has led to lack of initiatives in the country to address the small business requirements, and dairy sector is one of them. However, the technology-based SME in this dairy sector of Pakistan has not been able to show results in terms of the innovation that aids the home-grown family business of dairy. The government policies on innovation and technology-based development lacks the impetus due to the national level of innovation rate being slow to cater to bring in, a comprehensive growth. The rural thrust has been lacking which is evident from the small business owners who are still trying to overcome the procedural challenges in overcoming for starting a business. The loan process and lack of dairy technology exposure, availability of SME level dairy technology has been a key inhibitor for the attracting investment in the rural areas. Therefore, the provision of the concept of innovation is mostly in terms of processing raw milk, elemental equipment to store milk. The biochemical composition of milk to be altered for increasing the market of the milk by-products, is also dependent on the technological innovation done in the laboratory which is lacking in Pakistan. Even though the progress is made, the penetration of technology in the rural small dairy farmers has not been able to impact the development and growth towards industrialisation.

THEME 2: Research scholar/Professor of dairy sector in Pakistan

Q 3. What kind of technology does the Pakistan SME dairy industry current require to sustain its dairy industry amidst domestic challenges? Does it need to be borrowed from foreign dairy firms? Please elaborate.

The current technology is very basis that poses a significant challenge in bringing in new technology at rural areas of Pakistan. The leveraging of technology has many advantages, though the level of learning, training needed to dissipate through the dairy farmers over time, it requires new method of technology adoption. The possible options are existing industries producing variety of milk by-products need to scale down a model of the entire processing plant for rural scale of operations. This is a technology and innovation combination that is required to bring out a solution for the smaller volume of milk production in rural Pakistan. The issue is about the scattered dairy farmers who are not concentrated in one area but serving their respective villages each having few animals (1-6) as a part of home-based business. The technology needs to adapt to low volume milk processing capabilities, which is typical to the rural Pakistan dairies. The nature of the challenges in rural areas is lack of knowledge and technology and everything manual requires to adopt semi-automatic or fully automatic milk processing plants. The use of scaling down the technology is needed as it would help the low exposure and knowledge in technology perspective to put to test. The existing industries having plants can open the centres amidst three or more villages' vicinity that helps to procure the minimum volume of litres of raw milk to process in a plant. This is a step down of existing technology that requires innovation at national level instead of importing SME level milk processing plant from the west. The cost advantages in home grown innovation is more, and the reliability of performance is also dependent on the engineers who have constructed the framework. The national laboratories or incubation (funded research project) in the engineering colleges of Pakistan is an opportunity to develop similar prototype of technology enabled solution for designing a milk processing plant. The same can be for true for the milking systems that use manual hand-based methods currently. The use of circular milking systems that are used in the western nations is indeed fast and eliminates the chances of contamination. The milking system made automated requires the movement of the animals from the small home-based dairies in Pakistan to buy these milking systems attached to the animal udder. The challenge in adopting this technology is training and the issues of disinfecting the extractor with chemicals every time it

is being used for milking of each animal. The knowledge of how disease spreads and the use of milk extracting system is ideally to be disseminated to all dairy owners in rural level. This is a key element in the automated practice of milking that needs careful observation and the acquire the knowledge about the advantages and disadvantages of it. The localisation of the technology in joint venture from the western firms in Pakistan is an option given the mass scale of small farmers who have (1-6) animals in their home. Though it is a cost for individual farmer, the use of milk extractors automates the process, frees the manual labour put in by the family members for each animal. There are, however, villages that do not have supply of electricity and hence, the option is to create localised milking procurement plants strategically situated in each village. This will reduce the journey of travel for the animals to be milked every day and eliminate the farmers having to buy number of extractors as per herd size though the challenge is on the availability of electricity. The animal health and its maintenance require technology as most of the small dairies is devoid of breeding technology. The small dairy farmers in rural areas are using manual methods of animal breeding as it is the only way to increase the herd size. The agenda is to grow in home-based business as the productivity of the animals goes down over the years. Therefore, the breeding requires advanced technology involving genetics that makes the certain traits of genes in the animals to be resistant to diseases, better genetic makeup for more milk production. This is an innovation in the biotechnology and genetics that uses specialised knowledge in the national laboratories. However, it requires to be tested once the gene is ready and disseminated in rural areas to make the breed more robust though it takes years (two generations) before showing the actual outcome of genetic breeding. The use of technology in the animal fodder is important as the weather is very harsh in Pakistan unlikely in New Zealand and Australia there are lush green grazing lands. Therefore, food for the animals require technology laden composition that is important to develop fodder for the animals in the barn. The issue however is the affordability of the small dairy farmers, to use the fodder in terms of animal feed for the rural dairy farmers. This is important for upkeeping the health of the

The intention is to sustain the rural dairy farmers' capabilities and equip them to use technology that makes breeding challenges to be eliminated. The issue is important in the long run and the Pakistan higher education universities can have sponsored research in buffalo genome programme that benefits the long-term interests of the rural small dairy farmers. The level of technology is high and specialised that is available in the western countries at a high cost. However, the strains

of genes and methodology requires localisation and setting up of research and development project helps the sponsored university doctoral programmes to take part developing genetic programme to aid the rural farmers of Pakistan at a lower cost. The milk processing technology is important particularly the mass scale technology for high volume pasteurisation, which is a typical in automated plants. The availability of this technology in a smaller scale helps to eliminate the most dreaded contamination factor in the rural dairy sector. The pasteurisation method is a proven one and has been already in use globally, the requirement is therefore to adapt the processing in a SME level equipment that serves the rural villages. This is a critical element in shaping the future of technology-based output that impacts the rural milk to become standardised. The western milk production MNCs (multinational companies) has the calibrated elements of vitamins, trace minerals, lactose found in milk. This requires to be aligned in Pakistan small scale dairies as well, which is important from consumption point of view. The maintenance of biochemistry of milk in the rural setup equipment of milk production and processing requires testing every day for each batch of milk production as it holds the key to its shelf life. It is also important to consider the perishability and the storage factor as it is related to the rural farmers' ability to reach a standard that is accepted in manufacturers SOP (standard operating practices). The use of pasteurisation in fact also opens the possibilities to use the product output to be used in a wide variety of applications for manufacturing milk-based by-products. The marketability of the milk processed increases highly as the automated system of packing the output increases the chances of the rural milk to be accepted in market and fit for consumption by urban consumers. The inclusion of technology to produce multiple variants of the milk helps to increase the rural farmers capability to produce cheese, butter, butter milk, yoghurt, probiotic milk that is a huge boost toward the utilisation of the raw milk produced in Pakistan. The indirect effect is on the local economy that is able to develop solutions to generate income for the small dairy home-based farmers whose production of daily milk is finding steady acceptance of wider penetration in Pakistan due to technology-based adoption of equipment. This is a facility that manual milking process does not allow currently, as automated processing in limited time, as the ability to produce variants of milk products using technology is a significant shift of capability and efficiency. It also relates to the factors like cost and resources which are inbuilt in the production plant process, though the maintenance and using the equipment requires training. The knowledge gap in harnessing the technology and the above practices mentioned in a rural sector is bound to fail. Therefore, the creation of a nodal organisation

is necessary that can harness wide variety of the technology domain necessary to equip rural dairy sector to develop over time. The challenge is adoption of technology is not likely to happen soon, due to learning capabilities of the rural people and inability to outgrow their manual method of milking habits. All of these is a time-based project that cannot be laid out immediately as there are too many technologies of specialised nature, each of them being different makes it difficult for the small dairy farmers to connect. The nodal organisation in charge of the responsibilities from procuring equipment, a small-scale SME format processing unit, university-based R&D for genetics, the medicine, fodder, designing SME level plant equipment. This is important as the rural farmers is on the verge of a potential marketing success if all the above is possible to implement. The use of technology allows them to reduce the cost, develop new avenues to adapt to the rural area challenges that existing in the dairy sector in Pakistan. While some of the technologies are too specialised and requires investment, the nodal body and its presence in all the rural areas of Pakistan serving three or four villages is essential to form a catchment area to serve all the small dairy farmers. However, there is also a model of organisation that is needed as to who will form nodal organisation, the central or provincial government, or cooperatives as evident from the world over case studies. The training also forms a critical part of the operations as the viability of the entire proposed technology-based inclusion in rural areas is dependent on it. The rural farmers are bound to get faster processing speed of their fresh raw milk produced every day and achieve the marketization of the output to urban cities of Pakistan. This is a local economic sustainability that government of Pakistan has missed to improve and is now important as it helps to produce the demand centric output of milk by-products that the market needs. It is a development of not only a local rural area, but a capability of processing even though the success is dependent on ability to harness technology and maintain it. The most valuable addition of entire milk production process established in rural sector is the harnessing the power of small dairy farmers which has not been achieved before. It is a methodological breakthrough in socio technical framework involving many stakeholders. The critical question of the funding and setting up of the nodal body its powers, the vested interest of the technology providers private or government in dairy sector is dependent on many issues that require several rounds of dialogue. The formation or type of nodal organisation which is using its power to get the objective of procuring technology is critical to the entire discussion above while it is also important to understand how the alignment of process and output is aligned. The training forms a key role just as the farmers' role in the organisation having many

branches dotting the Pakistan rural areas to increase the footsteps all over Pakistan to procure milk of small dairy players. The question of government role and intervention in the entire processing stages and the economics of the operation is to be ascertained as the finances spent needs to be recovered to sustain the nodal organisation sustenance. The other viewpoints can be inviting the dairy farmers on a common platform by the ministry of agriculture and food, to understand the probability of a PPP (public private partnership) model. This serves the greater interest of everyone who is participating and helps to assign roles to each stakeholder in the entire process. Failure of setting up the nodal organisation is an indicator of greater power seeker in the entire agenda of rural dairy business, though a balance needs to be achieved. The use of SME based formation of an enterprises with small branches all over Pakistan in rural areas is a potential management-based approach after a legal company formation. The need to study the different models of dairy development across developed nations and developing nations however shows that cooperative is a best option. The evidence from USA (developed) and India (developing) shows how a policy-based approach and high-level government intervention with high level of interest has been able to create structures, process, and methods in order to overcome the challenges. The absence of small dairy representation and resolve their challenges at ground level which is resolved by the nodal institution on their behalf. This is a structural innovation in the dairy sector as the lack of the initiation, government apathy towards rural small dairy farmer is evident over the years. Thus, not only technology adaptation in rural SME sector but also capabilities of harness the power to process to be adopted in the model centric organisation that serves the greater interest of the small dairy farmers. It is bound to create the competitive advantage for the rural small dairy farmers which is a disadvantaged group which requires technology-based solutions to equip the rural people. Though it is a great shift and a time-based transformational journey which is required and that tests the viability of the entire establishment of the nodal agency and its functions. It is not easy to lay down the above stated strategies, though innovation in structure, technology adaptation is necessary is needed to make it work. The success of the above identified incapability and rudimentary abilities of the small dairy farmers is therefore, subject to an experimentation approach which has been proposed.

Appendix:

Quantitative questionnaire analysis

Q 1. What are the existing technological elements you are using in the end-to-end dairy process?

Options		
Breeding technology		
Dairy technology		
Quality fodder		
Medicine for wellbeing		
Others		

Q 2. What are the key challenges you are facing while running the operations of a dairy?

Options		
Preservation of milk		
Pasteurisation of milk		
Storage constraints post processing		
Maintaining precision quality of milk for consumption		
Absence of technology to increase shelf life		
Others		

Q3. Are you aware of the Pakistani governments' initiative 'National Dairy strategy' and SME level assistance to start-up technology inclusive dairy production?

Options		
Yes		
No		
Can’t say		

Q4. Does existing rural milk production technology in Pakistan dairy market is able to meet market-based demand-supply requirements?

Options		
Yes		
No		
Can’t say		

Q5. What are the challenges you are facing as a milkman with small size business in terms of technology innovation in the dairy sector?

Options		
Breeding using genetics		
Require quality fodder		
Tough to maintain animal health and hygiene		
Milk purity from production-storage is challenging		
Lack of milk processing equipment for milk-based variants		
No financing available		
Poor transport		
Others		

Q6. Are you aware about the genetic breeding technologies that lead to selective breeding for better cattle progeny creation impacting Pakistan dairy sector future?

Options		
Yes		
No		
Can’t say		

Q7. The livestock gene analysis, genome scans and traits, molecular genetics technologies would impact the Pakistan dairy livestock production to be strategic for future?

Options		
Strongly agree		
Agree		
Neutral		
Disagree		
Strongly disagree		

Q8. Knowledge exposure level in terms of dairy technology for producing milk products would increase your business value, growth, and direction?

Options		
Strongly agree		
Agree		
Neutral		
Disagree		
Strongly disagree		

Q9. Do you feel that technology inclusivity in controlling quality in animal fodder would lead to quality milk production as per FAO standards?

Options		
Yes		
No		

Can’t say		

Q10. Do you believe that to start SMEs dairy in Pakistan requires technology equipment that impacts both structural and functional change in activities?

Options		
Strongly agree		
Agree		
Neutral		
Disagree		
Strongly disagree		

Q 11. Do you believe that technology cost overrides the ability of milk processing, storage, fermentation process, acts as a value function for the end user (fit for consumption)?

Options		
Strongly agree		
Agree		
Neutral		
Disagree		
Strongly disagree		

Q 13. Do you believe that both product-based innovation and process-based innovation in dairy technology is needed to meet the demand-supply gap in Pakistan?

Options		
Strongly agree		
Agree		
Neutral		
Disagree		
Strongly disagree		

Q 14. After all your experience, do you rate a structural gap, process-based gap at infrastructural perspective in Pakistan dairy sector to drive a SME sector growth?

Options		
Yes		
No		
Can't say		

Q 15. Do you agree that dairy technology is needed to eliminate adulteration of milk in Pakistan informal milk markets for improve milk quality?

Options		
Strongly agree		
Agree		
Neutral		
Disagree		
Strongly disagree		

Q 16. Do you feel that technology and innovation can address the gaps in Pakistan dairy sector resolving challenges in milk food supply chain and its marketability?

Options		
Yes significantly		
To maximum extent		
Neutral		
Partially		
Least impact		

Q 17. Do you agree that integrated technologies (pasteurisation and packaging) in milk processing in rural sector can add value?

Options		
Strongly agree		
Agree		
Neutral		
Disagree		
Strongly disagree		

Q 18. Do you think that technology and innovation is able to eliminate contamination risks in the milk products, improve variety, quality, and quicker market access?

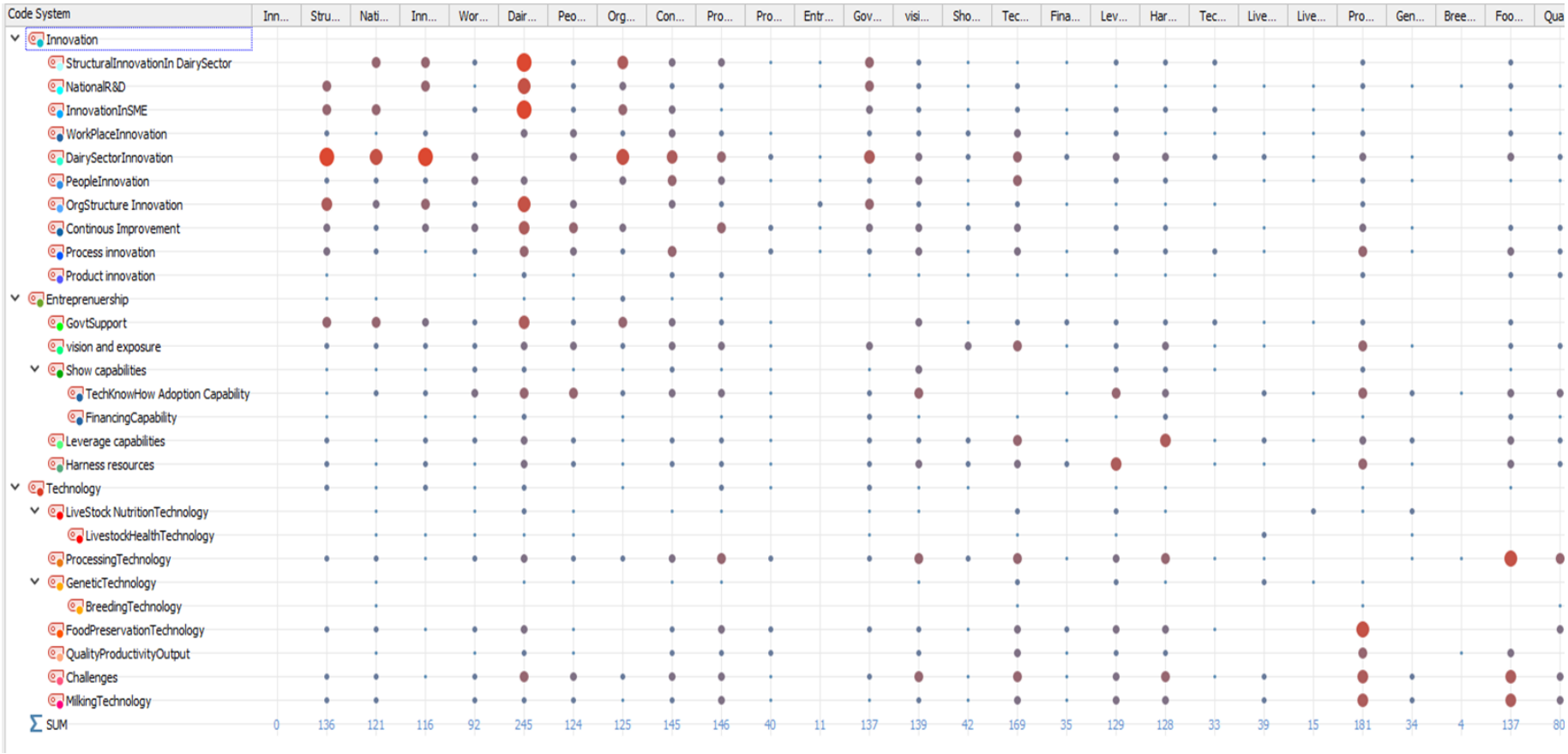
Options		
Strongly agree		
Agree		
Neutral		
Disagree		
Strongly disagree		

<u>Qualitative questions</u>

Q 1. What kind of challenges did you face in bringing dairy technology that drives the operational capabilities of your set up? Is this technology innovative enough to drive sustainability? Please elaborate.

Q 2. What are the conditions that impacts the extent of dairy technological innovation, for improving the Pakistani dairy sector (SMEs)? Please elaborate.

Q 3. What kind of technology does the Pakistan SME dairy industry current require to sustain its dairy industry amidst domestic challenges? Does it need to be borrowed from foreign dairy firms? Please elaborate.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