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Chapter

A Synthesis of Risks in Dairy Value Chains in Southern Africa: Cases of South Africa and Zimbabwe

Chari Felix and Ngcamu Bethuel Sibongiseni

Abstract

An increase in frequency and intensity of slow- and fast-onset disasters in Southern Africa has crippled milk producers' value chain with catastrophic effects to consumers. Milk production is vulnerable to disruptions from natural disasters, poor transport and infrastructure. The chapter considers the cases of South Africa and Zimbabwe, two countries that have organized dairy production. Against this bleak backdrop, this chapter explores the contribution of the milk industry to the economy and the benefits to consumers of milk and dairy products. The chapter also identifies the key players in the dairy supply chain in Southern Africa. It explores different types of disaster risks prevalent in Southern Africa and how they affect the production of raw and processed milk along dairy supply chains. It further interrogates risk management strategies employed by the key players to mitigate these risks to make dairy supply chains sustainable. This chapter reviewed literature and analyzed governments, non-governmental organizations, and industries' documents with the aim to present value chain resilience strategies. This chapter also presents an insight into the policymakers and milk industries on the risk reduction strategies that are employed to mitigate the effects of risks on the milk and dairy products' value chain.

Keywords: dairy industry, drought, milk production, risk reduction strategies, value chain

1. Introduction

The Southern African Development Community (SADC) has experienced the growing demand for dairy products, increased the milk returns, employee productivity, quality milk yields, and demand, as well as the application of world-class technology. Mlambo and Zitsanza [1] contemplate this growing demand which has led to the dairy industry's contribution to the economic development of both South Africa and Zimbabwe. Furthermore, the price fluctuations in the SADC region have led to an increase in the milk demand. The milk production, favorable trade, and job creation can be utilized as criterions to determine the economic benefits of the dairy industry.

The agricultural sector contributes to the gross domestic product (GDP) of the emerging and developing countries including South Africa and Zimbabwe. Hence, the dairy demand is expected to grow by 2.3% a year over the next decade.



Figure 1.
Effects on the demands of the dairy products. Source: authors.

The primary drivers of growth in demand remain population growth and growth in the per capita consumption of dairy products [2]. There is a plethora of benefits in improving the levels of milk production and profitability of dairy farmers. These include the following (**Figure 1**):

- A growing demand for dairy products in developing countries and SADC countries are no exception.
- An increase in milk returns.
- An increase in labor productivity.
- An increase in milk yields.
- The creation of job opportunities.
- Improved demand for quality of milk and its price.
- Improved supply of milk yields by the utilization of production in technology.
- Acceleration of women empowerment.
- Development of farmers' cooperatives.

In Zimbabwe, the agricultural sector provides employment and livelihood to 70% of the population, contributing between 40 and 60% of exports and 15–25% of gross domestic product (GDP) [3]. The dairy sector is equally critical for the success of rural communities as it reduces poverty and ensure food and nutrition security. At the height of production in 1990, milk production reached an all-time annual high of 262 million liters [4]. However, the estimated demand for milk and milk products of 180 million liters in Zimbabwe presents a supply gap of 129 million liters, implying that there is an opportunity for import substitution through improved competitiveness and increased production, especially from local smallholder dairy farmers [4].

On the contrary, the World Wildlife Fund South Africa (WWF [5]) suggests that the South African dairy products import percentage has superseded the export percentage since 2010, although the South African milk production has been changing relatively. *Agriculture Statistics* [6] posits that over the last 20 years, the milk production has remained constantly due to the substantial decrease of the dairy of the national herd. The sudden change in production occurred even though the number of farmers has declined since 1993 with the dairy sectors being detrimentally affected [7], whereas international dairy product prices dropped by 61% from February 2014 to May 2016. The decrease in prices was caused by higher production, fueled by higher producer prices, and a decrease in demand, especially from China [2]. Furthermore, the milk consumption in South Africa has declined, and South African farmers are unable to compete against farmers from the first world countries who receive state funding from their countries and export their products to South Africa. Hence, this slow-onset disaster (drought) had a multiplicity of repercussions including the severe depletion of the natural grazing with livestock slaughter, reduction of summer crop plantations, extreme temperatures in summer months, and grain deficits with an increase in importations. Furthermore, the inability of the agricultural sector to attract clients with purchasing power, a depreciating currency, and an increase in food prices were the effects of drought in southern Africa. It is imperative to investigate the risk issues in the dairy value chain due to the importance of the dairy industry in regional economic development, contribution to the GDP, and poverty alleviation.

2. Milk production value chain

The scarcity of farmland and water has limited the growth of the dairy industry. The key players in the value chain are input suppliers, dairy farmers and milk processors, middlemen, government, financial institutions, nongovernmental organizations, buyers in the markets, and value chain supporters. Both large-scale and many smallholder dairy farmers in the country need several inputs from input suppliers to raise the cows and produce raw milk. South African and Zimbabwean milk production is dominated by large-scale farmers who own fairly large farms with high producing pure exotic cows. The other players in the dairy value chain in Zimbabwe are middlemen (wholesalers and retailers) who buy milk produce from farmers and processors in bulk in order to retail to the consumers. The sale of milk and milk products is through supermarkets and shops around the country. The processing companies also sell milk products directly to final consumers through their salesmen who patrol streets in towns and residential areas with refrigerated push and bicycle carts. The other key players are the consumers of the milk products themselves. Without the consumers in the value chain, there is no business; hence, milk products' consumers are important in the milk value chain. Dairy value chain supporters provide support to the main actors to guarantee that dairy products get to the final consumer. The supporters in the dairy value chain in Zimbabwe include:

dairy services, the Department of Veterinary Services, Livestock Research Institute, extension services, farmers' unions, and nongovernmental organizations.

There are a multiplicity and diverse actors in the dairy supply value chain who perform various pivotal roles that service dairy industries including educators from agricultural schools, universities and technical colleges, farmers and stock people, farm advisors, local agribusiness, policymakers, and research scientists. There are also pivotal key stakeholders in the dairy value chain in South Africa which include the Department of Agriculture, Forestry and Fisheries, National Disaster Management Centres, Industrial Development Corporation, Land Bank, Banking Association of South Africa, South African National Consumer Union, and National Chamber of Milling. The stakeholders aim to improve the productive performance of the training and development programs and training on the foundations of dairy production technology. Midgley [8] mentions that consumers, dairy processors, informal traders, retailers, bulk milk collectors, transport operators, importers and exporters, and large commercial and medium and small dairy producers can be considered as the dairy supply value chain. The author argues that the dairy industry has noticed the number of producers declining with the cattle sizes increasing and the milk production efficiencies improving.

3. Drought effects in the dairy industry

The SADC region has been prone to drought, which is associated with the climatic phenomena called EL NINO. This phenomenon occurred when sea temperatures surpassed the Western coast of South America affecting global weather patterns. The effects of EL NINO in South Africa has resulted in seven out of nine provinces being declared disaster zones which had catastrophic effects on the dairy supply including the milk. The severe impact of drought in the SADC region with South Africa as no exception has drastically paralyzed the milk supply value chain. This became conspicuous as most dairy farmers were unable to produce and supply sufficient milk due to the impact of drought which has increased the cost of milk drastically. Consequently, this led to the majority of dairy farmers in South Africa to experience a reduction in the milk production, which led to an increase in prices by retailers which had an adverse effect on consumers. The local supply situation remains uncertain as the final effect of the 2016 and 2017 drought remains to be seen. Lower grain prices will probably have a beneficial effect on production but the scarcity of roughage, higher beef prices, and the weaker condition of herds after the drought impacted negatively on production. Milk production growth remained slow during the rest of 2017 [2]. There are a number of factors that have necessitated some dairy processors to pay commercial farmers an exorbitant amount of money per liter per average for milk to ensure a consistent supply which includes, *inter alia*:

- The effects of drought leading to poor pasture conditions.
- Increase in grain prices.
- Importation of dairy products (milk) from other countries was very expensive as the Rand was very weak despite lower international prices.
- The volatile exchange rate made imports expensive.
- Increase in electricity tariffs increased input costs for farmers and milk processors.

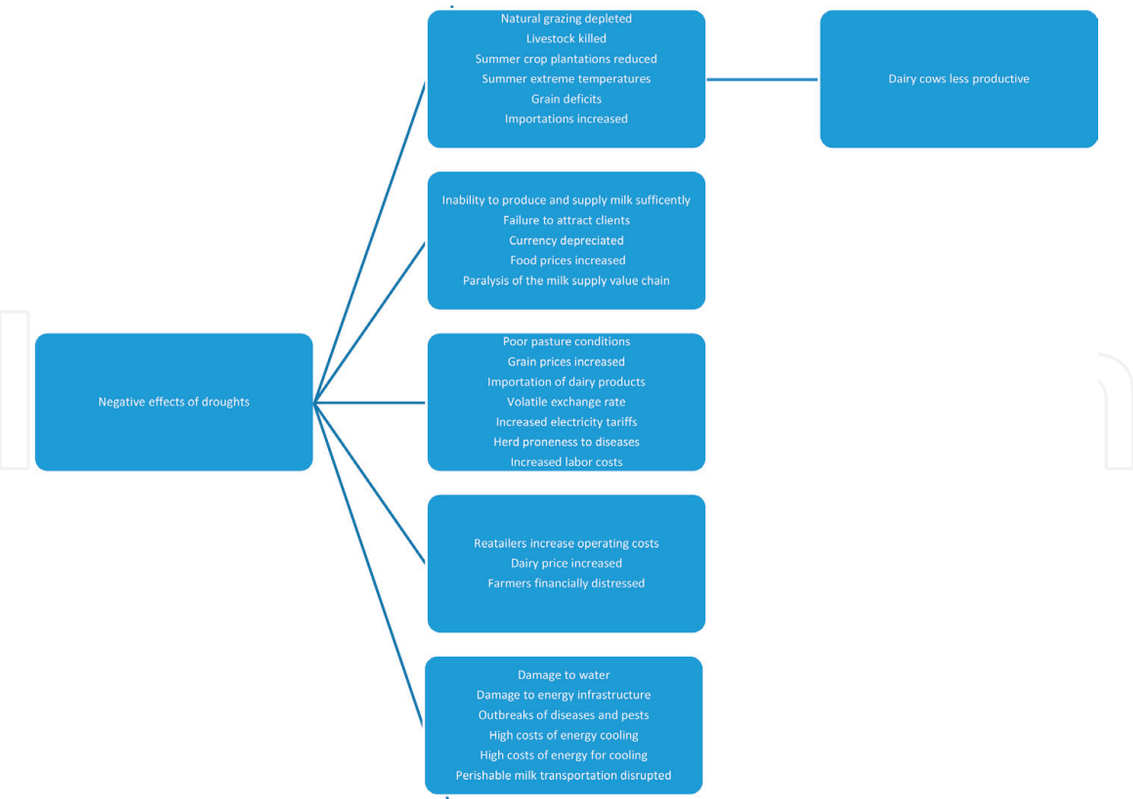


Figure 2.
Adverse effects of droughts in the dairy supply. Source: authors.

The above factors have influenced retailers to increase operating costs for the entire milk value chain, which necessitated retailers to increase the dairy milk and other dairy products which consumers purchase at a hefty price. Lakew [9] opines that the dairy farmer's profitability on their products are negatively affected; a reduction in the production of milk and unfavorable balance of trade can be originated on the decline in the production of milk (**Figure 2**).

Transporters collect and transport bulk raw milk from farms to processing plants, usually situated in towns. In Zimbabwe, the transport system is dominated by the National Dairy Co-operative (NDC), an organized farmers' co-operative transport organization. The transporters use refrigerated bulk tanks to ensure that the quality of milk is maintained. The major processing companies are Dairibord Zimbabwe Private Limited (DZPL), Dendairy (Pvt) company, and Nestle Zimbabwe, which add value to raw milk by being processed into various milk products such as yogurt, cheese, pasteurized milk, ice cream, and butter.

4. Risks in dairy value chains

The complex dairy value chain comprises dairy farmers, transporters, processors, wholesalers, retailers, and consumers who use milk products created in the value chain [10]. The dairy supply chain is vulnerable to disruptions from numerous risks as it involves many stakeholders. Risks may arise from any component within its supply chain. According to Gertenbach [11], environmental factors which include temperature, rainfall (quantity and distribution), sun hours, and soil types contribute significantly to livestock production. Climate change has negatively affected the SADC region's dairy farmers and industry in particular. For instance, the increased temperatures have decreased the dry matter intake for animals, reproductive performance declined, and the overall productivity declined. Heat stress impairs milk

production, reproductive performance, metabolic and health status, and immune response. The dairy cows are less productive in the event of increased temperature levels. Hence, cows that are experiencing extreme heat are identified by the signs of the reduced feed intake, which directly contributes to the decreased milk yield. The extreme climatic variations which are prevalent in the SADC region have both direct and indirect impacts on the dairy cattle where the following have been identified:

- Fodder and pasture yields decreased,
- Increased susceptibility to diseases,
- Shortage and increased feed costs.
- Infrastructural destruction, and
- Cost increase due to overutilization of energy.

The main risks associated with Zimbabwe dairy include financial, technology, political unrest, policy barrier, and natural disasters.

4.1 Financial risks

To purchase the required infrastructure in the dairy industry requires large sums of money [12]. The high perishability of milk requires dairy farmers to make substantial capital investments right from production up to sale. The procedure to secure finance in Zimbabwe is burdensome and highly bureaucratic and complex [12]. Credit providers have become more risk-averse and are equally reluctant to offer loans to farmers producing on land that lacks collateral value. Women entrepreneurs are adversely affected where banks demand collateral security in the form of property in urban areas for them to access business loans. Fewer women than men own fixed assets [13]. High lending rates of up to 14% [14] make the cost of capital expensive. Available financing is more suitable for short-run farming projects, while there is limited availability of medium to long-term finance for the broader agricultural sector. Resultantly, farmers are unwilling to make long-term investments in dairy farming leaving Zimbabwe food insecure [15].

4.2 Input risks

The most important dairy component is the livestock itself—the heifers. Building the dairy herd takes long gestation periods of up to 9 months. The long gestation makes it difficult to grow the herd much faster to boost milk output. In like manner, dairy farmers incur high costs to breed or purchase heifers which become a production constraint [12]. An equally important input is electricity provided by a state-owned monopoly, the Zimbabwe Electricity Supply Authority (ZESA). The frequent disruptions in power supplies have seen a decrease in capacity utilization in the agricultural sector which, in turn, affects capacity utilization simultaneously fuelling input costs in the dairy industry as the dairy processors have to consider other sources of power like generators to prevent disruptions in their production lines [16]. The high-input costs push the price of the final milk products up.

Furthermore, the Zimbabwe dairy industry has very high labor costs negatively affecting viability. An increase in labor costs reduces returns, and income earned may not be adequate to cover costs [17]. Zimbabweans are among the heavily taxed in the world. Currently, above paying taxes to the Zimbabwe Revenue Authority,

dairy producers pay levies to the Dairy Services Department, Environmental Management Authority, Agriculture Marketing Authority, Local Authorities, and Zimbabwe National Water Authority, among others [18].

4.3 Political risks

The poor performance in the agricultural sector is also as a result of poor government policies. During the period from 1998 to 2000, Zimbabwe experienced negative economic growth. There was political instability in Zimbabwe following the fast track land reform program. The political instability negatively affected milk production as large-scale commercial dairy farmers were among those who lost their farms land invaders [19]. Following the implementation of the fast track land reform, cattle population declined. It is estimated that the dairy herd was reduced by 50% from what it was before the land reform program in year 2000. Land tenure security is threatened by lack of title deeds, and therefore, dairy farmers are not prepared to make long-term investments, negatively affecting milk quantity and quality [20]. Political commitment to creating an enabling environment for investment growth in Zimbabwe is questionable and uninspiring [21].

The other challenge that local farmers face is their limited capacity to influence policy outcomes. Intervention by NGOs is heavily restricted by the restrictive political environment. Governance concerns continue to block any progressive success made toward foreign interventions in the form of assistance from emergency interventions to long-term development support.

4.4 Competition risks

The high costs of breeding dairy cattle translate to very uncompetitive raw milk which costs US $0.62 per liter compared to neighboring South Africa and Kenya, which costs US $0.40 and US $0.30, respectively [22]. There is fierce competition emanating from the influx of foreign milk and milk products from plants in Europe and South America, which is choking the dairy industry to date [23]. Most dairy products from South Africa are threatening the agricultural sector, thereby prompting dairy farmers and processors to come up with initiatives that promote the buying and consumption of locally produced dairy products to mitigate the unfair competition from foreign dairy products [24, 25].

4.5 Natural disaster risks

The disastrous drought which affected the SADC region between the period of 2015 and 2017 has negatively affected the already ailing agricultural sector (commercial, small holding, and subsistence) which left farmers financially distressed. The intensity and magnitude of drought which struck South African farmers including dairy farmers were beyond their world-class disaster contingency plans. Even though South African farmers are recognized as the best in the world in terms of their planning and production and risk assessment and planning, they did not cope with the disaster. The extreme risk to the dairy production and its value chain is associated with the climatic variations with mostly the variable weather conditions more especially droughts. The recent slow-onset disaster (drought) directly affects both rain-fed and irrigated pastures, as well as prices of purchased feeds. The climatic risks also encapsulate erratic rainfall patterns, heavy rainfall and floods, and heat waves. Extreme weather conditions have negative repercussions which include damage to water and energy infrastructure; outbreaks of pests and diseases; high costs of energy for cooling under hot conditions; and disruption of transport of perishable milk due to road and bridge destruction.

While all countries suffer from disasters, low-income countries are more susceptible to the impact of disaster risks. The natural and manmade disaster risks have severely disrupted dairy production, thereby leading to increased prices of dairy produce, decreased sales, and created perpetual vulnerability. Unexpected climate change affecting Zimbabwe and other southern African countries are exposing dairy farmers to both production and marketing risks. They tend to affect many farms and dairy processing firms. Secondary data available on climatology such as rainfall pattern erraticism and extreme weather events in Zimbabwe show that the country is already experiencing the effects of climate change [26].

The unbearably high temperatures extended Zimbabwe's dry regions that are less productive, thereby shrinking the main farming regions. These human-induced climate changes are caused by the greenhouse effect [27] and mostly affect African countries like Zimbabwe resulting in food insecurity. The challenges posed by unforeseen climate changes are depleting the most essential natural resource, water. It is increasingly becoming difficult to sustain viable agriculture given such harsh, unpredictable weather conditions for many agro-based economies like Zimbabwe. Rain-fed agriculture is becoming less reliable to maximize agricultural productivity.

Zimbabwe, being an agro-based economy, faces severe threats from these climatic changes. Dairy farming, in particular, thrives well in regions which record high rainfall. Zimbabwe, in particular, is at risk and is vulnerable to these new climatic conditions because it heavily relies on rain for its agricultural activities [28]. These erratic rainfall patterns and dry spells are impacting negatively on the productivity of dairy farms. The low rainfall experienced in Zimbabwe country makes dairy cows breeding more difficult by the day as there are changes in feed resources [29].

Over a million cattle starved to death as a result of the 1991/1992 drought [30, 31]. The impact of the drought was felt by individual farmers, as well as all the industries dependent on agricultural raw materials such as milk and beef processing [31]. The 2015/2016 drought threatened food security in Zimbabwe as thousands of cattle starved to death due the drought [32]. Grazing conditions remained poor in most of the southern half of the region [32]. The foot-and-mouth disease (FMD) of year 2015 also contributed to the calamity as it resulted in a decline in the national herd [33].

4.6 Technology risks

Poor technology in Zimbabwe, among other factors, has adversely affected capacity utilization in the milk processing industry [34]. Dairy farmers face technological risks as they have problems cooling milk in areas without electricity, adversely affecting the quality of milk. Consequently, some farmers use manual milking which is quite difficult for large herds. Low agricultural output is, therefore, attributed to the low capital endowment (Zimbabwe Vulnerability Assessment Committee [35]).

5. Risk management strategies employed by stakeholders

Various strategies which can be harnessed in order to increase domestic milk production and yield a positive contribution to the economy include, *inter alia:*

- Prioritizing increasing the number of dairy farmers without emphasizing changing the average milk production per cow or farm.

- Emphasizing the increasing yields per cow milk rather than expanding the population of dairy farmers.

- Increasing the total number of the milking herd (cows) without changing dairy farms.
- Increasing the number of dairy farms, the size of the milking cows, and per cow production combined.
- Reforming small holding dairy farms to larger farms and "mega farms."
- To eliminate wastage at the production plant (farm) and by the consumer.
- To avoid the high mortality rates of young stock.
- The development of a national breeding center.
- The importation of breeding heifers.
- To have a skilled labor force.

There is no straight solution to manage risks. Each value chain possesses its uniqueness; so, the criterion for management differs from others. Various risk mitigation strategies to mitigate the risks associated with the dairy value chain are explored in this section. The dairy farmers have utilized various mitigation strategies. These strategies include the use of smaller dairy breeds like Jersey, growing fodder crops, and the utilization of crop residences.

Furthermore, the low-cost to high-cost adaption strategies have been utilized to counter heat stress on dairy cattle productivity and reproductive performance. The low-cost measures employed by farmers include reducing overcrowding, maximizing shade, improving ventilation, and high-cost measures included the designing and installation of thermos air conditioning. Both adaptation and mitigation strategies were utilized by dairy farmers to ensure that production and productivity inputs are at an optimal level. Sprinkler fans, changing the feeding periods to coincide with the cooler times of the day and reducing the exertion required by animals to gain access to food, minerals, and water are the mitigation strategies that were being employed by farmers.

To fully implement the above strategies dairy farmers relied on collaboration, legislation and policy, education and training, insurance, technology, and international assistance [15]:

5.1 Collaboration

A plethora of commentators [36–38] opine that a key strategy to effectively mitigate risk on dairy supply is through collaboration among key stakeholders. Such key stakeholders from diverse sectors and disciplines including leaders of government ministries, NGOs, and private sector organizations play a pivotal role in risk reduction. The collaboration and partnership of stakeholders yields positive results as partner organizations share skills, technical knowledge, information and resources, experiences, and best practices resulting in saving money due to elimination of duplications and wastage. Collaboration is also evident in Zimbabwe's dairy sector. The Zimbabwe farming community has formed collaborations with NGOs to try and mitigate exposure to risk. There are many NGOs providing assistance in the agrarian sector in Zimbabwe of which Technoserve, Land O'Lakes, European Union, United States Agency for International Development (USAID), and Zimbabwe Agricultural Competitive Program (ZimACP) are active in providing support and assistance to the dairy farming sector [21].

NGOs such as Land O'Lakes partner National Association of Dairy Farmers (NADF) train community livestock workers in dairy management [39]. Likewise, milk processing companies, Dairibord Zimbabwe Holdings, Nestle Zimbabwe, and Dendairy develop small, medium, and large-scale farmers across the country through heifer programs to boost milk production [40]. The livestock was distributed to farmers in an effort to ensure continuity of supply across the supply chains. According to the Dairibord Holdings Annual [40], this milk supply intervention has realized benefits as it has contributed 8% to the milk supplies for Dairibord Zimbabwe.

5.2 Legislation

Disaster legislation is one of the instruments that can highlight the efforts and commitment a country has in disaster reduction and management practices. This section highlights the legal and institutional framework that deals with risk reduction and management in Zimbabwe. The Civil Protection Department is tasked with the mandate of preparing for and providing for prevention where possible, as well as mitigating the effects of disaster whenever it occurs, through the Civil Protection Act of 2001 [41]. This was a reflection of the government's commitment to disaster management [42]. The Civil Protection Act of 2001 resulted in the setting up of a Civil Protection Department under the flagship of the Ministry of Local Government, Rural and Urban Development [43]. Besides the Zimbabwe Civil Protection Unit efforts, there has been an increased focus on disaster risk reduction (DRR) by other sectors of government. The Zimbabwean Civil Protection Act is complimented by other acts: Environmental Management Act (20:27), the Rural District Councils Act (29:12), the Urban Councils Act (29:14), the Water Act No. 31 of 1998, the Defence Act (11:02), the Police Act (11:10), and the Public Health Act (15:09) [44].

5.3 International assistance

Zimbabwe is among the top 40 recipients of disaster risk reduction (DRR) financing from humanitarian organizations. However, there is still a concentration of DRR financing by these humanitarian organizations within the top four recipients (Pakistan, India, Indonesia, and Bangladesh) [45]. The farming community has formed collaborations with international NGOs to try to mitigate exposure to risk. There are many NGOs providing assistance in the agrarian sector in Zimbabwe of which Technoserve, Land O'Lakes, European Union, USAID, and Zimbabwe Agricultural Competitive Program (ZimACP) are active in providing support and assistance to the dairy farming sector [21]. The activities of these organizations are coordinated by the Food and Agriculture Organization.

5.4 Policy

In a plight to increase agricultural activity and curb the risks posed by natural hazards in Zimbabwe, various stakeholders have formulated the Comprehensive Agricultural Policy Framework (2012–2032) [46]. Due to changes in the socio-economic environment, such as the land reform program, there has been a need to review the national agricultural policy. The policy is aimed at, among other issues, increasing production and productivity of livestock and improved animal health and welfare in the country [46]. The Comprehensive Agricultural Policy Framework also recommended agricultural subsidies so that local farmers will be able to compete with imports. Despite these noble efforts, a gap still exists concerning agricultural policy formulation and implementation which will guide

any programs directed toward mitigation of natural hazards and meteorological disasters like drought. Zimbabwe has to date made many attempts to create a comprehensive agricultural policy, which have remained in draft form to date [21].

5.5 Education and training

Education and training strengthen all aspects of risk management at all the stages in the risk management cycle. Risk management (RM) education can be introduced in school curricula. Zimbabwe has successfully integrated DRR and emergency preparedness into its education system. Education would be a handy strategy with most dairy farmer's literate (96%) and are able to interact with providers of farmer training courses [47]. Similarly, conferences compliment formal education and workshop training [48].

5.6 Insurance

Zimbabwe has a total of 25 registered insurance companies and 15 insurers, representing about 60%, which currently provide agricultural insurance [49]. However, there is a low penetration of agricultural insurance products in the country. Furthermore, insurers do not provide specialized agricultural insurance packages. Insurance enables the farmers to transfer risks to insurance companies [50]. Insurance reduces individual loss exposure, thus spreading risks by collecting premiums from many individuals and paying for damage caused by natural disasters that are very large for individual households and companies. Agricultural insurance policies cover against a many risks including drought, floods, heat waves, and other natural disasters. One such insurance by Zimnat Lion Insurance, Zimnat Livestock Insurance, insures farmers against fire, theft, lightning, explosion, and death of livestock [51].

5.7 Technology

Most dairy farms in the developed world make use of emerging technologies to improve efficiency and profitability in dairy enterprises. In particular, automation technology is used to improve profitability, milk quality, reduce costs of production, and improved animal welfare. These new automated technologies have incorporated computers and cellphones application to manage milk production and animal health. Various technologies recommended to dairy farmers in Zimbabwe were first tested on demonstration plots before they were adopted across the country. However, adoption of these technologies was a hurdle to poor farmers because of resource unavailability [52].

5.7.1 Emerging technologies and benefits in the dairy industry

The dawn of the agricultural revolution which is engrained on technology has increased efficiency and profitability in the South African and Zimbabwean dairy industry. The introduction of technology has boosted milk yields, enhanced milk quality, and reduced the costs associated with producing white stuff. **Table 1** depicts emerging technologies and benefits in the dairy industry.

The abovementioned technologies assist the dairy industry production as there is a scarcity of committed labor in both the developing and developed countries. Furthermore, such new technologies save time and reduce labor expenses, thus increasing efficiency, productivity, and profits.

Technology	Benefits
Cow collars	• Track and collect data on the health, habits, and happiness of the herd. • Data can be accessed anywhere by using modern devices including laptop or smartphones. • Share abnormal information with a vet. • Detect illness and respond early. • Detect when the cow is in heat. • Boost chances of healthy pregnancies which enhance milk production.
Drone technology	• Monitor the location of the herd. • Monitor the entire farm and identify early risks including: ○ Intruders. ○ Stock thieves. ○ Illegal invaders. ○ Identify perimeters that need repair. ○ Identify areas of dry land that require irrigation. ○ Monitor the entire farming business.
Facial recognition technology	• Using details such as: ○ Pelt patterning. ○ Distance between the ages and length of face. • Detect each cow in a dairy farmer's herd. • Send alerts when a cow behaves erratically: ○ Walking irregularly or missing feeds. ○ Track the link between each cow's food intake and their milk production.
Robotic milking technology	• Enhanced milk yields.

Table 1.
Emerging technologies and benefits in the dairy industry.

6. Conclusion

This chapter espoused the high level of preparedness and resilience by dairy farmers during and in the aftermath of droughts to selected countries. It is observed in this chapter that while drought effects have paralyzed the dairy industry, the demand of dairy products has remained constant. The increase of the demand of the dairy industry has improved the quality of life of people as it provided formal and seasonal employment. Moreover, it also increased competition among the dairy farmers coupled with profits gained. Consumers also benefited as they have purchased quality dairy products which were influenced by the competition among dairy industries. This chapter has depicted the adverse effects of drought which have affected the dairy supply value chain from the grazing fields, herd health and productivity, infrastructure, economy, and resource availability. Various technological inventions and applications have been seen as beneficial to dairy farmers which has increased the health and productivity of cows, monitoring of the entire business and detection strategies which have increased cow milk yields. The technological, financial, political, and natural disasters and input risks have been the dominant risks in the dairy supply chain and have had catastrophic effects on

consumers. Various risk mitigation strategies have been implemented to mitigate the risks associated with the dairy supply chain that includes collaboration, legislation, policy, education and training, technology insurance, and international assistance. However, most strategies failed because of unavailability of resources to fully implement them.

A major limitation in this study is methodological in nature as this chapter only employed a document analysis. This research method makes it difficult to test the reliability and validity of the findings as inferences cannot be used to other countries. It is advisable for future researchers to employ various methodologies and approaches in both countries where reliability and validity testing will be conducted.

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