

# Chapter 11

## Leveraging Machine Learning Techniques to Improve Learning and Recommendations Within Dairy Farms: Towards High Milk Yields for Small-Scale Farmers

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### **ABSTRACT**

*Tanzania's small-scale dairy industry faces similar challenges to those of other developing nations whereby insufficient infrastructure, outdated technology, and low productivity are serious problems for higher milk yield. Tanzania urgently needs to adopt cutting-edge solutions in order to boost dairy performance. With 3500 households' secondary data and 202 households' primary data from 8 villages throughout the Kilimanjaro and Arusha regions, this chapter demonstrates the use of machine learning (ML) techniques to derive homogeneous production clusters and recommendations for more milk yield among dairy farmers. The likelihood for higher milk yield is demonstrated for various clusters with the use of support, confidence, and lift values of association rules analysis. Finally, the production clusters and recommendations are deployed through a mobile application. Recommendations for future improvement are suggested especially on further deployment of learning recommendations and development of a platform-independent mobile solution.*

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## **INTRODUCTION**

Over 150 million farm households around the world are supported by small-scale dairy farming, which is characterized by small herds of 1-2 milking cows (Chawala et al., 2019). Small-scale farmers are most prevalent in developing nations (Chawala et al., 2019). Due to the valuable food items it produces that improve household nutrition and food security, small-scale dairying is a significant agricultural activity in many developing countries (Kingu & Ndiege, 2018). In line with an expanding population and rising per capita income, there is a substantial increase in the demand for dairy products (Taneja et al., 2019). In line with the rising demand for milk as a result of the world population's expansion to over 7 billion people, the dairy sector is a significant employer worldwide and is expanding (Gitau, 2013). The consumption of milk and dairy products is higher in industrialized countries than in developing ones, although this disparity is closing due to rising incomes, population growth, urbanization, and dietary changes (Taneja et al., 2019).

According to estimates, the number of people who consume dairy and dairy products would increase from 1.8 billion in 2009 to 4.9 billion by the year 2030 (Taneja et al., 2019). However, the development of techniques to raise agricultural and dairy sector yield has lagged behind the rate of demand growth (Taneja et al., 2019). While global milk output as a whole has increased by 32%, milk production per person has decreased by 9% (Gitau, 2013). Small-scale dairy farmers run around half of all livestock operations in Africa, yet they struggle to produce adequate amounts of milk due to lack of infrastructure and a framework that would allow them to do so (Mavura et al., 2022). In light of this, it can be concluded that global milk production has not kept up with the population growth (Gitau, 2013). New and efficient strategies are required to increase this sector's production capacity in order to meet the rising demand for food (Taneja et al., 2019).

## **BACKGROUND INFORMATION**

Goal two of the Sustainable Development Agenda aims to eradicate hunger, establish food and nutrition security, and advance sustainable agriculture by 2030 (Liverpool-Tasie et al., 2020). To achieve this, it is necessary for small-scale farmers to participate in and gain from the rapid expansion and development of food systems (Liverpool-Tasie et al., 2020). Small-scale livestock producers have an opportunity to improve their livelihoods and become food and nutritionally secure, thanks to the global increase in the demand for and production of animal-source foods, which has been mostly concentrated in Low and Middle Income Countries (LMIC) (four to fivefold increase between 1960 and 2015) (Balehegn et al., 2020). Globally, and especially in LMIC, the demand for animal products is expanding due to population increase, urbanization, and rising affluence (Balehegn et al., 2020). Consumer demand for milk in LMIC will increase by 5.5 million tons, by the year 2050 compared to 2005/2007 (Balehegn et al., 2020). The dairy farming sub-sector has a huge potential to raise people's standards of living (SDG#3) and help end poverty (SDG#1) by promoting better nutrition through milk consumption and revenue from the sale of milk and milk-related goods (Mbilu, 2015; Mzingula, 2019).

Tanzania's livestock sector includes the dairy industry as one of its key constituents (Mzingula, 2019). In terms of the Gross Domestic Product, it accounts for nearly one-third of the 4.6% share of the cattle industry (Mzingula, 2019). Small-scale dairy farming has grown quickly in Tanzania over the past three decades, mostly as a result of its effective role in reducing poverty and bridging the gap to rising demand

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