



## Mini Review Article

# Synergizing Crop Farming and Goat Production in Ethiopia

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## ABSTRACT

Smallholder farmers, who make up a significant part of the agricultural workforce in developing countries, often face ongoing challenges, such as low income, poor nutrition, and food insecurity. Traditional farming systems typically emphasize monocropping, which limits both resilience and diversification. The present study investigates the impact of integrating root crop cultivation with goat rearing on the livelihoods of smallholder farmers in Ethiopia. Integrating goats into traditional farming systems improves soil quality, as their manure acts as an organic fertilizer, boosting the nutrient content of root crops. While cassava, yams, and sweet potatoes are energy-rich in Ethiopia, they lack sufficient protein. Providing high-quality protein, vitamins, and minerals is therefore essential for maintaining a balanced diet. Goat milk and meat can address seasonal food shortages and improve dietary diversity. Integrating goats with root crop farming diversifies agricultural production, provides alternative income streams, reduces dependency on a single crop, enhances resilience against climate variability, and market instability. Since goats can thrive on marginal land, farmers can optimize land use while maintaining crop yields. Sales from goats can help cover household expenses or be reinvested into farm operations, thus ensuring long-term profitability. Moreover, manure produced by goats enhances soil fertility and boosts root crop productivity, thereby increasing both yields and profit margins. The crop–livestock interaction fosters sustainable agriculture by reducing reliance on chemical fertilizers and improving soil health. In conclusion, the combination of goat husbandry with root crop farming provides a complementary strategy that can enhance food security, income, and resilience among smallholder farmers in Ethiopia.

## 1. Introduction

Ethiopia's agriculture sustains the livelihood of more than 80% of the country's population through small ruminants, particularly goats. The vast number of sheep and goats (approximately 42.9 million and 52.5 million, respectively), placing Ethiopia among the nations with the highest small ruminant populations globally<sup>1</sup>. These numbers represent about 10% of the continent's small ruminant stock and nearly 4% of the global population<sup>2</sup>.

Although these animals are vitally important in the economy and nutrition, there is a significant gap in detailed information about their management and living conditions. Findings by Wodajo et al.<sup>3</sup> reveal considerable regional variation in ownership. In the highland regions of Ethiopia, farmers primarily practice mixed farming, and 11%-60% of households keep small ruminants; in contrast, the ownership

rate in lowland pastoral areas ranges from 41% to 95%. These statistics highlight the crucial role of sheep and goats in ensuring food security for households in livestock-dependent communities<sup>4</sup>.

The preference for small ruminants among farmers can be attributed to several advantages, including lower initial investment costs, rapid reproduction, and high fattening rates<sup>5</sup>. Compared to cattle, these characteristics enable faster financial returns, enhance short-term cash flow, and facilitate quicker herd rebuilding after drought.

Small ruminants contribute approximately 25% to Ethiopia's total meat production and play a crucial role in the national economy, particularly through exports. From 2018 to 2019, about 8% of the 45 million dollars was earned from live animal exports, while 86% of the 93 million dollars in revenue



came from meat exports<sup>6</sup>.

Despite its population and potential, Ethiopia's small ruminant production is largely based on traditional, subsistence-level practices. Commercialization and the adoption of limited modern techniques have resulted in low production take-off rates and suboptimal output levels<sup>5</sup>.

The extended age to reach maturity, longer intervals for lambing and kidding, along with high mortality rates among young stock, all contribute to decreased reproduction rates<sup>7</sup>. To foster long-term improvements within the industry, it is imperative to conduct a technical assessment of the challenges linked to current production practices and to investigate potential interventions concerning feed, genetics, and health. A thorough comprehension of the population structure, biomass, production levels, and economic significance of the system is vital for this undertaking. However, such insights are limited in the small ruminant livestock sector in Ethiopia. Consequently, the current study aimed to evaluate the integration of goat farming and root crop cultivation to enhance the farmers' livelihoods and benefit the community.

### **Goat production system in Ethiopia**

Several interconnected factors, including breed types, housing conditions, levels of intensification, feeding practices, and environmental constraints, shape goat production in Ethiopia<sup>8</sup>. Production systems for small ruminants differ significantly by region, as local ecological and socioeconomic conditions greatly influence them. In much of Sub-Saharan Africa, including Ethiopia, smallholder farmers largely rely on mixed crop–livestock farming, which is the main form of subsistence agriculture<sup>9</sup>. Agricultural practices, access to natural resources, such as land and water, governmental agricultural regulations on agriculture, and resources for farmers significantly influence how Ethiopian producers manage livestock.

The role of livestock in household income, both as a source of food and as a financial asset, alongside crop production types, species diversity, and mobility patterns, forms the basis for classifying production systems. In Ethiopia, traditional small ruminant farming can be categorized into three main systems. The first system integrates with semi-arid and pastoral regions, where goats and sheep are predominant. The second system is associated with annual crops, mainly in the highlands of the north, northwest, and central areas, and systems linked to perennial crops in the southern and southwestern highlands. The third system is linked to perennial crops in the southern and southwestern highlands<sup>10</sup>. Solomon et al.<sup>11</sup> expanded this framework into five subcategories, considering feeding strategies, veterinary care, and housing practices. These include the subalpine-cereal system, semi-intensive or extensive systems with minimal inputs, highland cereal-livestock systems where tethering is prevalent, and large-scale lowland agro-pastoral models that rely on rangeland grazing and housing<sup>12</sup>.

Housing plays an essential role in Ethiopian goat production, as it protects animals from harsh weather, predators, and theft while improving management and feeding practices<sup>13</sup>. In areas such as Bale Zone (Oromia), Jimma Zone (Goma district), Degahabur in the east, and Wollega in the west, farmers typically house goats overnight and often

provide them with supplemental feeding<sup>14</sup>. In some districts, however, many farmers still keep their sheep outdoors without shelter, while others provide simple coverings or occasionally house them indoors<sup>15-17</sup>.

### **Feed resources for goats in Ethiopia**

Goat nutrition in Ethiopia relies heavily on natural pasture, which provides 80-90% of total feed, followed by crop residues (10-15%). Other common sources include fallow land, roadside grazing, communal pastures, crop aftermath, hay, browses, and agro-industrial byproducts, such as brewery waste (*Atela*)<sup>18</sup>. Additionally, farmers utilize non-conventional feeds, including weeds, crop tillers, and household leftovers. Regional variations exist across Ethiopia's diverse agro-ecologies, where resources, such as *Ensete ventricosum* leaves, sugarcane byproducts, and banana stems, are locally important. The use of enhanced forage species and crop residues as supplementary resources is increasing, although access remains inconsistent<sup>19</sup>.

### **Reproductive performance of goats**

Reproductive efficiency is a critical factor determining the productivity of goats. Successful goat farming relies on regular breeding, proper replacement of stock, and continued production of milk, meat, hides, and fiber<sup>20</sup>. Assessing reproductive traits helps identify gaps and opportunities for improving herd performance, profitability, and integration with crop-livestock systems<sup>21</sup>.

### **Constraints to goat production**

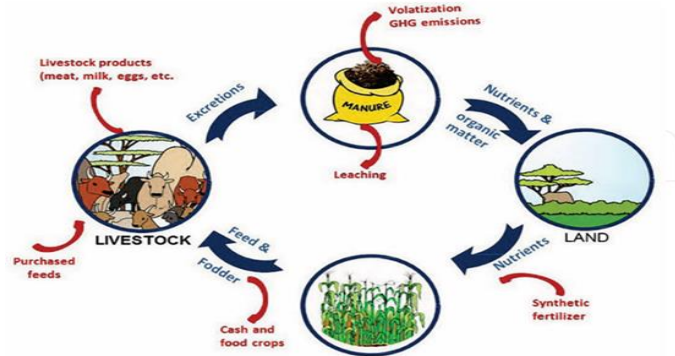
In Ethiopia, goats have significant potential; however, they are often underproductive due to poor feeding practices, a shortage of quality feed, limited veterinary services, and disease outbreaks. Farmers also face constraints, including theft, market access issues, financial limitations, water scarcity, and a shortage of labor. Additional challenges, such as inadequate infrastructure, climate variability, and exposure to predators, further reduce productivity<sup>22</sup>.

### **Housing management**

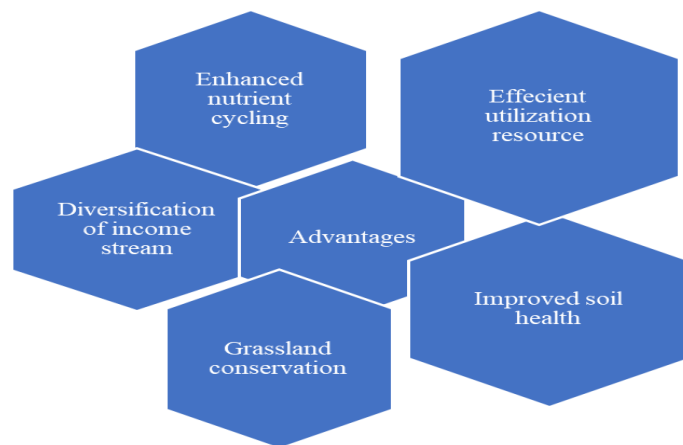
Proper housing is particularly important in regions with harsh climates or predator risks. Structures protect animals against cold, heat, wind, and rain, while also facilitating feeding, breeding control, and disease management<sup>23</sup>. In several areas, goats and sheep are housed at night throughout the year, improving both survival and productivity.

### **Benefits of integrating crop and livestock systems**

Connecting goat farming with crop production provides multiple advantages (Figure 1). Livestock manure improves soil fertility, reduces reliance on chemical fertilizers, and strengthens nutrient recycling, while crop residues and byproducts can be used as animal feed, thereby minimizing waste<sup>24-27</sup>. Integration also improves soil structure, water retention, and biodiversity through sustainable grazing practices. Economically, combining livestock and crops diversifies income streams, enhances resilience to market fluctuations, and strengthens adaptation to climate change. Farmers can maximize resource use by feeding goats with surplus crops, cover crops, and residues, creating a sustainable and mutually reinforcing system (Figure 2)<sup>28</sup>.



**Figure 1.** Advantages of integrating livestock and crop systems, which enhance nutrient cycling and improve soil health in Grassland conservation (The Figure is designed by the authors)



**Figure 2.** Advantages of efficient resource utilization and integration of crop and goat production

#### 4. Conclusion

The integration of crop cultivation and goat farming in Ethiopia represents a sustainable agricultural approach that enhances food security and improves livelihoods. This method capitalizes on the synergies between crop production and goat husbandry, enabling farmers to optimize land utilization and resource efficiency. Additionally, the integration of crop and goat production in Ethiopia as a viable strategy can improve agricultural productivity, secure household food supplies, and promote rural livelihoods. However, it requires supportive policies, resource accessibility, and educational initiatives to fully realize its potential. Further studies are needed to clarify other methods of crop cultivation and livestock farming in different climates and areas.

#### Declarations

##### Competing interests

The authors declare no conflict of interest.

##### Authors' contributions

Mengistu Lemma reviewed articles and designed the study. Mesfine Melese revised the final version. All authors read and approved the final version of the manuscript.

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#### Availability of data and materials

Data will be available on reasonable request from the corresponding author.

#### Ethical considerations

This review was prepared according to the guidelines of the journal and is free from plagiarism and has not been submitted to any other journals.

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