

Self-Sustaining Goat Farming Model for Abiotic Stressed Regions: A Pathway to Livelihood Improvement for Small and Marginal Farmers



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Abstract

Goat farming plays a vital role in an enhancing income and livelihood, especially for small and marginal farmers of dry semi-arid regions. Goats are versatile animals, providing milk, meat, fiber, and manure. They are adapted well to diverse agro-climatic conditions from arid to humid regions and they can survive on wide range of vegetations found in these regions. This makes goat farming a strong tool for poverty alleviation and employment generation among small, marginal, and landless farmers. However, immense challenges such as declining grazing resources, labor shortages, and abiotic stresses like extreme weather conditions leading to poor nutrition hinder productivity. To address these issues, a self-sustaining goat farming model has been developed using the Osmanabadi goat breed, climate-smart loose housing, and sustainable feeding practices. Over four years, this model showed higher income and benefit cost ratio as compared to conventional crops in dry semi-arid regions. The mean rearing cost in this system was Rs. 43,406, gross income of Rs. 96,639, and a net income of Rs. 53,232, with a benefit-cost ratio of 2.22. This approach supports climate-resilient livelihoods and enhances goat farming viability in abiotic stressed regions having, low-irrigation as compared to sole cropping or traditional goat rearing.

Keywords: Abiotic stress; Climate smart loose housing; Self-sustaining Goat farming; Livelihood improvement; Osmanabadi goat

Introduction

In changing climatic conditions, supply of food for increasing human population with decreasing natural resources is a big challenge across the globe. Climate change also has an impact on the animal production system, making it difficult to meet the increasing demand for animal protein. Increase in economic status and purchasing power, urbanization, and a shift in family values towards animal protein are all likely to drive up demand for meat in the future [1]. Diversification of livestock components with crops will help make the farmer's farming system more resilient. Livestock is an integral part of the farming system; it provides consistent income and nutritional security to households while also alleviating rural poverty by providing consistent income throughout the year in changing climatic conditions.

Income from livestock in mixed farming in small and medium-sized farmers are higher and more sustainable. Goat farming is a valuable component of an Integrated Farming System (IFS) in marginal lands. Goat is a multipurpose animal that produces milk, meat, fiber, kid and manure. Goats can adopt to wide variety of Agro-climatic conditions ranging from arid dry to cold arid to hot humid, they can thrive well with poor quality roughages. Goat farming has tremendous potential in employment generation and poverty reduction in small, marginal and landless farmers in rural areas. Goat farming provides insurance against the crop failure in Agriculture mixed farming practices [2]. Goat is considered as resilient animal species in dry land agriculture. Goats are tolerant to most of the environmental stresses and can survive with least resources. Goat farming can be carried out in less fertile areas

like rain fed regions in a sustainable way. One fifth of the world's livestock population is present in India. India has nearly 20% of world's goat population. Total Goat Population in the country is 148.88 million during 2019. Total Goat population has increased by 10.14% over previous Livestock Census (2012). About 27.8% of the total livestock is contributed by goats in India. Growth in this sector leads to more balanced rural economic development and an improvement in the economic status of poor people associated with livestock. Goat rearing is carried out mainly by feeding locally available fodder resources, supplementing with top feeds and crop residues for meeting their feed and fodder requirements, but these resources are declining day by day in our country. The rearing practice of goat are gradually transformed from transhumance and extensive production system to semi-intensive and intensive system, which involves greater input to meet the deficit and to harness profit as well [1]. Vihan [3] reported that goat will produce more milk and meat production per unit of live body weight as compared to buffalo, camel and sheep. Rahimi et al. [4] reported that shifting herd composition towards the inclusion of, or replacement with, goats can secure production and resilience against climate change. The forage supply from grazing land is decreasing due to higher grazing pressure and stocking density. Goat is considered as black gold; the animals can be sold at any time during the requirement of money. There is lot of demand for goat meat because of its taste and nutritional value, goat meat is leaner and has low cholesterol level, is expected to rise at a faster pace in the domestic as well as international markets [5]. The meat and milk of goat is accepted by people of most of the communities. Many people are interested in goat farming, but due to lack of sufficient grazing resources due to decreasing grazing land, unavailability of labour for grazing the goat, people face difficulties in goat farming. To support sustainable growth, a self-sustaining goat farming model has been developed for semi-arid regions. It includes climate-smart loose housing system, locally adapted Osmanabadi goat breed and sustainable feeding management practices, tailored for local conditions. The study was conducted to evaluate the impact of the self-sustaining goat farming model on goat production, reproductive performance, and overall economics, and to compare the model's economic performance with that of major crops commonly grown in semi-arid dry regions.

Methodology

The research work was designed to develop self-sustaining goat farming model in dry semi-arid region with limited irrigation conditions. The model is developed at ICAR-National Institute of Abiotic Stress Management, Baramati. The National Institute of Abiotic Stress Management (NIASM) is situated at 18°09' N latitude and 74°30' E longitude with an altitude of 550m MSL. In political division, it comes under the Pune district, part of the Western Maharashtra region of India. As per the agro-climatic zone, the area falls under the scarcity zone (NARP zone: AZ-95).

It is a well governed place of Deccan plateau. The area comes under dry land region with an average annual rainfall of 55cm. The rainfall distribution is also a highly skewed in nature. Most of the rainfall occurs in the period from June to October. The July to August usually relatively a dry period with low rainfall occurrence while September is wet one. Temperature of this region ranged from a low of 13.6 degree Celsius to the maximum at 38.9 degree Celsius. The experiment was conducted during the period from July 2020 to March 2025 for a period of five-year duration. The experiment conducted dealt with the following parameters. Growth performance and reproductive performance of Osmanabadi goat fed with fodder shrubs grown on boundaries of field with limited irrigation, climate smart loose housing system for goats and cost economics of rearing. For developing self-sustaining goat farming model, available ten Osmanabadi goats breed were used at the start of model during 2020-21. Growth parameters such as birth weight of kids and body weight of goats were recorded. The birth weight of kids was recorded using a digital weighing balance immediately after kidding. The birth weight of kids was recorded within 24 hours after birth. The body weight of kids was recorded every fortnight till the end of the experiments with the help of digital balance. This was performed in the morning before the animals were allowed for grazing at fortnight intervals. The Reproductive parameters were recorded such as kidding rate and twinning percentage. The kidding rate in Osmanabadi goat was measured as the number of kids born to the total number of does/Goats mated. The twinning percentage was measured as the number of does giving birth to twins to the total number of animals mated in each rearing system. All the animals were dewormed before starting the experiments.

Feeding management

For feeding of goat different fodder shrubs were grown on the boundaries of fields. The animals were fed with fodder (*Sesbenia aegyptiaca*, *Moringa oleifera*, *Morus spp.*, *Leucaena leucocephala*, *Desmanthus*, *Medicago sativa*, *Cajanus cajan*). Fodder was provided to the goats in rectangular feeder, twice in a day, in the morning and evening. The animals were fed with 5kg green fodder fodder/day/animals without concentrate feed. Fodder was provided in Elevated rectangular feeders prevent goats from stepping in or lying on their feed. Feeds were given clean and fresh, since goats eat nothing that is dirty or foul. All the animals were provided with clean, fresh ad libitum drinking water in the shed during the period. In addition to green fodder, dry fodder in terms of crop residue available was us offered to goats.

Housing management

The adult animals and kids were provided with a covered area of 1m² and 0.5m²/animal respectively. Climate smart housing system was developed for housing the goats. In this system animals are kept loose by fencing the boundaries with chain-link fencing. In this system common feeding and watering facility was provided. The animals were free to move in the shed the shed or

outside the shed as per the comfort of goat due to weather, the climate smart loose housing system minimises adverse effect of extreme weather conditions. Murum flooring (*Kachha*) was used as flooring material. The shed was designed in a way that it will have sufficient ventilation and air circulation to keep the floor dry. Height of roof of the goat shed was kept 10 feet the sides and 12 feet at the center for proper ventilation The Dimensions

of climate smart loose housing system and climate smart animal shed for goats is developed are presented in Table 1 & 2. Feeders and waterer were cleaned regularly in the sheds and maintained hygienically throughout the experimental period. The sheds were cleaned daily in the morning and lime was applied at monthly intervals in the animal shed.

Table 1: Dimensions of climate smart loose housing system for goats.

Sr.no	Parameters	Dimensions of Shed (Feet)
1	Roof type and material	Two pan roof, steel sheets
2	Floor type	<i>Kachha</i> /Murum
3	Length of shed	20
4	Width of shed	15
5	Height of shed a) Center height b) Sides height	12 10
6	Total covered floor Area (Sq. ft.)	300
7	Widthwise Top side covered with steel	3.5
8	Bottom side covered	6

Table 2: Dimensions of shed in loose housing system for goats farming.

Sr. no	Parameters	Dimensions (Feet)
1	Length of chain-linking fencing	66
2	Width of chain-linking fencing	22
3	Height of chain-linking fencing above the ground	4.7
4	Size of Chain-linking mesh (Inch)	2
5	Gauge of Chain-linking fencing wire	12
6	Gate- Length	8
7	Gate -Height	5
8	Total open space available (Sq.ft.)	1320

Water productivity

The water productivity of goat farming model was worked out, where water required for the different routine activities such as drinking water, water required for cultivation of fodder, water required for cleaning of animal shed and animals are taken into account. The water utilized is divided by the gross income and net income to calculate the gross and net water productivity.

Economics analysis

An economic analysis of the self-sustaining goat farming model was conducted. The cost of cultivation, gross income, net income, and benefit-cost ratio were calculated. These economic indicators were compared with those of major field crops commonly cultivated by farmers in dry semi-arid regions with limited irrigation resources. The comparison was made using data collected from farmers' fields to evaluate the cost of cultivation, gross income, net income, and benefit-cost ratio of the self-

sustaining goat farming model against conventional crop farming practices.

Results

Feeding management in model

For feeding of goats in this system fodder shrubs were cultivated on the field boundaries with the help of drip irrigation. The green fodder yields in the system are presented in the Table 3 & 4. It is recorded that the fodder yields (kg/meter running length) of *Sesbania sesban*, *Desmanthus leptophyllous*, *Cajanus cajan* and *Pennisetum purpureum* was 8,1.2, 9 and 3.5kg, respectively. The fodder crops having high protein content were grown in this model. The green fodder yields of (kg/m²) of Mulberry (*Morus* spp.), Subabool (*Leucaena leucocephala*), Shevari (*Sesbania sesban*) and *Moringa oleifera* + *Desmanthus Virgatus*) was 6.5, 8.4, 8.6 and 1.8 (kg/ tree), respectively.

Table 3: Fodder yield during flush season and cultivation practices of different fodder shrubs on farm boundaries.

Local Names	Scientific Names of Fodder Shrubs/Crop	First Cutting After Well Establishment (Months)	Space between Rows (cm)	Average Fodder Yield After Sowing on First Cutting (kg/Meter Running Length)
Shevari	<i>Sesbania sesban</i>	6	40	8
Dashrath grass	<i>Desmanthus leptophyllous</i>	2.5	30	1.2
Perennial Pigeon pea	<i>Cajanus cajan</i>	4	40	9
Hybrid Napier	<i>Pennisetum purpureum</i>	3	40	3.5

Table 4: Fodder yield of different protein rich fodder species grown in model.

Protein Bank (Fodder Name)	Green Fodder Yield (kg/sq.m/Cutting)
Mulberry (<i>Morus</i> spp.)	6.5
Subabool (<i>Leucaena leucocephala</i>)	8.4
Shevari (<i>Sesbania aegyptiaca</i>)	8.6
Drumstick (<i>Moringa oleifera</i>) + Dashrath (<i>Desmanthus Virgatus</i>)	1.8

Herd dynamics in self-sustaining goat farming model

At the beginning of the model, there were 10 female goats. By the end of the first year (2020-21), the population had increased to 18 animals, including their kids during this year, 9 new kids were born, and there was one mortality, bringing the total to 18 animals (Table 5). No animals were sold during this period. The second year (2021-22) began with a total of 18 animals' strength. There were 6 new kids added through new births and 5 animals were sold, resulting in a year-end total of 19 animals. In the third year (2022-23), the opening balance was 19 animals. There were 10 new births, a mortality rate of 3.4% (1 animal), and 5 animals

were sold. The closing balance for the year (2022-23) was 23 animals. During the fourth year (2023-24), the herd began with 23 animals. With 16 new births, 3 mortalities, and 4 sales, the year ended with 32 animals. In the fifth year (2024-25), 13 new animals were borned. There was 1 mortality was recorded and 12 animals were sold in order to maintain sustainable goat stock, maintaining a closing balance of 32 animals. Over the five-year period from 2020-21 to 2024-25, a total of 26 animals were sold, and the closing balance remained at 32 animals. From the initial 10 female goat stock, the model produced a total of 64 offspring, out of which 26 animals were sold and 6 animals lost to mortality and the closing balance was 32 animals.

Table 5: Herd strength in the Model since the Start of the Experiment.

Sr. no	Opening Balance of Goat Stock at the Start of Year	Goat Strength at Start of Period (no. s)	Birth/ New Addition (no. s)	Mortality (no. s)	Mortality (%)	Sale (no. s)	Closing Balance of Goat Stock at the End of Year (no.s)
1	2020-21	10	09	01	5.2	-	18
2	2021-22	18	06	-	0.0	05	19
3	2022-23	19	10	01	3.4	05	23
4	2023-24	23	16	03	7.6	04	32
5	2024-25	32	13	01	2.2	12	32

Growth and reproductive performance of osmanabadi goats breed

Mean body weight of Osmanabadi kids at different stages fed with shrubs without concentrate feed are presented in Table 6. The mean body weights (kg) at birth in male and female was 2.58 ± 0.21 and 2.42 ± 0.14 , respectively which is similar to the birth weight reported by [6] who reported average birth weight of Osmanabadi goat kids was 2.607 ± 0.234 kg. Feeding of different shrubs fodder without concentrate ration did not influence the

birth weight of kids and body weight at different stages. Meel et al. [7] reported that feeding of *italic* leaves replacing concentrate feed at 25%, 50%, 75% and 100% levels improved body weights and average daily body weight gain as well as feed intake and overall health of Sirohi goat kids. Rahman et al. [8] reported that green grass, diets supplemented with tree forages resulted in better body weight gain, digestibility, and nitrogen balance. He also reported that goat diets can be supplemented with tree forages of *S. grandiflora*, *L. leucocephala*, *E. orientalis*, and *M. alba* for improved growth performance (Table 7).

Table 6: Mean body weight of Osmanabadi kids at different stages fed with shrubs without concentrate feed.

Goat Kids	Body Weight at Birth(kg)	Body Weight at 1 Month of Age(kg)	Body Weight at 3 Months of Age(kg)	Body Weight at 6 Months of Age(kg)	Body Weight at 9 Months of Age(kg)	Body Weight at 12 Months of Age(kg)
Male kids (5)	2.58±0.21	3.80±0.25	7.58±0.10	11.44±0.19	14.88±0.19	18.60±0.13
Female kids (4)	2.42±0.14	3.82±0.25	7.45±0.26	11.30±0.18	14.75±0.23	18.25±0.22

Table 7: Twinning and Kidding percentage in Osmanabadi Goat breed fed with shrubs without concentrate feed.

Sr.no.	Reproductive Parameters			
1	Kidding Rate			
	Total no. Of breed-able Goats	Total no. of goats mated	No. of goat produced young ones	Kidding %
	6	6	8	133
2	Twining %			
	6	8	2	25

Kidding percentage and twinning ability are the most important parameters to study reproductive efficiency in a goat herd. These parameters are related to higher production and profit in goat farming. The kidding and twinning percentages were 133 and 25, respectively, which was higher than the reports of

Sahare et al. [9] who has reported that the kidding percentage and twinning ability 55.87% and 10.52 %, respectively in Osmanabadi goats breed reared in organized farm and Deokar et al. [10] also reported kidding percentage ranged between 80 to 90%.

Economics of Self-sustaining Goat Farming Model (2021-22)

Table 8: Economics of goat fed with shrubs without concentrate feed (2021-22).

Sr. no	Name of Item	Description of Item	Cost in (Rs.)/ Unit	Quantity (kg/ no.s)	Total Amount (Rs.)
I	Recurring cost				
1	Cost of green fodder for 10 goats along with their kids	Cost of growing green fodder on boundaries of IFS model	0.5	32120	16060
2	Cost of dry fodder	Crop residue/ red-gram residue/ soyabean residue/dried ground-nut leaves	1	760	760
3	Medicine and treatment cost				3000
4	Labour cost		200	91	18200
	Total recurring expenditure				52270
III	Income				
1	Sale of kids		340	258.8	87992
2	Sale of goat manure	2.5 ton			17520
IV	Gross income				105512
V	Total recurring expenditure				38020
VI	Net income				67492
VII	Gross income/ goat/ year				9592
VIII	Net income/goat/year				6135
IX	Benefit: cost ratio				2.77

Goat farming has contributed to higher human development indices in semi-arid areas of India as well as in other countries, which has been made possible by the use of technologies that make this production economically and environmentally feasible [11]. The cost of goat rearing was calculated based on the prevailing market rates for the different items. The cost of production per ton of green fodder was taken and the labour cost per minimum wage was taken into account for the calculation of labour cost. The economics of goat unit is presented in Table 8. The total recurring cost of production of in second year of experiment during 2021-22 of (10) animals along with their growing kids was Rs.38070 and the gross income was Rs.105512 with a B:C ratio of 2.77, without supplementation of concentrate feed. The net income obtained was Rs.6744/ goat/year in this study. Kumar et al. [12] have also been reported that the maintenance cost per goat was Rs. 790/per year without considering the family labors in low input production system in Bikaner District of Rajasthan. They also reported that among maintenance cost, highest expenditure

was incurred on feeding (65%) followed by shelter (21.67%) and veterinary medicines (13.31%), respectively. The gross and net profit was Rs. 102232 and 59300 in small flock size (5-10 goats). The net return worked was Rs. 6895/ per goat/year. Shivakumara & Siddaraju (2019) is reported that among the variable cost, major cost incurred was on labour (50.61%) and followed by fodder and concentrates (23.06%) in intensive goat feeding system. They also reported that returns per rupee of investment was 2.1 in intensive goat farming system.

The economics of self-sustaining goat farming model for the study was under taken for four years (Table 9). In the year 2020-21 during the first year the cost of goats rearing was Rs. 31242, gross income was Rs.59500 and net income was Rs. 28258 with a B:C ratio of 1.9. In all the four years, the B:C ratio was more than 1.9, which shows a highly profitability of goat farming. The mean cost of rearing, gross income and net return was Rs.43406, Rs. 96639 and Rs.53232. The B:C ratio was of 2.22.

Table 9: Year-wise Economics of Self-sustaining Goat Farming Model (2020-21 to 2023-24).

Year	Cost of Rearing (Rs.)	Gross Income (Rs.)	Net Income (Rs.)	B:C Ratio
2020-21	31242	59500	28258	1.9
2021-22	38070	105512	67442	2.77
2022-23	33600	84689	51089	2.52
2023-24	70715	136857	66142	1.93
Mean	43406	96639	53232	2.22

Comparison of economics of goat model with major crops grown in semi-arid dry regions

The cost of cultivation, gross income and net returns of major crops grown in dry semi-arid regions and free-range goat farming is presented in Table 10. The cotton is a cash crop with cost of cultivation, gross income and net income is higher as compared to

other crops. The B:C ratio of cotton crop is 1.78. The goat model has shown highest B:C ratio with highest net profit from (0.1ha) of model. The local adapted goat breed with climate smart housing system and sustainable fodder production on land (0.1ha) with limited irrigation water can be yielded sufficient fodder to maintain 10 goats along with their growing kids.

Table 10: Comparative economic analysis of goat model with major crops grown in dry semi-arid regions with farmers practices.

Enterprise	Cost of Cultivation/Rearing (Rs.)	Gross Income (Rs.)	Net Income (Rs.)	B:C Ratio
Soyabean (0.1 ha)	4875	7000	2125	1.43
Cotton (0.1 ha)	7375	13125	5750	1.78
Sorghum+Redgram (0.1 ha)	4060	6170	2110	1.51
Goat farming (10+ 1 unit) free range grazing system	58400	98100	39700	1.6
Goat model (0.1 ha, 10 goats)	43406	96639	53232	2.22

Water productivity

Livestock water productivity (LWP) is the ratio of livestock products and services to the amount of water utilized [13]. Goat is one of the important livestock species that can be reared in dry lands and limited irrigation conditions. Major portion of water was used in growing of fodder for the goats farming. The

livestock water productivity in this model is presented in Table 11 & 12. The net water productivity in this model was Rs 8.60/ m³. The water productivity for production of live weight of goat 33g/m³. Haileslasie et al. (2009) observed that improved feed sourcing, increased livestock productivity, and multiple livestock use strategies can all contribute to more water-efficient animal production systems.

Table 11: Water productivity of Osmanabadi goat breed.

Water Requirement	Water (Lit.)
Drinking	73000
Washing and Cleaning	14600
Green Fodder	7403660
Dry Fodder	350360
Total Water used	7841620
m ³	7841.62
Gross income	105512
Net income	67442
Gross water productivity (Rs. /m ³)	13.45
Net water productivity (Rs. /m ³)	8.60

Table 12: Water productivity in Livestock/unit produce.

Livestock	Water Productivity (Rs/m ³)	Water Productivity for (unit /m ³)
Goat	13.49	Live weight (meat)-0.033

Discussion

Locally adapted Osmanabadi goat breed was used to develop the model, so that with less available inputs and management, maximum production could be obtained. The Osmanabadi goat breed is highly adaptable to extreme weather conditions such as drought and heat stress, making it well-suited for the semi-arid regions of Maharashtra. Its flexible feeding habits, strong production potential, and resilience have made it popular among farmers, particularly for meat production. Although a dual-purpose breed, it is primarily reared for meat. Osmanabadi goats are medium-sized with long bodies and legs, well adapted to arid and semi-arid climates. The breed is valued for its high meat yield, early puberty, and frequent multiple births, often producing twins or triplets. Its disease resistance, fast growth rate, and suitability for various rearing systems make it especially beneficial for smallholder farmers. Wankar et al. [14] reported that, despite high THI ranges (81-82), during summer and monsoon seasons which resulted in physio-biochemical alterations, the Osmanabadi goat kids were able to maintain a steady growth rate, due to higher thermotolerance and are better adapted to regional climatic conditions.

Feeding management

Locally adapted different types of fodder shrubs were grown on boundaries on field for feeding of goat. Rectangular feeders were used for providing fodder to goats. Longer rectangular feeders provide higher linear feeding space, allowing several goats to eat at once without crowding. This helps reduce aggression and ensures lower-ranking animals get access to feed. Goat are browser in feeding habit and they prefer tender leaves of herbs, shrubs and small trees [15]. The goat can put their front legs on the rectangular feeders, and feel their natural habit of browsing by feeding in rectangular feeder. The DM requirement of goat dual-

purpose breed is 3 to 5%. They digest poor quality roughages efficiently [16]. Goats have highly flexible foraging behavior in changing climatic conditions [17]. The total area available for the grazing of sheep and goats in 1951 was 82.1 million ha, which has now decreased by 47% to 43.3 million ha, but the small ruminants (sheep, goats and rabbit) population has increased by 105%, resulting in overstocking and overgrazing of available land and resources. The area required for the razing as per the reports of CSWRI, Avikanagar, is 1.3 hectare/ACU (Adult Cattle Unit), but availability is 0.77 hectare/ACU (Adult Cattle Unit). To maintain the production in future, farmers have to search for alternative goat or sheep rearing systems, intensive rearing with minimal inputs is one of the promising options [18]. For greater sustainability of small ruminant production systems, it is necessary to utilize locally available feed resources through scientific and economic feeding practices [1]. The most promising fodder trees and shrubs are *Leucaena leucocephala*, *Sesbania sesban*, *Ziziphus nummularia*, *Moringa oleifera*, *Medicago sativa*, *Tamarindus indica* [19] can be produced and fed to the goats. Upreti et al. [20] reported that rectangular feeder in which tree leaves, grasses, concentrates and crop residues can be fed simultaneously, has lowest feed wastage and contamination, and hence is suitable for feeding goats in stall-fed management system. Goats prefer browsing and also graze on grasses and weeds. Fodder should not be over fed to goat. Over feeding may cause bloating in animal and can cause mortality. Fodder was given clean and fresh, as goats do not accept s dirty or foul-smelling fodder. They dislike wet, stale or trampled fodder. For this reason, it is advisable to feed them in hay racks or hang the feed in bundles. Drastic changes to the diets of goats should be avoided to avoid a major digestive problem. Make change in their diets slowly, giving the rumen microorganism to adjust with the feed. Hassan et al. [21] observed that *M. oleifera* and *L. leucocephala* fodder can be fed to goats without any adverse effect on their growth performance. Dry fodder @ 0.5-1.0kg/day/

animal can be fed to adult goat. During the monsoon season, dry fodder should be provided to the animals to ensure good digestive health and performance. Devasena & Rama Prasad [22] reported that farmers generally fed crop residues, particularly leguminous straws, which have valuable edible biomass due to their high nutritional value and can serve as a potential feed resource during the lean period. Rama Prasad et al. [23] reported that these crop residues can be incorporated up to 60% as basal roughage in the complete diets of small ruminants.

Housing management

One of the most important management strategies for maximizing output from livestock farming is the housing system. The construction of housing for goats will vary according to the type of production system, the size of the herd, and the agroclimatic conditions. Animal housing can range from environment-controlled animal house with precision waterers and feeding facility to very simple sheds with only a roof and no walls. A climate-smart loose housing system was developed for housing goats. In this system, goats were provided with both a covered area and an open space, allowing them to move freely between the two according to their needs and comfort. The open space was enclosed with chain-link fencing to prevent goats from leaving the housing area. Since summers in this region are particularly stressful, the housing system was designed to provide maximum comfort to the goats during the summer season. Housing systems protect the animals from climatic stresses such as heat, cold, or heavy precipitation, as well as providing an ideal environment that aids in the improvement of their production performance, behavior and welfare. Panda et al. [24] reported that provision of floor space was positively correlated with the growth performance of Osmanabadi kids. The animals were provided with an extra open space for free movements. Provision of open space for free movements of animals is very important in intensive system of goat housing. Sufficient feeding and watering space was provided to avoid crowding and uniform access to fodder and water. In loose housing system, the animals have a choice of spending time either under a shed during heat period or in open paddocks in morning and evening hours as per their choice and season. Loose housing system is economical as the cost of construction is significantly lower than conventional type of housing. Also, it is possible to make further expansion in herd size without much change. Loose housing facilitates easy breeding of animals. The floor was kept dry, by providing proper ventilation so that provide the desired amount of fresh air to all parts of the shelter; to keep temperatures within threshold limits and to keep the floor dry. Murum flooring (*Kachha*) as flooring material prevents dampness and stagnation of water/urine due to improper drainage is one of the important factors for responsible for diseases in goat. Wakchaure et al. [25] observed that Osmanabadi kids exhibited superior growth performance under murum flooring as compared to concrete flooring and also reported that stall-fed goat farmers may adopt murum flooring for obtaining maximum profit. Bhakat & Nagpaul [26] found that the kaccha floor has good practical economic

significance as compared to the concrete floor. Jadhav & Killedar [27] observed that goats under tree shade in open housing were more comfortable as the frequency of resting was higher also frequency of other activities was found to be optimum. Their observations and results suggest that the tree shade housing is the best housing system for Surti goats. Selda [28] reported that instead of traditional housing, alternative new barn designs that take into account local area preferences and behavior indices are needed to increase goat production and their welfare. Animal behavioral needs are also fulfilled, animal gets optimum exercise, feel free and perform well with even minimum nutrition having better health and production. The behavioral needs of the animals are also satisfied, which helps the animals perform better with limited fodder resources. If proper design of shed is made, the shed will have sufficiently ventilation and sunlight [29].

Conclusion

The self-sustaining goat farming model presents a sustainable and practical solution for small and marginal farmers in semi-arid dry regions with limited land and water resources. By integrating climate-resilient practices such as the use of locally adapted breeds, climate-smart loose housing, and micro-irrigated fodder cultivation. This model addresses key challenges in traditional goat farming. It not only reduces labor dependency but also ensures consistent fodder supply, improve the behaviour and welfare of animals and provide higher income. Compared to conventional crop farming in dryland areas, this approach offers a more resilient and profitable livelihood option, particularly for rural youth and landless farmers. Adoption of this model can play a significant role in improving rural livelihoods and strengthening climate-resilient agriculture. This generated information will help in orientation of research and development programs aiming at improvement of livelihood of small, marginal and landless farmers through goat farming in limited irrigation conditions.

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