



Research Article

Livestock Population Dynamics in Arid Zone of India

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Abstract: Livestock husbandry is one of the most noteworthy agricultural sectors that has been competing with overall economic expansion in the arid zones of the world. It plays a central role in the economy of Rajasthan because it fits in better with environmental, economic, social and demographic matrix of the region, especially in the western desert areas. The study attempts livestock husbandry and sustainability of large livestock rearers of western arid Rajasthan, India where the largest number of livestock of the country are reared particularly by the Rebari, Raika, Bishnoi, Jat, etc. The mainstay of the Raika or Rebari, Sindhi Muslims, and the Rajput population is rearing of small ruminants, cattle and camel, whereas Jats and Bishnoi usually rear cattle and camel. The data analysis of 1956-2012 indicates that the population of buffalo has increased by about 300% whereas the population of the camel has decreased by about 49.5% during the same period. Droughts of 1962, 1972, 1988 and 2007 negatively affected livestock population due to distress release and sale. During a normal rainfall year, females have contributed up to 71.2% in livestock husbandry for a barn and cleaning while men performed 67.8% marketing activities. Earlier, more than 78% agricultural operations were done by men using livestock. The animal husbandry contributes 85-92% income among the 21.52% households of small farmers. Annual income from livestock grew 8.9% during 2007-2012. However, rearing of goats and sheep was remarkable for high value-added role (19%) during 2007-12. The primary, as well as secondary sources, were used for analysis. Data were collected from field survey and different journals, reports, magazines, etc. and collated and analyzed with simple statistical techniques. The study presents recommendations for the improvement of social-economic sustainability of small farmers.

Keywords: Small ruminants, Spatiotemporal changes, Economic viability, and sustainability

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Introduction

Sixty-one percent of the area of the Rajasthan state lying in the north-west of the Aravallis forms part of the Thar Desert where, on account of scarcity and erratic rainfall, crop failure is a recurring phenomenon. People have, to a large extent, depend on livestock husbandry to tide over economic stress periods. Livestock husbandry is one of the important segments of the inhabitants of the arid Rajasthan due to frequent droughts and famines. It has been practiced as a main coping mechanism or drought proofing activity to tide over the failure of monsoon since antiquity. Hardy animals like cattle, goats, sheep, camel, donkeys are being reared as domestic and subsistence animals with traditional management and practices. Except in the case of milk and meat production, a commercial form of livestock husbandry rarely existed in western Rajasthan. Production has remained at the small-scale targeted at meeting local and urban demands. Moreover, animals have an entwined sustainable relationship with rainfed agriculture, so the economy of western arid Rajasthan has predominantly been a livestock-based. Cattle have been reared in subsistence and semi-subsistence types of economies and were used mainly to work in agriculture as milk/ draft animals. Cow dung is a premium product that is used as manure and domestic fuels in most of the villages. Before the introduction of liquefied petroleum gas (LPG), cow dung was also used in peri-urban areas. Despite it being primitive and traditional form of livestock husbandry, arid Rajasthan has the largest number of cattle, sheep, goats, and poultry in the country [1]. Recent inclination towards high milch yielding breeds has introduced changes in livestock composition.

The setting

The twelve districts (Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jalore, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, Pali, and Sikar) lie in the western part of

arid Rajasthan or the Great Indian Desert (24°37'- 30°11'N and 69°29' E-76°06' E) covering an area of 208,751 sq.km [Fig-1]. This hot arid region is characterized by low and high erratic rainfall, high evaporation loss and extremes of diurnal and seasonal temperatures. The average annual rainfall varies from 456 mm in north-east to less than 100 mm in the western most part of Jaisalmer district. The coefficient of variability of annual rainfall varies from 40 to 70%. About 95% of the rainfall is received during June-September months. The probability of drought occurrence varies between 50-60%. Dominant landforms are the sandy plains with varying degree of hummocks and sand dunes. The vegetation of this region is quite sparse with a limited number of xerophytic plants and thorny bushes. The drainage, except the ephemeral Luni river system, is mostly internal. It harbours a total domestic livestock population of nearly 30.18 million heads – an increase of 14.63 million heads (94.72%) over the 1956 census figures. The desert region has about 52.3% of the State's livestock. As per 2011 census, the region has 27.12 million human population. The density of human population varies from 17 in Jaisalmer to 361 in Jhunjhunu district and that of livestock from 83 in Jaisalmer to 274 Sikar.

Objectives of the study

The overall aim of this paper is to analyze the causes and underlying driving forces that drive small-scale animal rearers as the cause of livestock composition changes during the last few decades.

1. To inspect the driving forces responsible for inducing changes in livestock composition in this arid region; and
2. To assess the trends of livestock growth in the arid area of Rajasthan.



Fig-1 Study Area

Materials and Methodology

District-wise livestock data were obtained from field survey and various published and unpublished reports and periodicals of Rajasthan state; Central Arid Zone Research Institute (CAZRI), Jodhpur; Directorate of Economic and Statistics, Govt. of Rajasthan, Jaipur [2]; and other concerned departments of the central and state governments. Later, data were agroclimatic zone wise collated and imported in the ArcGIS-environment for visualization and analysis.

Results and Discussions

(a) Trends of livestock growth in the arid area of Rajasthan

Livestock census data pertaining to the desert districts of Rajasthan from 1956 to 2012 – a period of 56 years provides some interesting facts. During this period, cattle registered the 35.69% growth rate, while buffalo (299.67%) and goat (252.70%) populations had higher growth rates. The population of sheep (20.11%) increased appreciably while that of camel (-49.51%) registered a steep negative. The high growth rate of buffaloes and goats increases the deficits in demand and supply of fodder in the region [3, 4]. These increases in the animal numbers are also reflected in the shift in the human: livestock ratio of 1.12 whereas it was 1.23 in 1972. It obviously points out to the pre-eminence of the livestock sector in the rural economy of arid western Rajasthan, and of the state as a whole. The density of livestock population far exceeds the human population which is 145 and 130 heads km⁻² respectively [Fig-2]. Livestock population declined sharply during 1973 [5], 1988 and 2003 and has shown a negative growth due to severe drought in the arid region during 1986-88 and 2002-2003. Farmers went to distress sale and disposed-off their animals as the monsoon failed completely. The livestock population showed a decline of -11.72% in 2003. Cattle suffered very badly and population showed a negative trend of -2.22% (1966), -24.76% (1972), -21.62% (1988) and -3.83% (2007), particularly the indigenous breed suffered a lot – even in normal years. It is being replaced by hybrid breeds of cattle and buffalo [Fig-3]. During the last 56 years, sheep population suffered a serious setback during

1988, 2003 and 2012 when it showed a decline of -25.83%, -29.26% and 18.43%. During interactions with the sheep rearers, various factors emerged for such negative trends in growth: (a) young generation is not showing any interest towards this profession of sheep rearing; (b) it is not a profitable occupation anymore; (c) they have to face a lot of hardships during migration to other states; and (d) lack of any institutional support or facilities. Goat breed of the arid region is quite hardy and can sustain local climatic fluctuations with a sufficient ease. These also suffered during 1962 (-4.52%), 1983 (-26.79%) and 2003 (-11.50%). Goat population has increased by 253% over 1956 population in the arid region. Camel population in the Rajasthan desert has shown an overall decline of -49.5% over 1956 population. Since 1983, its population has consistently shown a decreasing trend. Livestock Census of 2012 showed a sharp decrease of (-)20.36%. Analysis of district-wise livestock population data indicates that buffalo population has been increasing in all the arid districts of Rajasthan except Barmer, Jaisalmer, and Bikaner. It is due to the fact these districts receive very little amount of rainfall and face drought every alternate year. Lack of fodder and extremes of climatic fluctuations hinders small farmers from rearing buffalo. Recently, buffalo rearing has increased in some areas of Bikaner, Barmer, and Jaisalmer where canal irrigation has been introduced [Fig-4]. Actually, sheep population is on an increase in Jalor, Barmer, Bikaner and Jaisalmer districts whereas goat population has increased in Churu, Jhunjhunun, and Jodhpur districts. Cattle population has also increased in Ganganagar and Hanumangarh districts due to year-round availability of green fodder and water due to canal irrigation. While considering agro-climate-wise distribution and dependency pattern, it has become clear [Fig-5] that over a period of 56 years (1956 to 2012), with the increase of livestock heads, area for grazing has drastically decreased. Considerable negative changes are clearly visible in the culturable wasteland (decreased from 24.63% in 1956 to 15.87% in 2012), long-term fallow land (decreased from 38.28% in 1956 to 7.26% in 2012), and current or short duration fallow land (decreased from 9.05% in 1956 to 7.55% in 2012).

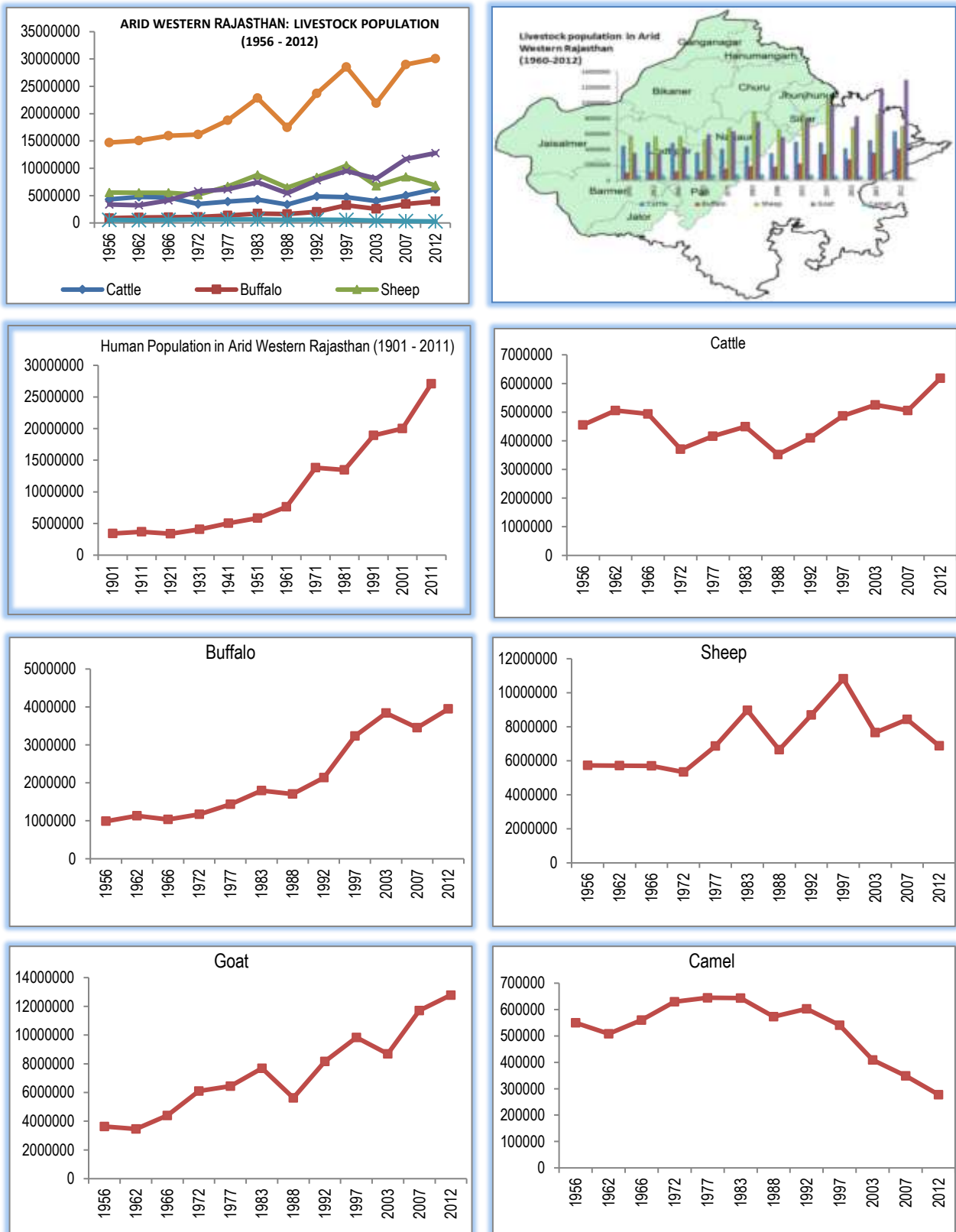


Fig-2 Livestock population (1956 - 2012) in western arid Rajasthan

Whereas, the net area sown has immensely increased (at the cost of long and current fallow lands) from 9.05% in 1956 to 53.40% in 2012 whereas area sown more than once has also increased tremendously from 1.17% in 1956 to 13.58% in 2012. It indicates that exploitation of land resources has been quite high in the arid region. People used to leave the land as fallow for short and long durations for grazing purpose of their own animals and also regaining fertility. But, this traditional practice is gradually on the verge of vain. The Arid Western Plain (I-A) comprising of Jodhpur and Barmer districts 25.21% livestock population in 1956-57 census that increased to 29.68% in 2012. The main increase has been in the goat and buffalo population whereas camel and sheep population have declined

drastically. Cattle population has also declined appreciably. Further, main areas like culturable wastelands and long fallows where animals used to graze have declined sharply. Net area sown also increased from 39.9% in 1956-57 to 54.2% in 2012 due to the availability of water for irrigation from the canal and tube wells. As a result, the area sown more than once has multiplied tremendously from 0.1% in 1956 to 6.9% in 2012 [Table-1]. Bikaner, Churu, and Jaisalmer districts are part of Hyper-Arid Irrigated (Partial) Plain (IC) where net sown areas and the total cropped area has increased from 16.8% and 17.5% in 1956 to 40.7% and 48.5% by 2012 respectively. Bikaner has remained irrigation facility since 1927 from Gang Canal whereas Jaisalmer has a water supply from the Indira Gandhi Canal.

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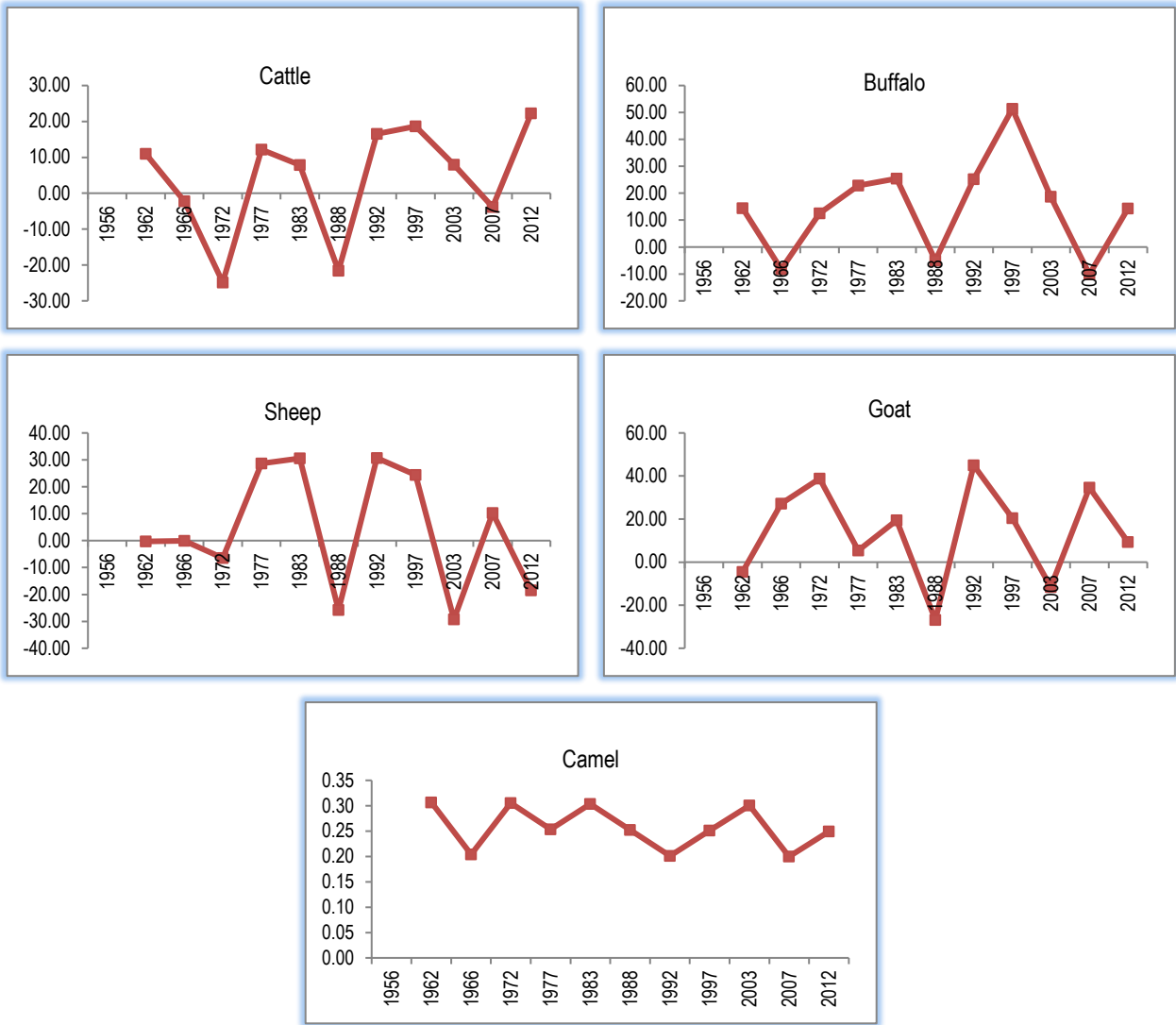
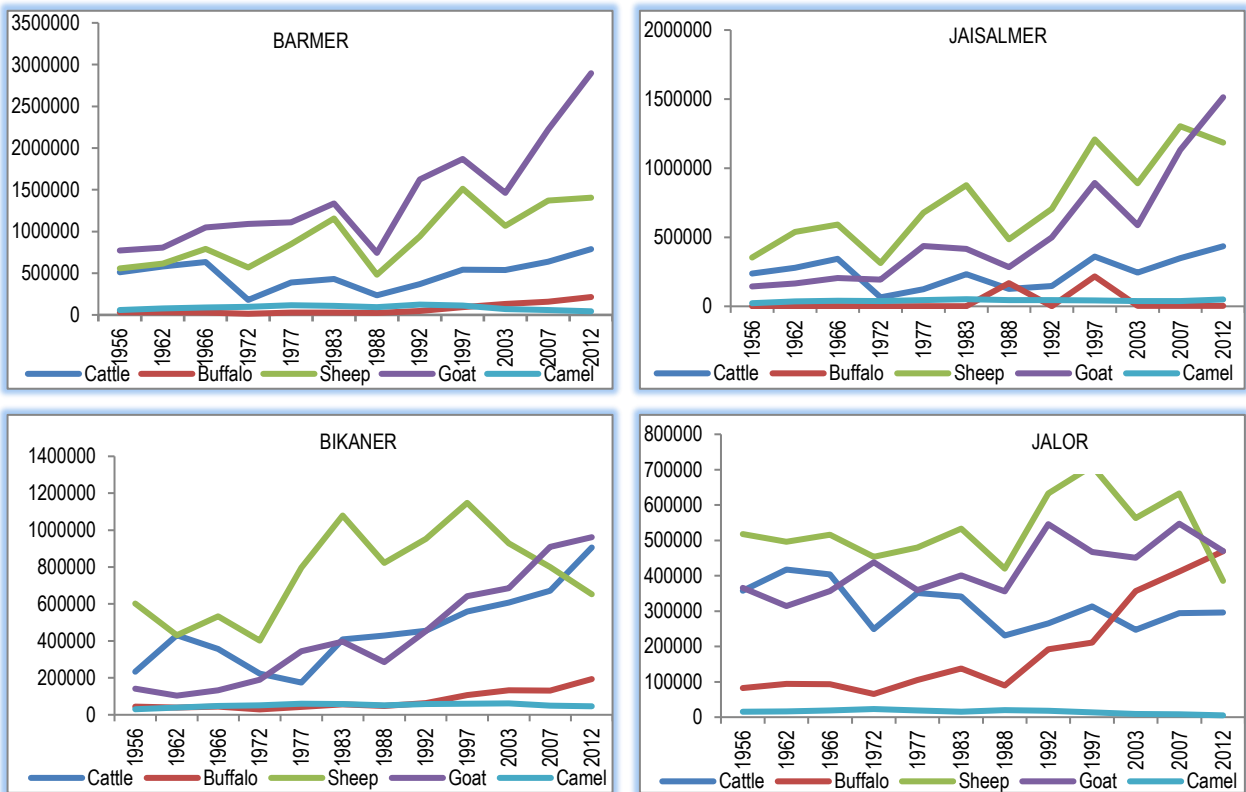


Fig-3 Percentage livestock population growth (1956 -2012)



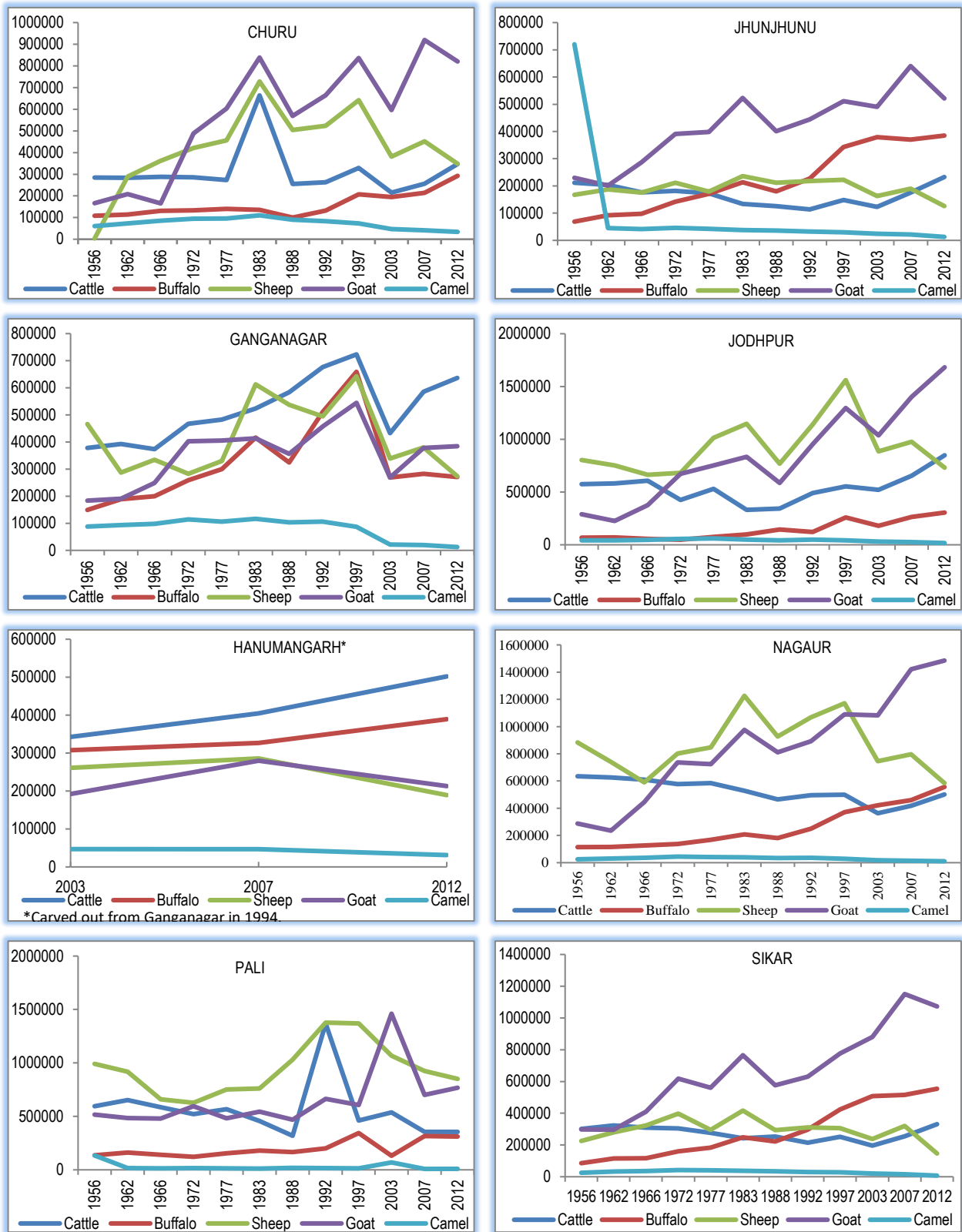


Fig-4 District-wise distribution of livestock population (1956 -2012)

Availability of water has brought more areas under irrigated cultivation. As a result, livestock population has increased by more than 321% during the same period (2,435,415 heads in 1956 and 7,818,361 in 2012) due to an extraordinary jump in buffalo, cattle and goat population. Even though its share in the livestock population of western Rajasthan shows a measured increase only but if livestock heads are considered, then there is a sharp increase in livestock due to the availability of green fodder round the year. In 1956, there were only 393,583 heads of sheep in Churu district that has increased to 348,522 heads in 2012 but the population of the camel is just halved as its utility has gradually diminished and

rearing is a costly affair. Ganganagar and Hanuman districts form *Irrigated North Western (IB)* part of the arid zone. Hanumangarh was carved out of Ganganagar in 1994 as a separate district. Both these districts have benefitted initially from the Gang Canal and later from Indira Gandhi Canal and have been considered as the granary of Rajasthan. All kinds of grains are grown in this area. Sand dunes have been a boon for the raising of various crops and horticulture plantation round the year. This region of arid zone has shown a ray of hope of survival in the harsh climatic condition. It is the only region where the sheep population has shown a marginal decline whereas cattle, buffalo and goat population has shown

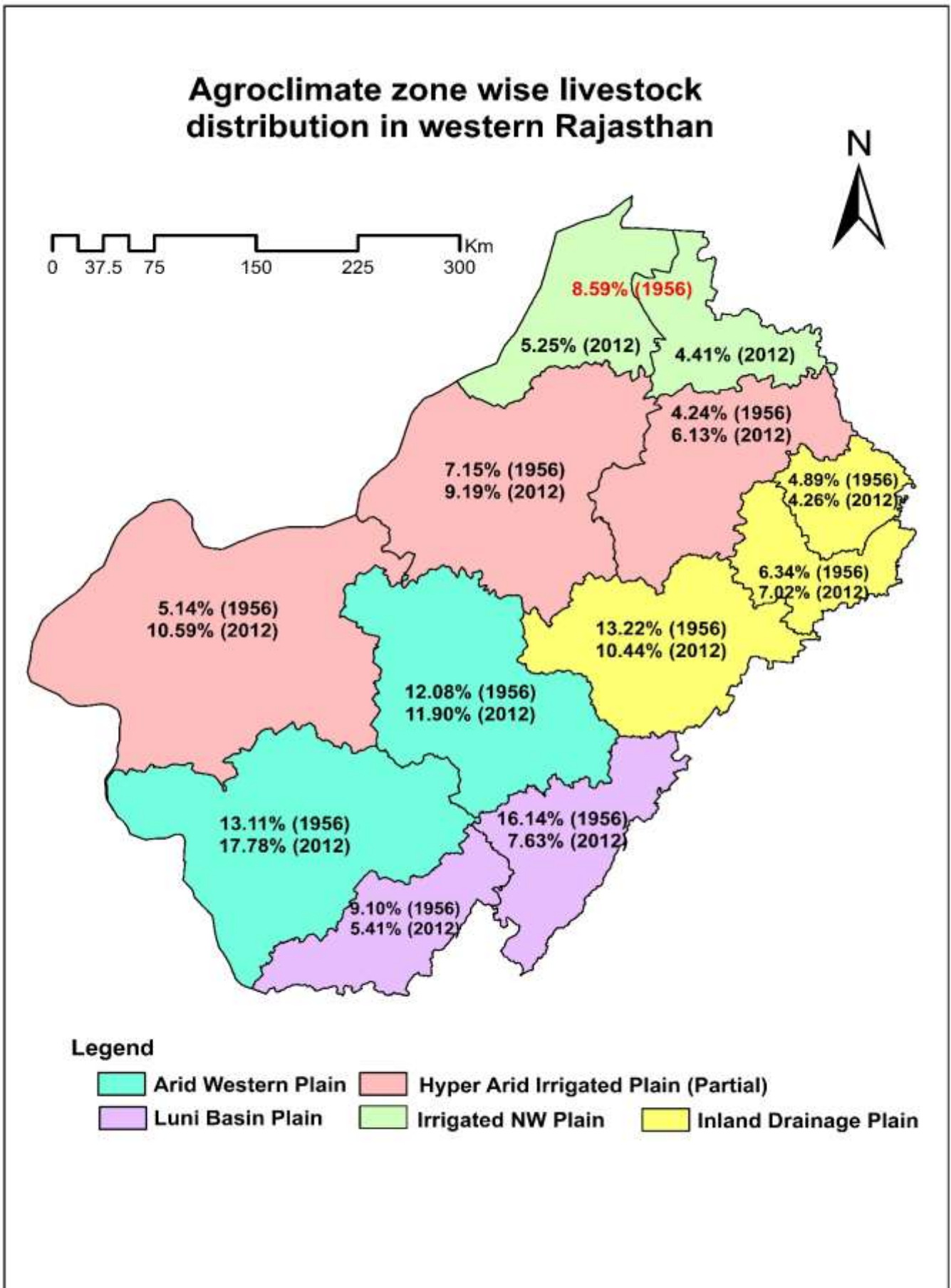


Fig-5 Agro-climate zone wise distribution of livestock in Western Rajasthan

Table-1 Agro-climatic zone wise land use and livestock population (in %)

Agro-climatic zones	Livestock Population (%)		Not Available for cultivation (%)		Permanent pastures & other grazing lands (%)		Culturable Waste Land (%)		Long Fallow Lands (%)		Current Fallows (%)		Net Area Sown (%)		Total Cropped Area (%)		Area Sown More than Once (%)	
	1956	2012	1956	2012	1956	2012	1956	2012	1956	2012	1956	2012	1956	2012	1956	2012	1956	2012
IA - Arid Western Plain	25.2	29.7	8.7	8.4	2.6	6.4	8.2	4.5	23.8	13.4	16.2	12.4	39.7	54.2	39.9	61.0	0.1	6.9
IC - Hyper Arid Irrigated (Partial) Plain	16.6	25.9	33.6	10.0	0.9	2.4	46.7	35.6	7.8	4.3	3.4	4.6	16.8	40.7	17.5	48.5	0.1	7.8
IB - Irrigated North Western	8.8	9.7	42.9	6.3	1.3	0.6	46.4	1.4	2.3	4.5	5.1	5.4	2.3	78.0	58.9	115.6	0.0	37.5
IIB – Transitional Plain of Luni Basin	25.3	13.0	14.5	14.0	4.4	6.1	3.3	3.1	3.1	9.6	13.9	7.5	45.3	55.4	46.8	70.6	1.5	15.2
IIA - Inland Drainage Plain	24.5	21.7	9.0	7.6	4.7	4.9	1.7	1.0	7.4	5.6	11.7	9.1	64.7	68.1	68.3	90.9	4.6	22.8

Source: Animal Husbandry Department and District Statistical Handbooks, Government of Rajasthan

Table-2 District-wise number of tractors available (in numbers)

District	1961	1966	1972	1977	1983	1987	1992	1997	2003	2008-09	2010-11
Barmer	27	39	188	429	1074	1505	3183	7280	4310	7288	8967
Bikaner	6	7	14	108	722	1567	2651	4819	7540	14007	17432
Churu	9	18	52	104	515	1039	1521	3569	5772	10194	12056
Ganganagar + Hanumangarh	1745	1349	2741	7488	14879	21203	32840	26345	54358	59707	61548
Jaisalmer	3	16	19	41	219	277	570	1141	1529	2547	3172
Jalore	57	60	180	798	1979	3285	6445	12094	9791	14242	16123
Jhunjhunun	27	33	65	161	366	748	1456	2737	5811	10786	13203
Jodhpur	157	380	1513	2120	4286	5052	9843	14093	34189	39899	44886
Nagaur	67	280	812	1498	3817	4947	8459	11562	42589	68378	80524
Pali	129	249	743	1387	3212	3477	5911	7223	8771	11460	12467
Sikar	24	122	246	401	1020	1658	3100	4862	8328	14605	17066
Total	2251	2553	6573	14535	32089	44758	75979	95725	193208	267567	303860

Source: Department of Economics & Statistics, Government of Rajasthan

Table-3 Percentage land use classes in arid zone of western Rajasthan during 1960-61 to 2011-12

Year	Forest (%)	Non-agriculture use (%)	Barren & uncultivated land (%)	Pasture & Cultivable waste land (%)	Fallow (%)	Net area sown (%)
1956-57	0.97	2.79	11.86	26.93	47.33	36.33
1960-61	0.89	2.84	12.08	25.69	19.32	39.17
1965-66	0.87	3.09	12.03	25.45	16.35	42.21
1970-71	0.99	3.18	11.81	25.18	14.44	44.41
1975-76	1.66	3.25	5.68	29.04	15.15	45.22
1980-81	2.00	3.49	5.11	28.34	14.10	46.96
1985-86	2.30	3.42	5.29	26.96	15.63	46.40
1990-91	2.53	3.65	5.18	25.93	13.58	49.14
1995-96	2.64	4.34	5.13	23.20	14.11	50.58
2000-01	2.75	4.54	5.07	22.36	16.76	48.51
2005-06	2.86	4.84	4.83	21.31	15.49	50.67
2011-12	2.37	5.03	4.53	19.87	12.23	56.07

Source: Department of Economics & Statistics, Government of Rajasthan

tremendous population growth. People are inclined to rear highly productive animals only which can be stall-fed rather than keeping cost-intensive draught animals requiring vast free grazing areas. It is due to the fact that grazing lands and culturable wasteland have declined severely. Thus, there are limited areas left for animal grazing. Further, the total cropped area (58.85% in 1956 and 115.57% in 2012) and the area sown more than once (almost nil in 1956 to 37.54% in 2012) has shown tremendous growth. *Transitional Plain of Luni Basin* (IIB): Pali and Jalore district are part of this agro-climatic zone where in terms of share of livestock population at arid zone level has decreased (25.29% in 1956 and 13.03% in 2012). In real terms, the total population of this zone was 3,722,569 heads in 1956 that has marginally increased to 3,933,379 heads in 2012. Such a growth is not reported by any other zone. Even though land under grazing areas available has increased but biomass density and composition is very poor and badly degraded. Also, the area sown more than once has also increased immensely (from 1.54% in 1956 to 15.23% in 2012). Secondly, the social composition in this area has changed a lot. Animals (cattle, goat, sheep, and

camel) rearing caste (Rebari, Raika, and others) have migrated to other parts of the country and are engaged in other commercial activities. Their inclination towards the rearing of animals is also decreasing over the period and more interested to enter into the mainstream of the society and contribute through other means. *Inland Drainage Plain* (IIA): Nagaur, Jhunjhunun, and Sikar districts are part of this agro-climatic zone of arid western Rajasthan. This region houses more goats than human beings. Actually, the situation has reversed. In 1956, sheep population was 1,274,616 and declined to 857,171 in 2012 whereas the goat population was 815,859 in 1956 which has increased to 3,080,108 in 2012. Cattle population has decreased due to low milk production and diminished utility in agriculture and transport sector whereas the population of high milk yielding animals like buffalo shown great leap from 268,706 in 1956 to 1,495,576 in 2012. People are inclined to rear stall-fed and high milk yielding animals. Land under permanent pasture is almost static but the condition is quite dilapidated and degraded. Nagaur and Jhunjhunun are the two districts where the highest number of tube wells has come into existence in the last two decades and more land area

has been brought under irrigated agriculture. This resulted in the decline of culturable wastelands (1.69% in 1956 to 0.65% in 2012), long fallow (7.42% in 1956 to 5.59% in 2012) and current fallow (11.70% in 1956 to 9.12% in 2012) where animals could freely graze. Whereas there are perceptible changes in the area under net sown (64.71% in 1956 to 68.10% in 2012), total cropped (68.32% in 1956 to 90.92% in 2012) and sown more than once (4.57% in 1956 to 22.8% in 2012).

(b) Driving forces responsible for inducing changes in livestock composition:

Buffalo is preferred by the farmers and has a drastic increase of more than 300% over 1956 population (0.89 million in 1956 to 3.95 million in 2012) because of distinct advantages over cattle, like (a) it gives 3-4 times more milk, (b) once it is over from milching period, without affecting religious sentiments, unlike cattle it can be easily sold to the slaughterhouses for meat, (c) fat content in the buffalo milk is more than cattle milk so fetch good price in the market, (e) they are more disease resistant, and can thrive well with crop residue also, and, (f) male heifers can be easily sold to abattoirs and yields higher price on sale. Whereas, neither female nor male cattle calf can be sold to the abattoirs due to various restrictions. So, market forces are driving cattle out. Earlier male calf (bull) was mainly required for the drafting of water or for transportation purpose but now it is not required as better alternatives are available. Secondly, it was used for breeding purpose but artificial insemination practices are also diminishing its utility also. Buffalo is mostly stall-fed and maintenance cost is quite higher.

Camel is such an environmentally important animal that is sadly lost its utility very fast in the arid zone (from 0.54 million in 1956 to 0.28 million in 2012). Its identity with the life of arid zone was synonymous and was known as the ship of the desert. Jalore and Pali districts, having a huge concentration of Raika community, so its presence was quite thick but its population has steeply declined (134290 heads in 1956 and 8353 in 2012, in Pali district; 15704 in 1956 and 5114 in 2012 in Jalore district). The major reason for its declining population is that: (i) it has lost its economic utility as a draft animal, (ii) camel meat is not preferred in the local market so practically there is no demand as such, and (iii) it is no more used as a means of transportation due to the growing affordability of trucks and tractors that replaced camels as a means of transport. (iii) Efforts to popularize camel milk have not gained much ground in the state due to its taste and smell. (iv) The camel was reared and bred by Raika or Rebari/ Bishnoi/ Jat/ Rajput communities - indigenous pastoralists - only and in this profession new generation is not much interested due to fast dwindling of grazing lands, and youth is more interested in urban jobs. (v) It was a known fact that Raikas never used to sell female camels, but today they do. As a result, camels are being herded out of Rajasthan in large numbers for the slaughterhouses of other states. Its skin is sold to leather factories. (vi) Lack of access to health services for the camels to prevent trypanosomiasis and to cure it. (vii) The continuous shrinking of grazing resources to irrigated agriculture and rapid mechanization in agricultural farming, continuous drought and poor implementation of policy for livestock. A ruling from the Supreme Court of India bans all grazing animals from national wildlife reserves. Earlier they used to move to coastal Gujarat where the mangroves were a seasonal resource but now they are also closed to camels. Further, the sale of camel milk and its products have been initiated by the ICAR-National Research Centre on Camel, Bikaner at their counter.

Sheep: There was an increase in the sheep population from 5.57 million heads in 1956 to 68.78 million heads in 2012. Its population increased tremendously in 1962 when it crossed 11.08 million heads that more or less remained stagnant. But in 1983, population further jumped to 17.55 million heads. The sheep population was 20-25% of the total livestock population but has declined during 2012 Quinquennial Livestock Census over the Livestock Census of 2007. It has also resulted in a decline of sheep share in the total livestock population from 20 to 16% in the state. Lack of pasture land, fodder and drinking water and poor market availability at native place forced sheep herders to migrate temporarily or permanently to other locations. However, during the same periods, the reverse was the case of permanent migration. Overall, the growth in total migration declined from 11% during the time period 1997-98 to 2001-02 to 8% during the

period 2003-04 to 2010-11. The year 2002-03 was classified as a severe drought year in the Rajasthan state and a sudden increase in the proportion of sheep migration was recorded during this year. It indicated a relationship between close relationship between migratory sheep population and the occurrence of drought. The major factor responsible for the decline in the temporary migration was the recurrent droughts in the state which forced the flock owners to shift towards permanent migration and to sell a large number of animal for livelihood security. These drought conditions also led to increasing the permanent migration in the recent past. However, the variability in the permanent and temporary migration declined during the recent years in comparison to the previous period [6].

Rearing of small ruminants depends on labour inputs of all family members. The work is divided between the adult male and female of a family with children helping in all kinds of activities. Demand for slaughtered animals is high, and Muslim agents regularly visit the Raika homesteads looking for animals to buy. Small ruminants are utilized for meat, wool, dung, and milk; the production system is market-oriented. The migration of small ruminants is a regular feature in western Rajasthan. Migration strategy of livestock owners revolves around availability of fodder and water resources in the native region. The degree of mobility depends on the flock/ herd size, and the location of the family or village, as well as on the amount of fodder produced in a given year [7].

(c) Mechanization and Land use pattern changes

The agricultural sector in arid western Rajasthan has traditionally relied on manual and draught animal power. However, there is now an increasing dependence on tractors and power tillers. Available data up to 2010-11, suggests that about 47.2% of the total tractors available in the state are being found in arid western Rajasthan. A large number of tractors and other related implements like cultivators, disc harrow, power tillers, mould-board plough, threshers, rotavator, leveller, combine harvester, reaper, etc. come from adjoining areas during the season. Due to farm mechanization at large scale, utility share of livestock, particularly camel, bullock and buffalo bullock in agriculture and transportation purpose gradually but sharply declined in the region. This is evident from the following [Table-1]. The farmers of the region has adopted newer techniques and technologies to optimize farm outputs. The number of tractors and tillers has increased five times in the last 50 years. According to the Department of Agriculture, the share of agriculture workers and draught animals (farm power sources in agriculture) has come down from 63.5% in 1971-72 to 13.67% in 2009-10, whereas the share of tractors, power tillers, and motors has gone up from 36.51% to 86.33% during the same period. The increasing cost of agricultural labour and upkeep of draught animals has also partly resulted in the greater adoption of tractors for farm operations. About one-fourth of tractors available in the arid zone is found alone in the Ganganagar district, followed by Jhunjhunu and Jodhpur districts [Table-2]. The area under non-agricultural use and the net sown area has increased in the arid region since 1960. The total cultivated area comes to be 68.30%, this includes 56.07% net sown area and 12.23% fallow lands. The total cropped area comes to 64.15%. Cropping intensity varies from 106% in Barmer to 153% in Jhunjhunu district. The irrigation intensity varies from 106% in Pali to 182% in Hanumangarh district. The level of agricultural development varies from 26.42% in Barmer to 47.92% in Ganganagar district. Expansion of cultivated area has mainly taken place in Bikaner, Jaisalmer, Churu and Barmer districts whereas intensification of agriculture has taken place in Sikar, Jhunjhunu, Ganganagar and Hanumangarh districts [Table-3]. Available forage from farming, cultivable waste, fallows, pasture lands is about 63.3% of the needs of existing livestock under normal years of rainfall. The production is very much lower during the years with subnormal rainfall leading to acute scarcity conditions resulting in an alarming problem. This entails transport of fodder from other states to keep the livestock survive [8]. In addition to that the livestock is forced to migrate to other state where they get crossed with local mongrels resulting in loss of breed entity, contacting of diseases which cause economic losses, reduction in livestock production potentials, reduced employment to local people, less availability of nutritive feeds like milk and meat to the local population, and devoiding of animal excreta to soils in this tract, etc. [9]. The net irrigated area has increased by 366.92% (from 0.61 to 285 mha) as a result fallow lands and pastures and grazing

lands have been brought under cultivation. As a result, lands available for grazing of livestock have reduced drastically. Therefore, with the increase in the utilization of means of farm machinery like tractor, utility share of livestock declined in the arid zone.

(d) Economic Utility and importance of livestock for sustenance

Animal husbandry, though secondary to cultivation plays an important role in the economy of the region. The livestock population in the arid districts far exceeds the human population. With the introduction of the tractor on a large scale, use of the draft power of bullocks has declined. The importance of goat lies not merely in returns to the owner, but also in its role as an aid to the raising of sheep. The goats often act as foster mothers to the lambs as well as assist the shepherd in grazing and herding the sheep [10]. The animals are known to provide various kinds of services to the human beings as well as enrich the nature. These include draught power, hides & skin, food products (like milk), dung as manure and domestic fuel. These also bring regular source of cash income for households [11]. The sheep and goat are treated as form of financial, social and natural capital [12], which can be easily reproduced to act as a living bank with offspring as interest, and an insurance against income shocks of crop failure and natural calamities [13]. Livestock employed a good percentage of the agricultural workforces and promotes gender equity. More than three-fourths of the labour demand in livestock production is met by women. Land in the arid zone of western Rajasthan is intimately linked from livestock to natural resource management. Livestock management system is quite different in different agro-climatic zones of the region and has different impacts on land use and its changes. There are several types of livestock transition like the transition from pastoral to agro-pastoral systems, from agro-pastoral systems to mixed crop-livestock systems with different degrees of intensification, from mixed crop-livestock systems to specialized industrial landless systems etc [14]. The economic advantage of livestock production in grazing lands has long vanished [15] and that most of the animal production system, it is now mostly dependent on the arable lands. Animal husbandry plays a key role on grazing land management, economic development and poverty reduction but available grazing lands are not sufficient to support expansion of animal husbandry intensively in the arid zone. It would require raising of forage and fodder crops for the successful expansion of this sector. Looking at the biophysical status of the community grazing lands, at present, this sector needs lot of support for improvement. There is also a need to increase herder's income for achieving economic and social stability. Herders of this region are progressively losing interest in traditional pastoral system due to various reasons [7] including shrinking in grazing areas. The Rajasthan Common Land Policy, 2010, drafted under the 2011 ruling of Supreme Court of India, underlines the importance and the need to preserve and secure common land (commons) in rural areas. Supreme Court of India has explicitly recognized customarily used ponds, land and other natural resources as commons.

Conclusion

Livestock rearing is an important source of food security through meat and milk and other dairy products, which enrich nutritional intake. Though, increasing urbanization and burgeoning middle-class population, improvement in income and socio-economic transformation have expanded the demand of meat and milk products but traditional castes like Raika, Rebari etc. who mainly rear small ruminants, cattle, and camel on migration basis while there are farming communities who rear bovines for milk production. These castes are not keen to continue livestock rearing now. Further, cattle are highly uneconomical in terms of low milk production and other products except it produces a good draft animal. Native pastures have deteriorated to the last stage of degradation due to the heavy pressure of local livestock population [9, 16]. Also, with the gradual decline of grazing areas and fallow lands with recurring droughts in the region, the situation is extremely dismal about the proper supply of fodder [17]. The situation has become bleaker as livestock husbandry, has not been able to generate rural employment to youth, enhancing incomes of small farmers through job creation in agricultural off-season, after the introduction of MGNREGA by the central government [18]. The population of buffalo has been increasing by 8.5% even

during drought and famine years while the population of other animals such as cows, goats, sheep, and camels has decreased mostly due to famines and droughts. During an interactive discussion with the livestock rearers, a majority of them expressed need of indigenous breeds, which are well adapted to the local climate and can survive on the normal feeding of local grasses. Livestock in these regions helps in moderating risks, provide resilience, diversifying livelihood and can be migrated or liquidated during calamities. However, livestock production systems in these areas are characterized by low productivity, low fertility, and shortage of feed resources-especially green forage. Arid zones systems are much more resilient. Resource-poor farmers depend heavily on livestock as a major source of income [19, 20]. However, the cattle rearers of the sample villages also suggested that the livestock rearing can be a good source of regional development and sustainable development through feed and fodder management, the supply of good quality bulls for breed improvement, the revival of grazing lands, effective veterinary services, financial assistance and proper management of dependent animals.

Application of research

This would be helpful for researchers, planners and policy makers for the benefit of the livestock keepers of the arid region.

Research Category: Animal science, socio-economic and geography

Abbreviations:

LPG: Liquefied Petroleum Gas

MGNREGA: Mahatma Gandhi National Employment Guarantee Act

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References

- [1] Anonymous (2012) *Animal Husbandry Department, Government of Rajasthan.*
- [2] DES (1956-2012) *Various Statistical Handbooks. Government of Rajasthan.*
- [3] Mathur B.K., Misra A.K., Kumawat R N., Patidar M. and Roy M. M. (2015) *Proc. of National Seminar on "Livestock Economy of India", January 19-20, at Institute of Development Studies Jaipur, India, 164.*
- [4] Mathur BK., Singh J.P., Ullha U. and Bohra R.C. (2016) *In: Climate Change & Agriculture Adaptation and Mitigation (Eds. R.K. Bhatt, U. Burman, D.K. Painuli, D.V. Singh, Ramavtar Sharma and S.P.S. Tanwar), 527-548. Satish Serial Publishing House, Azadpur, Delhi 110033, 548.*
- [5] Kalla J.C. and Goyal D. (1986) *APR, Division of Agricultural Economics & Statistics, CAZRI, Jodhpur.*

- [6] Kumar Rakesh, Singh D.R., Prawin Arya, Anil Kumar (2015) *Online available: <http://www.biotecharticles.com/Agriculture-Article/Sheep-Production-System-in-Rajasthan-Sheep-Wool-and-Meat-3373.html>* (Accessed on 10th January 2016)
- [7] Louhaichi Mounir, Sarker Ashutosh, Murari M. Roy, Arun K. Misra, Khem Chand, Mahesh K. Gaur and Douglas E. Johnson (2015) ICARDA Working Paper No. 28 (Pp. 32), August, 2015. Accessed on 10th January 2016) ISBN: 92-9127-474-7
- [8] Ahuja L.D. and Muthana K.D. (1969) *Development of Arid Regions in India*, Monogram, Central Desert Development Board, Jaipur.
- [9] Ahuja L.D. (1978) *Proc. Indian Natn. Sci. Acad.*, 44, Part B, No. 5, 252-265.
- [10] Malhotra S.P. (1978) *Proc. Indian Natn. Sci. Acad.*, Vol. 44, Part B, No. 5, 423-430.
- [11] Yadav J., Tripathi Hema and Shyam Janmoni (2014) *Indian Res. J. Ext. Edu.*, 14 (4), 42-44.
- [12] McLeod A. and Wilsmore T. (2001) In: Perry, B.D., McDermott J.J., Randolph T.F., Sones K.D. and Thornton P.K. (eds). *Investing in animal health research to alleviate Poverty. International Livestock Research Institute, Nairobi, Kenya*, 304-339.
- [13] Iqbal Md. Asif (2013) *International Journal of Scientific and Research Publications*, 3(5), 1-4.
- [14] Frans Swanepoel, Aldo Stroebel and Siboniso Moyo (2010) *Co-published by The Technical Centre for Agricultural and Rural Cooperation (CTA)*.
- [15] Wang G., Hua L., Squires Victor R., Du Guozhen (2017) *AIMS Agriculture and Food*, 2(4), 354-369.
- [16] Kumar Suresh, Singh J.P., Venkatesan K., Mathur B.K. and Bhatt R.K. (2017) *Range Management and Agroforestry*, 38(1),35-42
- [17] Patidar M. and Mathur B.K. (2017) *Agroforestry Systems*,91,713-727
- [18] Anonymous (2011) *State Livestock Development Policy, Animal Husbandry Department, Government of Rajasthan*, 23.
- [19] CAZRI (2012) *Feed production technologies for sustainable livestock production in arid areas*, 50.
- [20] CAZRI (2014) *Improving livelihood of farmers through livestock interventions in Nagaur district of Rajasthan*, 66.