

AN INVESTIGATION OF DYNAMICS OF LAND USE PATTERN IN RAJASTHAN

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ABSTRACT

The present study attempts to investigate land use dynamics in Rajasthan. For this study, secondary data on land use statistics for the period from 1974-75 to 2013-14 were collected from different publications of Government of Rajasthan. The findings revealed that land use pattern was dominated by net sown area. Regarding temporal changes in different land use categories, it was observed that, the per cent share of forest land, area under non-agricultural use, land under miscellaneous tree crops & groves and net area sown to total reporting area has gone up in the Rajasthan. The dynamics of shift in land use indicated that about 10.91 lakh hectares area was shifted in last 40 years from ecological sector of which 44.22 per cent area was shifted towards non-agriculture sector and 55.78 per cent area to agriculture sector. These types of shifting of land have serious implications on the ecological balance as well as land productivity. As far as rate of growth was concerned, it was found that, over a period of time positive and significant growth observed in case of forest (1.05%), land put under non-agricultural use (0.78%) and net sown area (0.44%). Common property land resource of Rajasthan was declined from 153.43 lakh hectares in 1980-81 to 126.83 lakh hectares in 2013-14. The instability index showed that highest instability was observed in miscellaneous tree crops and groves (30.52%). The grazing pressure was increased for every hectare of grazable land. The density of population and agricultural density had been increased during reference period.

Keyword: Agriculture, common property, cultivable wasteland, ecology, forest etc.

Introduction

The world population grew by four times from 1.6 billion to 6.1 billion persons during 1900 to 2000 (United Nations, 2001). India also has experienced a six-fold increase in population (200 million to 1200 million) in same century (DES, 2010). Land use pattern and agrarian expansion in any region mainly depends on its physical characteristics besides the institutional and other resources endowments like labour and capital available.

In general land use pattern at given point of time mainly reflects degree of economic development. The rapid pace of economic development along with the human as well as animal population growth, urbanization and industrialization exert tremendous pressure on land. The increasing demand for land for various purposes forces conversion of productive agricultural lands into non-agricultural uses. This poses a serious challenge in front of researchers and policy

makers to strike a balance in the use of land, keeping in mind the need for their conservation of sustainable development and food and livelihood security. There is need for serious policy discussion as to how to address various issues related to land use planning in a country where pressure on the land is four to six times more as compared to the world average (Rai, 2008). Land use change / land cover change is one of those major challenges as well as driving forces of global environmental change and central to the sustainable development debate (Lambin *et al*, 2000). The causes and consequences of land use change on the physical and social environment have been area for research (Veldkamp and Verburg, 2004).

Rajasthan is eighth largest state in terms of population in India (Census, 2011) with highest geographical area (342239 Sq. Km.). Rajasthan has approximately 577 lakh livestock animals (19th Livestock census, GoI). In 2011, State's human population reached 6.86 crore which constitutes 5.67 per cent of India's population while net sown area was about 182.68 lakh ha in 2012-13, about 0.27 ha per capita, and twice India's average (0.13) and also more than world average of 0.23 ha (GoI, 2015). This problem of limited availability of land has been compounded by growth in population of human and livestock, urbanization and diversion of productive agricultural land for non-agriculture purposes. An analysis of structural changes in land use over a period of time is needed for planned and proper managing of land for sustainable development. An understanding of the land use dynamics in state can greatly contribute to economy of Rajasthan. Many research studies have been conducted, so far, on land use dynamics across the different parts of the country. A very few studies also have done on land use dynamics in Rajasthan earlier but no attention has been paid to study the land use dynamics in Rajasthan recently. Keeping these

facts in view, the present study aims to document the land use dynamics and population in Rajasthan with the specific objectives to: (i) assess pattern of temporal trend in land use classes (ii) impact of land use change on ecosystem sectors, and (iii) examine the pressure of human and livestock population on land.

Material and Methods

The Rajasthan state was selected purposively for the present study. This study is based on time series data. For the present study, data set compiled for different time periods from various secondary sources including various issues of Basic Statistics of Rajasthan published by Directorate of Economics and Statistics, Government of Rajasthan, Rajasthan and used to study the levels, trends and differentials. It includes information on population, land use pattern, livestock population, and agricultural variables, etc.

Land use dynamics: Standard classification of land use (Ministry of Food & Agriculture, 1948) adopted for present study. The land use statistics is generally reported in nine broad classes and it can be expressed as: Total reporting area (R) = Forest (F) + Area under non-agricultural use (NA) + Barren and unculturable land (BU) + Permanent pastures & other grazing lands (P) + Land under miscellaneous tree crops & groves (M) + Culturable waste land (C) + Old fallow lands (OF) + Current fallows (CF) + Net Area Sown (S).

The land use dynamics was studied in Rajasthan as per using methodology which adopted earlier by Pandey and Tewari (1987), Gajja and Purohit (1998) M. S. Rathore (2007), Takle et al. (2007), Wani et al. (2009), and Bardhan and Tewari (2010).

The total land of any region (Rajasthan) being constant (i.e. R = constant), it was assumed that land use pattern can change within and between different classes of land. Hence, land use changes overtime can be expressed in linearly additive form in following form:

$$\Delta R = (\Delta F + \Delta P + \Delta M + \Delta BU) + (\Delta NC) + (\Delta C + \Delta OF + \Delta CF + \Delta S) \dots\dots (1)$$

$$\Delta R = (\Delta E + \Delta NA + \Delta A) \dots\dots (2)$$

Where, R = total reporting area

ΔE = Net change in ecological sector

ΔNA = Change in non-agricultural sector

ΔA = Net change in agricultural sector

$$\Delta E = (\Delta E_1 + \Delta E_2) \dots\dots (3)$$

Where $\Delta E_1 = \Delta F + \Delta P + \Delta M$ and $\Delta E_2 = \Delta BU$

$$\Delta A = (\Delta C + \Delta OF + \Delta CF + \Delta S) \dots\dots (4)$$

The overall inter-sectoral land use shifts can be expressed as;

$$\Delta R = (\Delta E_1 + \Delta E_2 + \Delta NA + \Delta A) \dots\dots (5)$$

Analysis of growth: Annual compound growth rate in different land use categories were computed by fitting the following exponential trend equation.

$$Y_t = Y_0 (1+r)^t$$

Where,

Y_t = Land under particular category at tth year

Y_0 = Land under particular category at base year

r = Compound growth rate

t = 1, 2, 3,.....years.

The log transformation of above equation becomes

$$\text{Log } Y_t = \text{Log } Y_0 + t \text{ Log } (1+r)$$

$$r = (\text{Antilog } (1+r) - 1) \times 100$$

Analysis of instability: The instability index is estimated by the following formula called Cuddy-Della Valle index (Cuddy and Della Valle, 1978);

$$CD = CV \cdot (1 - R^2) \cdot 0.5$$

Where,

CD = Cuddy-Della Valle index

CV = Coefficient of variation (%) and is equal to standard deviation/mean

R² = Coefficient of determination adjusted for number of degree of freedom obtained from trend regression in equation

Grazing pressure, rangeland and common property land resource: The grazing pressure on land was calculated by dividing number of adult cattle units (ACU) by per hectare of rangelands.

Rangeland was worked out by adding barren land, pasture and grazing land, area under miscellaneous trees, culturable waste land, fallow land and 50 per cent area of forest land. Different types of animals have been converted into standard adult cattle unit (ACU) using standard conversion ratio (Tyagi, 1999). Common property land resource was worked out by adding area under forest, barren and uncultivable lands, cultivable wastes, pastures and other grazing lands, fallow land other than current (Joshi, et al. 2009).

Results and discussions

Temporal change in land use pattern

The nine fold classification of land used by state government for land use statistics in Rajasthan has been depicted in Table 1. The changes in each category of land in Rajasthan from 1974-75 to 2013-14 is discussed below.

Forestlands

It is revealed from Table 1 that the area under forest, which constituted 4.79 per cent (1640 thousand hectares) of the reporting area in 1974-75, increased to 8.05 per cent (2757 thousand hectares) in 2013-14. Thus, overall increase in the category of forest land was observed 3.26 per cent during the period between 1974-75 and 2013-14.

Lands not available for cultivation

The category of land not available for cultivation comprises of two types of land: (a) area under non-agricultural use and (b) land under barren and uncultivated land. Land put to non-agricultural uses increased from 4.11 per cent to 5.51 per cent during the reference period. This increase may be attributed to rise in human population as well as launching of development activities for boosting the economy and urbanization also. With the increase in population, the share of geographical area for non-agricultural uses is expected to go up.

Table: 1. Temporal changes in Land Utilisation Pattern in Rajasthan (1974-75 to 2013-14)
(‘000’ hectares)

Particulars	1974-75	1980-81	1990-91	2000-01	2010-11	2013-14	Percent (+/-)
Reporting area (R)	34268 (100)	34227 (100)	34253 (100)	34265 (100)	34270 (100)	34267 (100.00)	0.00
1. Forest (F)	1640 (4.79)	2088 (6.10)	2353 (6.87)	2606 (7.61)	2743 (8.00)	2757 (8.05)	+ 3.26
a. Area under non-agricultural use (NC)	1407 (4.11)	1507 (4.40)	1491 (4.35)	1740 (5.08)	1889 (5.51)	1889 (5.51)	+ 1.40
b. Barren and unculturable land (BU)	4479 (13.07)	2917 (8.52)	2791 (8.15)	2566 (7.49)	2379 (6.94)	2385 (6.96)	-6.11
2. Area not available for cultivation (a+b)	5886 (17.18)	4424 (12.93)	4282 (12.50)	4306 (12.57)	4268 (12.45)	4274 (12.47)	-4.71
c. Permanent pastures & other grazing lands (P)	1823 (5.32)	1833 (5.36)	1912 (5.58)	1707 (4.98)	1694 (4.94)	1693 (4.94)	-0.38
d. Land under miscellaneous tree crops & groves(M)	9 (0.03)	24 (0.07)	22 (0.06)	14 (0.04)	21 (0.06)	24 (0.07)	+ 0.04
e. Culturable waste land (C)	5704 (16.65)	6416 (18.75)	5566 (16.25)	4908 (14.32)	4233 (12.35)	4000 (11.67)	-4.98
3. Other uncultivated land excluding fallow land (c+d+e)	7536 (21.99)	8273 (24.17)	7500 (21.90)	6629 (19.35)	5948 (17.36)	5717 (16.68)	-5.31
f. Old fallow lands (OF)	2030 (5.92)	2089 (6.10)	1927 (5.63)	2444 (7.13)	1727 (5.04)	1847 (5.39)	-0.53
g. Current fallows (CF)	3218 (9.39)	2085 (6.09)	1814 (5.30)	2415 (7.05)	1235 (3.60)	1403 (4.09)	-5.30
4. Fallow land (f+g)	5248 (15.31)	4174 (12.20)	3741 (10.92)	4859 (14.18)	2962 (8.64)	3250 (9.48)	-5.83
5. Net area sown (S)	13958 (40.73)	15268 (44.61)	16377 (47.81)	15865 (46.30)	18349 (53.54)	18268 (53.31)	12.58

Source: Statistical Abstract of Rajasthan, various issues

Figures in parentheses indicate percentages to total reporting area

Land under barren and uncultivated declined from 13.07 per cent to 6.96 per cent during the reference period. This category of land is very vital from the point of view of land use planning for economic and eco-system development.

Overall decline in category of area not available for cultivation from 5886 thousand hectares to

4274 thousand hectares by 4.71 per cent during the period between 1974-75 and 2013-14. Under this category, area under non-agricultural use increased from 1974-75 to 2013-14 while that of barren and uncultivated land declined during the same period. This indicates that a barren land has been put to other uses.

Other uncultivated lands excluding fallow land

The pasture and grazing land declined from 1823 thousand hectares (5.32%) in 1974-75 to 1693 thousand hectares (4.94%) in 2013-14. The area under the pasture and grazing land in the year 2013-14 is very less to sustain 57.73 million livestock animals in the state.

Lands under miscellaneous tree crops and groves witnessed marginally increased from 0.03 per cent to 0.07 per cent from 1974-75 to 2013-14. Like the pasture and grazing land, culturable land also declined from 5704 thousand hectares (16.65%) in 1974-75 to 4000 thousand hectares (11.67%) in 2013-14. The culturable waste land has the option to put land under economic uses after amendments/reclamation.

Overall decline in other uncultivated land from 7536 thousand hectares to 5717 thousand hectares by 5.31 per cent during the period between 1974-75 and 2013-14. Under this category, area under pasture and grazing land and culturable land decreased from 1974-75 to 2013-14 while that of land under miscellaneous tree crops and groves a bit slightly increased during the same period.

Fallow lands

Land under old fallow declined from 5.92 per cent (2030 thousand hectares) to 5.39 per cent (1847 thousand hectares) during the study period. Similarly land under current fallow also declined from 9.39 per cent (3218 thousand hectares) to 4.09 per cent (1403 thousand hectares) during the same period.

Total fallow land was declined from 5248 thousand hectares to 3250 thousand hectares by 5.83 per cent during the period between 1974-75 and 2013-14. This declining trend in this category is favorable from the point of view of both agricultural growth and ecological balance in the state.

In the year 2013-14, culturable wastelands and old fallow land constitutes a share 11.67 per cent and 5.39 per cent, respectively, useful for cultivation. It needs to harness for agriculture to raise the food resources. This land has to be examined at micro

level and reclamation measures applied for development.

Net area sown

The share of net sown area has increased from 13958 thousand hectares (40.73%) to 18268 thousand hectares (53.31%) from 1974-75 to 2013-14 and thus, the state has more than half of land under net sown area (NSA) for production of various types of agricultural products including food grains, oilseeds, pulses, cash crop and fodder crops. Net sown area increased by 12.58 per cent during the period 1974-75 to 2013-14. The increasing trend in this category of land is favorable from the point of view of agricultural production. This might be due to green revolution, mechanization operation of agriculture and energized pumps for water lifting for irrigation purpose.

Land use change across sector

The change in area which was adjusted/shifted in the different categories of land use has been presented in Table 2. The desirable sub-sector of ecology (E1) registered an increased in area (1003 thousand hectares) which has favorable implication on ecology of state. Moreover, forest registered an increase in area (1118 thousand hectares) which has favorable implication on ecology. Un-desirable sub-sector of ecology (E2) consisted of area under barren and un-culturable land (BU) has decreased by 2094 thousand hectares which has favorable implication on ecology if it diverted towards desirable ecological sector. Thus overall net area under ecological sector (E) has reduced by 1091 thousand hectares which has unfavorable implication on ecological sector.

Area under non-agricultural sector (NA) has increased by 482 thousand hectares which have unfavorable implication on ecology. The land shifts towards non-agricultural uses point towards a tremendous pressure of urban and industrial expansion on land use, which calls for a more rational approach in urbanization and industrialization policies.

Net area under agricultural sector (A) has increased by 608 thousand hectares which has favorable implication for agricultural sector but at the cost of ecological sector. If it is diverted to forest, permanent pastures, grazing lands, tree

crops and groves, it creates the favorable impact on ecology of Rajasthan. The overall change in land use system in Rajasthan during 1974-75 to 2013-14 is as below.

Table: 2. Change in Land Use System of Ecological, Non-agricultural and Agricultural Sector ('000' hectares)

Sectors	1974-75	2013-14	Change
Ecological sector [E]			
E₁ (desirable ecology)	3472	4475	+1003
Forest (F)	1640	2758	+1118
Permanent pastures & other grazing lands (P)	1823	1693	-130
Land under miscellaneous tree crops & groves not included in net sown area (M)	9	24	+15
E₂ (undesirable ecology): Barren and un-culturable land (BU)	4479	2385	-2094
Net change in ecological sector (E ₁ +E ₂) or (F+P+M+BU)	7951	6860	-1091
Non-agricultural sector [NA]			
Area under non-agricultural use (NC)	1407	1889	+482
Agricultural sector [A]			
Culturable waste land (C)	5704	4000	-1704
Old fallow lands (OF)	2030	1847	-183
Current fallows (CF)	3218	1403	-1815
Net Area Sown (S)	13958	18268	+4310
Net change in agricultural sector (C+OF+CF+S)	24910	25518	+608
Overall change in land use system	34109	34267	-1

$$\Delta R = (1118-130+15-2094) + (482) + (-1704 -183 - 1815 + 608) = -1$$

$$\Delta R = (-1091 + 482 + 608) = -1$$

$$\Delta R = (1003 -2094+482 + 608) = -1$$

Further, it was observed from the sector-wise land use changes that sizeable land shifts have been taken place from the ecological sector (E1 and E2), viz., permanent pastures & other grazing lands (130 thousand ha) and barren and un-culturable land (2094 thousand ha). The use of land of this category has changed into agricultural and non- agricultural sectors. Thus, results of the study shows that there is negative shift in the area

of ecological sector and positive shifts in the area of agricultural and non- agricultural sectors.

The trend of increasing net sown area under agricultural sector is good opportunities for agriculture in the state. It will have positive impact on agricultural production and food availability in state. The area under culturable wastelands is declining because used for economic development activities without understanding their role in ecosystem.

Growth rate and instability of land use pattern The compound growth rates and instability indices for different land use classes in Rajasthan are worked out for period 1974-75 to 2013-14 and are

presented in Table 3. The compound growth rates of different land use classes in Rajasthan indicated that area under the forest increased by 1.05 per cent. Land put under non-agricultural use was increased by 0.78 per cent which might be due to ever-increasing pressure on human population leading to urbanisation and infrastructure development.

The significant and negative growth rate was noticed for barren and un-culturable land (-0.86%), all three categories of other uncultivated land viz., permanent pastures & grazing lands (-0.27%), culturable waste land (-1.24%), old fallow (-0.05%) and current fallow lands (-0.76%) while growth was significant and positive for net sown area (0.44%).

The highest instability was observed in miscellaneous tree crops and groves with instability index 30.52 per cent followed by current fallows (20.52%) and total fallow land (13.49%) under reference period. High instability in miscellaneous tree crops and groves in Punjab was also reported by Adhikari and Sekhon (2014). The lowest index was observed in other uncultivated land which was only 0.30 per cent and area under non-agriculture uses (33%). During the reference period (1974-75 to 2013-14) the study experienced year to year variation under the different land use pattern. Socio economic development played very important role in bringing the change in land use pattern. Thus highest instability was due to more year to year variation in area of miscellaneous tree crops and less instability was due to less year to year

variation in area of area under non-agriculture uses.

Common Property Land Resource (CPLR)

The Common Property Resources (CPRs) are important part of natural resources. CPRs are the resources accessible to the whole community of a village and to which no individual has exclusive property rights (Jodha, 1986). The magnitude of common property land and common property land as a percentage of the total reporting area was estimated to know the direction of change. The changing scenario of common property land resource available in Rajasthan from the year 1980-81 and 2013-14 is depicted in Table 4. A close examination of the table revealed that CPLR was declined from 153.43 lakh hectares to 126.83 lakh hectares during the study period. CPLR as per cent of total reporting area was 44.83 per cent in the year 1980-81 which has reduced to 37.01 in the year 2013-14. A rapid increase in population is an important factor for declining the extent of availability of common property land, which adversely affects quality and quantity of CPLR. The illegal encroachment of land by the private individuals, privatization and commercialization of rural economy has also decreased its availability. Thus, decline in CPLR is to be taken care by the administration and proper vigilance is required to manage this resource by the local people. Further negative compound growth rate (-0.502%) was found in common property land resource of Rajasthan during 1980-81 and 2013-14.

Table 3. Growth rate and instability index of land use categories in Rajasthan

S. No.	Land use pattern (Area in Hectares)	CAGR (%)	CV (%)	CDV Index (%)
1.	Forest	1.05**	12.08	0.48
a	Area under non-agricultural uses	0.78**	9.44	0.33
b	Barren and unculturable land	-0.86**	13.28	1.66
2	Area not available for cultivation (a+b)	-0.25**	5.83	1.98
c	Permanent pastures & other grazing land	-0.27**	3.54	0.39
d	Land under tree crops & Groves	-0.08	61.66	30.52
e	Culturable waste land	-1.24**	14.97	0.37
3	Other uncultivated land excluding fallow	-1.00**	12.01	0.30

	land (c+d+e)			
f	Old Fallow lands	-0.05	13.46	6.60
g	Current fallows	-0.76*	44.61	20.52
4	Fallow lands (f+g)	-0.39	28.10	13.49
5	Net Area Sown	0.44**	9.48	3.56

** Significant at 1 per cent level, * Significant at 5 per cent level

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Table: 4. Common Property Land Resource in Rajasthan during 1980-81 and 2013-14

Particulars	1980-81	1990-91	2000-01	2010-11	2013-14
Common Property Land Resource (CPLR) in lakh hectares	153.43	145.49	142.32	127.76	126.83
Total reporting area ('000'hectares)	342.27	342.53	342.65	342.70	342.67
CPLR (%)	44.83	42.48	41.53	37.28	37.01

Land and Livestock

The composition of livestock is governed by the available land mass and land use pattern in any region or part of the country. The range land management assumes great significance in the supply of forage for the ever increasing livestock population. Forage supply is possible through land use classes. The grazable land is one of the essential components of land resource. Over-exploitation of common grazable lands is a matter of great concern because overgrazing causes many

adverse effects. The net effect of overgrazing is a degradation of common grazable resource. Over the period of time grazing land has been declined in different parts of the county as observed by Jodha (1985), Prasad (1994), Sharma et al. (1998), NSSO (1999), Joshi et al. (2009), Marikkani (2012), Kannan and Ramar (2013), Government of India (2013), and Sharma and Singh (2014). The extent of grazable land and grazing pressure on rangeland in Rajasthan are presented in Table 5.

Livestock animals in terms of adult cattle unit (ACU) in the state has been increased while rangeland was decreased during study period from 1980-81 to 2013-14. There were 1.27 adult cattle unit for every hectare of grazable land in the year 1980-81 which has been increased to 2.32 adult animals in 2013-14. Grazing intensity has been decreased from 0.79 in 1980-81 to 0.43 hectare of grazable land for each adult cattle unit. The rangeland as total reporting area was 47.94 and 37.15 per cent in the year 1980-81 and 2013-14, respectively. Thus, availability of common grazing land per livestock has decreased due to increase in livestock population. Further, negative compound growth rate (-0.645%) was found in rangeland of Rajasthan during the period 1980-81 and 2013-14.

Land and Human

In order to understand the population-land relationship in any geographic region as well as impact of increasing population on agriculture, it is very important to comprehend the density of the population, agricultural population, cultivated area, land man ratio etc. The same has been depicted in the following Table 6.

The table clearly reflects that the total human population of Rajasthan increased from 343 lakh persons in 1980-81 to 685 lakh persons in 2010-11. The density of population had also been doubling from 100 persons/Sq. Km in 1980-81 to 200 persons/Sq. Km in 2010-11. The net sown area increased from 152.67 lakh hectares in 1980-81 to 183.49 lakh hectares in 2010-11. Land-man ratio is a suitable index to measure the pressure of population upon the land. The land-man ratio decreased from 0.45 hectares in 1980-81 to 0.27 hectares in 2010-11, which means that there had been a decline of about 39.86 per cent during the period under reference, while as the net area sown per agricultural person decreased - it was 1.64 hectares in 1980-81 and 1.19 hectares in 2010-11, which was about 27.24 per cent during the period under study. Agricultural density was increased from 61 person/Sq. Km in 1980-81 to 84 person/Sq. Km in 2010-11, which means that there

had been an increase of about 37.64 per cent during the study period.

From the above results, it is very much clear that there had been a significant relationship between increase of population and corresponding increase in net area sown - the population of the state increased by about 99.85 per cent between 1980-81 and 2010-11 whereas net area sown increased by only 20.18 per cent during the same period.

Conclusion

It was observed that trend in forest area is consistently increasing during the reference period in land use categories owing to various afforestation programmes and implementation of forest policy by state government. Still there is need to increase area under forest in order to bring one-third of geographical area. There has been an increase in land under non-agricultural uses. This may be attributed to rise in human population, urbanization and industrialization. There has also been an increase in net area sown as a result of green revolution, mechanization operation of agriculture and energized pumps for water lifting for irrigation purpose. This increase in net area sown has positive impact on agricultural production and food availability. The results of sector-wise land use changes showed that significant land shifts have been taken place from the ecological sector (especially from undesirable sub sector, E2) to agricultural and non-agricultural sectors. Such tendency of shifting land is not favorable from the point of view of ecological balance in state. It is the matter of concern for policy makers for future period of time. The shifting trend in land from ecology sector needs to be checked by formulating suitable land policy so that ecology of state can sustain. The land reform measures should be implemented by strict laws and regulations and the construction of housing buildings and other establishments on agricultural land should be prohibited. Land under miscellaneous tree crops & groves and current fallow lands were less stable while other uncultivated land and area under non-agricultural

land were more stable during the study period. Common property land resource was decreasing continuously in the study area during the study period. The pressure of livestock animals on rangelands is continuously increasing. Both human population and net area sown have increased in state during the study period. However, the rate of the increase of net area sown in the state could not keep pace with the rate of the increase of population. This leads to continuous decline in the land-man ratio, availability of cultivated land per

capita of agricultural population and increase in the agricultural density during the study period. Thus, shifting of area from ecological sector, declining of common property land resource and increasing pressure of livestock animals on rangelands are the great challenge in front of the policy makers in Rajasthan. In future, the land resource has to be used, improved and managed in such a manner so that everyone may utilize the resource for securing their livelihood for long time on a sustainable basis.

Table 5: Rangeland and Grazing Pressure during 1980-81 and 2013-14

Particulars	1980-81	1990-91	2000-01	2010-11	2013-14
Livestock in ACU (lakh No.)	208.84	203.87	260.78	282.98	294.93
Rangeland ('000' hectares)	164.08	152.09	153.57	126.61	127.31
Grazing pressure (ACU/ha)	1.27	1.34	1.70	2.24	2.32
Grazing intensity (ha/ACU)	0.79	0.75	0.59	0.45	0.43
Rangeland (%)	47.94	44.40	44.82	36.94	37.15

Table 6. Land-man ratio, land per capita of agricultural population, agricultural density in Rajasthan

Year	1980-81	1990-91	2000-01	2010-11	Change ⁺
Total population [TP] [Lakh]	343.00	440.06	565.07	685.48	99.85
Population density (Person/Sq. Km.)	100	129	165	200	100
Net area sown (NAS) in Lakh hectares	152.67	163.77	158.65	183.49	20.18
Total agricultural population [AGP*] [000]	9297	12762	18559	15357	65.18
Land-Man ratio [NAS/TP]	0.45	0.37	0.28	0.27	-39.86
Cultivated land per capita of agricultural population [NAS/AGP]	1.64	1.28	0.85	1.19	-27.24
Agricultural density [AGP/NAS] Persons/Sq. Km.	61	78	117	84	37.64

*Cultivars and agricultural labourers, +change over base period (1980-81)

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