Study Report 4

Prioritization of Rainfed Areas in India

NATIONAL RAINFED AREA AUTHORITY
PLANNING COMMISSION
GOVERNMENT OF INDIA
NEW DELHI

February 2012

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Study by

Central Research Institute for Dryland Agriculture
Hyderabad

&

Indian Agricultural Statistics Research Institute
New Delhi

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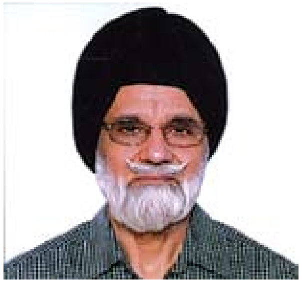

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सत्यमेव जयते

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Foreword

Rainfed areas currently constitute 55 per cent of the net sown area of the country and are home to two-thirds of livestock and 40 per cent of human population. The business as usual approach of taking all the major interventions uniformly across all the regions of the country has not paid much dividend. Therefore, regionally differentiated interventions befitting natural resource endowment and livelihood status are need of the hour. The approach adopted for prioritization of rainfed areas of the country integrates the natural resources and livelihood indices and addresses the above issue.

I appreciate the efforts of Dr. A.K. Sikka, Technical Expert (Watershed Development), National Rainfed Area Authority (NRAA) for initiating the important task of prioritization of rainfed areas of the country. The task was assigned to two most reputed institutions namely Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad and Indian Agricultural Statistics Research Institute (IASRI), New Delhi. I thank the study team comprising of CRIDA and IASRI scientists for their joint efforts and collective wisdom. In consultation with and guidance of NRAA, CRIDA and IASRI together have come up with "Rainfed Areas Prioritization Index" (RAPI) by combining natural resource index (NRI) and integrated livelihood index (ILI). Based on RAPI score, the study has identified 167 districts, the top one-third among 499 as prioritized districts. Among the prioritized 167 districts, 50 of them deserve immediate attention for enhancing productivity and livelihood as resource-wise they are rich but the productivity and livelihood status are poor.

Besides prioritization of rainfed districts of India, the study has highlighted the crop and livestock-based interventions to meet the targeted growth rate of 4 per cent per annum. The study serves as a yardstick for finding the standing of a particular district *vis-à-vis* others in the country with respect to several bio-physical and socio-economic indicators.

I am sure that this publication will bridge the gap and will be useful for the planners, administrators, scientists and developmental agencies for coming up with location-specific and need-based interventions through convergence of various schemes. Further, it will help in channelizing the limited resources to the targeted region and will pave the way for sustainable development of rainfed areas and second green revolution

(J.S. Samra)

ACKNOWLEDGEMENT

The study was conducted by Central Research Institute for Dry land Agriculture (CRIDA), Hyderabad and Indian Agricultural Statistics Research Institute (IASRI), New Delhi. The study team received excellent support from the various line Departments from different states and Central Ministries in terms of information, data on ranfall, availale water content, wastelands, ground-water status, irrigation intensity, status of natural resources, rainfed area etc. and suggestions on methodology. Their prompt response in providing the data is appreciated. In collaboration with NRAA, the study team has put its sincere efforts in prioritizing rainfed areas and the team deserves appreciation.

CONTENTS

EXECUTIVE SUMMARY

Rainfed areas currently constitute 55 per cent of the net sown area of the country and are home to two-thirds of livestock and 40 per cent of human population. Even after realizing the full irrigation potential, about 50 per cent of the cultivated area will remain rainfed. The business as usual approach of taking major interventions uniformly across all the regions of the country has not paid much dividend. Therefore, regionally differentiated interventions befitting natural resource endowment, social capital, infrastructure and economic conditions are need of the hour to meet the local challenges and enhance livelihoods. Earlier efforts of characterization of rainfed areas mainly focused on a few bio-physical indicators without giving importance to socio-economic aspects related to livelihoods issues. In order to meet this challenge, the current study was taken up to prioritize the rainfed areas for resource allocation and targeting of interventions based on resource availability, livelihood parameters and potential for development.

Realizing the importance of characterization of rainfed areas of the country and prioritization of the districts based on natural resource and livelihood indicators, National Rainfed Area Authority (NRAA) identified two premier institutes namely Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad and Indian Agricultural Statistics Research Institute (IASRI), New Delhi to work on two components, viz., natural resources and livelihood status, and integrate the outcome to prioritize the rainfed areas of the country. CRIDA developed a "Natural Resource Index" (NRI) comprising of nine variables, viz., rainfall, frequency of drought, available water content, extent and per cent of degraded and wastelands, irrigation intensity, extent and per cent of rainfed areas and ground water status. Similarly, IASRI constructed an "Integrated Livelihoods Index" (ILI), which is a composite of three sub-indices, viz., socio-economic index, health and sanitation index and infrastructure index. Both NRI and ILI were constructed as a weighted sum of the relevant variables with weights generated from principal component analysis (PCA). The results of NRI derived from PCA generated weights largely agreed with the weights suggested by the subject matter specialists during National Stakeholders Consultation meeting on methodology held at New Delhi.

The study considered 'district' as a unit as it is the unit of administration. All the districts covered under Census 2001 have been considered for prioritization. Common minimum data set available across the country led to inclusion of 499 districts in the study. These districts account for more than 90% of country's population and area. The districts that are not part of this study are: districts of Jammu & Kashmir, districts of north-eastern region except Assam, districts of Goa, and Union Territories. Totally urban districts like

Chennai, Mumbai, Kolkata and Hyderabad were also excluded. Data for newly formed districts were added to 'original' district data, wherever a district was bifurcated.

Rainfed Areas Prioritization Index (RAPI) was derived by assigning two-thirds weight to natural resource (NR) priority index and one-third weight to livelihood priority index as suggested by subject matter specialists. Accordingly, the top one-third districts (167) based on RAPI score may be considered as high priority rainfed districts for taking up crop and livestock-based interventions.

In majority of prioritized districts, natural resources status and livelihoods status are inversely related. In eastern India, NRI is medium to high but ILI is low indicating scope for improving the livelihoods through better access and utilization of natural resources. Based on RAPI, most of the districts having high priority fall in western India and southern peninsula. Therefore, further yield and livelihood gap was examined which was not considered in the RAPI. In order to bridge the gap through investment for harnessing natural resources, of the top one-third districts (167), 50 districts have been identified. The districts identified are mostly in eastern India and deserve developmental initiative on priority basis as there is unexploited potential for development. Rice is a major commodity of food security and eastern India provides many opportunities for enhancing production and productivity of rice. In these districts there is an immediate need of effective enabling mechanism and support services. On the other hand, NRI is low in western India and southern peninsula but ILI is medium to high. These districts have been receiving good investments on NRM for quite some time. However, our study indicates that these districts require **continued attention** in terms of NRM, particularly *in-situ* and *ex-situ* water harvesting, controlling soil loss and land degradation. Therefore, there is a need to come up with new policy guidelines and developmental strategies in relation to natural resources and livelihoods status.

There is a considerable scope for land use diversification and crop intensification in areas having high NRI and low or medium ILI. Agricultural development should receive high priority in areas having medium or high NRI irrespective of ILI. This calls for support services in the form of technology, infrastructure, credit, capacity building, forward and backward linkages, etc. Rather than individual components, packaging of the technologies is the need of hour and single window delivery mechanisms need to be explored for sustainable development of prioritized rainfed areas. Lastly, areas having low NRI deserve creation of off-farm employment opportunities with focus on land use diverisification, micro-enterprises and industrialization.

1. PRIORITIZATION OF RAINFED AREAS: HISTORICAL PERSPECTIVE

1.1 Background

Rainfed areas currently constitute 55 per cent of the net sown area of the country. Even after realizing full irrigation potential, about 50 per cent of the cultivated area will continue to remain rainfed. Moreover, two thirds of livestock and 40 per cent of human population of the country live in rainfed regions. In order to achieve overall development of agriculture in the country, it is essential to bridge the yield gaps, enhance the productivity and profitability, minimize risk and improve the livelihoods of millions of people dependent on rainfed agriculture. Although a large number of technologies have been generated by the National Agricultural Research System (NARS), their impact on the livelihoods of those living in rainfed regions has been limited and the recent slow down in agricultural growth has further widened the inequality between irrigated and rainfed areas.

The "green revolution" era had largely by-passed the rainfed agriculture. Subsequently several development programmes were initiated for improving rainfed farming. The "Everything Everywhere" approach of taking up all major interventions uniformly across all regions of the country has not paid much dividend. The specific needs of rainfed farming besides their characterization are of paramount importance. Some efforts have gone in this direction. Earlier most of the efforts of demarcation of dry farming regions in India (Sarkar et al., 1982) and its characterization (Soman and Kumar, 1990) were on the basis of rainfall variability within the range of 400 to 1000 mm of rainfall (Das and Kore, 2003). The rainfed areas *per se* (beyond the purview of drylands) didn't get focused attention for increasing production and productivity. Later, the efforts of prioritization have concentrated mainly on few parameters like percentage irrigation, BPL families, aridity index, etc. for delineating rainfed areas/districts, which are the basis for formulating specific area developmental programmes. This approach also did not fully capture all other aspects like livelihood, soil resources, reliability of irrigation, the socio-economic profile, infrastructure, communication means, etc. Therefore, regionally differentiated interventions befitting to the natural resource endowment, social capital, infrastructure and economic condition are need of the hour to meet the current challenges. For this, it is important to prioritize the areas and identify the possible interventions for formulating any new programme. In view of the above, there is an urgent need to prioritize the rainfed areas based on resource availability and livelihood parameters. This chapter deals with the earlier efforts on classifying rainfed areas and the next chapter focuses on the methodology adopted for the current study on prioritization of rainfed areas.

1.2 Agro Climatic Regions/Zonation

Several approaches have been adopted for delineation of zones based on various parameters. The approaches followed by the Ministry of Rural Development, Planning Commission and ICAR are discussed below:

1.2.1 DPAP and DDP Districts

Drought Prone Area Programme (DPAP) is the earliest area development programme launched by the Ministry of Rural Development, Government of India during 1973-74 to address the problem of rainfed areas chronically affected by drought. Similarly, Desert Development Programme (DDP) was launched during 1977-78 to address the problems of hot and cold desert areas. Based on encouraging response and requests from various states, a High Level Technical Committee was constituted in April 1993 under the chairmanship of Prof. C.H. Hanumantha Rao to critically review the programme in terms of methodology and implementation effectiveness. The committee developed the criteria to identify districts to be covered under DPAP and DDP. This was mainly based on climatic zones and percent net irrigated area. Moisture Index (MI) was used to assess the climatic zones. Moisture index is worked out using the formula [(P-PE)/PE]*100, where P=Precipitation and PE=Potential Evapotranspiration.

According to this criterion, the districts having arid ecosystem (MI <–66.7) and net irrigated area not more than 50% were considered under DDP. The districts with semi-arid ecosystem (MI = –66.7 to –33.3) and net irrigated area not more than 40% were covered under DPAP while dry sub-humid ecosystem having net irrigated area not more than 30% were also made eligible for coverage under DPAP (MoRD, 1994). Accordingly, 183 districs in 16 states were covered under DPAP while 40 districts in seven states under DDP.

1.2.2 Planning Commission

Planning Commission (Khanna, 1989) has identified 15 agro-climatic regions in the country, 14 in the main land and one covering the islands of Bay of Bengal and the A*rabi*an sea. The Planning Commission aimed at the regionalization of the Indian agricultural economy and attempted to bring integration of plans of the agro-climatic zones (ACZs) with the state and national plans. The agro-climatic classification of the Planning Commission is primarily based on geographical basis for developmental purpose and the list of zones is as follows:

1. Western Himalayan: J&K, HP, UP and Uttarakhand
2. Eastern Himalayan: Assam, Sikkim, West Bengal and all North-Eastern States
3. Lower Gangetic Plains: West Bengal
4. Middle Gangetic Plains: UP and Bihar
5. Upper Gangetic Plains: UP

6. Trans-Gangetic Plains: Punjab, Haryana, Delhi and Rajasthan
7. Eastern Plateau and Hills: Maharashtra, UP, Orissa and West Bengal
8. Central Plateau and Hills: MP, Rajasthan and UP
9. Western Plateau and Hills: Maharashtra, MP and Rajasthan
10. Southern Plateau and Hills: AP, Karnataka and Tamil Nadu
11. East Coast Plains and Hills: Orissa, AP, Tamil Nadu and Puducherri
12. West Coast Plains and Ghat: Tamil Nadu, Kerala, Goa, Karnataka and Maharashtra
13. Gujarat Plains and Hills: Gujarat
14. Western Dry: Rajasthan
15. The Islands: Andaman & Nicobar and Lakshadweep

Of late, the Planning Commission has come up with a list of 150 disadvantaged districts based on the following criteria:

- High population of landless and agricultural wage earners
- Low household income and high rate of migration
- Higher per cent of SC and ST population
- Status of infrastructure

1.2.3 Indian Council of Agricultural Research (ICAR)

1.2.3.1 NARP Zones

The concept of homogenous agro-ecological zones was initiated by the ICAR in 1979 under the National Agricultural Research Project (NARP), with the support from International Development Agency (IDA) of the World Bank. Under the NARP, the concept of zoning was mainly based on ecological land classification, recognizing various components like soils, climate, topography, crops, vegetation, etc., as major influencing factors. The zones were selected as contiguous areas within the state boundary and to the possible extent zones have homogeneous physical characteristics such as topography, rainfall, soils, cropping patterns and irrigation availability. Generally each NARP zone covers 2-4 districts and is spread over an area as high as 40-50 thousand sq.km. Under NARP, the country was divided into 127 agro-climatic NARP zones falling under 17 major states and 6 states/ Union Territories of North Eastern Hills Region. The criteria followed for delineation of NARP zones in different states is different, as depicted in **Table 1.1.** Of the total 127 NARP zones, 73 are predominantly rainfed (**Fig.1.1**).

1.2.3.2 Agro-Ecological Regions (AERs)

National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Nagpur has come up with 20 agro-ecological regions (Sehgal et al., 1992 and 1995) for the country and 60 agro-ecological sub-regions (AESR) (**Fig. 1.2**). The major criteria for the delineation of

Table 1.1 Criteria for Agro-climatic zoning under NARP

State	Broad criteria	No. of zones
Andhra Pradesh	Soil and climate, total rainfall and rainfall distribution	7*
Assam	Rainfall, terrain and soils	6
Bihar	Rainfall, temperature, terrain, soils	6
Gujarat	Climate, topography, soils, cropping pattern	8
Haryana	Climate, topography, soil, cropping pattern, irrigation facility	2
Himachal Pradesh	Altitude, rainfall, temperature, humidity	4
Jammu & Kashmir	Soil, climate, altitude	4
Karnataka	Rainfall, topography, soils and cropping pattern	10
Kerala	Climate, topography, soils and cropping pattern, sea water incursion, irrigation facility	5
Madhya Pradesh	Rainfall, topography, soils, cropping pattern	12
Maharashtra	Rainfall, topography, soils, cropping pattern	9
Orissa	Rainfall, climate, soils	10
Punjab	Rainfall, water resources, soils and cropping pattern	5
Rajasthan	Rainfall, soils, irrigation, irrigation facility and cropping pattern	9
Tamil Nadu	Rainfall, altitude, soils, cropping pattern	7
Uttar Pradesh	Rainfall, terrain and soils	10
West Bengal	Rainfall, temperature, soils, topography and cropping pattern	6
N.E.H. Region	Rainfall, topography, temperature and soils	6
Andaman & Nicobar	Topography and soils	3
Pondicherry	Soils, climate, topography, cropping pattern	2

Note: * revised to 9 ACZs

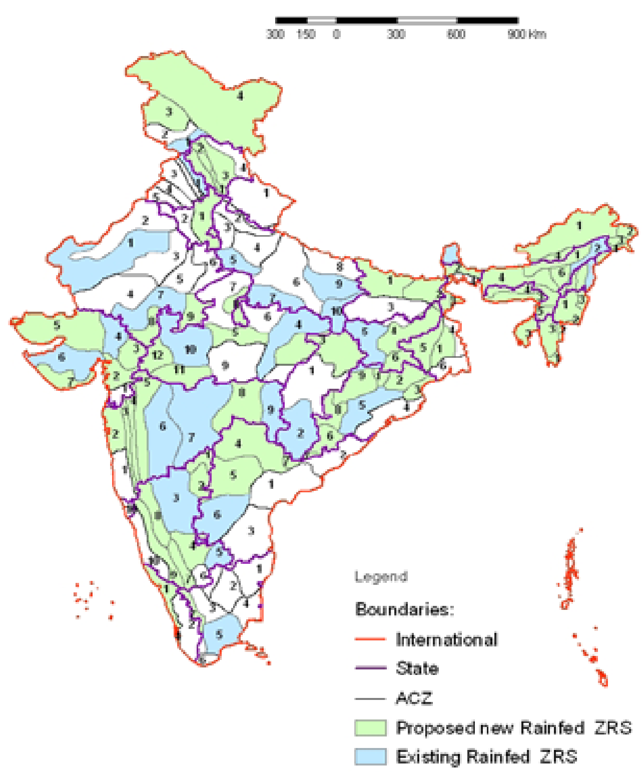
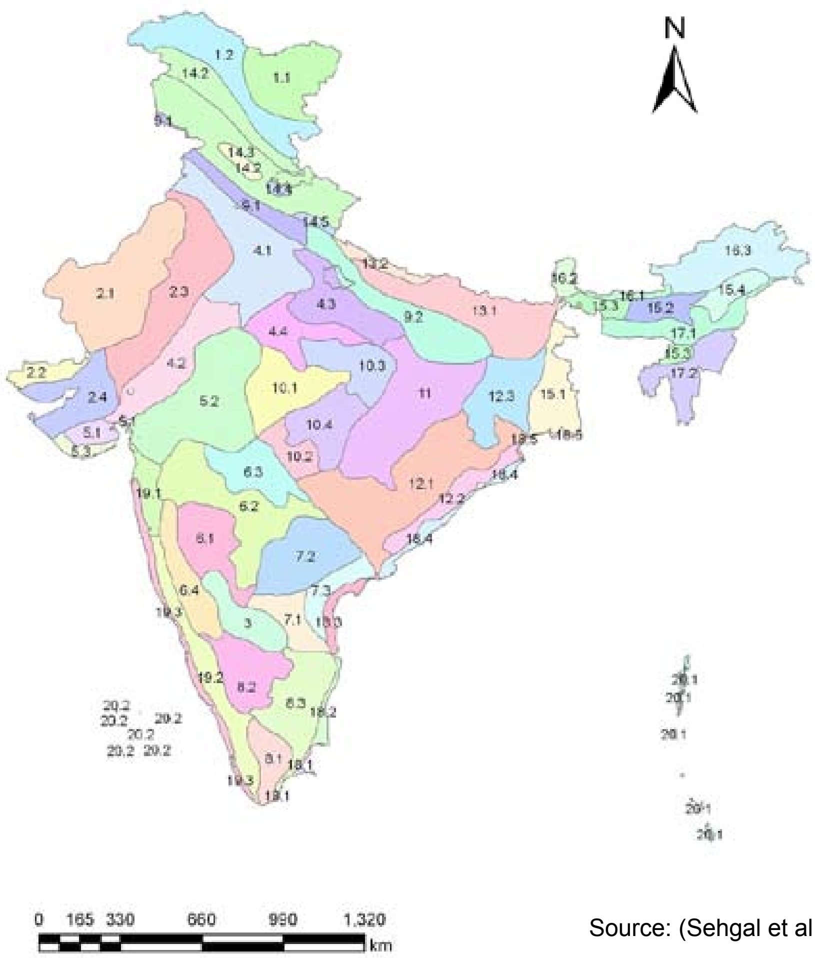


Fig. 1.1 Delineation of NARP zones

regions were: (i) length of growing period as an integrated criterion of effective rainfall (ii) soil groups enjoy precedent over physiography (iii) delineated boundaries adjusted to district boundaries (iv) number of regions as minimal as possible.

1.2.3.3 Production Systems Approach

Under the National Agricultural Technology Project (NATP), the concept of production systems was introduced by ICAR. For prioritization of rainfed districts of India, data on crop, livestock and socio-economic parameters for all districts with less than 30 percent irrigated area (considered as rainfed) were analyzed. Districts with highest area under a given crop/cropping system but with stagnant, declining or low productivity were considered as high priority districts. The underlying implication of this approach was that any improvement in the productivity of crops and livestock in such districts will have a greater impact at the state and national level due to the involvement of large area/ number of farmers (NATP, 2004).



Source: (Sehgal et al., 1992 & 1995)

Fig. 1.2 Agro-ecological sub-regions of India (Legend: Annexure – I)

In this approach, the rainfed agro-ecosystem was sub-divided into 5 homogenous production systems, viz.,

i. Rainfed rice based system
ii. Nutritious (coarse) cereals based system
iii. Oilseeds based system
iv. Pulses based system
v. Cotton based system

The rainfed rice production system is mostly prevalent in eastern and north eastern parts of India (**Fig. 1.3**). Coarse cereals are staple food of poor people and principal source of fodder for livestock is mainly confined to western and central parts of the country and the semi-arid hot high lands of Deccan plateau. Oilseed-based production system which is mostly rainfed wherein crops are grown both during *kharif* and *rabi* seasons under sole, inter and sequence cropping systems. The groundnut is mostly cultivated in western plains, central high lands, semi-arid Deccan plateau and Eastern Ghats while soybean is mainly confined to Madhya Pradesh and Uttar Pradesh in the central high lands, Malwa-Gujarat plains and Kathiawar peninsula and is now spreading to areas like Vidarbha region in Maharashtra. In case of pulses-based production system, ninety per cent of pulses are grown under rainfed conditions as intercrops or in sequence cropping system all over the country. Pigeon pea and chickpea are the two most important pulse crops and grown during *kharif* and *rabi* seasons, respectively. Cotton-based production system has **s**ixty per cent of the cropped area under rainfed condition mostly in the Deccan plateau and hot semi-arid peninsular parts of India.

All the above efforts made earlier for characterization of rainfed areas by-passed many key parameters essential for drawing meaningful conclusions and need- based interventions. The agriculture and allied developmental efforts need to match with the available natural resources and livelihood. The integration of natural resources and livelihood parameters is required to characterize the rainfed areas of the country. The integrated method adopted for prioritization of rainfed areas in the country is discussed in the following chapter.

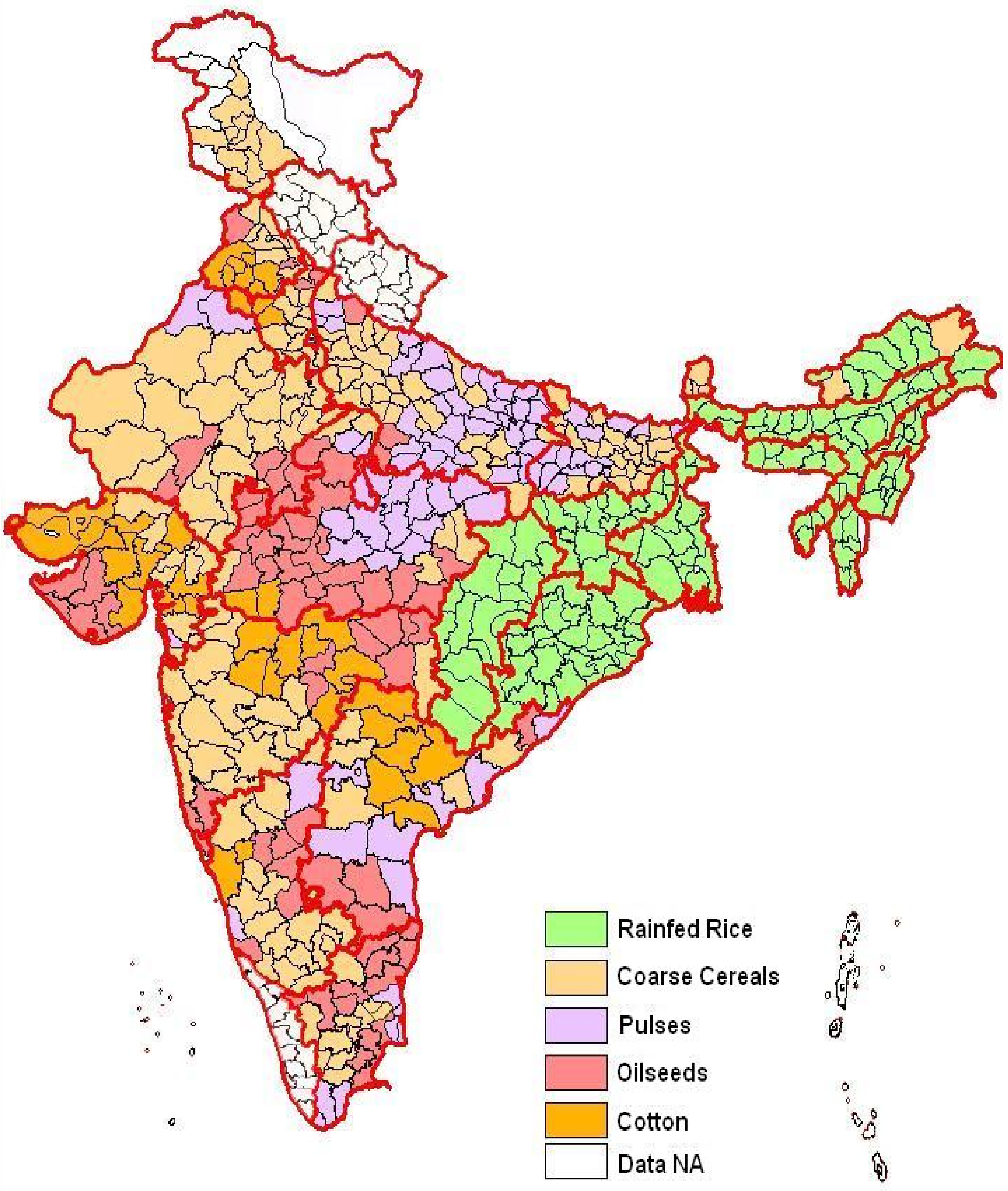


Fig. 1.3 Major rainfed production systems of India

(Note: Kerala, Himachal Pradesh and Uttarakhand are mainly horticulture-based production systems)

2. METHODOLOGY FOR PRIORITIZATION OF RAINFED AREAS

Prioritization of rainfed areas has to be made on a scientific basis; therefore, the study team realized the need for a composite index. Rainfed Areas Prioritization Index (RAPI), evolved by the study team is composed of two sub-indices, viz., Natural Resources Index (NRI) and the Integrated Livelihood Index (ILI) to account for the both natural resource and socio-economic parameters.

This study considered 499 districts that existed as on March 31, 2001, the date of reference for Census-2001. These districts account for about more than 90 % of country's population and area. The districts that could not form part of the study are all the districts of Jammu & Kashmir, north-eastern region except Assam, Goa, and Union Territories. The basic reason for not including them is the non-availability of data for certain key parameters used in the study. Totally urban districts like Chennai, Mumbai, Kolkata and Hyderabad were also excluded from the purview of the study. Data of newly formed district were added to 'original district' data from which such new district was carved out.

2.1 Natural Resources Index (NRI)

Natural Resources Index was derived by considering nine major variables set out in **Table 2.1**. The table lists these variables and their measurement units, source of data along with remarks.

Table 2.1: Variables considered for computation of natural resources index

Variables	Measurement/unit	Data source	Remarks
Rainfall	Normal rainfall values expressed as mm of rainfall. The upper limit of mean annual rainfall of 1500 mm was considered as cutoff which accounts for more than 80% of the total geographical area (Mandal et al., 1999). Moreover, the demand to meet the potential evapo-transpiration for the cropping season is well within 1500 mm for 99.8% of the total geographical area (IMD Science Report No. 36).	Mostly IMD. State Government websites for districts where data were not available from IMD. Global dataset of CRU, UK through India water portal was used for few districts.	The upper limit of 1500 mm was considered to give greater emphasis to low rainfall areas.
Drought	Measured in terms of probability of severe drought. Computed by sum of probability of severe drought and half the probability of moderate drought. It means two moderate droughts were considered equivalent to one severe drought.	Gore et al., 2010	A negative deviation of 26 to 50% from normal rainfall was considered as a moderate drought, while any deviation that exceeds 50% is treated as severe drought

Available water content of soil	AWC is generally expressed in milli meters (mm) of water available to crop plants and it is determined by soil depth and texture. Each district was given a score between 1 and 6 depending on the AWC. ***AWC Score*** >125mm 1 100-125mm 2 75-100mm 3 60-75mm 4 40-60mm 5 0-40mm 6	Derived by superimposing the soil maps developed by NBSS & LUP and global data sets (IIASA) in GIS environment	Higher scores indicate lower water availability and receive higher priority.
Area under degraded and waste lands	Area under degraded and wastelands was considered in two ways i.e., the extent (m ha) and proportion (as percent of geographical area)	ICAR (2010)	Area under degraded and wastelands was not provided for certain newly formed districts like Neemuch, Umaria, etc.; but the area was provided for pre-divided districts. In such cases, the area under degraded and wastelands was derived in proportion to geographical areas. Districts having larger area under degraded and wastelands get high priority.
Rainfed area	Rainfed area was derived by subtracting net irrigated area from net sown area. It was also considered in two ways, both in terms of extent (m ha) and proportion.	Agricultural Census, GoI, Department of Agriculture and Cooperation, GoI, CRIDA-ICRISAT database, State Bureaus/ Directorates of Economics and Statistics, State Planning Departments via State government websites, District websites and correspondence	Net sown area and net irrigated area used for deriving rainfed area mostly refer to average of three years data (2004-05, 2005-06 and 2006-07). Where data are not available for certain districts, the latest years for which data are available are considered. Districts with larger area under rainfed condition get higher priority
Status of ground water	Scores were given to each district based on the groundwater status as classified by Central Ground Water Board: Safe (1), semi-critical (2), critical (3) and over-exploited (4)	Central Ground Water Board (2006)	Ground water status was not provided for certain districts. The status of such districts was ascertained by looking at map of CGWB. Districts with over- exploited ground water get higher priority.
Irrigation intensity	Expressed as percentage, it is the ratio of gross irrigated area and net irrigated area	Agricultural Census, GoI, Department of Agriculture and Cooperation, GoI, CRIDA-ICRISAT database, State Bureaus/ Directorates of Economics and Statistics, State Planning Departments via State government websites, District websites and correspondence	The data used for deriving irrigation intensity mostly refer to average of three years data (2004-05, 2005-06 and 2006-07). If data are not available for certain districts, the latest years for which data are available are considered. Districts with lower irrigation intensity get higher priority.

Thus, nine variables that capture the most important natural resource parameters critical for production and required for formulating interventions in rainfed areas were considered in developing the natural resource index. The data for these variables were subjected to Principal Component Analysis (PCA) as described in **Annexure-II.** NRI derived by PCA method agreed with that of weights given by the subject matter specialists i.e. budget method (r=0.93 for index score and r=0.88 for ranks). Therefore, PCA method was used for developing NRI to avoid subjectivity.

As the scores given to NRI variables indicate priority (higher score means higher priority), NR priority index was first developed using the weights derived by PCA method. Then NRI is derived as (1-NR priority index). Low values of NRI depict poor status of NR and thus require higher priority.

2.2 Integrated Livelihood Index (ILI)

Apart from the status of natural resources, the level of economic development is also an important factor in determining the priority. Accordingly, districts with lower levels of development are to be given higher priority. For this, an integrated livelihood index (ILI) was constructed considering a number of factors that indicate the level of economic development.

The ILI is a composite of three sub-indices, viz., socio-economic index, health and sanitation index and infrastructure index. The variables that went into the computation of these sub-indices are set out in **Table 2.2**.

The variables in each of these three sub-indices were first normalized to make them unit-free and then combined using the weights obtained from PCA as in case of NRI. The three sub-indices were then subjected to PCA again to derive weights which were then used to construct the livelihood index.

Table 2.2: Variables considered for computation of various component indices of ILI

Socio-Economic Index

S. No.	Variable (parameter)
1	Percentage of SC Population
2	Percentage of ST Population
3	Percentage literacy rate
4	Per capita expenditure in rupees
5	Poverty gap ratio
6	Number of radio and transistors per thousand households
7	Number of television sets per thousand households
8	Number of telephones per thousand households
9	Number of scooters, motor cycles, etc. per thousand households
10	Number of cars, jeeps, vans per thousand households

Health & Sanitation Index

S. No.	Variable (parameter)
1	Number of houses with good and livable housing conditions per thousand houses
2	Number of houses with latrine facility in the premises per thousand houses
3	Number of villages with drinking water facility per thousand villages
4	Number of villages with medical facility per thousand villages
5	Number of households with drainage facilities per thousand households
6	Number of households with bathroom facilities per thousand households
7	Number of households with LPG connection per thousand households

Infrastructure Index

S. No.	Variable (parameter)
1	Number of villages with power supply per thousand villages
2	Number of villages with Educational Institutes per thousand villages
3	Number of villages with P&T facilities per thousand villages
4	Number of villages with paved approach roads per thousand villages
5	Number of households availing banking facilities per thousand households
6	Number of households with electricity as source of lighting per thousand households

(**Source of data:** 61st round, consumer expenditure, socio-economic survey, July 2004-05, NSSO, GoI; Population Census of India, 2001)

2.3 Rainfed Areas Prioritization Index (RAPI)

NRI and ILI scores are rescaled using range. Priority indices were derived corresponding to NRI and ILI using the following expressions.

NR priority index = (1-NRI)

Livelihood priority index = (1-ILI)

These two indices have been combined by assigning two-thirds weight to NR priority index and one-third weight to Livelihood priority index to derive RAPI as suggested by Experts (unanimous opinion) during National Stakeholders Consultation meeting held on 18th May 2010 at NASC complex, New Delhi. The resultant RAPI is estimated as under:

RAPI = {2/3 (1-NRI) + 1/3 (1-ILI)}

Accordingly all the 499 districts have been prioritized and their values are set out in **Annexure – III** and the results are presented in chapter-3.

2.4 Milk Production Potential

The milk production potential for 499 districts was estimated using 18th Livestock Census (2007) provisional data for planning interventions in the dairy sector. The milk production potential of the district was determined based on the index developed using the following three steps:

- The density was estimated by dividing the population (cows and she-buffaloes) with respective geographical area of the district.
- Per cent cross-bred cows was estimated by dividing the population of cross-bred cows with total number of cows of the district. In case of Bihar, the total population data were available but lacked districts wise break up, hence density of cows and buffaloes and % cross-bred cows for the state was considered to represent status of districts of Bihar.
- The above three parameters namely cow density, she-buffalo density and per cent cross-bred cows' data were normalized using the following formula:

$$Z_i = \frac{X_i(Max) - X_i}{X_i(Max) - X_i(Min)}$$

Z_i= Normalized value of the parameter for ith district

X_i = Original value of the parameter for ith district

The milk production potential index was derived by combining these three normalized parameters by assigning weights, 0.25, 0.25 and 0.5 for cow density, per cent cross-bred cows and she-buffalo density, respectively. Based on the index value, all the districts were regrouped into three classes having high, medium and low milk production potential (**Annexure - IV**).

3. PRIORITIZATION OF RAINFED AREAS: RESULTS

Districts were prioritized based on the Rainfed Areas Prioritization Index (RAPI) score derived by combining Natural Resource Index (NRI) and Integrated Livelihood Index (ILI).

3.1 Natural Resource Index (NRI)

The natural resource index is based on nine parameters mainly rainfall, the frequency of moderate and severe drought, the extent and percent of rainfed areas, groundwater status, available water content, the extent and percent of degraded & wastelands and irrigation intensity. The NRI accounts for two-thirds of the weight assigned while within the NRI, the rainfall and drought account for the major share as they decide the outcome of rainfed agriculture. The major findings are given variable-wise and also depicted through maps.

3.1.1 Rainfall

- Per humid region receiving excessive rainfall is confined to Western Ghats extending from Maharashtra to Kerala along the coast, West Bengal, North-Eastern region (**Fig. 3.1**).
- Dry sub-humid and moist sub-humid areas are spread over Orissa, Chattisgarh, Bihar, Jharkand, West Bengal & Parts of UP.
- Dry and moist semi-arid extend from the interior of Karnataka, AP, MP, Gujarat, Rajasthan and parts of UP thus form a contiguous region.
- Arid region mostly spreads over Western part of Rajasthan and two districts of Gujarat.

3.1.2 Drought

Combined probability of moderate and severe drought at district level based on the IMD maps (Gore et al., 2010) was worked out (**Fig. 3.2**). The probability of severe drought is high in Western parts of Gujarat and Rajasthan followed by Haryana, while it is moderate in the interior parts of Gujarat, Rajasthan, South India, Central India, (Maharashtra & MP), and Indo-Gangetic Plains (IGP) of Punjab and UP. Rest of the country has <10% probability of experiencing drought.

3.1.3 Available Water Content

Available water content, in absolute terms (i.e. in mm) indicates the storage capacity of soil and its availability to plants. Available water content, derived from grid based global soil data sets, averaged over soil depth and derived for the district indicate more than 125 mm available water content in IGP districts, parts of MP and Maharashtra. The available water content in many coastal districts in AP, TN, Orissa, West Bengal, and Parts of Rajasthan is less than 100mm (**Fig. 3.3**).

3.1.4 Degraded and Wastelands

- Major part of degraded and wastelands are in the range 0-20% & 20-40% in majority of the districts in the country (**Fig. 3.4**).
- Severely degraded land is found in parts of UP, Rajasthan, MP, Maharashtra and in West Coast.
- 60-80% district area is degraded in some of the districts of UP & MP.
- Less than 20% of degraded and wastelands are observed in Central India, West Bengal, Orissa, Gujarat, Coastal Region of Tamil Nadu, and parts of AP.

3.1.5 Rainfed Area

Based on the percent rainfed area, districts were categorized into 3 classes i.e. <35% rainfed area, 35-70% and >70% rainfed area (**Fig. 3.5**). Except for few districts in coastal areas of AP, Tamil Nadu and IGP, rest of the districts are having more than 35% area as rainfed. Most of the districts of Central India, parts of AP and Karnataka, are having more than 70% area under rainfed condition and also come under dry & moist semi-arid climate. Parts of Orissa, Chattisgarh, West Bengal having more than 70% rainfed areas come under moist sub-humid climate.

3.1.6 Groundwater Status

Based on groundwater utilization, the districts are categorized into safe, semi-critical, critical and over-exploited by Central Ground Water Board (CGWB). Major parts of Eastern India, Central India, Northern Parts of AP are safe in terms of exploitation of groundwater (**Fig. 3.6**). Most parts of Punjab, Haryana, Rajasthan, Southern AP, Parts of Tamil Nadu are considered as over- exploited. Many districts under IGP where the recharge is mainly through canal supplies are also over-exploited indicating the need for immediate remedial measures in terms of change in cropping pattern.

3.1.7 Irrigation Intensity

More than 100% of irrigation intensity indicates assured availability of water for more than one cropping season in a year. Typically, these areas are located in canal command areas and deltaic areas (**Fig. 3.7**). Irrigation intensity is high in delta areas of Cauvery, Krishna & Godavari basins followed by the irrigated areas of Punjab, Haryana, Rajasthan & Parts of UP, Parts of Orissa and West Bengal. The districts falling under these regions have more than 40% of area under cultivation for more than one cropping season.

3.1.8 Status of Natural Resources (NRI)

The combined status of natural resources (NRI) is low on left half of the country, i.e., Western and Central part extending from Haryana to Tamil Nadu with exception of West Coastal region of Karnataka & Kerala (**Fig. 3.8**). The NRI is high in eastern parts of India particularly in West Bengal, Bihar, Jharkhand, Chhattisgarh and Orissa.

3.2 Integrated Livelihood Index (ILI)

Integrated livelihood index has three sub-component indices namely socio-economic status, health and sanitation and the status of infrastructure.

3.2.1 Socio-Economic Status

- The status is low in case of Orissa, Chattisgarh, Bihar, Jharkhand, and parts of UP & MP, West Bengal, Rayalaseema & Southern Telengana districts of AP. Few districts of Karnataka located adjacent to Rayalaseema and Southern Telangana regions also score low (**Fig. 3.9**).
- Medium status in case of Central India, coastal AP, Parts of Karnataka and Parts of Rajasthan.
- High in West Coast region extending from Gujarat, Maharashtra to Kerala, Punjab & Haryana of IGP and Hilly regions of HP.

3.2.2 Health and Sanitation

- Low in Orissa, Bihar, Jharkand, Chattisgarh, West Bengal, NE Region, few districts in Maharashtra & MP (**Fig. 3.10**).
- Medium in Karnataka, Tamilnadu, North Coastal Andhra, Gujarat & Rajasthan.
- High in Punjab, Haryana, Western UP, South Coastal AP, Western & Northern parts of Maharashtra, parts of Gujarat.

3.2.3 Status of Infrastructure

The status of infrastructure is poor in UP, Bihar, Jharkhand, West Bengal, Orissa and few districts of Gujarat, Rajasthan & Maharashtra (**Fig. 3.11**). Infrastructure development status is high in South India, Punjab, Haryana, Southern part of Gujarat while medium in central India.

3.2.4 Status of Livelihood (ILI)

The combined status of integrated livelihood (ILI) is high on west coast and IGP region while it is medium in northern and central India (**Fig. 3.12**). Livelihoods status is poor in the eastern parts of India particularly in West Bengal, Bihar, Jharkhand, Chhattisgarh and Orissa while these areas are rich in natural resources (high NRI). Therefore, there is high scope for unexpoited tapping of unexploited natural resources in these regions for improving the livelihood status with meaningful location-specific interventions

3.3 Rainfed Areas Prioritization Index (RAPI)

The ranking of districts was based on RAPI score and the list is presented in **Annexure-III**. Based on RAPI score, the districts are grouped into low, medium and high priority categories (**Fig. 3.13**). Of the total 499 districts, the top one-third districts (167) based on RAPI may be considered as high priority districts (**Fig. 3.14**). Of the 167 districts, 50 of them were further shortilisted possessing high potential for development (i.e. natural resources availability) and large yield gap to address food and livelihood security. These 50 districts have medium to high NRI, low to medium ILI and large yield gap.

Chapters 4 and 5 deal with bio-physical and socio-economic interventions for enhancing crop and livestock productivity, respectively, for the top 167 prioritized districts, while chapter 6 focuses on development perspective and policy issues.

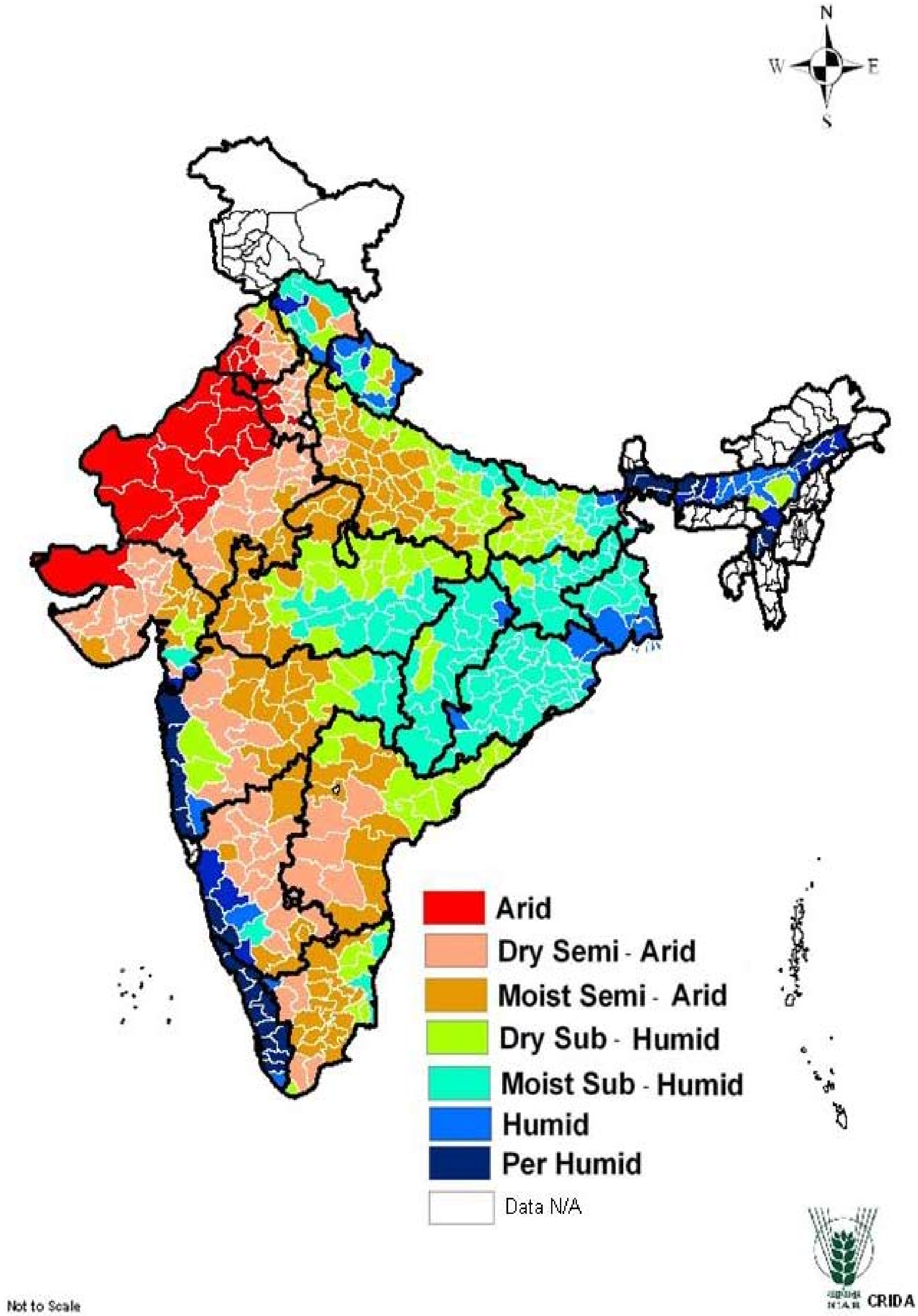


Fig. 3.1 Climatic classification based on rainfall

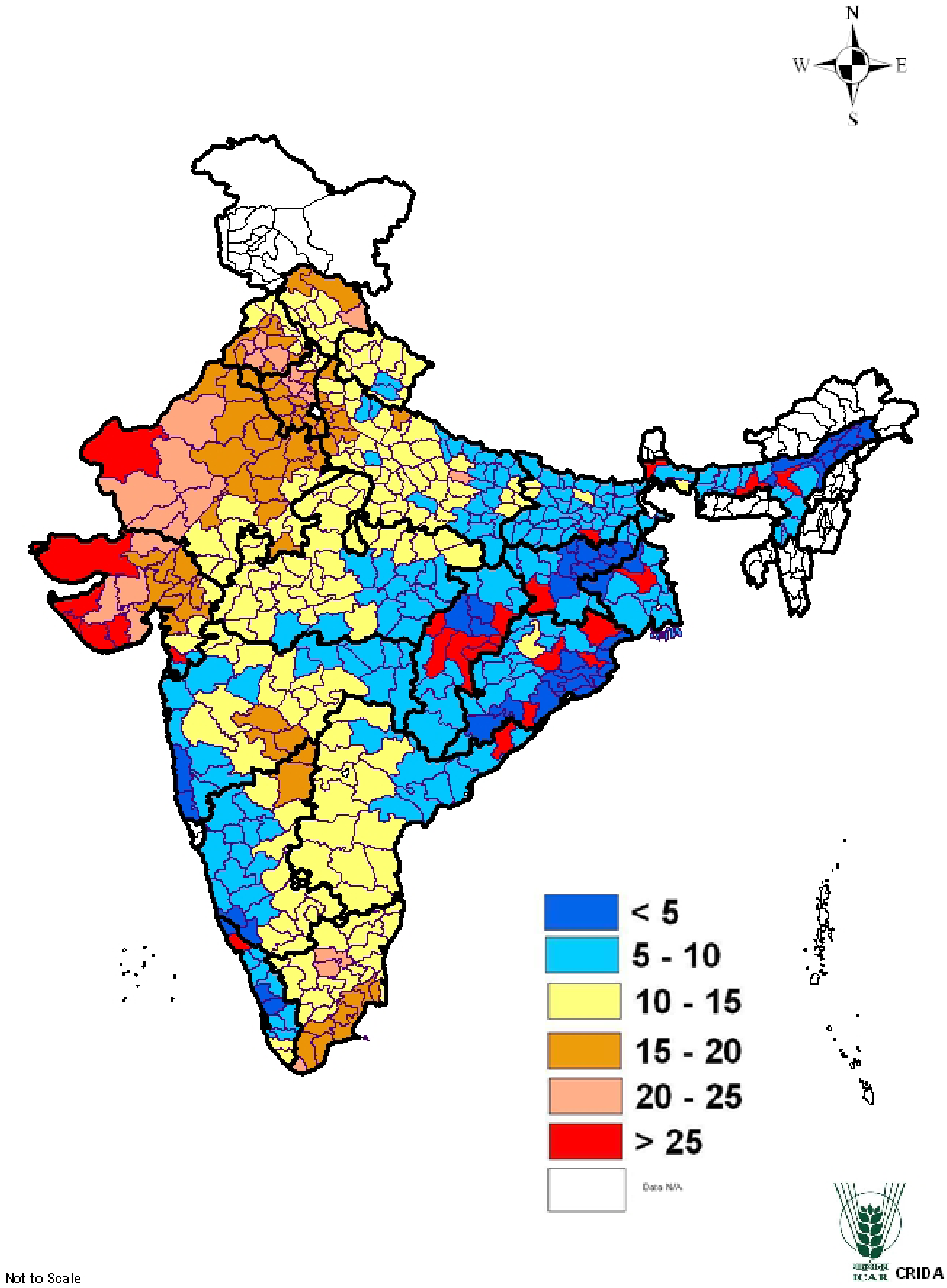


Fig. 3.2 Per cent probability of occurrence of severe drought

(two moderate droughts are considered equivalent to one severe drought)

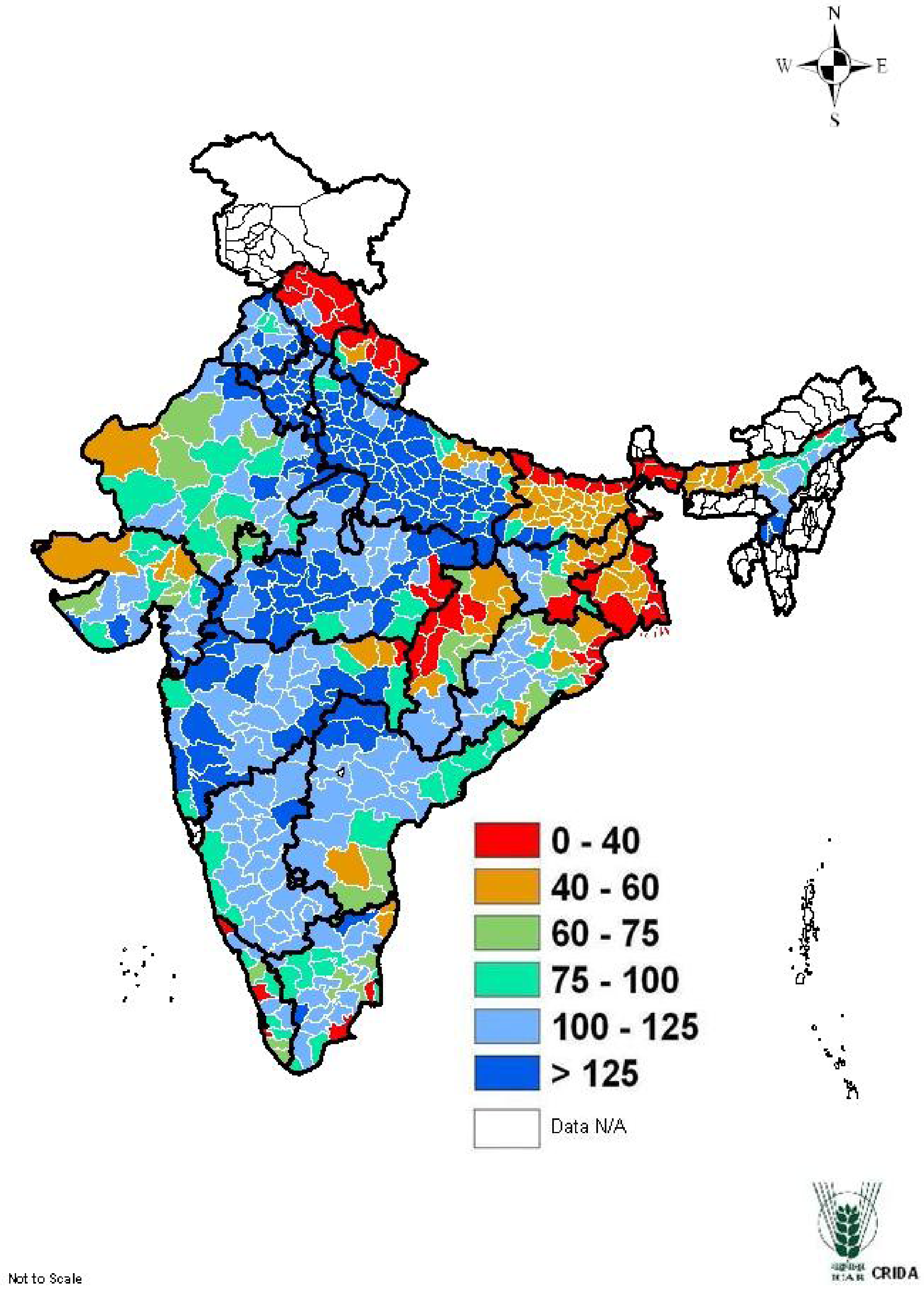


Fig. 3.3 Available water content (mm)

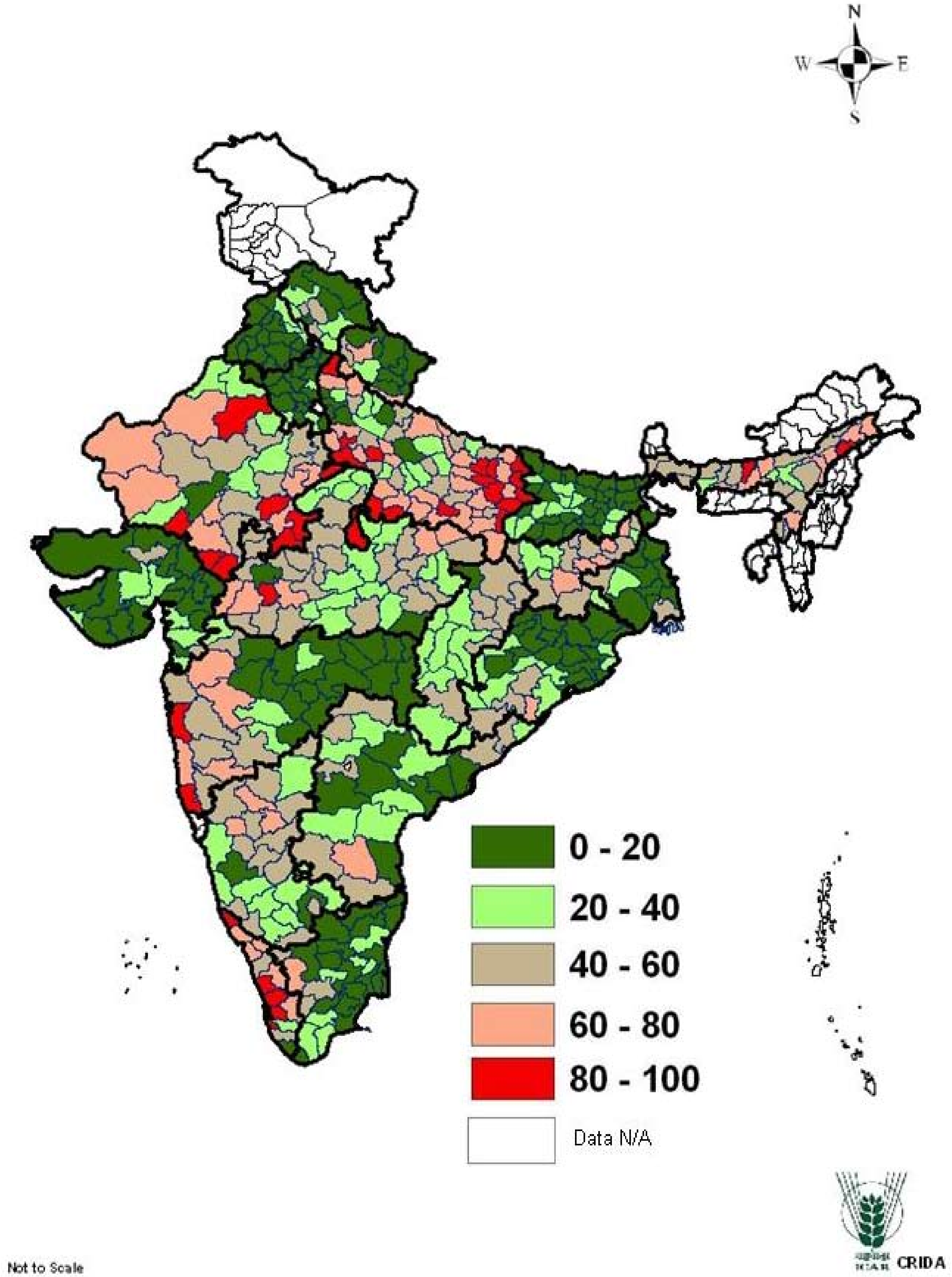


Fig. 3.4 Percent area under degraded and wasteland to total geographical area

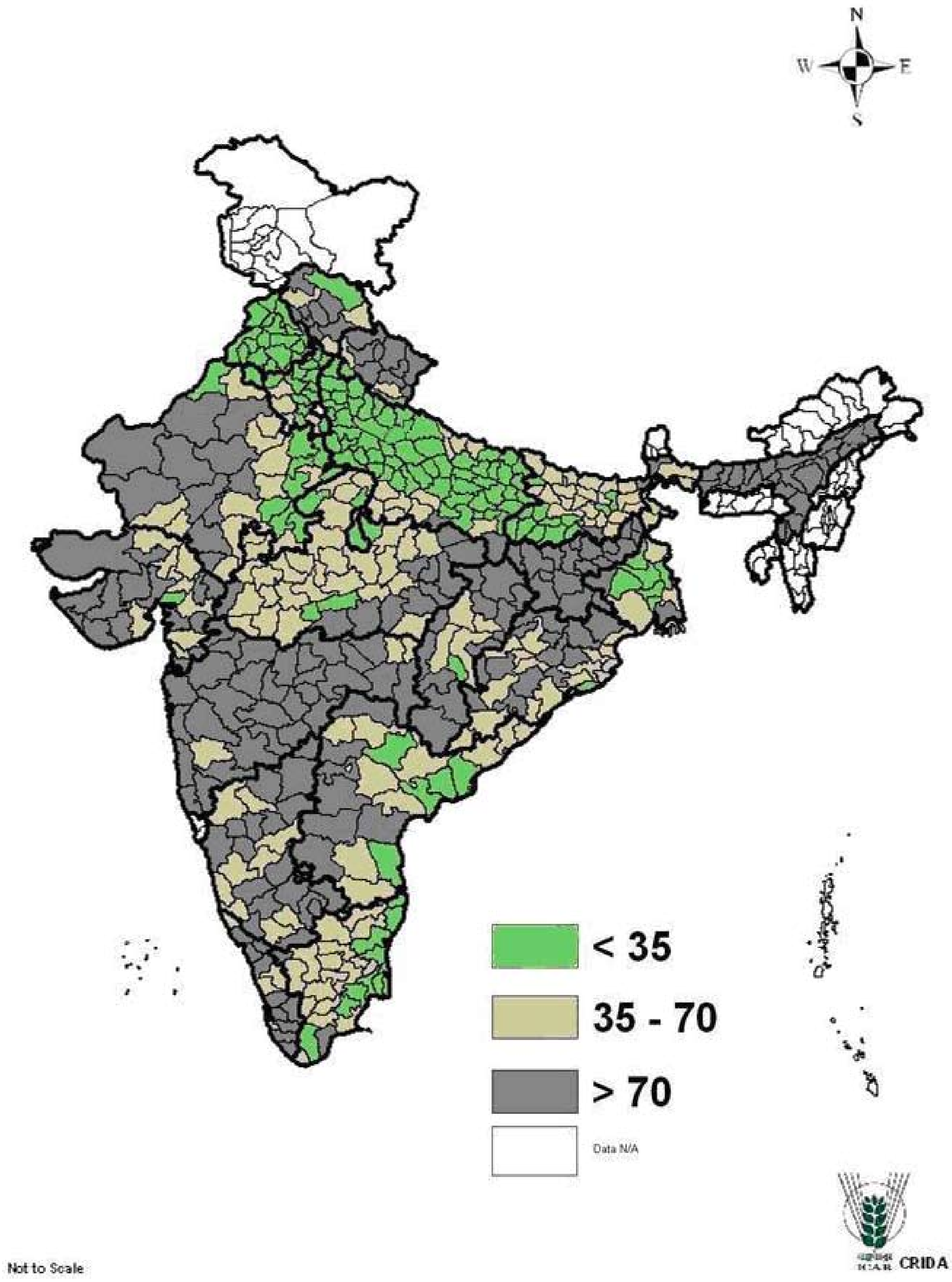


Fig. 3.5 Percent rainfed area to net sown area

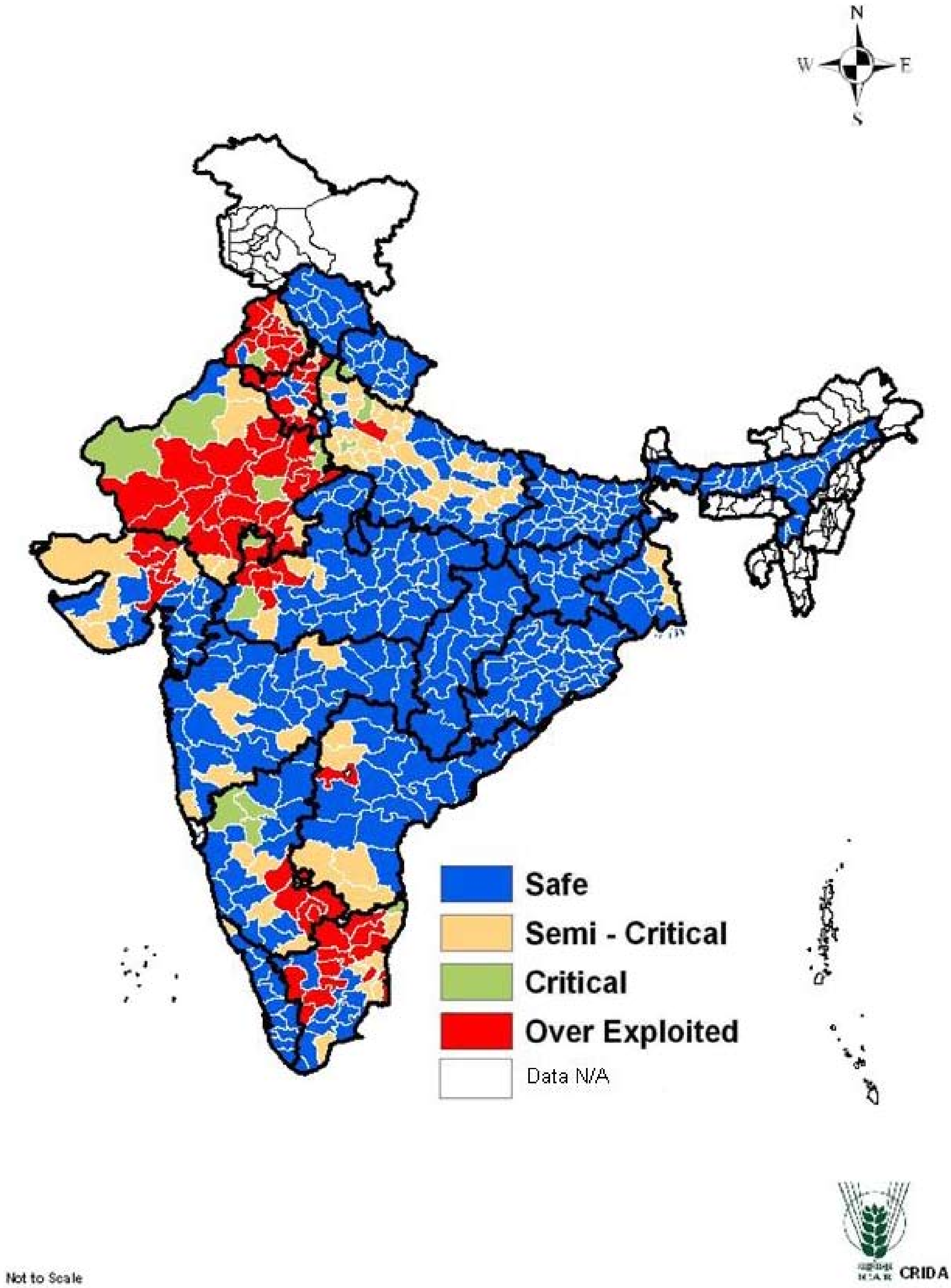


Fig 3.6 Status of groundwater

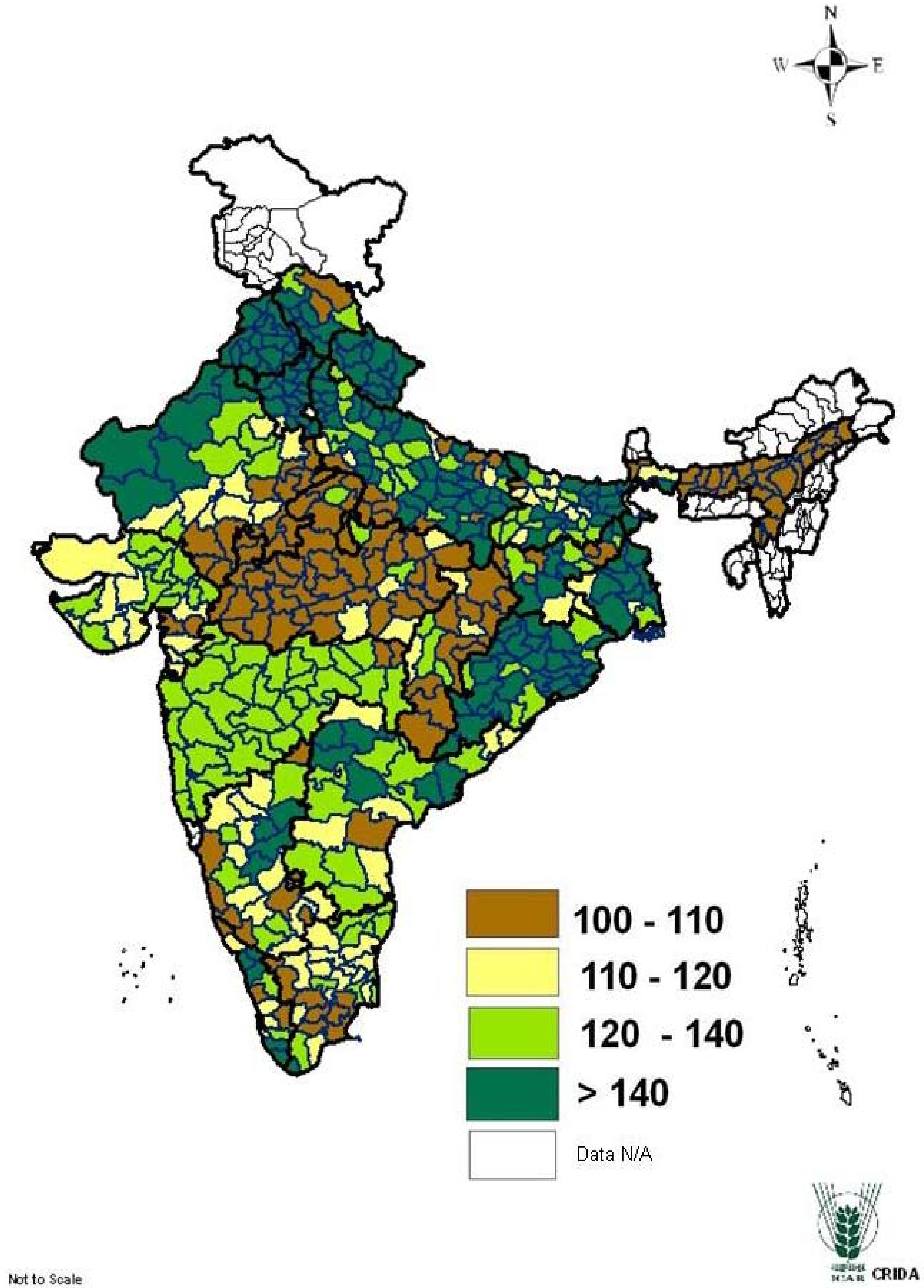


Fig 3.7 Irrigation intensity (%)

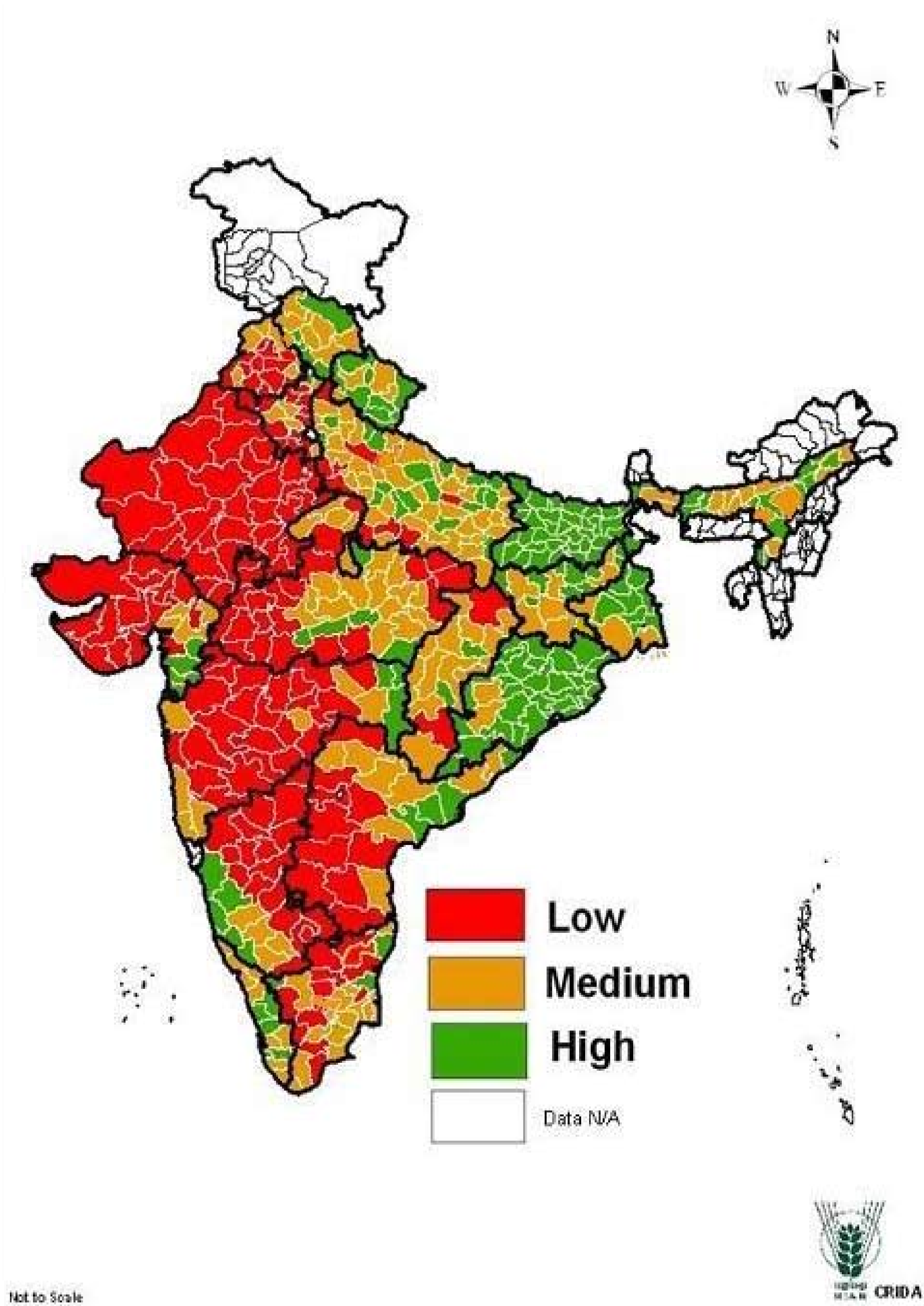


Fig. 3.8 Status of natural resources based on NRI

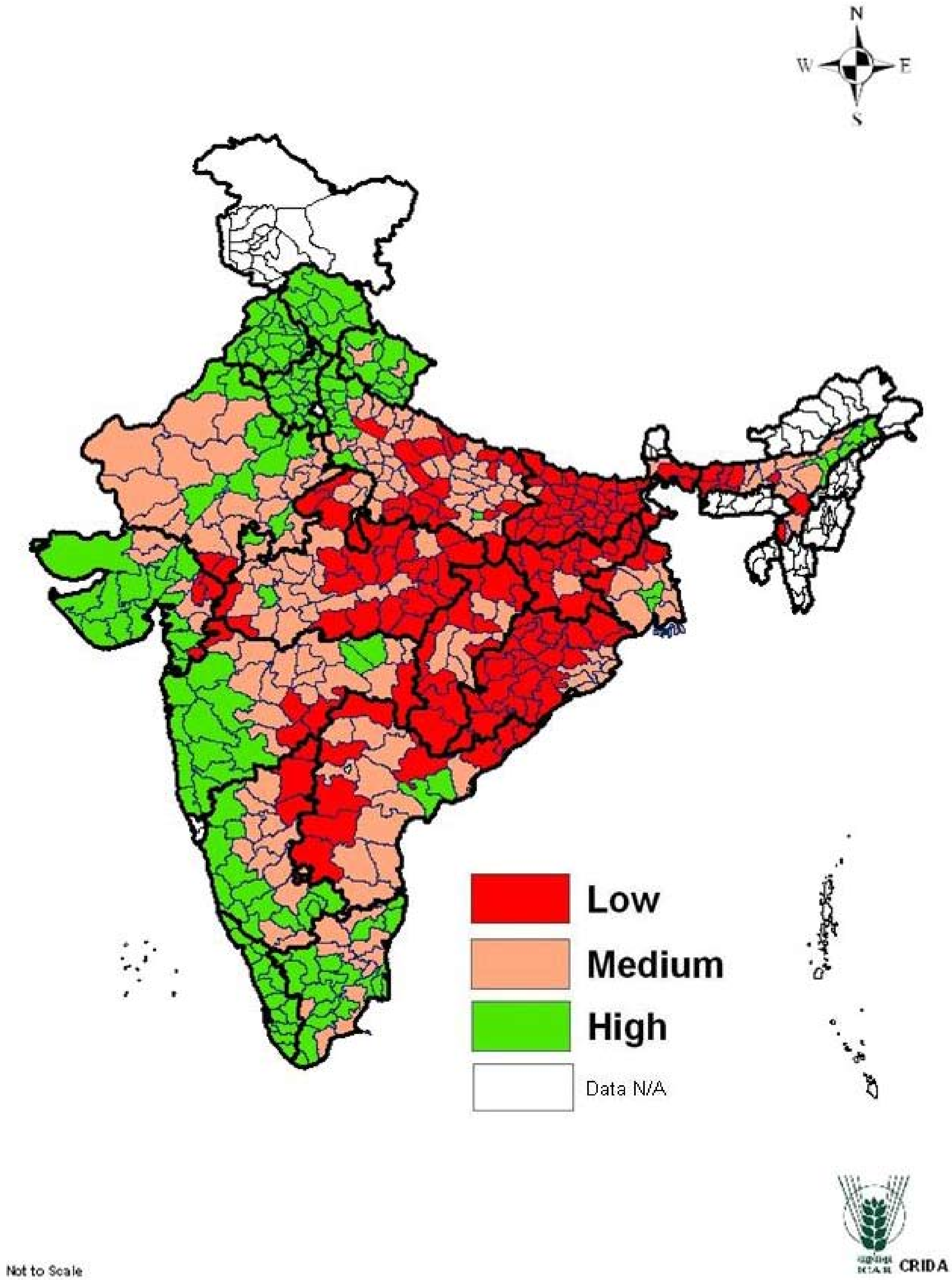


Fig. 3.9 Socio-economic status

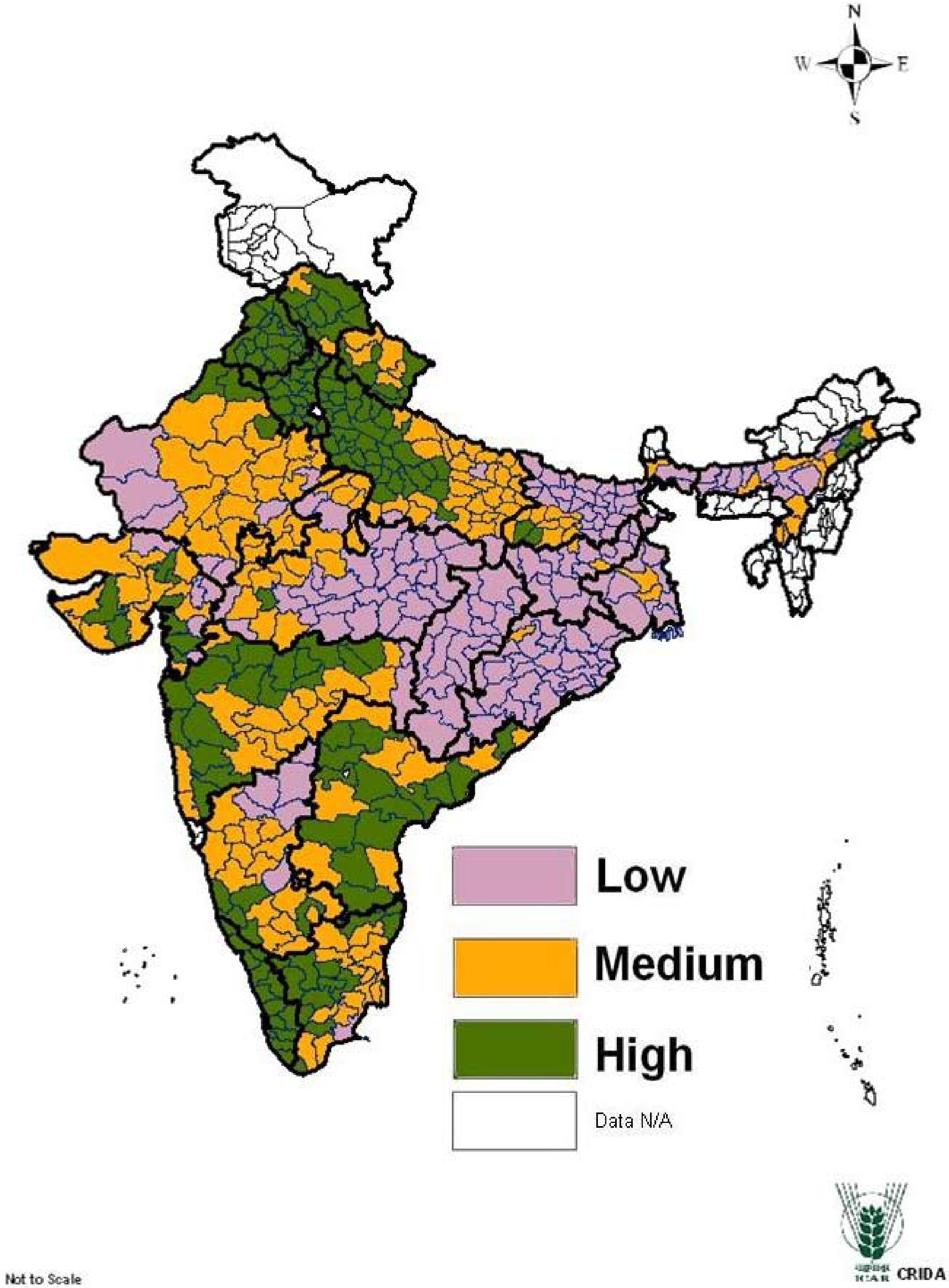


Fig. 3.10 Status of health and sanitation

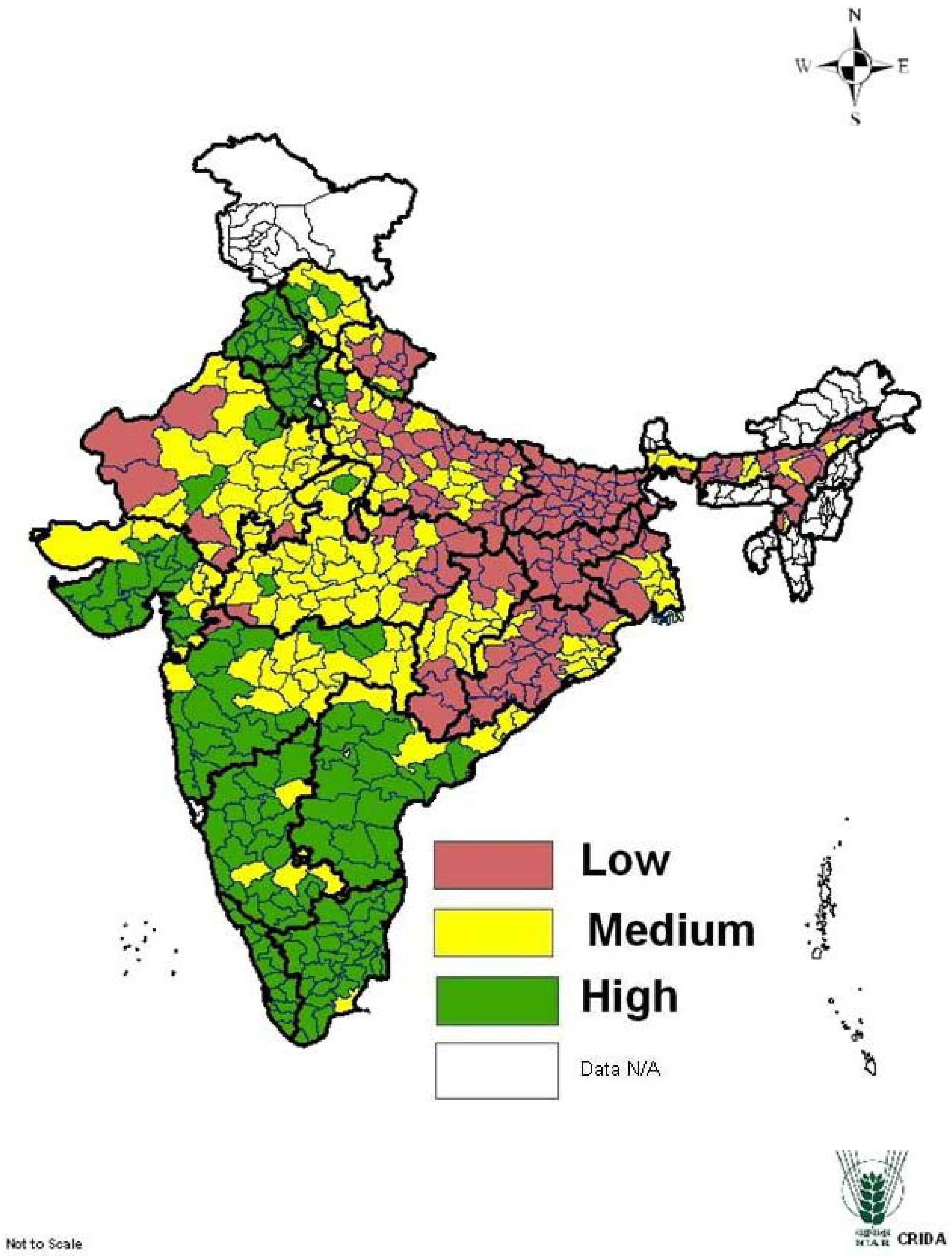


Fig. 3.11 Status of infrastructure

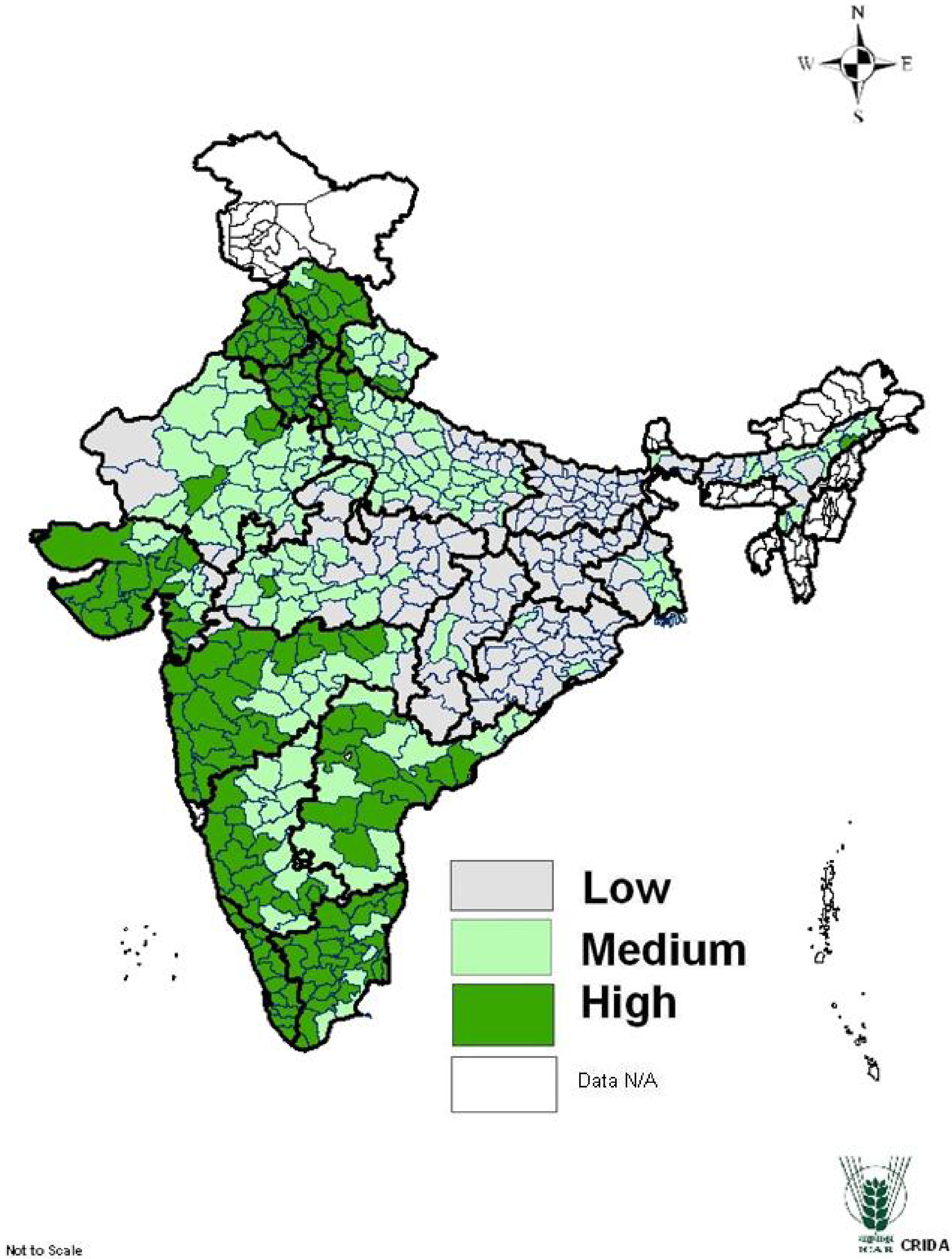


Fig. 3.12 Status of livelihoods based on ILI

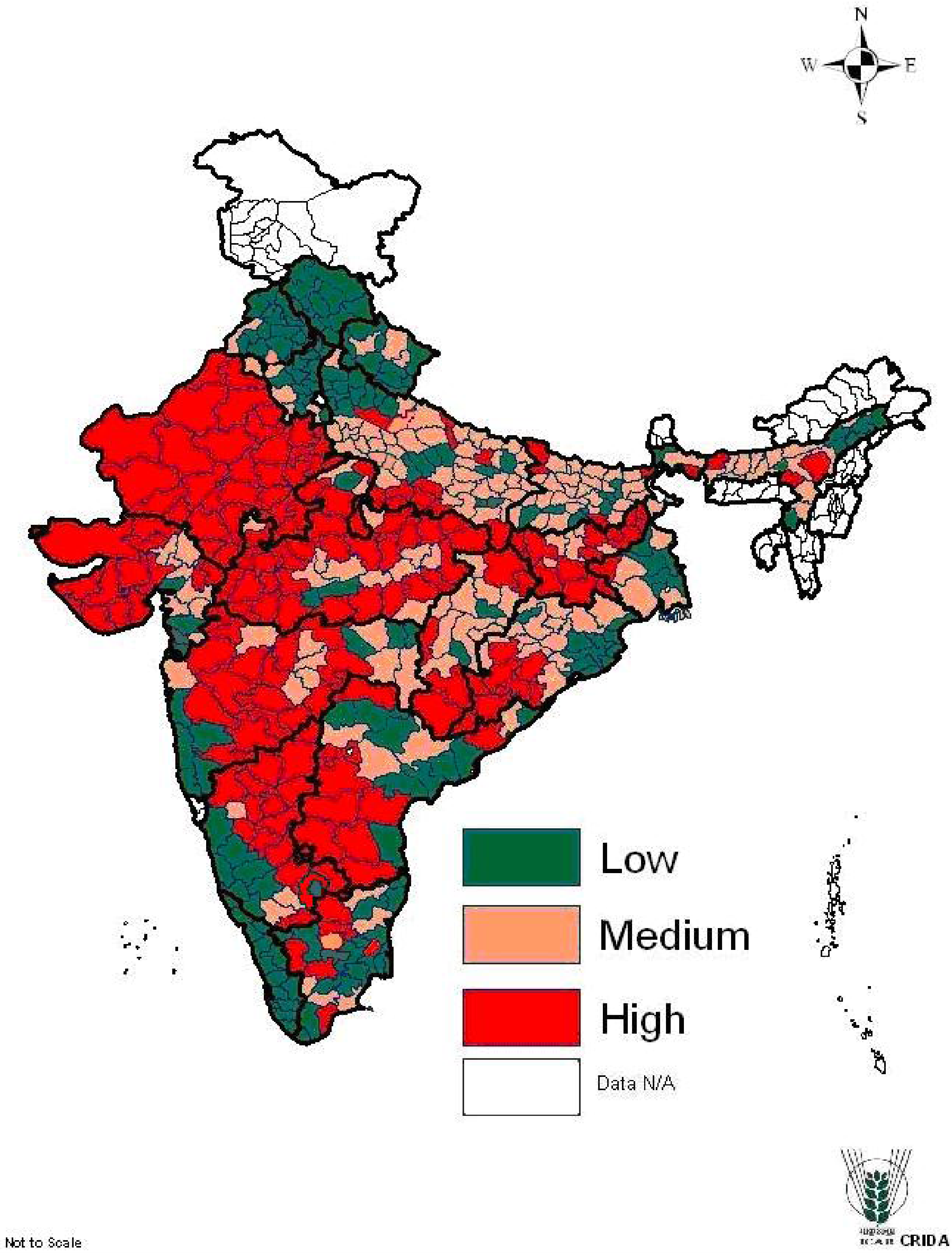


Fig. 3.13 Priority status based on RAPI

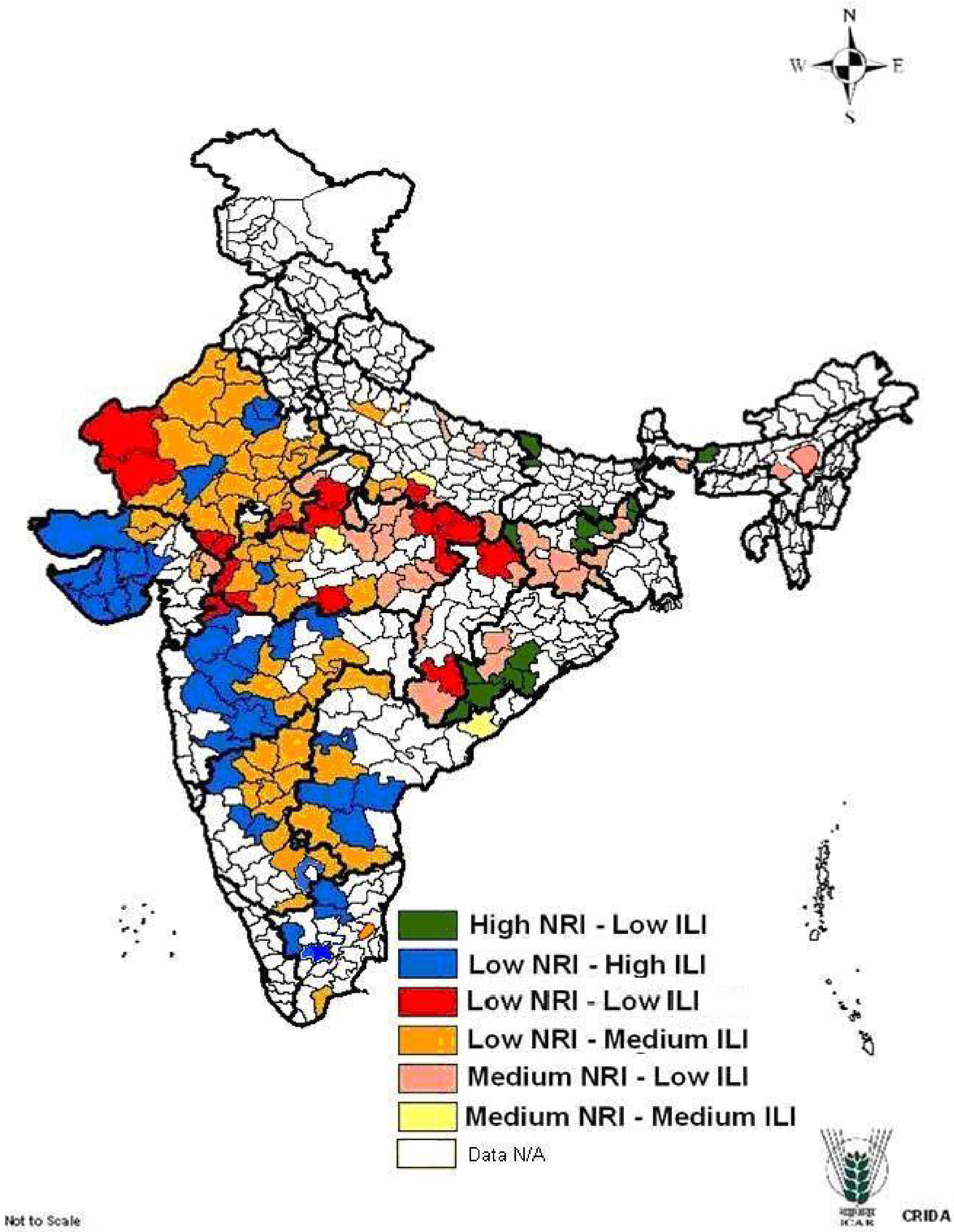


Fig. 3.14 Status of natural resources and livelihoods in high priority districts

4. PRODUCTIVITY ENHANCEMENT OF MAJOR RAINFED CROPS IN PRIORITIZED DISTRICTS

4.1 Introduction

As stated earlier the National Agricultural Technology Project (NATP) identified five major production systems viz., coarse cereals based, groundnut based, rainfed rice based, cotton based and soybean based production systems based on soil, climate and cropping pattern for identifying technologies to enhance productivity. The current approach not only accounts for the production systems but also major rainfed crop of each prioritized district. The prioritized districts based on RAPI were further characterized in terms of cultivation of different rainfed crops, their area, production and productivity. For each district crop-wise rainfed area was derived by subtracting the irrigated area from the total area cultivated under the crop. Mostly the data correspond to average of 2004-05, 2005-06 and 2006-07. Data on crop-wise area sown, production and area under irrigation were gathered from multiple sources, viz., Department of Agriculture and Cooperation, GoI, Agricultural Census, GoI, CRIDA-ICRISAT database, CMIE database (Mumbai, India), State Bureaus/ Directorates of Economics and Statistics, State Planning Departments through State government websites, District websites and correspondence. All the crops grown in a district were arranged in descending order of rainfed area and the uppermost crop was identified as major rainfed crop of the district.

Productivity of the major rainfed crop in each prioritized district (167 nos.) has been derived by dividing the total production by total area sown, which is inclusive of irrigated area. Major interventions were suggested based on level of productivity in relation to natural resource and livelihood indices.

4.2 Rainfed Rice Production System

All the major rainfed rice growing districts fall under the category of low integrated livelihood index (ILI) indicating association of rainfed rice area with poverty and backwardness. Most of these districts are, however, blessed with medium to high natural resources (NRI) reflecting under-utilization of available resources. Of the 167 top priority districts, there are 44 rainfed rice growing districts that fall mainly in the Central, Eastern and North-Eastern regions of India in the states of Madhya Pradesh (8), Jharkhand (12), Chhattisgarh (5), Orissa (8), Bihar (4), Assam (2), West Bengal (2) and Uttar Pradesh (3).

Of the total area of 55.13 lakh ha under 44 districts growing rice, only four districts (8%

area) possess high productivity (>2.0 t ha^{-1}) followed by 24 districts (54% area) exhibiting medium productivity (1 -2 t ha^{-1}), while the rest 16 districts (38%) are in low category (<1.0 t ha^{-1}) (**Table 4.1, Fig. 4.1**). Districts having low productivity are mostly confined to Madhya Pradesh (8), Chhattisgarh (3), Orissa (2) and the remaining three are one each in Bihar (Champaran West), UP (Sonbahdra) and Jharkhand (Gadhwa).

As all the above districts fall under the category of low ILI, therefore, there is an immediate need of improving socio-economic condition and infrastructure as the area is rich in natural resources. There is ample scope for integrated farming systems approach of rice-fish-duck/piggery by allocating 10% area to on-farm reservoirs (OFRs). Rainwater harvested in OFRs can be made use for rearing of fish and duck and also for supplemental irrigation to paddy during dry spells. National Agricultural Technology Project (NATP), clearly demonstrated usefulness of on-farm reservoirs (OFRs) in the States of Jharkhand, Chhattisgarh and Orissa and the farmers could realize an additional income of Rs. 8,000 to 10,000/- per hectare. Apart from above the following interventions may be planned and facilitated, which are highlighted in the **Table 4.2**.

Table 4.1: Relationship between NRI, ILI and rice productivity in rainfed districts of India

NRI	ILI	Name of the State	Name of the district	Productivity*
Low	**Low**	CG	Sarguja	L
		CG	Bastar	M
		MP	Rewa	L
		MP	Satna	L
		MP	Shahdol	L
		MP	Sidhi	L
Medium	**Low**	Assam	Karbi-Anglong	M
		CG	Jashpur	L
		CG	Raj Nandgaon	M
		CG	Dantiwara	L
		Jharkhand	Dumka	M
		Jharkhand	Ranchi	M
		Jharkhand	Gumla	M
		Jharkhand	West Singbhum	M
		Jharkhand	East Singbhum	M
		Jharkhand	Palamu	M
		Jharkhand	Godda	H
		MP	Dindori	L
		MP	Seoni	L
		MP	Mandla	L
		MP	Panna	L
		Orissa	Bolangir	L
		Orissa	Kalahandi	L
		UP	Bahraich	M
		UP	Basti	M
		UP	Sonbhadra	L
		W. Bengal	Cooch Behar	M
		W. Bengal	Purulia	H

High	**Low**	Assam	Kokrajhar	M
		Bihar	Champaran(West)	L
		Bihar	Gopalganj	M
		Bihar	Jamui	M
		Bihar	Kishanganj	M
		Jharkhand	Girdih	H
		Jharkhand	Gadhwa	L
		Jharkhand	Devgarh	H
		Jharkhand	Sahebganj	M
		Jharkhand	Pakud	M
		Jharkhand	Bokaro	M
		Orissa	Gajapati	M
		Orissa	Phulbani (Kandhamal)	M
		Orissa	Rayagada	M
		Orissa	Nawarangpur	M
		Orissa	Malkangiri	M

* L = <1.0 t ha^{-1} M = 1.0 – 2.0 t ha^{-1} H = > 2.0 t ha^{-1}

Table 4.2: Interventions based on NRI, ILI and productivity – Rainfed rice

NRI	ILI	Productivity	Interventions
L	L	L	Crop diversification and alternatives to paddy
		M	Promotion of improved varieties of rice in the Bastar region and on-farm reservoirs (OFRs)
M	L	L	Improved varieties along with INM
		M	Improved varieties along with INM and IPM
		H	All the above plus suitable infrastructure for storage and market support services
H	L	L	Diversified farming system as area is rich in natural resource
		M	Improved varieties and site-specific nutrient management (SSNM) to realize the full potential
		H	SSNM and OFR for sustaining and improving the productivity

4.3 Sorghum Production System

There are 27 districts with major rainfed crop as sorghum and are mostly confined to few States namely Madhya Pradesh, Maharashtra, Karnataka, Rajasthan, Tamil Nadu and Andhra Pradesh. Sorghum is mostly restricted to districts having low NRI but associated with low to high livelihood indices. Only three districts fall under the category of low ILI, while 14 and 10 under medium and high category, respectively (**Table 4.3**). The productivity is as low as 0.23 t ha^{-1} to as high as 1.3 t ha^{-1} indicating variation and high yield gaps (**Fig. 4.2)**. The total area under 27 districts growing sorghum is 47.23 lakh ha, of that 46.3% is under low productivity (<0.5 t ha^{-1}), 42.7% area under medium productivity (0.5-1.0 t ha^{-1}) and the rest 11% area under high category (>1.0 t ha^{-1}).

As sorghum is grown in areas having poor natural resources (NRs), there is a need for improving NRs through effective soil and water conservation measures. Maharashtra and Karnataka account for substantial area and it is mostly under *rabi* sorghum. The area under

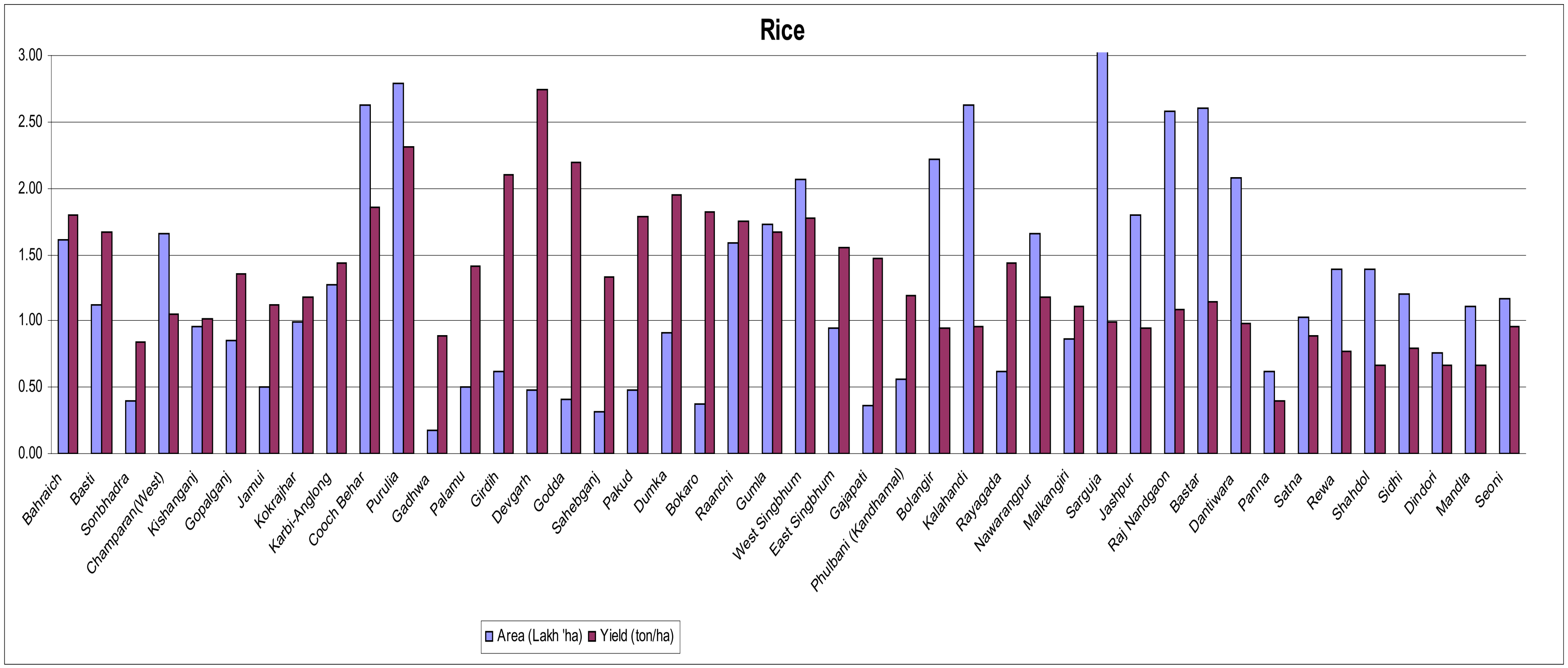


Fig. 4.1. Area and productivity in prioritized districts having rice as a major rainfed crop

kharif sorghum has declined drastically while there is no change in case of *rabi* sorghum because of good patronage by people as quality is superior. *Kharif* sorghum mostly suffers from late rains at the time of harvest and quality gets affected. The area of *kharif* sorghum is lost mostly to other crops mainly cotton and soybean. Additional efforts are needed to improve the yield of *rabi* sorghum through improved soil and water conservation measures, support services and price mechanism. Other specific interventions based on NRI, ILI and productivity are set out in **Table 4.4**.

Table 4.3: Relationship between NRI, ILI and sorghum productivity in rainfed districts of India

NRI	ILI	Name of the State	Name of the district	Productivity*
Low	Low	MP	Barwani	M
		MP	Betul	H
		Maharashtra	Nandurbar	H
Low	medium	MP	Rajgarh	M
		Rajasthan	Ajmer	L
		Rajasthan	Tonk	L
		Rajasthan	Kota	H
		Maharashtra	Jalna	M
		Maharashtra	Beed	M
		Maharashtra	Latur	H
		Maharashtra	Bagalkot	M
		Maharashtra	Bijapur	M
		Karnataka	Bidar	H
		Karnataka	Raichur	M
		Karnataka	Gadag	L
		Karnataka	Bellary	H
		Karnataka	Chamrajnagar	M
Low	High	Maharashtra	Aurangabad	M
		Maharashtra	Pune	L
		Maharashtra	Ahmednagar	L
		Maharashtra	Osmanabad	M
		Maharashtra	Solapur	L
		Maharashtra	Sangli	L
		Andhra Pradesh	Ranga Reddy	H
		Karnataka	Belgaum	M
		Tamil Nadu	Coimbatore	L
		Tamil Nadu	Dindigul	M

* L = <0.5 t ha^{-1} M = 0.5 – 1.0 t ha^{-1} H = > 1.0 t ha^{-1}

Table 4.4: Interventions based on NRI, ILI and productivity- sorghum

NRI	ILI	Productivity	Interventions
L	L	M	Improved varieties of sorghum plus INM, integration with livestock
		H	Farm mechanization and post-harvest infrastructure for realizing higher income
L	M	L	Alternative to sorghum, mainly pearl millet
		M	In-situ and ex-situ water conservation measures plus INM
		H	Incentives to the farmers, creation of storage facilities and procurement at large scale for supply under PDS
L	H	L	Soil and water conservation measures for enhancing productivity, compartmental bunding and ridge and furrow planting in *rabi*-sorghum growing areas, recycling of tank silt, mulching, etc.
		M	Farm mechanization for timely seeding and weed control through custom hiring
		H	Improved infrastructure for supply of inputs and procurement of output

4.4 Pearl millet (bajra) Production System

There are 25 districts having major rainfed area under bajra and are mostly confined to few States namely Rajasthan (17), Gujarat (3), Maharashtra (2) and one each in Madhya Pradesh, Karnataka and Tamil Nadu. Bajra is mostly restricted to districts having low NRI with an exception of one district from Madhya Pradesh having medium NRI (Sheopur Kalan). Districts growing bajra are associated with low to high livelihood indices. Only three districts fall under the category of low ILI, while 16 and 6 are under medium and high category, respectively (**Table 4.5**). This means in these districts people have already diversified and major portion of their income is derived from other sources, particularly livestock. The productivity is as low as 0.29 t ha^{-1} to as high as 1.95 t ha^{-1} (**Fig. 4.3**), indicating high variation and scope for improvement by technology adoption in low productivity

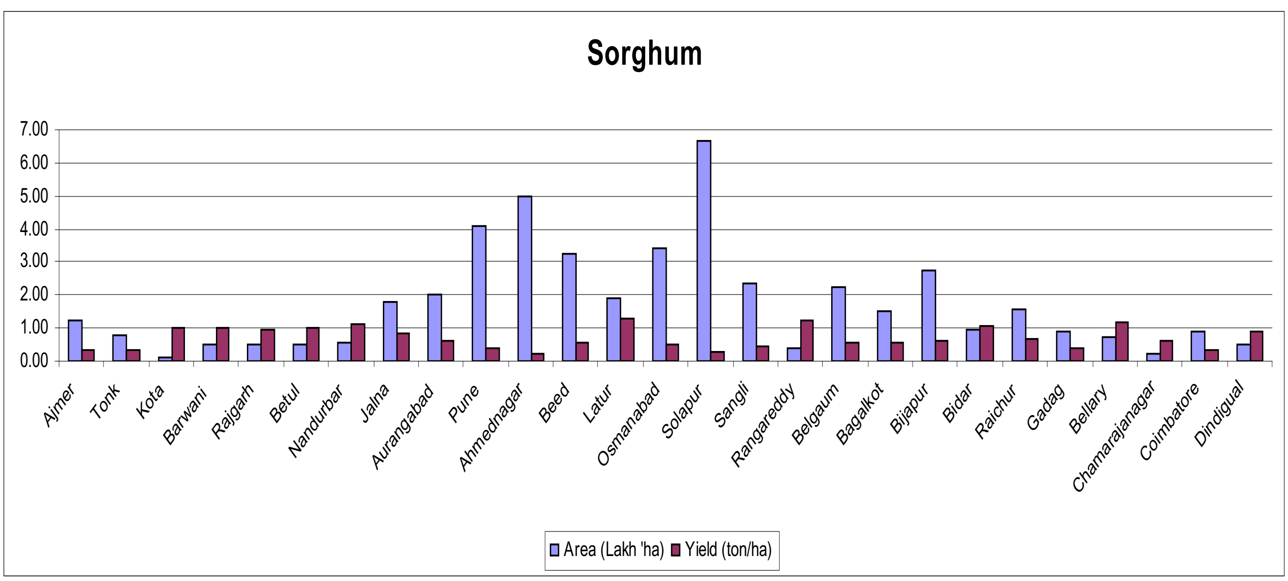


Fig. 4.2 Area and productivity in prioritized districts having sorghum as a major rainfed crop

district. The total area under 25 districts growing pearl millet is 53.72 lakh ha, of that 26.7% is under low productivity (<0.6 t ha^{-1}), 57.4% area under medium productivity (0.6-1.2 t ha^{-1}) while the remaining 15.9% area is under high category (>1.2 t ha^{-1}).

As the bajra is grown in areas having poor NRs, there is a need for improving NRs through effective soil and water conservation measures. Rajasthan accounts for large number of districts and substantial area under bajra, which receives very low rainfall. Therefore, *in-situ* soil and moisture conservation measures and farm mechanization hold the key along with efficient support services. Specific interventions based on NRI, ILI and productivity are set out in **Table 4.6**.

Table 4.5: Relationship between NRI, ILI and bajra productivity in rainfed districts of India

NRI	ILI	Name of the State	Name of the district	Productivity*
Low	Low	Rajasthan	Jaisalmer	L
		Rajasthan	Barmer	L
Low	Medium	Rajasthan	Bikaner	M
		Rajasthan	Churu	L
		Rajasthan	Alwar	H
		Rajasthan	Bharatpur	M
		Rajasthan	Dholpur	H
		Rajasthan	Karauli	H
		Rajasthan	Sawai Madhapur	H
		Rajasthan	Dausa	H
		Rajasthan	Jaipur	H
		Rajasthan	Nagaur	M
		Rajasthan	Jodhpur	M
		Rajasthan	Jalore	M
		Gujarat	Banaskanta	M
		Gujarat	Patan	M
		Karnataka	Koppal	L
		Tamil Nadu	Thoothukudi	H
Low	High	Rajasthan	Jhunjunu	M
		Rajasthan	Sikar	M
		Rajasthan	Pali	M
		Gujarat	Kutch	M
		Maharashtra	Dhule	M
		Maharashtra	Nasik	M
Medium	Low	MP	Sheopur Kalan	M

* L = <0.6 t ha^{-1} M = 0.6 – 1.2 t ha^{-1} H = > 1.2 t ha^{-1}

Table 4.6: Interventions based on NRI, ILI and productivity - bajra

NRI	ILI	Productivity	Interventions
L	L	L	Silvipasture management and integration with sheep, arid horticulture, particularly *'ber'* with provision of supplemental irrigation through drip
L	M	L	Agri-horti system with *ber* and other arid fruits with provision of supplemental irrigation through drip
		M	Improved seed, INM and in-situ soil moisture conservation measures
		H	SSNM and farm mechanization
L	H	M	SSNM and farm mechanization
M	L	M	Intercropping of bajra with pigeon pea as NR is good

4.5 Maize Production System

There are 20 districts having major area under maize and are mostly confined to Rajasthan (10), Madhya Pradesh (6), Gujarat (2) and Karnataka (2). Rainfed maize is mostly cultivated in districts having low NRI with the exception of Dahod in Gujarat with medium NRI. Districts growing maize are associated with low to high ILI. Only five districts fall under the category of low ILI, while 13 and 2 are under medium and high category, respectively (**Table 4.7**). The productivity is as low as 0.89 t ha^{-1} to as high as 2.53 t ha^{-1} (**Fig. 4.4**), indicating large variation and scope for productivity enhancement. The total area under 20 districts growing maize is 18.4 lakh ha, of that 5.6% is under low productivity (<1. t ha^{-1}), 72.4% area under medium productivity (1.0 - 2.0 t ha^{-1}) and the rest 22% under high category (>2.0 t ha^{-1}).

Rajasthan accounts for large number of districts, which receive low rainfall compared to Madhya Pradesh. Productivity is better in MP than in Rajasthan due to better NRs, however in Southern Rajasthan large area is under rainfed maize and it is staple diet of the region. Maize is responsive to management and inputs as it is grown mostly in districts with poor NRs. There is a need for improving NRs through effective soil and water conservation measures. Therefore, *in-situ* soil and moisture conservation, water harvesting for supplemental irrigation and farm mechanization hold the key here. Specific interventions based on NRI, ILI and productivity are set out in **Table 4.8**. Other options for enhancing profitability in maize growing areas need to be explored through processing and value addition.

Table 4.7: Relationship between NRI, ILI and maize productivity in rainfed districts of India

NRI	ILI	Name of the State	Name of the district	Productivity*
Low	Low	MP	Jhabua	M
		Rajasthan	Jhalawar	M
		Rajasthan	Dungarpur	L
		Rajasthan	Banswara	M
Low	medium	Gujarat	Panchmahal	M
		MP	Shajapur	M
		MP	Ratlam	H

		MP	Mandsaur	H
		MP	Dhar	H
		MP	Chhindwara	H
		Rajasthan	Udaipur	M
		Rajasthan	Sirohi	L
		Rajasthan	Rajsamand	M
		Rajasthan	Chittorgarh	M
		Rajasthan	Bundi	M
		Rajasthan	Bhilwara	M
		Rajasthan	Baran	M
Low	High	Karnataka	Haveri	M
		Karnataka	Davanagere	H
Médium	Low	Gujarat	Dahod	M

* L = <1.0 t ha^{-1} M = 1.0 – 2.0 t ha^{-1} H = > 2.0 t ha^{-1}

Table 4.8: Interventions based on NRI, ILI and productivity – maize

NRI	ILI	Productivity	Interventions
L	L	M	Improved varieties, seed treatment, seed priming, ridge and furrow planting, improved seeding devices, soil and water conservation measures, integrated farming systems approach
L	M	L	*In-situ* soil and moisture conservation measures, improved varieties, weed control and nutrient management
		M	All the above plus intercropping of maize with blackgram (2:2)
		H	Ridge and furrow making, use of herbicides for weed control, intercropping of maize with soybean (2:6)
M	L	M	Sowing across the slope, improved varieties, nutrient management.

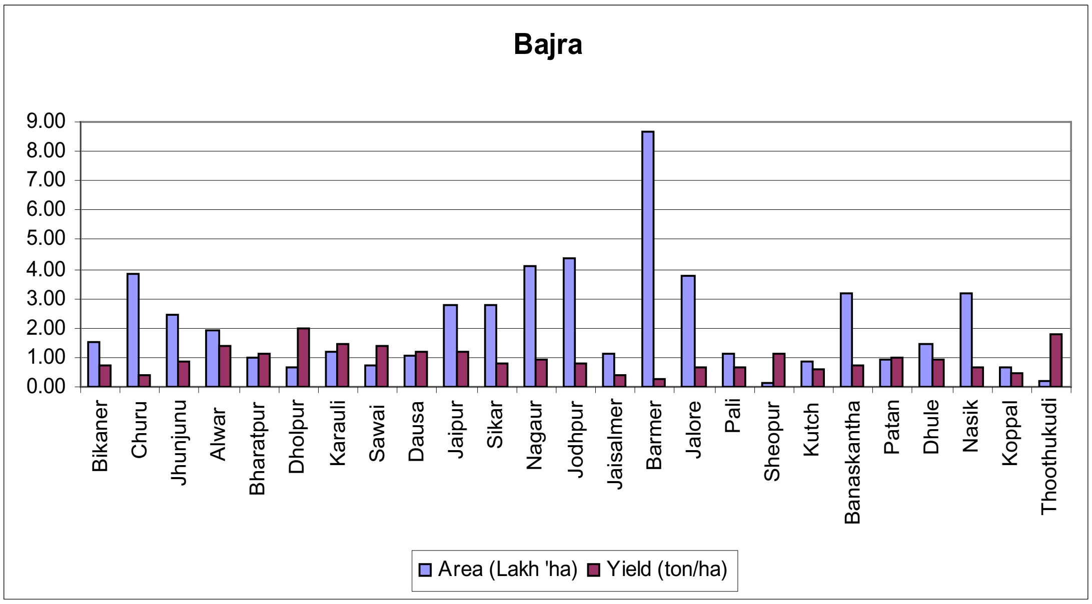


Fig. 4.3 Area and productivity in prioritized districts having bajra as a major rainfed crop

4.6 Ragi Production System

There are only six districts having large area under ragi and concentrated in Karnataka (3) and one each in AP, Tamil Nadu and Orissa. Like other millets, ragi is also cultivated mostly in districts having low NRs with the exception of Koraput and Vishakapatnam. The rural areas of these two districts are inhabited by mostly tribals and possess highly undulating topography. Out of six districts only one falls under the category of low ILI, while three and two are under medium and high category, respectively (**Table 4.9**). The productivity is as low as 0.62 t ha^{-1} to as high as 1.86 t ha^{-1} (**Fig. 4.5**). The total area under six districts growing ragi is 5.68 lakh ha, of that 12.5% area is under low productivity (<0.75 t ha^{-1}), 65.3% area under medium productivity (0.75-1.5 t ha^{-1}) and the rest 22.2% under high category (>1.5 t ha^{-1}).

Karnataka accounts for large area under ragi and is mostly cultivated in areas receiving low rainfall and has high productivity compared to Andhra Pradesh or Orissa having high rainfall but low productivity. Ragi is staple food in Karnataka while it is consumed mostly by tribals in other States. As ragi is confined to areas having poor NRs in Karnataka and Tamil Nadu, thus, there is a need for improving NRs through effective soil and water conservation measures for productivity enhancement besides other measures listed in **Table 4.10**.

Table 4.9: Relationship between NRI, ILI and ragi productivity in rainfed districts of India

NRI	ILI	Name of the State	Name of the district	Productivity*
Low	Medium	Karnataka	Tumkur	M
		Karnataka	Kolar	M
Low	High	Karnataka	Bangalore (rural)	H
		Tamil Nadu	Dharmapuri	H
Medium	Medium	AP	Vishakapatnam	M
High	Low	Orissa	Koraput	L

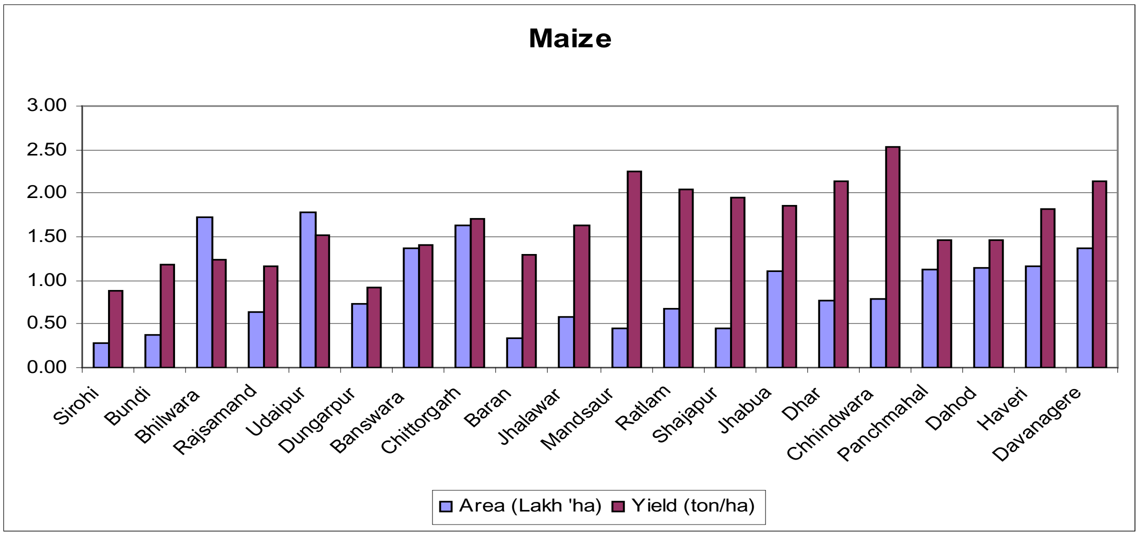


Fig. 4.4. Area and productivity in prioritized districts having maize as a major rainfed crop

* L = <0.75 t ha^{-1} M = 0.75 – 1.50 t ha^{-1} H = > 1.5 t ha^{-1}

Table 4.10: Interventions based on NRI, ILI and productivity - Ragi

NRI	ILI	Productivity	Interventions
L	L	M	Improved varieties, in-situ soil moisture conservation measure, silt application. Integrated farming systems approach, intercropping of ragi with pigeonpea in 3:2 ratio
	H	M	Improved varieties, in-situ soil moisture conservation measure, nutrient management, silt application, intercropping of ragi with pigeonpea in 3:2 row ratio
		H	Farm mechanization for seeding, weeding and SSNM
		M	Sowing across the slope, improved varieties, intercropping of ragi with pigeonpea in row 3:2 ratio
		H	Ridge and furrow making, use of herbicides for weed control, intercropping of ragi with pigeonpea in 3:2 row ratio
M	M	M	Sowing across the slope, improved varieties, nutrient management, intercropping of ragi with pigeonpea in 3:2 row ratio.
H	L	L	Sowing across the slope, improved varieties, nutrient management.

4.7 Groundnut Production System

There are only 13 districts having large area under groundnut and concentrated in few States namely Gujarat (6), AP (4) and one in each MP, Karnataka and Tamil Nadu. Like millets, groundnut is also cultivated mostly in districts having low NRs but with medium to high ILI with an exception of Shivpuri (**Table 4.11**). The productivity is as low as 0.46 t ha^{-1} to as high as 1.21 t ha^{-1} (**Fig. 4.6**), indicating wide variability. The total area under 13 districts growing groundnut is 32.44 lakh ha, of that 24.8% area is under low productivity (<0.5 t ha^{-1}), 59.9% area under medium productivity (0.5-1.0 t ha^{-1}) and the rest 15.3% under high category (>1.0 t ha^{-1}).

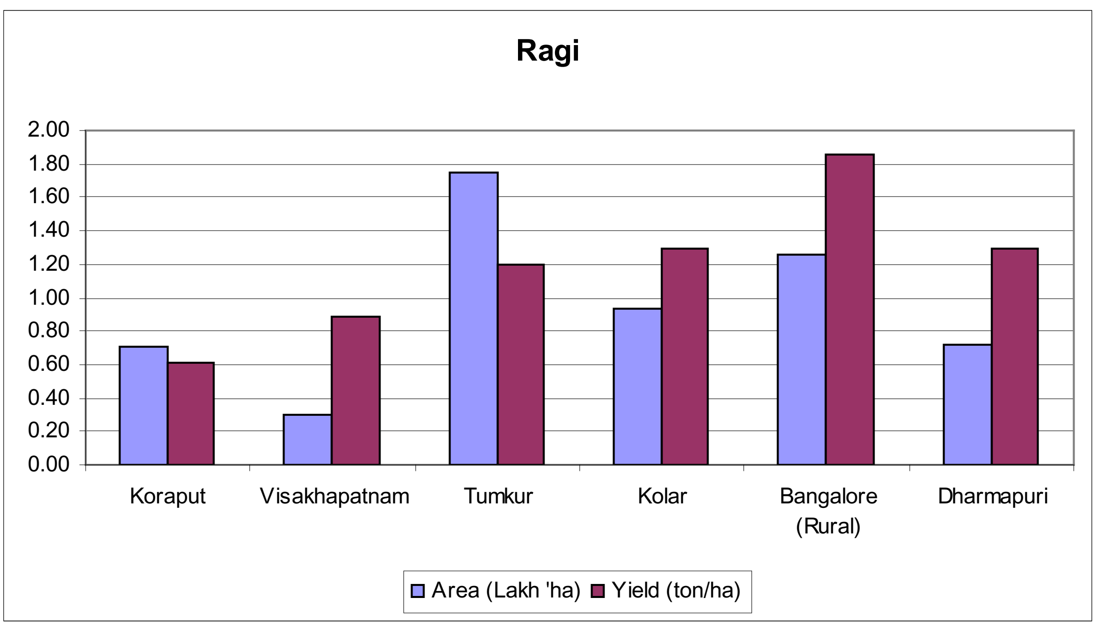


Fig. 4.5. Area and productivity in prioritized districts having ragi as a major rainfed crop

The scope for productivity enhancement is high through site specific nutrient management (SSNM) as most sites are showing deficiency symptoms for nutrients like boron, zinc and sulphur and excess of phosphorus. Anantapur in Andhra Pradesh while Jamnagar and Junagadh in Gujarat account for large areas receiving low to medium rainfall, thus effective soil and water conservation measures and supplemental irrigation from harvested rainwater from farm ponds are also equally important for productivity enhancement besides other measures as set out in **Table 4.12**.

Table 4.11: Relationship between NRI, ILI and groundnut productivity in rainfed districts of India

NRI	ILI	Name of the State	Name of the district	Productivity*
Low	Low	MP	Shivpuri	H
	Medium	AP	Anantapur	M
		AP	Chittoor	M
		Karnataka	Chitradurga	M
	High	Gujarat	Rajkot	L
		Gujarat	Jamnagar	L
		Gujarat	Porbander	H
		Gujarat	Junagadh	H
		Gujarat	Amreli	M
		Gujarat	Bhavanagar	M
		AP	Cuddapah	M
		AP	Kurnool	M
		Tamil Nadu	Salem	H

* L = <0.5 t ha^{-1} M = 0.5 – 1.0 t ha^{-1} H = > 1.0 t ha^{-1}

Table 4.12: Interventions based on NRI, ILI and productivity - groundnut

NRI	ILI	Productivity	Interventions
L	L	H	Improved infrastructure and support services for realizing better returns as productivity is high even NRI and ILI is poor. Integrated farming systems approach with focus on small ruminants.
	M	M	Improved varieties, seed treatment, provision of village seed bank, in-situ soil moisture conservation measures, SSNM, intercropping with pigeon pea
	H	L	Improved varieties, farm mechanization and weed control, SSNM, intercropping of cotton+groundnut in 1:2 ratio
		H	Improved varieties, SSNM and provision for supplemental irrigation, intercropping of groundnut + sesamum in 2:1 ratio
		M	Production of seeds of improved varieties for meeting the demand of the country by providing needed mechanism for realizing higher income by the farmers

4.8 Cotton Production System

There are only nine districts having large area under cotton and concentrated in four States namely Maharashtra (4), Gujarat (2), MP (2) and AP (1). All these districts fall under the

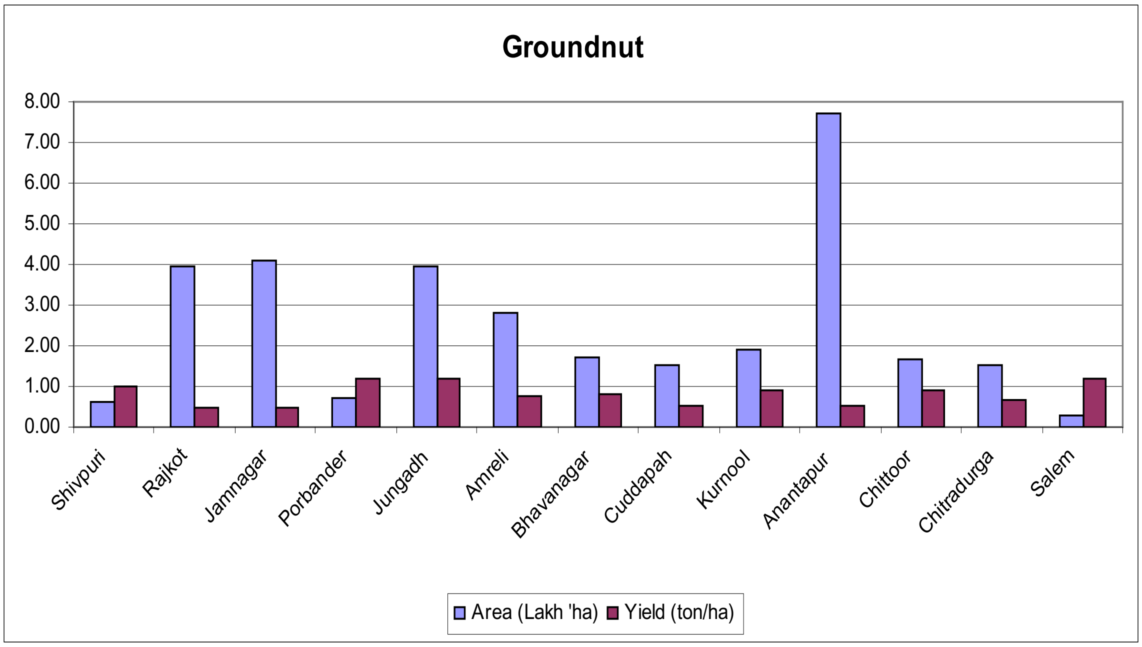


Fig. 4.6 Area and productivity in prioritized districts having groundnut as a major rainfed crop

category of low NRs but with medium to high ILI (**Table 4.13**). The soil depth is low and full potential of Bt. cotton is not realized here due to moisture stress. The productivity of cotton lint is as low as 0.11 t ha^{-1} to as high as 0.28 t ha^{-1} (**Fig. 4.7**). The total area under nine districts growing cotton is 21.09 lakh ha, of that 36.9% area is under low productivity (<0.15 t ha^{-1}), 34.0% area under medium productivity (0.15-0.25 t ha^{-1}) and the rest 29.1% under high category (>0.25 t ha^{-1}).

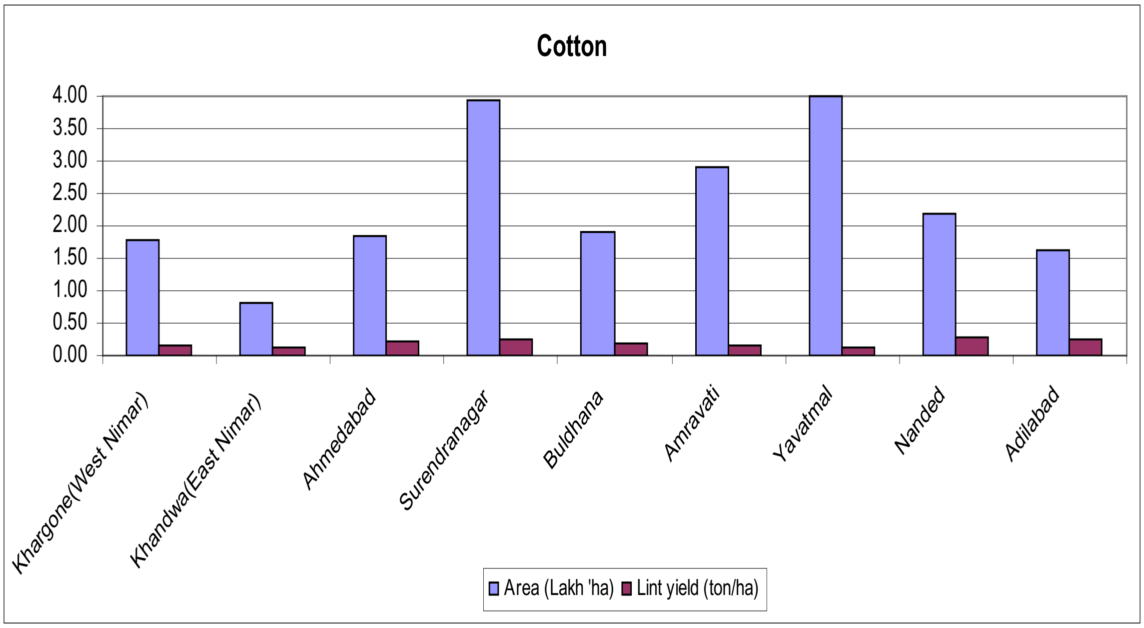


Fig. 4.7 Area and productivity in prioritized districts having cotton as a major rainfed crop

Table 4.13: Relationship between NRI, ILI and cotton lint productivity in rainfed districts of India

NRI	ILI	Name of the State	Name of the district	Productivity*
Low	Medium	AP	Adilabad	M
		Maharashtra	Yavatmal	L
		Maharashtra	Nanded	M
		MP	Khargone (West)	M
		MP	Khandwa	L
	High	Gujarat	Ahmedabad	M
		Gujarat	Surendranagar	H
		Maharashtra	Buldhana	M
		Maharashtra	Amaravati	L

L = <0.15 t ha^{-1} M = 0.15 – 0.25 t ha^{-1} H = $>$ 0.25 t ha^{-1}

There is a high scope for productivity enhancement through site-specific nutrient and water management (SSNM) as most sites are showing deficiency symptoms for nutrients like boron, zinc and sulphur. Surendranagar in Gujarat and Yavatmal in Maharashtra account for large areas receiving medium amount of rainfall, thus effective soil amelioration and moisture conservation measures are important for productivity enhancement as it is long duration crop besides other measures as set out in **Table 4.14**.

Table 4.14: Interventions based on NRI, ILI and productivity -cotton

NRI	ILI	Productivity	Interventions
Low	Medium	L	Rainwater harvesting and recycling for supplemental irrigation and balanced fertilization
		M	In-situ and ex-situ water conservation and SSNM, intercropping of cotton+groundnut in 1:2 ratio
		H	Need based infrastructure and creation of storage facilities
	High	L	Improved varieties, farm mechanization and weed control, SSNM
		M	Improved varieties, SSNM and provision for supplemental irrigation.
		H	Provision of storage and soft loan for realizing higher price by the farmers

4.9 Chickpea Production System

There are 15 districts having large area under chickpea concentrated in MP (7), UP (5), Rajasthan (2) and AP (1). All these districts fall under the category of low to medium NRI and low to medium ILI except Prakasam and Indore (**Table 4.15**). Prakasam is a unique example which brought chickpea revolution in Andhra Pradesh. Here the chickpea has substituted tobacco in a decade and showed tremendous growth in area and production mainly due to varietal replacement and complete mechanization of all operations from sowing to threshing. The productivity is as low as 0.32 t ha^{-1} to as high as 1.78 t ha^{-1} **(Fig.4.8).** The total area under 15 districts growing chickpea is 14.07 lakh ha, of that 69.3% area is under low productivity ($<$0.75 t ha^{-1}), 24.7% area under medium productivity (0.75-1.5 t ha^{-1}) and the rest 6% under high category ($>$1.5 t ha^{-1}).

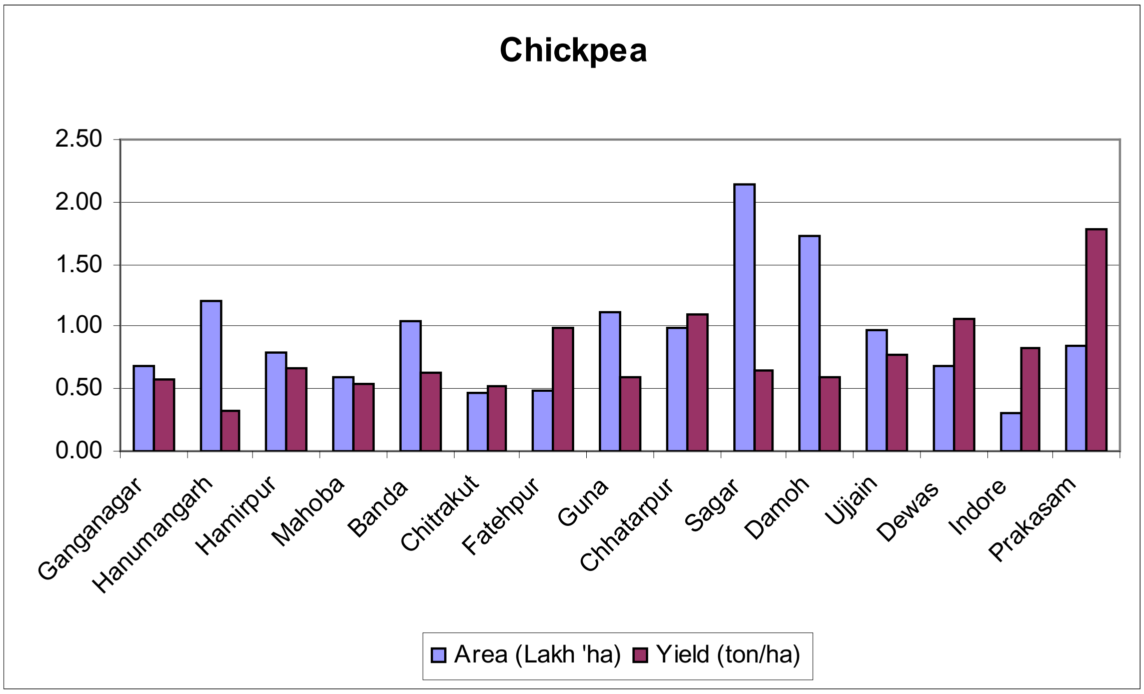


Fig. 4.8 Area and productivity in prioritized districts having chickpea as a major rainfed crop

Table 4.15: Relationship between NRI, ILI and chickpea productivity in rainfed districts of India

NRI	ILI	Name of the State	Name of the district	Productivity*
Low	Low	MP	Guna	L
		UP	Banda	L
	Medium	MP	Dewas	M
		MP	Ujjain	M
		Rajasthan	Ganganagar	L
		Rajasthan	Hanumangarh	L
		UP	Hamirpur	L
	High	AP	Prakasam	H
		MP	Indore	M
Medium	Low	MP	Chattarpur	M
		MP	Sagar	L
		MP	Damoh	L
		UP	Mahoba	L
		UP	Chitrakot	L
	Medium	UP	Fatehpur	M

L= <0.75 t ha^{-1} M = 0.75 – 1.5 t ha^{-1} H = > 1.5 t ha^{-1}

Chickpea is the major crop of Madhya Pradesh and accounts for more than fifty per cent of the total area. Chickpea is mostly grown on conserved moisture during *rabi* and one or two supplemental irrigations improve the yield by 100 per cent. Areas falling medium NRs with medium to high rainfall have scope for rainwater harvesting and recycling through farm ponds. Thus, effective soil and water conservation measures and supplemental irrigation are important for productivity enhancement besides mechanization as it is a post-monsoon rainfed crop (**Table 4.16)**.

Table 4.16: Interventions based on NRI, ILI and productivity – chickpea

NRI	ILI	Productivity	Interventions
Low	Low	L	Improved infrastructure and support services, supply of improved varieties
	Medium	L	Introduction of short duration varieties or crop substitution with lentil/ moth bean, etc. Efficient INM and IPM measures
		M	Water harvesting for supplemental irrigation in black soil areas, seed priming and treatment with *Rhizobium* and Phosphorus solubilizing bacteria (PSB), intercropping with lentil
	High	H	Farm mechanization and programme of seed multiplication of improved varieties for making the crop more remunerative.
Medium	Low	L	Water harvesting, seed priming and treatment with *Rhizobium* and Phosphorus solubilizing bacteria (PSB).
		M	Improved varieties and seed treatment and IPM measures
	Medium	M	Intercropping of chickpea with mustard as resource is good

5. LIVESTOCK-BASED INTERVENTION FOR LIVELIHOOD ENHANCEMENT

5.1 Introduction

Livestock sector provides employment to 11 million people as principal status and 8 million as subsidiary status, which is 5% of the total working population in India. Share of livestock sector contribution to the National Agricultural GDP has shown a sharp rise from 6.0% in 1970 to 26.5% in 2006. Livestock plays vital role in sustaining the livelihoods of poor in rainfed areas as they absorb shocks due to droughts.

India has about 15% of world ruminant (Cattle, Buffalo, Sheep & Goat) population with only 2.4% of world's geographical area. Recent decade saw a slow down in livestock population growth due to declining grazing lands and mechanisation of agriculture. There is also a significant change in the livestock composition with steep fall in bullocks and rise in cross-bred animals and buffaloes. As such, the livestock population is not expected to increase significantly in future, though there could be increase in number of milch animals and small ruminants. Higher small ruminant population in particular puts more pressure on the degraded grazing lands in rainfed areas. The Working Group on Animal Husbandry and Dairying of the Planning Commission in its Report (2002) projected a demand of 1170 m t of green and 650 m t of dry fodder with the corresponding availability figures at 411.3 and 488 m t, respectively. This leaves a deficit of 64.85% for green and 24.92% for dry fodder, respectively. By 2025, with significant increase in the demand for milk and other animal products, it may be necessary to devote at least double the net sown area for fodder production, which is presently around 6.15%. Cropped area under fodder production is about 11 million ha and there is no scope for expansion of fodder cultivation because of pressure on land for food and cash crops. The forest grazing area is also dwindling at a rate of 1.5 million ha per year. The grazing intensity is very high viz. 2.6 adult cattle unit (ACU) per ha in 1996 as against 0.8 ACU per ha in developed countries (Dwivedi and Ramana, 2002).

Income from livestock production accounts for 15-40 % of total farm household earnings in India (World Bank, 1999). Small ruminants is a major source of income for the poor families and their contribution ranges between 17 to 24 % of family income (Rangnekar, 2006) and provides gainful employment of 180 to 330 man-days per annum depending on the size of the flock (Misra et al., 2000). It has also been shown that irrespective of flock size, women and children contribute to labour force to the extent of about 90 % (Deoghare 1997). Hence farmers' dependence on livestock to complement their agricultural farming, as an alternative source of income, is very encouraging (Singh et al., 2004).

Among the rural development programs in rainfed areas, livestock development along with fodder production has become an essential module as it is felt as an instrument in changing livelihood status of the rural poor. The potential of livestock to reduce poverty is enormous as it contributes to the livelihoods of 19 million people, of which women constitute 71 percent (GoI, 2005). The improvement of livestock production will be important in the coming years, in view of the future demand of livestock products, which is expected to be doubled by 2020, while the natural resources that sustain livestock will become increasingly scarce, and degraded (Parthsarathy Rao et al., 2005 and Rangnekar, 2006). The expanding market for livestock products offers an opportunity for the resource-poor farmers and even for those who do not have access to land and could provide livelihoods through livestock production (FAO, 2000; Thomas and Rangnekar, 2004). However, to enable the resource-poor to take benefit of market demand, a favourable policy environment will have to be provided to improve common property resources (CPRs) besides addressing technical and socio-economic constraints.

5.2 Livestock Density

The 499 districts have been categorized into different classes (low, medium and high) based on density of small and large ruminants separately. The 33.3 and 66.6 percentiles have been used to classify them into above three groups. The livestock census (2003) data has been used.

The density classes of small ruminants for 167 prioritized districts are depicted in relation to NRI classes in **Fig. 5.1**. Of the total 167 districts 44, 62 and 61 districts fall under the category of low, medium and high density of small ruminants, respectively (**Table 5.1**). Small ruminants is the major source of livelihood for the poor but are also detrimental to natural resource because of high grazing pressure on the land. Therefore, the interventions need to be in conformity with resource base. Areas having high density with low natural resource index are prone to further degradation. Therefore, efforts may be made to reduce the density and promote alternate enterprises like dairy, poultry, apiary, fishery, etc. besides other options discussed in **Table 5.2**.

Table 5.1: Relationship between small ruminants' density and natural resources index (NRI) across selected prioritized districts of India

NRI	Small ruminants density (No./km^2)		
	Low (<35)	**Medium (35-71)**	**High (>71)**
Low	26 MP (13), Gujarat (7), (3), Chhattisgarh (2), Assam (1)	48 Rajasthan (14), Maharashtra (9), Karnataka (8), MP (6), UP (5), Gujarat (4), AP (1), Tamil Nadu (1)	44 Rajasthan (18), Karnataka (8), AP (7), Tamil Nadu (4), Maharashtra (4), MP (2), Gujarat (1)
Medium	11 MP (8), Chhattisgarh (2), UP (1)	12 UP (4), Jharkhand (3), Orissa (2), AP (1), MP (1), Chhattisgarh (1)	9 Jharkhand (4), UP (2), West Bengal (2), Gujarat (1)
High	7 Orissa (6), Assam (1)	2 Bihar (1), Jharkhand (1)	8 Jharkhand (5), Bihar (3)
Total	**44**	**62**	**61**

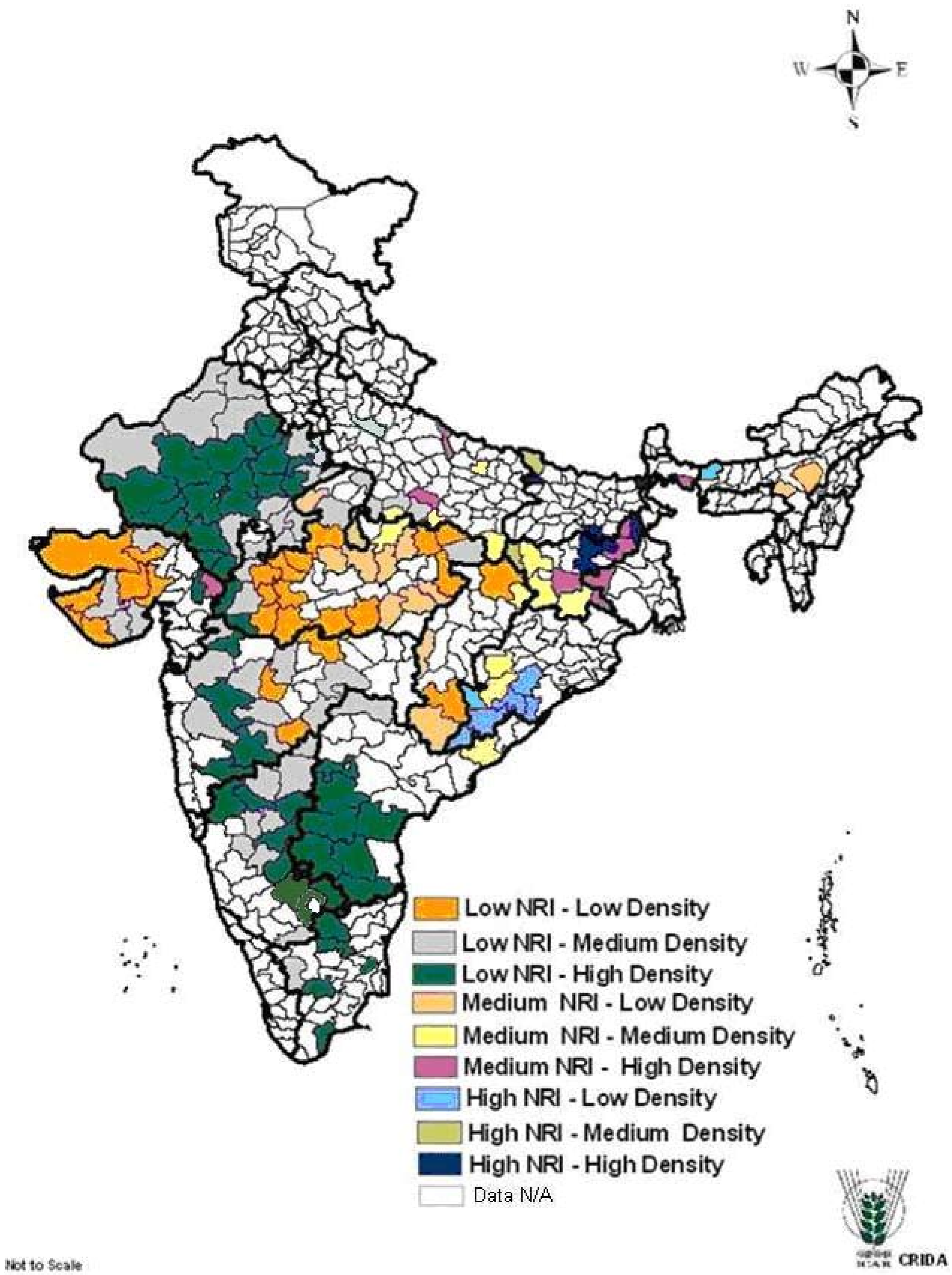


Fig. 5.1 Natural resource index vis-à-vis small ruminants density

Similarly density classes of large ruminants have been depicted against different classes of NRI (**Fig. 5.2**). Of the total 167 districts prioritized, 84, 63 and 20 fall under the category of low, medium and high density, respectively indicating that few districts are in high category unlike small ruminants where large number of districts are under high density. The density of large ruminants is high mostly in Rajasthan, UP, Bihar and Jharkhand (**Table 5.3**). High density with corresponding low natural resource index calls for immediate attention as it is likely to further deteriorate the resource base. The high population density is manageable wherever resources are better like in Bihar and Jharkhand. The interventions

Table 5.2: Scope of interventions based on small ruminants' density and natural resources index (NRI)

NRI	Small ruminants density (No./km^2)		
	Low (<35)	Medium (35-71)	High (>71)
Low	Resources are poor, therefore number of livestock to be maintained, if possible reduced. More concentration on productivity enhancement of pasture lands through soil and water conservation measures and inclusion of top-feed trees	Silvopastoral systems and supplemental feeding by growing fodder trees.	Efforts to be made to reduce the number and increase the productivity as carrying capacity is low by convincing the small ruminants rearing communities. Breed improvement.
Medium	Opportunity exists for agroforestry systems by integrating small ruminants which are more remunerative	The situation is in equilibrium but efforts to be made for improved animal health and supplemental feeding by raising improved perennial pasture, a mixture of grasses and legumes	Development of community owned lands and CPRs through user groups (UGs) and promotion of perennial grasses and legumes, harvest by cut and carry system
High	Scope for promotion of agro-silvo-pastoral, silvopastoral and hortipastoral systems by integrating small ruminants	More focus on animal health care and integrated farming systems approach	Dedicated efforts to improve grazing lands through agroforesty and soil and water conservation measures. Introduction of deferred and rotation grazing through community mobilization.

Table 5.3: Relationship between large ruminants' density and natural resources index (NRI) across selected prioritized districts of India

NRI	Large ruminants density (No./km^2)		
	Low (<78)	Medium (78-139)	High (>139)
Low	69 Rajasthan (14), Karnataka (12), Maharashtra (10), Gujarat (9), MP (8), AP (8), Tamil Nadu (5), Chhattisgarh (2), Assam (1)	43 Rajasthan (14), MP (13), Maharashtra (6), UP (3), Karnataka (4), Gujarat (2), Tamil Nadu (1)	6 Rajasthan (4), UP (1), Gujarat (1)
Medium	10 MP (5), Chhattisgarh (2), Jharkhand (1), AP (1), Oirssa (1)	14 Jharkhand (5), MP (4), UP (3), Chhattisgarh (1), Orissa (1)	8 UP (4), West Bengal (2), Jharkhand (1), Gujarat (1)
High	5 Orissa (5)	6 Jharkhand (3), Bihar (1), Orissa (1), Assam (1)	6 Bihar (3), Jharkhand (3)
Total	**84**	**63**	**20**

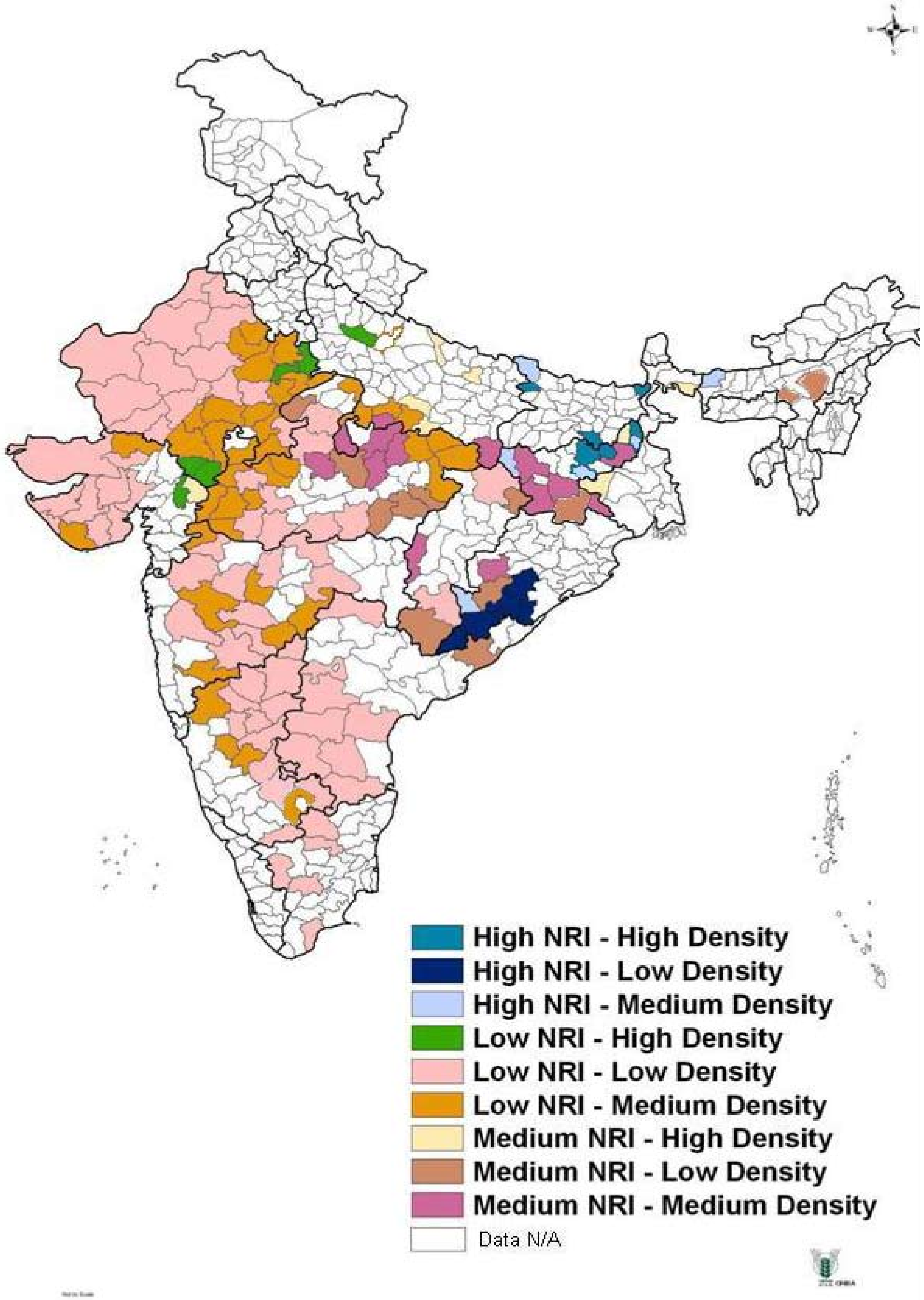


Fig. 5.2 Natural resource index vis-à-vis large ruminants density

need to be planned keeping in view the density and resource base and some of the options are discussed in **Table 5.4**.

Table 5.4: Scope of interventions based on large ruminants' density and natural resources index (NRI)

NRI	Large ruminants density (No./km^2)		
	Low (<78)	**Medium (78-139)**	**High (>139)**
Low	Effort to be made for improving natural resource base without increasing the number to make the enterprise sustainable	Sustaining the resource base should receive priority and efforts to be made for location- specific soil and water conservation measures and growing of fodder crops.	Number to be reduced, culling out of non-descript animals and breed improvement
Medium	As resource is better and number is low, efforts to be made for introducing improved grasses and legumes for improving productivity	Agroforestry and soil & water conservation and improvement of CPRs	More area to be brought under cultivated fodders plus breed improvement
High	A good scope for practicing integrated farming systems approach as resources are rich and number is low	Integrated farming systems approach by growing crops whose byproduct supports livestock	A good scope for dairy industry and necessary support mechanism to be extended. Also efforts to be made for productivity enhancement and breed improvement.

5.3 Milk Productivity and Production Potential

The milk productivity of cow and buffalo varies from 0.3 to 10.3 and 0.5 to 22.4 kg per day, with an average milk yield of 3.0 and 4.3 kg/day, respectively (based on 156 districts data from 10 states). This indicates very high variability in milk productivity of buffalo than cow; however demand for water by buffalo is more than cow. Milk productivity less than 2.70 and 3.54 kg/day of cow and buffalo, respectively was considered as low while more than that as high based on 50 percentile values. A list of States indicating low and high productivity of milk by cow and buffalo is set out in **Table 5.5** while names of districts among the prioritized ones for whose data are available in **Tables 5.6 & 5.7** in relation to NRI.

Table 5.5: Classification of states based on milk productivity of cow and buffalo

Productivity (kg/day)		States
Cow	**Low (<2.7)**	Assam, Chhattisgarh, Himachal Pradesh, Jharkhand, Maharashtra, Madhya Pradesh, Orissa, Uttar Pradesh, Uttarkhand, West Bengal
	High (>2.7)	Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Punjab, Rajasthan, Tamil Nadu
Buffalo	**Low (<3.5)**	Assam, Himachal Pradesh, Karnataka, Madhya Pradesh, Orissa
	High (>3.5)	Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Jharkhand, Kerala, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarkhand, West Bengal

(Source of data : Dept. of Animal Husbandry & Dairying-http://www.dahd.nic.in)

Table 5.6: Relationship between natural resources index (NRI) and milk productivity of cow across selected prioritized districts of India

NRI	Milk productivity* (kg/day)	State	Districts
Low	Low	AP	Adilabad, Anantapur, Cuddapah, Kurnool, Mahabubnagar, Prakasam, Ranga Reddy
		Gujarat	Amreli, Jamnagar, Junagadh, Kutch, Rajkot, Surrendranagar
		Karnataka	Belgaum, Bellary, Bidar, Gulbarga, Tumkur
		Maharashtra	Amravati, Beed, Buldhana, Dhule, Jalna, Latur, Nanded, Nasik, Osmanabad, Solapur, Yavatmal
		Tamil Nadu	Coimbatore, Dharmapuri
	High	Gujarat	Ahmedabad, Banaskantha, Bhavnagar, Panchmahal
		Karnataka	Bijapur, Chitradurga, Kolar, Raichur
		Maharashtra	Ahmednagar, Pune, Sangli
		Tamil Nadu	Salem
Medium	Low	AP	Vishakapatnam
		Orissa	Bolangir, Kalahandi
		West Bengal	Cooch Behar, Pururlia
	High	-	-
High	Low	Orissa	Koraput, Phulbani (Kandmahal)
	High	-	

* Low = <2.7 kg/day, High= >2.7 kg/day
(Source of data: INARIS data warehouse, IASRI, New Delhi. The data were available for 156 districts of 10 states only)

Table 5.7: Relationship between natural resources index (NRI) and milk productivity of buffalo across selected prioritized districts of India

NRI	Milk productivity* (kg/day)	State	Districts
Low	Low	AP	Adilabad, Anantapur, Cuddapah, Kurnool, Mahabubnagar, Prakasam, Ranga Reddy
		Gujarat	Jamnagar,
		Karnataka	Bellary, Bidar, Gulbarga, Tumkur
		Maharashtra	Amravati, Beed, Latur, Nanded, Osmanabad, Solapur, Yavatmal
		Tamil Nadu	Coimbator, Dharmapuri
	High	AP	Chittoor
		Gujarat	Ahmedabad, Amreli, Banaskantha, Bhavnagar, Junagadh, Kutch, Panchmahal, Rajkot, Surendranagar
		Karnataka	Belgaum, Bijapur, Chitradurga, Kolar, Raichur
		Maharashtra	Ahmednagar, Buldhana, Dhule, Jalna, Nasik, Pune, Sangli
		Tamil Nadu	Coimbatore, Salem
Medium	Low	Orissa	Bolangir, Kalahandi
		West Bengal	Pururlia
	High	AP	Vishakapatnam
		West Bengal	Cooch Behar
High	Low	Orissa	Phulbani (Kandmahal)
	High	Orissa	Koraput

* Low = <3.5 kg/day, High= >3.5 kg/day

Livestock productivity is constrained by lack of adequate feed and fodder availability and its poor quality besides high incidence of diseases. Several schemes are under implementation to address various types of CPRs.

5.3.1 Milk Production Potential

District-wise milk production potential is set out in **Annexure-IV** alongwith natural resource index (NRI). Districts having medium to high NRI and medium to high milk production potential deserve preference over other districts for promotion of dairy as an enterprise.

5.4 Meeting Fodder Needs during Lean Season

Crop production in uncertain rainfall areas is risky. Low and unstable yields are common and so is the income of dryland farmers. For imparting stability and providing sustainability to the farming systems, a tree-crop-livestock integration holds promise. Alley cropping, one of the options of agroforestry systems can meet the multiple requirements of food, fodder, fuel, fertilizer, etc., besides improved pasture management.

A major shortcoming of most of the common pastures is lack of production during hot summer lean period. A traditional way to overcome this is to use tree leaf fodder during summer. In the pasture lands, lot of trees are seen growing, but these are of least consequence in forage production. If these trees are replaced with top-feed trees species, they would supplement tree leaf fodder during the summer months and thus prolong the grazing period and improve animal productivity of the pasture. More than 60% of the fodder requirement of the goats in India is normally met with shrubs and tree fodder. All the tropical and subtropical grasses, owing to their faster rate of growth during the monsoon provide grazing for the livestock, mainly during rainy and post-rainy seasons. During the lean periods of spring and summer, tree-tops especially *Leucaena, Acacia, Gliricidia*, Neem etc., come to the rescue of the livestock owners. The young leafy succulent material provides crude protein and minerals, which serves as a concentrate. In view of the above, integrating fodder and fruit trees in terms of silvopastoral and horti-pastoral systems hold promise for non-arable and arable lands, respectively.

5.5 Options for Improving Common Pool Resources (CPRs)

5.5.1 Grazing land

Livestock production is one of the main occupations of resource-poor. Common grazing lands have always played a major role in livestock production system. Currently grazing lands are in highly degraded condition and encroachment is rampant. Permanent pastures and grazing lands in India are spread over an area of 11.8 million ha. About one million ha of land in semi-arid region is under degraded pasture/grazing land. There is drastic reduction in common pool grazing lands in most states due to encroachment and privatization.

Grazing lands in the semi-arid region can be categorised as permanent pastures, areas under tree crops and groves, fallow lands, and areas unsuitable for cultivation and belonging to the village panchayat, the state revenue department or forest department, or a religious trust. Farmers' fields become another major grazing resource after harvesting of crops and are mostly under open access regime. The productivity of common pool grazing lands is hardly one-third to one-fifth of the privately owned pastures.

Privatization and distribution of land is resulting in the decline of area under common grazing lands. Encroachment of grazing lands has taken place through both legal and illegal means. Currently, many watershed development projects aim to revive the productivity of common grazing lands (public/private). No effective management systems are in vogue and Panchayati Raj Institutions are not actively associated. Attempts by agencies like IFFCO and NDDB in reviving CPRs through silvipasture and other agroforestry models with grassroot level cooperatives need to be encouraged.

5.5.2 Forests

It is difficult to separate the causes from the effects of deforestation and forest degradation. Some direct causes of deforestation are land clearances for agriculture (including shifting cultivation), other land use changes including unplanned urbanization, land transfers, different forms of encroachments, over-grazing, uncontrolled and wasteful logging, illegal felling, and excessive fuelwood collection. The area under degraded notified forestland that forms the second largest category of wastelands in India (NRSA, 2000) is mostly either under state property regime or open access regime. Semi-arid region has an area of 8.2 m ha degraded notified forestland and it is spread over 183 districts. This area is subjected to high biotic and abiotic stress and needs suitable management system and higher investment. Undesirable shrubs can have an adverse impact on herbage yield of the CPRs due to their higher magnitude of infestation by reducing the open space for the grasses to grow. The degraded forest area is mostly covered with *Prosopis juliflora* or by poor quality grass species when verified on ground in a study conducted in Andhra Pradesh (Hebbar, et al., 1993). There is a growing concern among people of semi-arid region due to rapid colonisation of degraded forest/wastelands by *P. juliflora* leading to reduced availability of grass in Bhavnagar (Gujarat) and lowering of water table in Anantapur (Andhra Pradesh). Management of fringe forest areas with soil and moisture conservation measures and raising tree/grass fodder for augmenting water supplies and fodder availability for villagers hold promise.

5.5.3 Tank beds

Village tanks are one type of Common Pool Resources (CPR), which still exist, despite the fact that the encroachment is rampant. Tanks occupy 2 to 5 per cent of the total geographical area in a study in Andhra Pradesh (Ramakrishna et al., 2006). The water is used mainly for irrigation and for drinking water for cattle, washing clothes and religious purposes.

However, due to continuous siltation and reduced flows from the catchment areas, these tanks now remain dry for most part of the year and are serving as percolation pond. In semi-arid areas, more than half the tank bed becomes empty as the water recedes due to evaporation or used up for cultivation. Due to silt deposition, these tank beds are fertile and retain adequate moisture in the soil profile for cultivation of short duration annual fodder crops.

5.5.4 Management systems and strategies of CPRs

Livestock do not graze on all plant species equally and they concentrate on the most palatable and nutritious first, thus intensive grazing can lead to the disappearance of beneficial species. The practice of let loose free grazing has to be changed to stall feeding and rotational grazing. The grazing management is done by three ways: 1) managing the number of livestock per hectare of CPRs (called the stocking rate), 2) managing the location and timing of grazing and 3) the placement of watering sites and salt blocks, which can spread grazing more evenly over the CPRs. The single most important factor is the stocking rate, because it directly influences the total amount of forage removal from the CPRs. Deferred rotational grazing system is superior and results in greater number of animal days as compared to continuous system approach. Rotational grazing has steadily gained the popularity over the last two decades because it offers better control over livestock distribution and feeding patterns. An attempt has been made to identify problems, causative factor and suitable remedial measures have been suggested (**Table 5.8**).

Table 5.8: Identified constraints to low productivity of CPRs

Problem	Causative factor	Remedial measures
Poor regeneration of forages species	Severe damage due to over -grazing and stampede	Rotational and restricted grazing
Low forage production	Low yielding annual grass species and competition by unpalatable shrubs and trees	Reseeding of high yielding perennial grass species and bush clearing
Low nutritive value of the forage	Lack of legume forage species	Seeding of legumes like Stylo just before onset of monsoon and application of P as basal dose
Non-availability of green fodder during lean period	Very few tree species suitable as top feed in CPRs	Development of silvopastoral system

6. DEVELOPMENT PERSPECTIVE AND POLICY ISSUES

There is always limitation of funds which cannot be thinly spread over all the districts of the country for any developmental activity. Therefore, prioritization is important for allocating resources. An attempt was made to shortlist the rainfed districts that can give higher marginal rate of returns on investments and have the potential for development based on underutilized natural resources and lower livelihood indices. Among the top one-third districts (167) identified based on high RAPI score, 50 have been shortlisted as the high potential districts based on unexploited natural resources for investment on various interventions. These districts were further grouped into 3 classes (I, II and III) (**Fig. 6.1** & **Table 6.1**) based on medium to high NRI and low to medum ILI. The potential for development is high in these districts as the available resources are not effectively accessed and/or used for the agricultural productivity enhancement as well as livelihoods opportunities. The marginal return from the investments in the above identified 50 districts is expected to be higher in terms of bridging the yield gap and improving the livelihoods. This will also enable higher foodgrain production for meeting the increased demand for food security.

There is a need to come up with new policy guidelines and developmental strategies in relation to natural resources and livelihoods status. It is observed that in India natural resources and livelihoods status are inversely related. Poverty is high in areas with high natural resources indicating scope for improving the livelihoods through better access to natural resources and a need for enabling mechanism and support services.

Table 6.1. Classification of districts for prioritizing investment

NRI	ILI	Number of districts within the top 167 prioritized districts based on RAPI score	Districts having high potential for investment and category in parentheses
Low	Low	18	-
Low	Medium	64	-
Low	High	35	-
Medium	Low	30	30 (II)
Medium	Medium	3	3 (III)
Medium	High	0	NA
High	Low	17	17 (I)
High	Medium	0	NA
High	High	0	NA
Total		167	50

NA: Not available as no district falls under this category among the top one-third (167) prioritized districts

There is higher scope for land use diversification and crop intensification in areas having medium to high NRI and low or medium ILI. Agricultural development should receive high priority in areas having medium or high NRI irrespective of ILI. This calls for support services in the form of technology, infrastructure, credit, capacity building, forward and backward linkages, etc. Rather than individual components, packaging of the technologies in an integrated manner is the need of hour and single window services need to be explored. Areas having low NRI deserve creation of off-farm employment opportunities with focus on landuse diversification, micro-enterprises and industrialization.

Rice crop is associated with 38 districts among the 50 districts identified above, followed by chickpea (6), ragi (2) and one each of bajra, maize, wheat and blackgram (**Tables 6.2 a, b & c**). All the rice growing districts possess medium to high NRI and low ILI with low to medium productivity level except in four districts. The productivity enhancement of rice should form the main agenda in these districts in a farming system mode for ensuring food and livelihood security. There is an ample possibility of improving rural livelihoods through water harvesting in the form of on-farm reservoirs (OFRs) by integrating rice-fish-duck/pig system or by raising fodder for milch animals and following multiple water use based farming systems.

In case of livestock, there is scope for promoting small ruminants wherever the density is low to medium and large ruminants (milch animals) in districts having medium to high milk production potential. There is a need to practice semi-intensive grazing techniques for small ruminants while breed improvement in case of large ruminants. The area under

Table 6.2(a) Districts having potential (high NRI and low ILI)

S.No.	Name of the state	Name of the district	Major rainfed crop	Small ruminant density	Milk production potential
1	Assam	Kokrajhar	Rice (M)	L	H
2	Bihar	Champaran (West)	Rice (L)	M	L
3	Bihar	Gopalganj	Rice (M)	H	L
4	Bihar	Jamui	Rice (M)	H	L
5	Bihar	Kishanganj	Rice (M)	H	L
6	Jharkhand	Girdih	Rice (H)	H	H
7	Jharkhand	Gadhwa	Rice (L)	M	H
8	Jharkhand	Devgarh	Rice (H)	H	M
9	Jharkhand	Sahebganj	Rice (M)	H	M
10	Jharkhand	Pakur	Rice (M)	H	M
11	Jharkhand	Bokaro	Rice (M)	H	M
12	Orissa	Gajapati	Rice (M)	L	H
13	Orissa	Phulbani (Kandhamal)	Rice (M)	L	H
14	Orissa	Rayagada	Rice (M)	L	M
15	Orissa	Nawarangpur	Rice (M)	L	H
16	Orissa	Malkangiri	Rice (M)	L	H
17	Orissa	Koraput	Ragi (L)	L	H

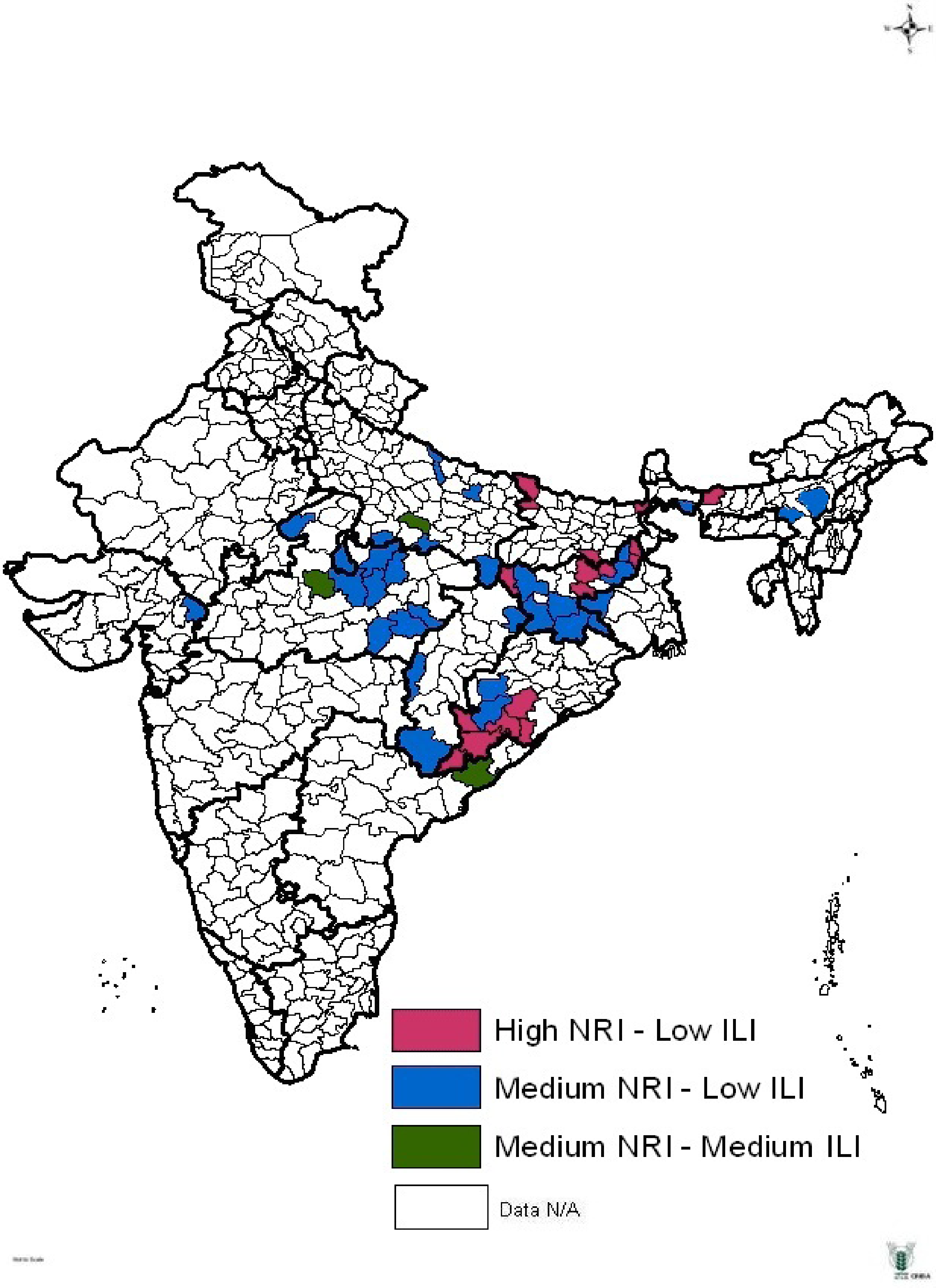


Fig. 6.1 Shortlisted districts having high potential for development and livelihoods security

fodder production needs to be enhanced from currently 5% to 10% to cater the demand of livestock with change in food habits and more demand for milk and meat products. The integrated farming systems approach calls for development of infrastructure and needed support systems. The on-going and new programmes should focus in these districts on enabling mechanisms for improved access to natural resources and needed support systems.

The policy aspects of grazing lands have not been addressed in the recent past either at national or state levels. There is an urgent need for action towards a sustainable feed, fodder and grazing land development policy, which will also have implications for institutionalising development of common lands with a regional and farmer focus.

Table 6.2(b) Districts having medium potential (medium NRI and low ILI)

S.No.	Name of the state	Name of the district	Major rainfed crop	Small ruminant density	Milk production potential
1	Assam	Karbi-Anglong	Rice (M)	L	H
2	CG	Jashpur	Rice (L)	M	H
3	CG	Raj Nandgaon	Rice (M)	L	H
4	CG	Dantiwara	Rice (L)	L	H
5	Jharkhand	Dumka	Rice (M)	H	H
6	Jharkhand	Ranchi	Rice (M)	H	H
7	Jharkhand	Gumla	Rice (M)	M	H
8	Jharkhand	W. Singbhum	Rice (M)	M	H
9	Jharkhand	E. Singbhum	Rice (M)	H	H
10	Jharkhand	Palamu	Rice (M)	M	H
11	Jharkhand	Godda	Rice (H)	H	M
12	MP	Dindori	Rice (L)	L	H
13	MP	Seoni	Rice (L)	L	H
14	MP	Mandla	Rice (L)	L	H
15	MP	Panna	Rice (L)	L	H
16	Orissa	Bolangir	Rice (L)	M	M
17	Orissa	Kalahandi	Rice (L)	M	H
18	UP	Bahraich	Rice (M)	H	H
19	UP	Basti	Rice (M)	M	M
20	UP	Sonbhadra	Rice (L)	M	H
21	W. Bengal	Cooch Behar	Rice (M)	H	M
22	W. Bengal	Purulia	Rice (H)	H	H
23	MP	Sheopur Kalan	Bajra (M)	L	H
24	Gujarat	Dahod	Maize (M)	H	M
25	MP	Chattarpur	Chickpea (L)	M	H
26	MP	Sagar	Chickpea (L)	L	H
27	MP	Damoh	Chickpea (L)	L	H
28	UP	Mahoba	Chickpea (L)	M	H
29	UP	Chitrakot	Chickpea (M)	M	M
30	UP	Lalitpur	Blackgram (M)	L	M

It is evident from the analysis of ISPA (1997) that policy interventions remained largely unrealized. There is a large gap between policies and programmes to tackle the issue of dependence on common lands for fodder.

Table 6.2(c) Districts having low potential (medium NRI and medium ILI)

S. NO.	Name of the state	Name of the district	Major rainfed crop	Small ruminant density	Milk production potential
1	AP	Vishakapatnam	Ragi (M)	M	M
2	MP	Vidisha	Wheat (M)*	L	H
3	UP	Fatehpur	Chickpea (M)	H	M

CONCLUSIONS

Earlier attempts for prioritization of rainfed regions for region-specific planning largely considered climatic or bio-physical criteria for identifying the targeted regions. It is now realized that this approach has by-passed several other deserving areas, which have a favourable natural resource endowment but remained under-developed due to poor infrastructure and socio-economic status. Therefore, in this study, an integrated approach was followed for prioritization of rainfed districts in India. The study has come up with a new criterion called Rainfed Areas Prioritization Index (RAPI), which integrates the natural resource and socio-economic endowments of a district. Two separate indices viz., Natural Resource Index (NRI) and Integrated Livelihood Index (ILI) were developed for each district separately and integrated as RAPI assigning two-third and one-third weights, respectively.

Accordingly, most of the rural districts covered under Census 2001 have been considered for prioritization and the top one-third districts (167) based on high RAPI score are considered as high priority districts. Among the top one-third districts, 50 have been identified as the most deserving districts that need immediate attention as these districts are resource-wise rich but livelihood status is poor. The marginal return from the investments in these districts is expected to be higher in terms of bridging the yield gap and improving the livelihoods as well as addressing the issue of food security.

As anticipated, several districts in western part of the country have emerged as high priority districts mainly due to poor natural resource base. Many districts with high RAPI score are having low NRI and low to medium ILI. These districts have been receiving good investments on NRM for quite some time. However, our study indicates that these districts require **continued attention** in terms of NRM, particularly *in-situ* and *ex-situ* water harvesting, controlling soil loss and land degradation and rational use of **groundwater.** Due to high grazing intensity, the CPRs have been completely degraded in these areas. Some **improvements** in grazing management are urgently needed. For sustaining productivity, diversified land use and efficient cropping patterns which require less water have to be promoted in these areas, if necessary through policy instrument of incentivization.

On the other hand, several traditionally rice producing districts in eastern states, though having high NRI have now figured in high priority districts due to very low ILI. Immediate attention on extensive human and social capital building and infrastructure development is needed in these districts for enabling access to natural resources. We cannot isolate rainfed agriculture development from the overall development of a region. Hence,

massive investments are needed here on infrastructure, value addition, access to market, communication, extension and capacity building of the communities.

In districts with medium NRI and ILI, equal focus is needed on both. The main focus should be on investments in maintaining the NR status and improving ILI. It is hoped that this study will help in channelizing future developmental efforts in rainfed areas in a more systematic and scientific way with area targeted approach.

> The outcome of this study in terms of ranking of districts must be considered keeping view of the methodology adopted and limitation of available district level data. This should be considered as a suggestive proposition.

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Legend Description for the Agro-ecological Sub-regions Map

1 Western Himalayas, cold arid eco-region
1.1 Eastern aspect of Ladakh Plateau, cold, hyper-arid eco-subregion (ESR)
1.2 Western Aspect of Ladakh Plateau and north Kashmir Himalayas, cold to cool, typic-arid ESR
2 Western Plain, Kachchh and part of Kathiawar Peninsula, hot arid eco-region
2.1 Marusthali hot, hyper arid ESR
2.2 Kachchh Peninsula (Great Rann of Kutch as inclusion), hot hyper-arid ESR
2.3 Rajasthan Bagar, North Gujarat Plain and South-Western Punjab Plain, hot typic-arid ESR
2.4 South Kachchh and North Kathiawar Peninsula, hot arid ESR
3 Deccan plateau, hot arid ecosubregion
3.0 Karnataka Plateau (Rayalseema as inclusion), hot arid ESR
4 Northern Plain (and Central Highlands) including Aravallis, hot semi-arid ecoregion
4.1 North Punjab Plain, Ganga-Yamuna Doab and Rajasthan Upland, hot semi-arid ESR
4.2 North Gujarat Plain (inclusion of Aravalli range and east Rajasthan Uplands), hot dry semiarid ESR
4.3 Ganga Yamuna Doab, Rohilkhand and Avadah Plain, hot moist semi-arid ESR
4.4 Madhya Bharat Plateau and Bundelkhand Uplands, hot, moist semi-arid ESR
5 Central (Malwa) Highlands, Gujarat plains and Kathiawar Peninsula Ecoregion
5.1 Central Kathiawar Peninsula, hot, dry semiarid ESR
5.2 Madhya Bharat Plateau, Western Malwa Plateau, Eastern Gujarat Plain, Vindhyan and Satpura range and Narmada Valley, hot moist semi-arid ESR
5.3 Coastal Kathiawar Peninsula, hot moist semi-arid ESR
6. Deccan Plateau, hot semi-arid eco-region
6.1 South Western Maharashtra and North Karnataka Plateau, hot dry semi-arid ESR
6.2 Central and Western Maharashtra Plateau and North Karnataka Plateau and North Western Telangana Plateau, hot moist semi-arid ESR
6.3 Eastern Maharashtra Plateau, hot moist semi-arid ESR
6.4 North Sahyadris and Western Karnataka Plateau, hot dry subhumid ESR
7. Deccan Plateau (Telangana) and Eastern Ghats, hot semi-arid ecoregion
7.1 South Telangana Plateau (Rayalseema) and Eastern Ghat, hot dry semi-arid ESR
7.2 North Telangana Plateau, hot moist semi-arid ESR
7.3 Eastern Ghat (South), hot moist semi-arid/dry subhumid ESR

11 Chattisgarh/Mahanadi Basin Agro-eco-region
11.0 Moderately to gently sloping Chattisgarh/ Mahanadi Basin, hot moist/dry subhumid transitional ESR
12 Eastern Plateau (Chhotanagpur) and Eastern Ghats, hot subhumid eco-region
12.1 Garjat Hills, Dandakaranya and Eastern Ghats, hot moist subhumid ESR
12.2 Eastern Ghats, hot moist subhumid ESR
12.3 Chhotanagpur Plateau and Garjat Hills, hot, dry subhumid ESR
13 Eastern Plain, hot subhumid (moist) ecoregion
13.1 North Bihar and Avadh Plains, hot dry to moist subhumid transitional ESR
13.2 Foothills of Central Himalayas, warm to hot moist subhumid ESR
14.Western Himalayas, warm subhumid (to humid with inclusion of perhumid) ecoregion
14.1 South Kashmir and Punjab Himalayas, cold and warm by dry semi-arid/dry subhumid ESR
14.2 South Kashmir and Kumaun Himalayas, warm moist to dry subhumid transitional ESR
14.3 Punjab Himalayas, warm humid to perhumid transitional ESR
14.4 Kumaun Himalayas, warm humid to perhumid transitional ESR
14.5 Foothills of Kumaun Himalayas (Subdued), warm moist subhumid ESR
15. Assam and Bengal Plain, hot subhumid to humid (inclusion of perhumid) eco-region
15.1 Bengal basin and North Bihar Plain, hot moist subhumid ESR
15.2 Middle Brahmaputra Plain, hot humid ESR
15.3 Teesta, lower Brahmaputra Plain and Barak Valley, hot moist humid to perhumid ESR
15.4 Upper Brahmaputra Plain, warm to hot perhumid ESR

16.Eastern Himalayas, warm perhumid eco-region
16.1 Foot-hills of Eastern Himalayas (Bhutan foot-hills), warm to hot perhumid ESR
16.2 Darjeeling and Sikkim Himalayas, warm perhumid ESR
16.3 Arunachal Pradesh (Subdued Eastern Himalayas), warm to hot perhumid ESR
17.North-eastern Hills (Purvachal), warm perhumid eco-region
17.1 Meghalaya Plateau land Nagaland Hill, warm to hot moist humid to perhumid ESR
17.2 Purvachal (Eastern Range), warm to hot perhumid ESR

8. Eastern Ghats and Tamil Nadu Uplands and Deccan (Karnataka) Plateau, hot semiarid eco-region 8.1 Tamil Nadu Uplands and Leeward Flanks of South Sahyadris, hot dry semi-arid ESR 8.2 Central Karnataka Plateau, hot moist semi-arid ESR 8.3 Tamil Nadu Uplands and Plains, hot moist semi-arid ESR **9. Northern Plain, hot subhumid (dry) eco-region** 9.1 Punjab and Rohilkhand Plains, hot dry/moist subhumid transitional ESR 9.2 Rohilkhand, Avadh and south Bihar Plains, hot dry subhumid ESR 10 Central Highlands (Malwa and Bundelkhand), hot subhumid (dry) eco-region 10.1 Malwa Plateau, Vindhyan Scarpland and Narmada Valley, hot dry subhumid ESR 10.2 Satpura and Eastern Maharashtra Plateau, hot dry subhumid ESR 10.3 Vindhyan Scarpland and Bundelkhand Plateau, hot dry subhumid ESR 10.4 Satpura range and Wainganga Valley, hot moist subhumid ESR	**18.Eastern Coastal Plain, hot subhumid to semiarid ecoregion** 18.1 South Tamil Nadu Plains (Coastal), hot dry semi-arid ESR 18.2 North Tamil Nadu Plains (Coastal), hot moist semi-arid ESR 18.3 Andhra Plain, hot dry subhumid ESR 18.4 Utkal Plain and East Godavari Delta, hot dry subhumid ESR 18.5 Gangetic Delta, hot moist subhumid to humid ESR **19.Western Ghats and Coastal Plain, hot humid-perhumid** **eco-region** 19.1 North Sahyadris and Konkan Coast, hot humid ESR 19.2 Central and South Sahyadris, hot moist subhumid to humid transitional ESR 19.3 Konkan, Karnataka and Kerala Coastal plain, hot humid to per humid transitional ESR **20. Islands of Andaman-Nicobar and Lakshadweep, hot humid to perhumid island ecoregion** 20.1 Andaman and Nicobar group of Islands, hot perhumid ESR 20.2 Level Lakshadweep and group of Island, hot humid ESR

Principal Component Analysis (PCA)

The weights used for constructing NRI and ILI were derived by subjecting the data to the Principal component analysis (PCA) after appropriate scaling and normalization of data set. PCA is a multivariate technique applied to a single set of variables to discover which sets of variables in the set form coherent subsets that are relatively independent of one another. Most of the times, the variables under study are highly correlated and as such they are effectively "saying the same thing". To examine the relationships among a set of *p* correlated variables, it may be useful to transform the original set of variables to a new set of uncorrelated variables called *principal components*. These new variables are linear combinations of original variables and are derived in decreasing order of importance.

Let $x_1, x_2, x_3, \ldots, x_p$ be variables under study, then first principal component may be defined as

$$P_1 = a_{11} x_1 + a_{12} x_2 + \ldots\ldots + a_{1p} x_p$$

such that variance of P_1 is as large as possible subject to the condition that

$$a_{11}^2 + a_{12}^2 + \ldots\ldots + a_{1p}^2 = 1$$

This constraint is introduced because if this is not done, then $Var(P_1)$ can be increased simply by multiplying any a_{1j}'s by a constant factor. The second principal component is defined as

$$P_2 = a_{21} x_1 + a_{22} x_2 + \ldots\ldots + a_{2p} x_p$$

such that $Var(P_2)$ is as large as possible next to $Var(P_1)$subject to the constraint that

$$a_{21}^2 + a_{22}^2 + \ldots\ldots + a_{2p}^2 = 1 \quad \text{and} \quad cov(P_1, P_2) = 0 \text{ and so on.}$$

Proceeding, in a similar way, p principal components can be defined with constraints as defined above. The estimates a_{ij} s are obtained under these constraints and substituted back to different principal component equations to get principal component scores for each record. It is quite likely that first few principal components account for most of the variability in the original data. If so, these few principal components can then replace the initial p variables in subsequent analysis, thus, reducing the effective dimensionality of the problem. An analysis of principal components often reveals relationships that were not previously suspected and thereby allows interpretation that would not ordinarily result. However, Principal Component Analysis is more of a means rather than an end in itself because this frequently serves as intermediate step in much larger investigations by reducing the dimensionality of the problem and providing easier interpretation.

Nagar and Basu (2002) presented more comprehensive presentation of this approach for development of social indicators. Principal component scores (P_i) are used as weighted linear combinations of the variables selected to compose the social indicators. Here weights are inverse of variance of Principal component scores.

Since the variables were expressed in different units, they have to be normalized. The method used for normalization in this study is rescaling method. As per this method the variables which contribute positively to desired index are normalized by using the following expression.

$$\frac{X_i - X_{\min}}{X_{\max} - X_{\min}}$$

Where X_i is the value of a variable for ith district

For variables which contribute negatively to desired index, the normalized score will be

$$\frac{X_{\max} - X_i}{X_{\max} - X_{\min}}$$

The resultant scores will vary between 0 and 1.

After normalization, correlation matrix R is computed from normalized variables, followed by solving the determinant equation $|R - \lambda I|$=0 for λ where R is a p x p matrix. This provides a pth degree polynomial equation in λ's and hence K roots. These roots are called eigen values of correlation matrix R. The λ's are then arranged in descending order of magnitude, as $\lambda_1 > \lambda_2 > .... > \lambda_p$. Corresponding to each value of λ, the matrix equation $(R - \lambda I)\alpha = 0$ is solved for the px1 eigenvectors of α, subject to the condition that $\alpha'\alpha = 1$ (normalization condition.). The index is estimated as weighted average of p principal components (P's), where the weights are the eigen values of the correlation matrix R, and it is known that

$$\lambda_1 = \text{var}(P_1), \lambda_2 = \text{var}(P_2) = ...\lambda_1 = \text{var}(P_p)$$

Thus, the index is:

$$I = \frac{\lambda_1 P_1 + \lambda_2 P_2 + ... + \lambda_p P_p}{\lambda + \lambda_2 + ..._1 + \lambda_p}$$

In a nutshell, the estimator of the index is computed as the weighted average of the Principal component scores.

The weight realized from this method for jth variable may be visualized as

$$W_j = \frac{\sum_{i=1}^{p} \lambda_i a_j}{\sum_{j=1}^{p} \sum_{i=1}^{p} \lambda_i a_j}$$

which will be applied to standardized variables (Z) to derive the desired index.

Rainfed Areas Prioritization Index (RAPI) and Component Indices (NRI & ILI)

State	District	NRI	ILI	RAPI	Priority Rank
Rajasthan	Barmer	0.0000	0.2293	0.9236	1
Rajasthan	Jaisalmer	0.1192	0.2375	0.8414	2
Rajasthan	Bikaner	0.0834	0.3902	0.8143	3
Rajasthan	Jodhpur	0.1870	0.4706	0.7185	4
Rajasthan	Churu	0.2759	0.4616	0.6622	5
Rajasthan	Nagaur	0.3305	0.4875	0.6172	6
Andhra Pradesh	Anantapur	0.4448	0.5381	0.5241	7
Rajasthan	Udaipur	0.5261	0.3801	0.5226	8
Rajasthan	Jalore	0.5285	0.4208	0.5074	9
Karnataka	Gulbarga	0.5318	0.4237	0.5042	10
Maharashtra	Ahmednagar	0.4498	0.6347	0.4885	11
Gujarat	Kutch	0.5214	0.5746	0.4609	12
Rajasthan	Bhilwara	0.5880	0.4544	0.4565	13
Chhattisgarh	Dantiwara	0.8184	0.0000	0.4544	14
Rajasthan	Chittorgarh	0.6066	0.4311	0.4519	15
Rajasthan	Pali	0.5440	0.5594	0.4509	16
Rajasthan	Jhalawar	0.6377	0.3736	0.4503	17
Gujarat	Patan	0.5737	0.5029	0.4499	18
Rajasthan	Ajmer	0.5679	0.5149	0.4497	19
Rajasthan	Tonk	0.6341	0.4104	0.4405	20
Rajasthan	Rajsamand	0.6062	0.4731	0.4381	21
Karnataka	Chitradurga	0.5916	0.5027	0.4380	22
Gujarat	Banaskantha	0.6180	0.4506	0.4378	23
Maharashtra	Solapur	0.5412	0.6052	0.4375	24
Karnataka	Tumkur	0.5957	0.4979	0.4369	25
Karnataka	Bijapur	0.6070	0.4835	0.4341	26
Rajasthan	Bundi	0.6430	0.4137	0.4334	27
Rajasthan	Banswara	0.7029	0.2984	0.4320	28
Rajasthan	Hanumangarh	0.5983	0.5094	0.4314	29
Rajasthan	Sikar	0.5618	0.5844	0.4307	30
Andhra Pradesh	Cuddapah	0.5638	0.5816	0.4303	31
Gujarat	Surendranagar	0.5734	0.5633	0.4300	32
Rajasthan	Karauli	0.6657	0.3831	0.4285	33
Rajasthan	Sirohi	0.6101	0.4997	0.4267	34
Maharashtra	Nasik	0.5600	0.6004	0.4265	35
Madhya Pradesh	Jhabua	0.7068	0.3081	0.4261	36

State	District	NRI	ILI	RAPI	Priority Rank
Rajasthan	Jaipur	0.6159	0.4901	0.4261	37
Madhya Pradesh	Dhar	0.6268	0.4733	0.4243	38
Chhattisgarh	Sarguja	0.7237	0.2928	0.4199	39
Rajasthan	Dholpur	0.6911	0.3842	0.4112	40
Andhra Pradesh	Adilabad	0.6743	0.4240	0.4091	41
Gujarat	Jamnagar	0.5773	0.6183	0.4090	42
Gujarat	Ahmedabad	0.5900	0.5930	0.4090	43
Chhattisgarh	Bastar	0.7834	0.2070	0.4087	44
Andhra Pradesh	Kurnool	0.6014	0.5801	0.4057	45
Rajasthan	Dungarpur	0.7024	0.3783	0.4056	46
Maharashtra	Beed	0.6570	0.4778	0.4027	47
Karnataka	Raichur	0.7048	0.3855	0.4016	48
Madhya Pradesh	Sidhi	0.7547	0.2871	0.4012	49
Rajasthan	Sawai Madhopur	0.6942	0.4105	0.4004	50
Madhya Pradesh	Ratlam	0.6750	0.4644	0.3952	51
Andhra Pradesh	Mahabubnagar	0.6621	0.4920	0.3946	52
Madhya Pradesh	Guna	0.7259	0.3726	0.3919	53
Rajasthan	Alwar	0.6648	0.4971	0.3911	54
Karnataka	Kolar	0.6656	0.4977	0.3904	55
Gujarat	Amreli	0.5915	0.6479	0.3897	56
Jharkhand	West Singbhum	0.8352	0.1615	0.3894	57
Karnataka	Bagalkot	0.6588	0.5154	0.3890	58
Madhya Pradesh	Shajapur	0.6847	0.4646	0.3886	59
Madhya Pradesh	Rajgarh	0.7160	0.4031	0.3883	60
Maharashtra	Yavatmal	0.6857	0.4641	0.3881	61
Karnataka	Belgaum	0.6135	0.6119	0.3870	62
Rajasthan	Dausa	0.7145	0.4129	0.3861	63
Madhya Pradesh	Shahdol	0.7722	0.2975	0.3860	64
Assam	Karbi-Anglong	0.7967	0.2509	0.3852	65
Uttar Pradesh	Sonbhadra	0.7985	0.2523	0.3836	66
Jharkhand	Ranchi	0.8009	0.2492	0.3830	67
Madhya Pradesh	Shivpuri	0.7452	0.3610	0.3829	68
Madhya Pradesh	Dindori	0.8076	0.2366	0.3827	69
Madhya Pradesh	Chhindwara	0.7262	0.3996	0.3827	70
Madhya Pradesh	Mandsaur	0.6711	0.5108	0.3823	71
Madhya Pradesh	Rewa	0.7628	0.3281	0.3821	72
Madhya Pradesh	Barwani	0.7629	0.3429	0.3771	73
Orissa	Kalahandi	0.8567	0.1578	0.3763	74
Uttar Pradesh	Banda	0.7638	0.3446	0.3759	75
Jharkhand	Gumla	0.8484	0.1817	0.3738	76
Madhya Pradesh	Ujjain	0.7047	0.4691	0.3738	77

State	District	NRI	ILI	RAPI	Priority Rank
Jharkhand	Dumka	0.8676	0.1467	0.3727	78
Orissa	Malkangiri	0.9121	0.0586	0.3724	79
Jharkhand	Godda	0.8630	0.1584	0.3718	80
Gujarat	Rajkot	0.5974	0.6963	0.3696	81
Gujarat	Porbander	0.6640	0.5636	0.3695	82
Rajasthan	Baran	0.7368	0.4184	0.3693	83
Maharashtra	Latur	0.6904	0.5129	0.3688	84
Madhya Pradesh	Panna	0.8042	0.2876	0.3680	85
Rajasthan	Bharatpur	0.7125	0.4777	0.3658	86
Karnataka	Gadag	0.6799	0.5433	0.3656	87
Rajasthan	Kota	0.6958	0.5122	0.3654	88
Andhra Pradesh	Chittoor	0.6785	0.5480	0.3650	89
Karnataka	Bangalore (Rural)	0.6685	0.5691	0.3646	90
Madhya Pradesh	Khargone	0.7113	0.4838	0.3645	91
Karnataka	Koppal	0.7051	0.4978	0.3640	92
Karnataka	Bidar	0.7175	0.4759	0.3630	93
Uttar Pradesh	Chitrakut	0.8097	0.2925	0.3627	94
Orissa	Kandhamal	0.8846	0.1427	0.3627	95
Gujarat	Jungadh	0.6392	0.6349	0.3622	96
Maharashtra	Nandurbar	0.7832	0.3474	0.3620	97
Jharkhand	Palamu	0.8620	0.1933	0.3609	98
Madhya Pradesh	Satna	0.7775	0.3688	0.3587	99
Maharashtra	Pune	0.6149	0.6947	0.3585	100
Maharashtra	Nanded	0.7395	0.4463	0.3583	101
Uttar Pradesh	Bahraich	0.8078	0.3128	0.3572	102
Uttar Pradesh	Mahoba	0.8110	0.3068	0.3571	103
Jharkhand	East Singbhum	0.8686	0.1921	0.3569	104
Orissa	Bolangir	0.8520	0.2266	0.3564	105
Tamil Nadu	Salem	0.6778	0.5759	0.3561	106
Rajasthan	Jhunjunu	0.6558	0.6201	0.3561	107
Uttar Pradesh	Hamirpur	0.7651	0.4024	0.3558	108
Jharkhand	Deoghar	0.8842	0.1659	0.3553	109
Orissa	Koraput	0.8807	0.1730	0.3552	110
Jharkhand	Sahibganj	0.9003	0.1349	0.3548	111
West Bengal	Purulia	0.8365	0.2649	0.3540	112
Orissa	Rayagada	0.8990	0.1459	0.3521	113
Madhya Pradesh	Betul	0.7862	0.3715	0.3520	114
Gujarat	Bhavanagar	0.6789	0.5871	0.3517	115
West Bengal	Cooch Behar	0.8444	0.2571	0.3514	116
Jharkhand	Pakur	0.9144	0.1198	0.3505	117
Orissa	Gajapati	0.8826	0.1837	0.3504	118

State	District	NRI	ILI	RAPI	Priority Rank
Tamil Nadu	Thoothukudi	0.7067	0.5380	0.3495	119
Gujarat	Dahod	0.8033	0.3476	0.3486	120
Maharashtra	Amravati	0.6792	0.5964	0.3484	121
Orissa	Nawarangpur	0.8928	0.1703	0.3481	122
Madhya Pradesh	Mandla	0.8413	0.2748	0.3475	123
Andhra Pradesh	Prakasam	0.6944	0.5692	0.3473	124
Jharkhand	Giridish	0.8760	0.2062	0.3473	125
Chhattisgarh	Jashpur	0.8345	0.2894	0.3472	126
Andhra Pradesh	Rangareddy	0.6648	0.6319	0.3461	127
Tamil Nadu	Coimbatore	0.6191	0.7272	0.3448	128
Madhya Pradesh	Khandwa	0.7477	0.4718	0.3443	129
Uttar Pradesh	Basti	0.8176	0.3356	0.3431	130
Karnataka	Bellary	0.7296	0.5118	0.3430	131
Rajasthan	Ganganagar	0.7172	0.5367	0.3429	132
Madhya Pradesh	Sagar	0.8310	0.3137	0.3414	133
Jharkhand	Garhwa	0.8950	0.1862	0.3413	134
Madhya Pradesh	Dewas	0.7568	0.4629	0.3412	135
Uttar Pradesh	Budaun	0.7799	0.4170	0.3411	136
Maharashtra	Sangli	0.6235	0.7341	0.3397	137
Maharashtra	Dhule	0.6936	0.5942	0.3395	138
Karnataka	Chamarajanagar	0.7512	0.4830	0.3382	139
Karnataka	Haveri	0.7165	0.5534	0.3379	140
Chhattisgarh	Raj Nandgaon	0.8143	0.3580	0.3378	141
Assam	Kokrajhar	0.8795	0.2302	0.3369	142
Maharashtra	Buldhana	0.7113	0.5671	0.3368	143
Bihar	Kishanganj	0.9154	0.1591	0.3367	144
Madhya Pradesh	Chhatarpur	0.8313	0.3283	0.3364	145
Madhya Pradesh	Vidisha	0.7994	0.3927	0.3361	146
Madhya Pradesh	Bhind	0.7762	0.4392	0.3361	147
Tamil Nadu	Dharmapuri	0.7118	0.5692	0.3357	148
Madhya Pradesh	Seoni	0.8299	0.3333	0.3356	149
Madhya Pradesh	Sheopur Kalan	0.8348	0.3235	0.3356	150
Karnataka	Davanagere	0.7176	0.5616	0.3344	151
Gujarat	Panchmahal	0.7914	0.4170	0.3334	152
Uttar Pradesh	Fatehpur	0.8024	0.3952	0.3333	153
Madhya Pradesh	Indore	0.6898	0.6227	0.3326	154
Uttar Pradesh	Jhansi	0.7755	0.4517	0.3324	155
Maharashtra	Osmanabad	0.7174	0.5682	0.3323	156
Tamil Nadu	Dindigual	0.6975	0.6091	0.3320	157
Madhya Pradesh	Damoh	0.8427	0.3202	0.3315	158
Bihar	Gopalganj	0.8830	0.2423	0.3305	159

State	District	NRI	ILI	RAPI	Priority Rank
Andhra Pradesh	Visakhapatnam	0.8054	0.3987	0.3302	160
Maharashtra	Jalna	0.7508	0.5101	0.3294	161
Maharashtra	Aurangabad	0.7298	0.5532	0.3291	162
Bihar	Champaran(West)	0.9085	0.1959	0.3290	163
Jharkhand	Bokaro	0.8780	0.2569	0.3290	164
Uttar Pradesh	Lalitpur	0.8412	0.3315	0.3287	165
Tamil Nadu	Ariyalur	0.7403	0.5360	0.3278	166
Bihar	Jamui	0.9164	0.1841	0.3277	167
West Bengal	Midnapore	0.8622	0.2935	0.3273	168
Bihar	Darbhanga	0.8874	0.2458	0.3265	169
Uttar Pradesh	Gonda	0.8229	0.3762	0.3260	170
Jharkhand	Chtra	0.9314	0.1610	0.3254	171
Andhra Pradesh	Medak	0.7365	0.5509	0.3254	172
Chhattisgarh	Kawardha	0.8705	0.2832	0.3253	173
Jharkhand	Hazaribag	0.8715	0.2814	0.3252	174
Orissa	Mayurbhanj	0.9025	0.2205	0.3248	175
Bihar	Banka	0.9248	0.1769	0.3245	176
Chhattisgarh	Mahasamund	0.8453	0.3366	0.3243	177
Madhya Pradesh	Neemuch	0.7391	0.5493	0.3241	178
Orissa	Sundargarh	0.8806	0.2675	0.3237	179
Chhattisgarh	Kanker	0.8641	0.3044	0.3225	180
Chhattisgarh	Koriya	0.8740	0.2850	0.3223	181
Uttarakhand	Tehri Garwal	0.8061	0.4211	0.3222	182
Uttar Pradesh	Mirzapur	0.8289	0.3781	0.3214	183
West Bengal	Dinajpur (Uttar)	0.9024	0.2318	0.3211	184
Madhya Pradesh	Katni	0.8475	0.3438	0.3204	185
Madhya Pradesh	Raisen	0.8397	0.3599	0.3202	186
Tamil Nadu	Ramanathapuram	0.8016	0.4387	0.3194	187
Orissa	Keonjhar	0.8902	0.2623	0.3191	188
Gujarat	Sabarkanta	0.7416	0.5627	0.3180	189
Bihar	Samastipur	0.8923	0.2616	0.3179	190
Assam	Dhubri	0.8947	0.2580	0.3176	191
Haryana	Mahendragarh	0.6907	0.6666	0.3173	192
Madhya Pradesh	Umaria	0.8721	0.3047	0.3170	193
West Bengal	24-Paraganas (South)	0.8327	0.3837	0.3169	194
Bihar	Katihar	0.9295	0.1903	0.3169	195
Bihar	Vaishali	0.8968	0.2566	0.3166	196
Gujarat	Mehsana	0.6989	0.6528	0.3164	197
Chhattisgarh	Bilaspur	0.8641	0.3231	0.3162	198
Uttar Pradesh	Kheri	0.8281	0.3957	0.3161	199
Madhya Pradesh	Morena	0.8212	0.4094	0.3160	200

State	District	NRI	ILI	RAPI	Priority Rank
Bihar	Purnea	0.9263	0.2004	0.3157	201
Maharashtra	Parbhani	0.7790	0.4953	0.3156	202
Chhattisgarh	Raigadh	0.8501	0.3536	0.3154	203
Tamil Nadu	Villupuram	0.7641	0.5281	0.3146	204
Assam	Barpeta	0.8608	0.3354	0.3143	205
Bihar	Araria	0.9342	0.1892	0.3141	206
Bihar	Madhubani	0.8932	0.2712	0.3141	207
Uttar Pradesh	Shahjahanpur	0.8308	0.3968	0.3139	208
Uttar Pradesh	Faizabad	0.7887	0.4817	0.3136	209
Chhattisgarh	Durg	0.8214	0.4174	0.3133	210
Madhya Pradesh	Sehore	0.8266	0.4100	0.3123	211
Orissa	Boudh	0.9465	0.1711	0.3120	212
Bihar	Muzafarpur	0.9021	0.2601	0.3119	213
Uttar Pradesh	Shravasti	0.8822	0.3013	0.3114	214
Bihar	Saran	0.9007	0.2652	0.3111	215
Haryana	Sirsa	0.6880	0.6918	0.3107	216
Orissa	Deogarh	0.9447	0.1786	0.3106	217
Assam	Bongaigaon	0.9019	0.2647	0.3105	218
Orissa	Nawapara	0.8976	0.2744	0.3101	219
Uttar Pradesh	Agra	0.7668	0.5383	0.3094	220
Assam	N C Hills	0.8897	0.2956	0.3083	221
Assam	Dhemaji	0.9056	0.2642	0.3082	222
Assam	Goalpara	0.8846	0.3077	0.3077	223
Uttar Pradesh	Rae-Bareily	0.8244	0.4282	0.3076	224
Chhattisgarh	Korba	0.8737	0.3307	0.3073	225
Bihar	Bhagalpur	0.9038	0.2730	0.3064	226
Bihar	Champaran(East)	0.8962	0.2904	0.3057	227
Bihar	Siwan	0.8976	0.2880	0.3056	228
Uttar Pradesh	Siddharth Nagar	0.8900	0.3044	0.3052	229
West Bengal	Jalpaiguri	0.8611	0.3639	0.3047	230
Uttar Pradesh	Etah	0.8174	0.4529	0.3041	231
Uttar Pradesh	Ballia	0.8382	0.4123	0.3038	232
Uttar Pradesh	Sant Kabir Nagar	0.8772	0.3355	0.3034	233
Uttar Pradesh	Allahabad	0.8213	0.4484	0.3030	234
Assam	Darrang	0.8690	0.3531	0.3030	235
Uttar Pradesh	Hatharas	0.7773	0.5374	0.3027	236
Uttar Pradesh	Hardoi	0.8583	0.3753	0.3027	237
Uttar Pradesh	Balrampur	0.8656	0.3609	0.3027	238
Jharkhand	Lohardaga	0.9449	0.2056	0.3015	239
Orissa	Angul	0.9167	0.2623	0.3015	240
Tamil Nadu	Namakkal	0.7211	0.6563	0.3005	241

State	District	NRI	ILI	RAPI	Priority Rank
Uttarakhand	Bageshwar	0.8619	0.3761	0.3001	242
Uttar Pradesh	Azamgarh	0.8344	0.4317	0.2998	243
Bihar	Gaya	0.9362	0.2284	0.2997	244
Madhya Pradesh	Tikamgarh	0.8754	0.3519	0.2991	245
Haryana	Bhiwani	0.6943	0.7145	0.2990	246
Andhra Pradesh	Khammam	0.8114	0.4806	0.2989	247
Jharkhand	Koderma	0.9213	0.2639	0.2978	248
Orissa	Sambalpur	0.9217	0.2633	0.2978	249
Andhra Pradesh	Nalgonda	0.7718	0.5636	0.2976	250
Uttar Pradesh	Ghazipur	0.8645	0.3783	0.2975	251
Uttar Pradesh	Jalaun	0.8123	0.4828	0.2975	252
Uttar Pradesh	Kushi Nagar	0.8716	0.3648	0.2973	253
Madhya Pradesh	Jabalpur	0.8643	0.3806	0.2970	254
Maharashtra	Jalgaon	0.6996	0.7100	0.2970	255
Uttar Pradesh	Deoria	0.8473	0.4148	0.2968	256
Maharashtra	Akola	0.7548	0.6006	0.2966	257
Chhattisgarh	Raipur	0.8660	0.3785	0.2965	258
Uttar Pradesh	Mathura	0.7839	0.5428	0.2965	259
Tamil Nadu	Theni	0.7191	0.6734	0.2961	260
Uttar Pradesh	Sultanpur	0.8235	0.4648	0.2960	261
Gujarat	Vadodara	0.8067	0.4993	0.2958	262
Karnataka	Dharwad	0.7671	0.5788	0.2956	263
Uttar Pradesh	Jaunpur	0.8388	0.4362	0.2954	264
Maharashtra	Hingoli	0.8134	0.4872	0.2954	265
Uttar Pradesh	Mainpuri	0.8320	0.4516	0.2948	266
West Bengal	Malda	0.9175	0.2820	0.2943	267
Uttar Pradesh	Pilibhit	0.8430	0.4316	0.2941	268
Uttar Pradesh	Kaushambi	0.8663	0.3856	0.2940	269
Uttar Pradesh	Saharanpur	0.7501	0.6183	0.2938	270
Assam	Sonitpur	0.8674	0.3842	0.2937	271
Madhya Pradesh	Bhopal	0.8279	0.4660	0.2927	272
Assam	Kamrup	0.8448	0.4323	0.2927	273
Orissa	Baragarh	0.8913	0.3394	0.2927	274
Assam	Cachar	0.8627	0.3970	0.2925	275
Maharashtra	Washim	0.7908	0.5423	0.2920	276
Gujarat	Dang	0.8965	0.3344	0.2909	277
Bihar	Buxar	0.9091	0.3138	0.2893	278
Tamil Nadu	Vellore	0.7701	0.5921	0.2892	279
Uttar Pradesh	Farrukhabad	0.8323	0.4721	0.2878	280
Bihar	Bhojpur	0.9001	0.3383	0.2872	281
Orissa	Nayagarh	0.9377	0.2634	0.2871	282

State	District	NRI	ILI	RAPI	Priority Rank
West Bengal	Murshidabad	0.9130	0.3135	0.2868	283
Haryana	Fatehabad	0.7260	0.6883	0.2866	284
Assam	Golaghat	0.8745	0.3911	0.2866	285
Assam	Nalbari	0.8700	0.4025	0.2859	286
Bihar	Sitamarhi	0.9423	0.2585	0.2856	287
Jharkhand	Dhanbad	0.8906	0.3638	0.2850	288
Bihar	Patna	0.8869	0.3723	0.2846	289
Karnataka	Mysore	0.8053	0.5387	0.2835	290
Bihar	Supaul	0.9496	0.2506	0.2834	291
West Bengal	Bankura	0.9299	0.2945	0.2819	292
Gujarat	Gandhinagar	0.7416	0.6714	0.2818	293
Uttar Pradesh	Aligarh	0.7999	0.5572	0.2810	294
Maharashtra	Nagpur	0.7908	0.5755	0.2809	295
Uttar Pradesh	Kanpur (Dehat)	0.8628	0.4320	0.2808	296
Bihar	Bhabhua(kaimur)	0.9288	0.3027	0.2799	297
Maharashtra	Chandrapur	0.8534	0.4538	0.2798	298
Uttar Pradesh	Sitapur	0.8844	0.3924	0.2796	299
Orissa	Sonepur	0.9580	0.2461	0.2793	300
Bihar	Begusarai	0.9259	0.3119	0.2788	301
Bihar	Saharsa	0.9563	0.2513	0.2787	302
Uttarakhand	Chamoli	0.8484	0.4674	0.2786	303
Bihar	Lakhisarai	0.9444	0.2780	0.2777	304
Gujarat	Kheda	0.8190	0.5294	0.2775	305
Uttar Pradesh	Firozabad	0.8408	0.4877	0.2769	306
Orissa	Ganjam	0.9282	0.3145	0.2764	307
Tamil Nadu	Virudhunagar	0.7936	0.5845	0.2761	308
Uttar Pradesh	Mau	0.8623	0.4489	0.2755	309
Haryana	Gurgaon	0.6991	0.7757	0.2753	310
Gujarat	Bharuch	0.7719	0.6316	0.2749	311
Assam	Nagaon	0.8870	0.4030	0.2744	312
Punjab	Firozpur	0.7400	0.6972	0.2743	313
Uttar Pradesh	Mharajganj	0.9054	0.3672	0.2740	314
Gujarat	Narmada	0.8773	0.4245	0.2736	315
Madhya Pradesh	Datia	0.8411	0.4991	0.2729	316
Andhra Pradesh	Vizianagaram	0.8461	0.4893	0.2728	317
Maharashtra	Gadchiroli	0.9271	0.3279	0.2726	318
Uttar Pradesh	Kannauj	0.8750	0.4325	0.2725	319
Bihar	Sivhar	0.9658	0.2513	0.2724	320
Karnataka	Mandya	0.8102	0.5631	0.2722	321
Maharashtra	Thane	0.8168	0.5503	0.2721	322
Madhya Pradesh	Narsinghpur	0.8980	0.3898	0.2714	323

State	District	NRI	ILI	RAPI	Priority Rank
Uttar Pradesh	Pratapgarh	0.8810	0.4240	0.2713	324
Uttar Pradesh	Chandauli	0.8913	0.4042	0.2711	325
Punjab	Mansa	0.7437	0.6993	0.2711	326
Uttar Pradesh	Etawah	0.8680	0.4546	0.2698	327
Assam	Hailakandi	0.8924	0.4062	0.2697	328
Bihar	Aurangabad	0.9463	0.2985	0.2696	329
Uttar Pradesh	Auraiya	0.8883	0.4145	0.2696	330
Bihar	Nalanda	0.9331	0.3260	0.2693	331
West Bengal	Dinajpur (Dakshin)	0.9711	0.2509	0.2690	332
Madhya Pradesh	Balaghat	0.9212	0.3508	0.2689	333
Assam	Morigon	0.9386	0.3163	0.2688	334
Assam	Karimganj	0.8933	0.4095	0.2680	335
Assam	Tinsukia	0.8718	0.4528	0.2679	336
Uttar Pradesh	Unnao	0.8928	0.4115	0.2676	337
Tamil Nadu	Perambalur	0.8213	0.5555	0.2673	338
Uttar Pradesh	Gorakhpur	0.9124	0.3736	0.2672	339
Karnataka	Hassan	0.8127	0.5730	0.2672	340
Maharashtra	Wardha	0.8006	0.5982	0.2669	341
Madhya Pradesh	Gwalior	0.8384	0.5238	0.2665	342
Uttar Pradesh	Sant Ravidas Nagar	0.8643	0.4771	0.2648	343
Uttar Pradesh	Ambedkar Nagar	0.8978	0.4106	0.2646	344
Bihar	Jahanabad	0.9518	0.3035	0.2643	345
Chhattisgarh	Janjgir	0.9224	0.3665	0.2629	346
Tamil Nadu	Thirunelveli	0.8099	0.5943	0.2620	347
Tamil Nadu	Thiruvannamalai	0.7933	0.6278	0.2619	348
Haryana	Kaithal	0.7384	0.7391	0.2614	349
Himachal Pradesh	Chamba	0.8547	0.5066	0.2614	350
Assam	Lakhimpur	0.9166	0.3839	0.2610	351
Punjab	Faridkot	0.7189	0.7795	0.2609	352
Andhra Pradesh	Warangal	0.8516	0.5159	0.2603	353
West Bengal	Nadia	0.9080	0.4053	0.2596	354
Bihar	Nawadha	0.9660	0.2904	0.2592	355
Uttarakhand	Almora	0.8903	0.4429	0.2588	356
Bihar	Monghyr	0.9505	0.3235	0.2585	357
Orissa	Balasore	0.9619	0.3046	0.2572	358
Uttar Pradesh	Varanasi	0.8592	0.5101	0.2571	359
Uttar Pradesh	Lucknow	0.8588	0.5128	0.2565	360
Uttar Pradesh	Bijnor	0.8246	0.5813	0.2565	361
Uttar Pradesh	Moradabad	0.8544	0.5250	0.2554	362
Uttarakhand	Haridwar	0.8000	0.6337	0.2554	363
Andhra Pradesh	Srikakulam	0.8849	0.4643	0.2553	364

State	District	NRI	ILI	RAPI	Priority Rank
Andhra Pradesh	Nizamabad	0.8070	0.6206	0.2552	365
Assam	Dibrugarh	0.8751	0.4854	0.2548	366
Bihar	Madhupura	0.9782	0.2815	0.2540	367
Uttar Pradesh	J.B.Fule Nagar	0.8677	0.5054	0.2531	368
Uttarakhand	Champawat	0.9093	0.4240	0.2525	369
Orissa	Dhenkanal	0.9451	0.3529	0.2523	370
Orissa	Jaipur	0.9586	0.3273	0.2518	371
Bihar	Khagaria	0.9658	0.3130	0.2518	372
Maharashtra	Raigad	0.7961	0.6525	0.2517	373
Haryana	Rewari	0.7554	0.7359	0.2511	374
Uttar Pradesh	Kanpur City	0.8784	0.4918	0.2505	375
Maharashtra	Ratnagiri	0.8112	0.6268	0.2502	376
Chhattisgarh	Dhamtari	0.9354	0.3816	0.2492	377
Andhra Pradesh	Nellore	0.8528	0.5473	0.2490	378
Uttarakhand	Pauri Garhwal	0.8781	0.4966	0.2490	379
Tamil Nadu	Pudukkottai	0.8679	0.5178	0.2488	380
Bihar	Rohtas	0.9506	0.3528	0.2487	381
Orissa	Kendrapara	0.9567	0.3418	0.2483	382
Uttar Pradesh	Barabanki	0.9015	0.4530	0.2480	383
Maharashtra	Satara	0.7680	0.7228	0.2470	384
West Bengal	Darjeeling	0.9062	0.4470	0.2469	385
Andhra Pradesh	Karimnagar	0.8372	0.5910	0.2448	386
Uttarakhand	Uttarkashi	0.8953	0.4792	0.2434	387
Orissa	Jharsuguda	0.9200	0.4318	0.2427	388
Orissa	Bhadrak	0.9672	0.3388	0.2422	389
Madhya Pradesh	Hoshangabad	0.9321	0.4114	0.2415	390
Haryana	Karnal	0.7490	0.7787	0.2411	391
Madhya Pradesh	Harda	0.9426	0.3929	0.2407	392
Haryana	Panipet	0.7318	0.8144	0.2407	393
Tamil Nadu	Nagapattinam	0.8371	0.6041	0.2405	394
Andhra Pradesh	Guntur	0.8051	0.6694	0.2402	395
Uttar Pradesh	Muzaffarnagar	0.8007	0.6799	0.2395	396
Uttarakhand	Pithoragarh	0.9150	0.4526	0.2392	397
Uttar Pradesh	Bareilly	0.8939	0.4976	0.2382	398
West Bengal	24-Paraganas (North)	0.9225	0.4456	0.2365	399
Karnataka	Bangalore (Urban)	0.7598	0.7750	0.2352	400
Assam	Jorhat	0.8941	0.5069	0.2350	401
Assam	Sibsagar	0.8744	0.5507	0.2335	402
Bihar	Sheikhpura	0.9747	0.3508	0.2332	403
Orissa	Jagatsingpur	0.9893	0.3234	0.2327	404
Uttar Pradesh	Bagpat	0.8040	0.6987	0.2311	405

State	District	NRI	ILI	RAPI	Priority Rank
Punjab	Moga	0.7272	0.8540	0.2305	406
Tamil Nadu	Erode	0.8131	0.6832	0.2302	407
Tamil Nadu	Madurai	0.8614	0.5879	0.2298	408
Maharashtra	Sindhudurg	0.8334	0.6478	0.2285	409
Tamil Nadu	Sivaganagai	0.8733	0.5684	0.2283	410
Maharashtra	Gondia	0.9319	0.4531	0.2277	411
Tamil Nadu	Thiruvarur	0.8710	0.5762	0.2273	412
Tamil Nadu	Kanniyakumari	0.8172	0.6844	0.2271	413
Uttarakhand	Rudraprayag	0.8930	0.5339	0.2267	414
Tamil Nadu	Thanjavur	0.8661	0.5884	0.2265	415
Orissa	Cuttack	0.9907	0.3483	0.2234	416
Uttar Pradesh	Bulandshahar	0.8658	0.6006	0.2226	417
Punjab	Sangrur	0.7391	0.8567	0.2217	418
Punjab	Bathinda	0.7575	0.8210	0.2213	419
Orissa	Puri	1.0000	0.3362	0.2213	420
Andhra Pradesh	East Godavari	0.8906	0.5553	0.2212	421
Tamil Nadu	Cuddalore	0.8842	0.5694	0.2207	422
Tamil Nadu	Thiruvallur	0.8496	0.6388	0.2207	423
West Bengal	Birbhum	0.9906	0.3573	0.2205	424
Himachal Pradesh	Mandi	0.8728	0.5956	0.2196	425
Orissa	Khurda	0.9766	0.3888	0.2194	426
Haryana	Sonipet	0.7365	0.8697	0.2191	427
Maharashtra	Bhandara	0.9280	0.4875	0.2189	428
Tamil Nadu	Karur	0.8591	0.6269	0.2183	429
Gujarat	Anand	0.8588	0.6289	0.2179	430
Haryana	Hissar	0.7983	0.7574	0.2153	431
Himachal Pradesh	Simla	0.8283	0.6998	0.2146	432
Tamil Nadu	Thiruchirapalli	0.8596	0.6379	0.2143	433
Karnataka	Chikmagalur	0.8729	0.6128	0.2138	434
Haryana	Faridabad	0.8356	0.6876	0.2137	435
Punjab	Amritsar	0.8018	0.7570	0.2131	436
Himachal Pradesh	Kulu	0.8303	0.7012	0.2127	437
Uttar Pradesh	Rampur	0.9123	0.5496	0.2086	438
Himachal Pradesh	Kinnaur	0.8176	0.7404	0.2081	439
Haryana	Jhajjar	0.7889	0.7997	0.2075	440
Gujarat	Valasad	0.9090	0.5674	0.2049	441
Gujarat	Surat	0.8762	0.6342	0.2045	442
Himachal Pradesh	Sirmaur	0.9085	0.5756	0.2025	443
Karnataka	Uttara Kannada	0.8976	0.6016	0.2010	444
Haryana	Jind	0.8275	0.7430	0.2007	445
Punjab	Muktsar	0.8365	0.7298	0.1990	446

State	District	NRI	ILI	RAPI	Priority Rank
Punjab	Gurdaspur	0.8121	0.7881	0.1959	447
Uttar Pradesh	Ghaziabad	0.8395	0.7342	0.1956	448
Haryana	Kurukshetra	0.7890	0.8369	0.1950	449
Haryana	Yamunanagar	0.8161	0.7922	0.1919	450
Tamil Nadu	Kancheepuram	0.9006	0.6324	0.1888	451
Maharashtra	Kolhapur	0.8449	0.7452	0.1884	452
Himachal Pradesh	Kangra	0.8669	0.7035	0.1875	453
West Bengal	Howrah	0.9886	0.4649	0.1860	454
Himachal Pradesh	Bilaspur	0.8971	0.6507	0.1850	455
Uttarakhand	Udham Singh Nagar	0.8985	0.6524	0.1835	456
Punjab	Patiala	0.7853	0.8807	0.1829	457
West Bengal	Hooghly	0.9795	0.4968	0.1814	458
Punjab	Fathegarh Sahib	0.8037	0.8520	0.1802	459
Punjab	Kapurthala	0.7576	0.9446	0.1801	460
Kerala	Idukki	0.8276	0.8057	0.1797	461
Andhra Pradesh	Krishna	0.8985	0.6659	0.1791	462
Uttar Pradesh	Meerut	0.8861	0.6935	0.1781	463
West Bengal	Burdwan	0.9976	0.4792	0.1752	464
Himachal Pradesh	Una	0.8733	0.7461	0.1691	465
Kerala	Kasaragod	0.8621	0.7704	0.1685	466
Uttarakhand	Dehardun	0.8936	0.7098	0.1677	467
Kerala	Wayanad	0.8732	0.7508	0.1676	468
Himachal Pradesh	Hamirpur	0.8870	0.7233	0.1676	469
Kerala	Kozhikode	0.8655	0.7697	0.1664	470
Punjab	Nawan Shehar	0.7947	0.9200	0.1635	471
Andhra Pradesh	West Godavari	0.9345	0.6410	0.1634	472
Karnataka	Shimoga	0.9568	0.6011	0.1618	473
Uttar Pradesh	G.Buddha Nagar	0.8960	0.7245	0.1612	474
Kerala	Kannur	0.8701	0.7783	0.1605	475
Himachal Pradesh	Lahaul & Spiti	0.9095	0.7028	0.1594	476
Haryana	Panchkula	0.8624	0.8044	0.1569	477
Tamil Nadu	The Nilgiris	0.8791	0.7756	0.1554	478
Kerala	Thiruvanathapuram	0.8631	0.8166	0.1524	479
Kerala	Kollam	0.8634	0.8197	0.1512	480
Kerala	Palakkad	0.8788	0.7890	0.1511	481
Uttarakhand	Nainital	0.9624	0.6242	0.1503	482
Haryana	Rohtak	0.8606	0.8322	0.1489	483
Himachal Pradesh	Solan	0.9116	0.7335	0.1478	484
Punjab	Ludhiana	0.7855	0.9894	0.1465	485
Kerala	Malappuram	0.8742	0.8122	0.1465	486
Punjab	Jalandhar	0.7832	1.0000	0.1445	487

State	District	NRI	ILI	RAPI	Priority Rank
Karnataka	Kodagu	0.8992	0.7891	0.1375	488
Punjab	Rupnagar	0.8340	0.9220	0.1366	489
Gujarat	Navsari	0.9612	0.6945	0.1277	490
Punjab	Hoshiarpur	0.8564	0.9059	0.1271	491
Haryana	Ambala	0.8946	0.8908	0.1066	492
Kerala	Alappuzha	0.9098	0.8682	0.1041	493
Kerala	Kottayam	0.8680	0.9577	0.1021	494
Kerala	Thrissur	0.9108	0.8831	0.0984	495
Karnataka	Dakshina Kannada	0.9513	0.8067	0.0969	496
Karnataka	Udupi	0.9415	0.8474	0.0898	497
Kerala	Eranakulam	0.8982	0.9629	0.0802	498
Kerala	Pathanamthitta	0.9049	0.9553	0.0783	499

Note: The figures have been considered up to fourth decimal for depiction

RAPI = 2/3 (1-NRI) + 1/3 (1-ILI)

District-wise Milk Production Potential

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
High	AP	East Godavari	18.08	39.25	55.06	0.793	Medium
High	AP	Krishna	6.82	15.14	91.88	0.807	Medium
High	AP	Srikakulam	85.12	47.14	14.83	0.766	Low
High	AP	West Godavari	17.26	28.91	77.60	0.784	Medium
High	Assam	Bongaigaon	56.44	1.58	0.51	0.934	High
High	Assam	Dhemaji	60.06	0.06	2.47	0.931	High
High	Assam	Dhubri	94.65	1.87	4.28	0.885	Medium
High	Assam	Dibrugarh	62.87	3.64	4.73	0.915	High
High	Assam	Goalpara	62.85	2.57	1.91	0.922	High
High	Assam	Golaghat	60.79	2.65	3.42	0.922	High
High	Assam	Hailakandi	49.75	21.61	13.40	0.870	Medium
High	Assam	Jorhat	91.98	3.55	6.94	0.880	Medium
High	Assam	Karimganj	85.73	8.42	14.93	0.862	Medium
High	Assam	Kokrajhar	60.28	0.14	1.85	0.931	High
High	Assam	Lakhimpur	102.40	1.46	3.90	0.879	Medium
High	Assam	Morigon	102.82	7.55	5.33	0.861	Medium
High	Assam	N C Hills	4.14	27.13	3.65	0.922	High
High	Assam	Nagaon	111.97	11.70	1.66	0.846	Medium
High	Bihar	Araria	82.40	21.04	57.36	0.765	Low
High	Bihar	Aurangabad	82.40	21.04	57.36	0.765	Low
High	Bihar	Banka	82.40	21.04	57.36	0.765	Low
High	Bihar	Begusarai	82.40	21.04	57.36	0.765	Low
High	Bihar	Bhabhua(kaimur)	82.40	21.04	57.36	0.765	Low
High	Bihar	Bhagalpur	82.40	21.04	57.36	0.765	Low
High	Bihar	Bhojpur	82.40	21.04	57.36	0.765	Low
High	Bihar	Buxar	82.40	21.04	57.36	0.765	Low
High	Bihar	Champaran(East)	82.40	21.04	57.36	0.765	Low
High	Bihar	Champaran (West)	82.40	21.04	57.36	0.765	Low
High	Bihar	Darbhanga	82.40	21.04	57.36	0.765	Low
High	Bihar	Gaya	82.40	21.04	57.36	0.765	Low
High	Bihar	Gopalganj	82.40	21.04	57.36	0.765	Low
High	Bihar	Jahanabad	82.40	21.04	57.36	0.765	Low
High	Bihar	Jamui	82.40	21.04	57.36	0.765	Low
High	Bihar	Katihar	82.40	21.04	57.36	0.765	Low
High	Bihar	Khagaria	82.40	21.04	57.36	0.765	Low
High	Bihar	Kishanganj	82.40	21.04	57.36	0.765	Low

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
High	Bihar	Lakhisarai	82.40	21.04	57.36	0.765	Low
High	Bihar	Madhubani	82.40	21.04	57.36	0.765	Low
High	Bihar	Madhupura	82.40	21.04	57.36	0.765	Low
High	Bihar	Monghyr	82.40	21.04	57.36	0.765	Low
High	Bihar	Muzafarpur	82.40	21.04	57.36	0.765	Low
High	Bihar	Nalanda	82.40	21.04	57.36	0.765	Low
High	Bihar	Nawadha	82.40	21.04	57.36	0.765	Low
High	Bihar	Patna	82.40	21.04	57.36	0.765	Low
High	Bihar	Purnea	82.40	21.04	57.36	0.765	Low
High	Bihar	Rohtas	82.40	21.04	57.36	0.765	Low
High	Bihar	Saharsa	82.40	21.04	57.36	0.765	Low
High	Bihar	Samastipur	82.40	21.04	57.36	0.765	Low
High	Bihar	Saran	82.40	21.04	57.36	0.765	Low
High	Bihar	Sheikhpura	82.40	21.04	57.36	0.765	Low
High	Bihar	Sitamarhi	82.40	21.04	57.36	0.765	Low
High	Bihar	Sivhar	82.40	21.04	57.36	0.765	Low
High	Bihar	Siwan	82.40	21.04	57.36	0.765	Low
High	Bihar	Supaul	82.40	21.04	57.36	0.765	Low
High	Bihar	Vaishali	82.40	21.04	57.36	0.765	Low
High	Chhattisgarh	Dhamtari	47.38	1.56	8.05	0.932	High
High	Chhattisgarh	Janjgir	91.05	2.17	6.86	0.884	Medium
High	Gujarat	Dang	17.21	26.14	2.82	0.911	High
High	Gujarat	Narmada	20.03	3.42	18.30	0.940	High
High	Gujarat	Navsari	50.57	71.56	37.56	0.705	Low
High	Gujarat	Surat	32.89	41.11	48.36	0.783	Medium
High	Gujarat	Valasad	53.88	41.04	20.07	0.806	Medium
High	Haryana	Ambala	28.17	57.02	122.81	0.629	Low
High	HP	Bilaspur	17.74	76.83	78.81	0.661	Low
High	HP	Hamirpur	11.67	84.04	97.21	0.620	Low
High	HP	Lahaul & Spiti	0.72	62.15	0.00	0.844	Medium
High	HP	Sirmaur	55.45	23.40	15.77	0.856	Medium
High	HP	Solan	45.10	48.01	40.41	0.766	Low
High	Jharkhand	Bokaro	70.06	7.98	13.34	0.882	Medium
High	Jharkhand	Chtra	48.83	1.57	13.29	0.922	High
High	Jharkhand	Deoghar	113.78	2.24	15.88	0.845	Medium
High	Jharkhand	Dhanbad	13.27	37.72	4.68	0.884	Medium
High	Jharkhand	Garhwa	57.54	0.56	17.61	0.908	High
High	Jharkhand	Giridish	71.09	0.99	13.14	0.899	High
High	Jharkhand	Koderma	44.33	1.56	9.83	0.932	High
High	Jharkhand	Lohardaga	23.86	7.60	2.80	0.951	High

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
High	Jharkhand	Pakur	77.57	0.36	18.05	0.886	Medium
High	Jharkhand	Sahibganj	106.35	3.21	25.14	0.836	Medium
High	Karnataka	Coorg / Kodugu	17.51	34.40	4.07	0.888	Medium
High	Karnataka	Dakshina Kannada	71.57	43.50	1.08	0.812	Medium
High	Karnataka	Shimoga	41.92	19.92	17.95	0.876	Medium
High	Karnataka	Udupi	68.70	26.83	0.98	0.857	Medium
High	Karnataka	Uttara Kannada	20.96	14.09	8.59	0.928	High
High	Kerala	Alappuzha	52.21	99.81	1.52	0.691	Low
High	Kerala	Eranakulam	47.39	97.40	0.83	0.703	Low
High	Kerala	Palakkad	42.31	92.06	0.71	0.723	Low
High	Kerala	Pathanamthitta	32.27	99.18	0.22	0.716	Low
High	Kerala	Thrissur	41.39	97.22	1.85	0.709	Low
High	Maharashtra	Bhandara	29.28	33.29	19.61	0.853	Medium
High	Maharashtra	Gadchiroli	19.52	1.21	3.33	0.970	High
High	Maharashtra	Gondia	29.53	6.49	12.96	0.931	High
High	MP	Balaghat	26.00	1.29	10.10	0.952	High
High	MP	Harda	26.03	2.76	20.17	0.932	High
High	MP	Hoshangabad	32.25	3.08	14.59	0.934	High
High	MP	Narsinghpur	47.96	3.50	21.12	0.905	High
High	MP	Tikamgarh	64.23	1.23	49.63	0.847	Medium
High	Orissa	Angul	30.23	5.45	3.02	0.949	High
High	Orissa	Balasore (Baleshwar)	117.97	3.43	0.74	0.862	Medium
High	Orissa	Baragarh	27.03	33.87	2.28	0.882	Medium
High	Orissa	Bhadrak	165.58	37.34	4.61	0.719	Low
High	Orissa	Boudh	28.96	5.70	6.31	0.944	High
High	Orissa	Cuttack	63.32	28.23	5.66	0.851	Medium
High	Orissa	Deogarh	25.67	23.50	1.34	0.911	High
High	Orissa	Dhenkanal	51.47	4.10	6.40	0.923	High
High	Orissa	Gajapati	9.99	27.82	1.67	0.917	High
High	Orissa	Ganjam	39.80	26.62	5.41	0.881	Medium
High	Orissa	Jagatsingpur	72.44	33.90	5.99	0.827	Medium
High	Orissa	Jaipur	133.67	2.69	3.55	0.842	Medium
High	Orissa	Jharsuguda	33.73	8.85	2.17	0.938	High
High	Orissa	Kendrapara	101.59	12.36	3.88	0.852	Medium
High	Orissa	Keonjhar	38.30	7.12	2.20	0.937	High
High	Orissa	Khurda	3.81	24.60	2.27	0.931	High
High	Orissa	Koraput	35.65	5.09	5.29	0.940	High
High	Orissa	Malkangiri	36.21	2.64	3.91	0.948	High
High	Orissa	Mayurbhanj	31.05	5.74	0.92	0.950	High
High	Orissa	Nawapara	15.27	5.13	3.94	0.964	High

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
High	Orissa	Nawarangpur	26.98	8.72	3.39	0.943	High
High	Orissa	Nayagarh	30.90	11.75	4.11	0.930	High
High	Orissa	Phulbani (Kandhamal)	13.07	21.75	4.66	0.924	High
High	Orissa	Puri	76.66	4.60	6.04	0.895	Medium
High	Orissa	Rayagada	15.51	48.67	7.79	0.849	Medium
High	Orissa	Sambalpur	19.15	13.07	1.08	0.945	High
High	Orissa	Sonepur	36.99	23.06	2.56	0.898	High
High	Orissa	Sundargarh	26.65	2.76	1.96	0.961	High
High	Tamil Nadu	Cuddalore	70.84	72.56	4.15	0.735	Low
High	Tamil Nadu	Kancheepuram	104.79	48.74	27.77	0.719	Low
High	Tamil Nadu	The Nilgiris	12.20	79.74	0.36	0.787	Medium
High	UP	Ambedkar Nagar	57.38	7.94	91.86	0.770	Medium
High	UP	Auraiya	40.11	4.71	81.82	0.813	Medium
High	UP	Barabanki	50.31	3.37	56.96	0.845	Medium
High	UP	Bareilly	37.69	3.88	90.84	0.803	Medium
High	UP	Chandauli	54.19	3.84	62.27	0.831	Medium
High	UP	G.Buddha Nagar	24.06	60.87	169.16	0.549	Low
High	UP	Gorakhpur	64.65	29.61	55.52	0.766	Medium
High	UP	Kannauj	46.77	5.42	90.42	0.790	Medium
High	UP	Kanpur City	55.40	3.49	87.02	0.791	Medium
High	UP	Meerut	48.86	65.79	255.72	0.370	Low
High	UP	Mharajganj	29.27	25.55	42.65	0.835	Medium
High	UP	Pratapgarh	51.98	15.04	50.54	0.824	Medium
High	UP	Rampur	34.50	21.26	61.15	0.811	Medium
High	UP	Sant Kabir Nagar	65.15	16.55	63.69	0.785	Medium
High	UP	Shravasti	55.91	0.98	38.87	0.874	Medium
High	UP	Siddharth Nagar	35.48	3.14	36.45	0.895	Medium
High	UP	Sitapur	52.05	0.63	50.85	0.860	Medium
High	UP	Unnao	42.57	1.89	75.07	0.828	Medium
High	Uttarakhand	Almora	43.18	13.40	34.88	0.863	Medium
High	Uttarakhand	Champawat	35.79	18.69	19.26	0.883	Medium
High	Uttarakhand	Dehardun	38.44	33.34	18.75	0.845	Medium
High	Uttarakhand	Nainital	29.88	29.22	25.33	0.854	Medium
High	Uttarakhand	Pauri Garhwal	43.74	7.03	9.63	0.919	High
High	Uttarakhand	Pithoragarh	19.73	12.69	9.94	0.931	High
High	Uttarakhand	Rudraprayag	27.76	3.23	20.73	0.928	High
High	Uttarakhand	Udham Singh Nagar	41.05	57.54	60.74	0.713	Low
High	Uttarakhand	Uttarkashi	6.87	20.27	4.61	0.934	High
High	West Bengal	24-Paraganas (North)	168.13	38.03	8.67	0.708	Low
High	West Bengal	Bankura	129.87	8.91	3.58	0.831	Medium

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
High	West Bengal	Birbhum	124.87	10.54	3.40	0.832	Medium
High	West Bengal	Burdwan	172.95	16.07	7.48	0.760	Low
High	West Bengal	Darjeeling	60.85	33.69	1.39	0.847	Medium
High	West Bengal	Dinajpur (Dakshin)	144.13	4.19	0.11	0.832	Medium
High	West Bengal	Dinajpur (Uttar)	146.52	7.09	1.73	0.820	Medium
High	West Bengal	Hooghly	229.70	25.63	6.94	0.675	Low
High	West Bengal	Howrah	194.27	13.88	7.06	0.742	Low
High	West Bengal	Malda	119.62	12.27	3.02	0.834	Medium
High	West Bengal	Murshidabad	162.63	44.26	4.68	0.705	Low
High	West Bengal	Nadia	159.48	44.24	1.46	0.713	Low
Medium	AP	Guntur	4.86	7.94	91.27	0.828	Medium
Medium	AP	Karimnagar	13.44	12.23	47.38	0.878	Medium
Medium	AP	Khammam	25.11	0.61	39.49	0.907	High
Medium	AP	Nellore	7.32	11.79	50.79	0.881	Medium
Medium	AP	Nizamabad	21.82	1.82	50.63	0.890	Medium
Medium	AP	Visakhapatnam	27.62	37.12	33.06	0.824	Medium
Medium	AP	Vizianagaram	40.20	48.65	29.77	0.787	Medium
Medium	AP	Warangal	19.28	3.67	47.64	0.893	Medium
Medium	Assam	Barpeta	80.80	8.76	2.81	0.886	Medium
Medium	Assam	Cachar	53.13	6.93	10.53	0.908	High
Medium	Assam	Darrang	48.49	3.55	2.59	0.934	High
Medium	Assam	Kamrup	78.41	12.20	0.82	0.883	Medium
Medium	Assam	Karbi-Anglong	17.33	4.76	0.73	0.968	High
Medium	Assam	Nalbari	56.91	11.98	1.82	0.905	High
Medium	Assam	Sibsagar	78.09	3.65	6.09	0.896	Medium
Medium	Assam	Sonitpur	68.01	5.22	2.19	0.909	High
Medium	Assam	Tinsukia	38.50	4.48	0.29	0.946	High
Medium	Chhattisgarh	Bilaspur	57.62	2.55	7.22	0.919	High
Medium	Chhattisgarh	Dantiwara	14.38	0.69	2.28	0.979	High
Medium	Chhattisgarh	Durg	76.76	1.48	8.73	0.899	High
Medium	Chhattisgarh	Jashpur	22.75	2.23	3.03	0.965	High
Medium	Chhattisgarh	Kanker	23.77	2.55	1.48	0.965	High
Medium	Chhattisgarh	kawardha	40.40	0.29	3.46	0.950	High
Medium	Chhattisgarh	Korba	22.65	3.32	4.21	0.960	High
Medium	Chhattisgarh	Koriya	19.12	1.79	3.56	0.969	High
Medium	Chhattisgarh	Mahasamund	38.97	4.75	4.65	0.938	High
Medium	Chhattisgarh	Raigadh	29.78	12.98	2.36	0.931	High
Medium	Chhattisgarh	Raipur	53.20	2.01	7.49	0.925	High
Medium	Chhattisgarh	Raj Nandgaon	43.56	0.83	3.67	0.945	High
Medium	Gujarat	Anand	39.56	51.72	126.88	0.623	Low

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
Medium	Gujarat	Dahod	59.75	1.08	60.13	0.835	Medium
Medium	Gujarat	Kheda	32.26	48.39	134.19	0.627	Low
Medium	Gujarat	Vadodara	28.47	8.72	53.88	0.860	Medium
Medium	Haryana	Faridabad	25.10	34.68	139.74	0.661	Low
Medium	Haryana	Hissar	18.21	25.14	105.18	0.748	Low
Medium	Haryana	Jind	19.49	15.24	155.04	0.691	Low
Medium	Haryana	Panchkula	16.70	21.73	67.46	0.819	Medium
Medium	Haryana	Rohtak	15.69	28.99	132.18	0.697	Low
Medium	Haryana	Yamunanagar	48.24	68.56	99.42	0.616	Low
Medium	HP	Chamba	27.47	14.22	5.61	0.925	High
Medium	HP	Kangra	38.37	64.11	24.73	0.758	Low
Medium	HP	Kinnaur	2.69	54.60	0.02	0.860	Medium
Medium	HP	Kulu	25.64	54.08	0.15	0.837	Medium
Medium	HP	Mandi	75.31	56.00	19.24	0.747	Low
Medium	HP	Simla	41.53	48.10	2.50	0.830	Medium
Medium	HP	Una	19.34	63.21	72.53	0.704	Low
Medium	Jharkhand	Dumka	68.43	1.43	6.20	0.912	High
Medium	Jharkhand	East Singbhum	43.23	8.31	2.62	0.928	High
Medium	Jharkhand	Godda	105.70	0.73	25.35	0.842	Medium
Medium	Jharkhand	Gumla	41.83	0.56	5.04	0.945	High
Medium	Jharkhand	Hazaribag	60.86	3.33	9.18	0.911	High
Medium	Jharkhand	Palamu	45.57	1.16	13.28	0.926	High
Medium	Jharkhand	Ranchi	32.21	10.92	6.05	0.928	High
Medium	Jharkhand	West Singbhum	14.40	5.66	1.40	0.968	High
Medium	Karnataka	Chikmagalur	32.80	19.07	11.45	0.898	High
Medium	Karnataka	Hassan	63.71	33.18	25.12	0.807	Medium
Medium	Karnataka	Mandya	56.13	53.21	32.60	0.753	Low
Medium	Karnataka	Mysore	57.56	32.45	8.82	0.842	Medium
Medium	Kerala	Idukki	32.78	94.38	0.43	0.728	Low
Medium	Kerala	Kannur	35.75	96.94	0.17	0.718	Low
Medium	Kerala	Kasaragod	35.62	56.58	1.26	0.818	Medium
Medium	Kerala	Kollam	46.14	99.24	1.10	0.700	Low
Medium	Kerala	Kottayam	52.71	99.58	0.58	0.693	Low
Medium	Kerala	Kozhikode	49.38	82.85	0.26	0.739	Low
Medium	Kerala	Malappuram	25.87	93.35	1.82	0.735	Low
Medium	Kerala	Thiruvanathapuram	63.75	98.88	0.83	0.682	Low
Medium	Kerala	Wayanad	27.56	94.18	0.60	0.733	Low
Medium	Maharashtra	Chandrapur	19.90	5.67	6.09	0.954	High
Medium	Maharashtra	Hingoli	23.83	6.36	14.33	0.935	High
Medium	Maharashtra	Kolhapur	19.60	79.09	78.42	0.654	Low

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
Medium	Maharashtra	Ratnagiri	19.25	6.79	4.40	0.955	High
Medium	Maharashtra	Sindhudurg	12.45	10.59	10.23	0.943	High
Medium	Maharashtra	Thane	19.11	4.36	16.48	0.942	High
Medium	Maharashtra	Wardha	28.12	21.62	8.49	0.902	High
Medium	MP	Bhopal	36.80	17.18	34.17	0.862	Medium
Medium	MP	Chhatarpur	35.34	0.33	32.13	0.909	High
Medium	MP	Damoh	49.31	0.24	13.97	0.923	High
Medium	MP	Datia	30.92	0.69	60.78	0.867	Medium
Medium	MP	Dindori	21.98	0.03	5.11	0.968	High
Medium	MP	Gwalior	35.09	4.38	48.44	0.873	Medium
Medium	MP	Jabalpur	46.92	5.03	17.82	0.908	High
Medium	MP	Katni	54.21	0.42	13.54	0.918	High
Medium	MP	Mandla	38.61	1.09	7.47	0.943	High
Medium	MP	Morena	20.74	2.39	81.68	0.840	Medium
Medium	MP	Panna	42.84	0.30	18.41	0.923	High
Medium	MP	Raisen	34.03	2.74	13.12	0.935	High
Medium	MP	Sagar	53.40	0.62	18.85	0.910	High
Medium	MP	Sehore	35.14	14.45	16.55	0.899	High
Medium	MP	Seoni	26.64	4.05	11.02	0.943	High
Medium	MP	Sheopur Kalan	28.61	0.17	16.08	0.943	High
Medium	MP	Umaria	36.35	0.47	8.99	0.945	High
Medium	MP	Vidisha	37.60	0.73	18.36	0.928	High
Medium	Orissa	Bolangir	32.30	30.56	8.72	0.874	Medium
Medium	Orissa	Kalahandi	14.48	6.43	3.15	0.963	High
Medium	Punjab	Amritsar	18.88	90.32	57.51	0.661	Low
Medium	Punjab	Fathegarh Sahib	35.85	97.24	131.81	0.505	Low
Medium	Punjab	Gurdaspur	34.71	83.77	72.68	0.635	Low
Medium	Punjab	Hoshiarpur	28.88	84.09	60.24	0.661	Low
Medium	Punjab	Muktsar	27.32	74.05	52.64	0.700	Low
Medium	Punjab	Rupnagar	12.01	91.97	69.06	0.646	Low
Medium	Tamil Nadu	Erode	51.41	80.83	22.16	0.706	Low
Medium	Tamil Nadu	Kanniyakumari	46.78	94.07	1.08	0.712	Low
Medium	Tamil Nadu	Karur	35.80	74.74	17.03	0.747	Low
Medium	Tamil Nadu	Madurai	81.72	82.80	1.40	0.702	Low
Medium	Tamil Nadu	Nagapattinam	95.84	60.96	10.43	0.726	Low
Medium	Tamil Nadu	Perambalur	46.46	89.29	1.58	0.724	Low
Medium	Tamil Nadu	Pudukkottai	96.48	42.93	12.28	0.768	Medium
Medium	Tamil Nadu	Ramanathapuram	24.92	99.49	0.60	0.723	Low
Medium	Tamil Nadu	Sivaganagai	39.50	33.34	1.45	0.871	Medium
Medium	Tamil Nadu	Thanjavur	93.98	68.18	6.40	0.717	Low

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
Medium	Tamil Nadu	Thiruchirapalli	73.67	79.64	8.51	0.707	Low
Medium	Tamil Nadu	Thirunelveli	54.83	72.75	12.19	0.739	Low
Medium	Tamil Nadu	Thiruvallur	51.37	69.88	30.60	0.720	Low
Medium	Tamil Nadu	Thiruvarur	86.48	66.96	2.63	0.734	Low
Medium	UP	Aligarh	41.92	26.28	194.00	0.576	Low
Medium	UP	Allahabad	66.30	9.62	77.19	0.779	Medium
Medium	UP	Azamgarh	79.03	24.35	73.52	0.735	Low
Medium	UP	Bagpat	39.67	48.09	203.11	0.509	Low
Medium	UP	Bahraich	36.64	0.77	32.53	0.906	High
Medium	UP	Ballia	93.54	15.64	63.56	0.757	Low
Medium	UP	Balrampur	41.64	3.18	33.00	0.894	Medium
Medium	UP	Basti	50.53	9.84	70.30	0.807	Medium
Medium	UP	Bijnor	29.58	22.75	74.17	0.791	Medium
Medium	UP	Bulandshahar	26.95	46.51	166.66	0.586	Low
Medium	UP	Chitrakut	53.36	0.31	38.03	0.880	Medium
Medium	UP	Deoria	61.95	24.82	61.06	0.772	Medium
Medium	UP	Etah	23.02	20.36	124.43	0.723	Low
Medium	UP	Etawah	34.81	4.56	77.18	0.826	Medium
Medium	UP	Farrukhabad	35.73	9.11	86.62	0.799	Medium
Medium	UP	Fatehpur	34.99	4.04	80.04	0.823	Medium
Medium	UP	Firozabad	32.53	31.78	133.34	0.670	Low
Medium	UP	Ghaziabad	70.26	46.64	310.10	0.307	Low
Medium	UP	Ghazipur	76.11	9.17	94.65	0.742	Low
Medium	UP	Gonda	63.84	7.87	57.20	0.819	Medium
Medium	UP	Hardoi	48.61	0.93	64.28	0.841	Medium
Medium	UP	J.B.Fule Nagar	35.46	34.63	162.28	0.613	Low
Medium	UP	Jalaun	35.93	2.29	40.82	0.889	Medium
Medium	UP	Jaunpur	85.33	19.07	78.01	0.734	Low
Medium	UP	Kanpur (Dehat)	41.78	12.91	77.94	0.797	Medium
Medium	UP	Kaushambi	0.00	0.00	0.00	1.000	High
Medium	UP	Kheri	33.42	6.10	36.62	0.889	Medium
Medium	UP	Kushi Nagar	40.60	47.13	49.41	0.758	Low
Medium	UP	Lalitpur	51.00	0.13	30.03	0.896	Medium
Medium	UP	Lucknow	51.31	3.79	56.97	0.843	Medium
Medium	UP	Mahoba	40.32	0.78	31.78	0.903	High
Medium	UP	Mainpuri	22.72	3.13	93.56	0.817	Medium
Medium	UP	Mau	76.36	16.70	70.99	0.761	Low
Medium	UP	Mirzapur	76.61	14.64	46.86	0.804	Medium
Medium	UP	Moradabad	34.79	21.20	136.97	0.688	Low
Medium	UP	Muzaffarnagar	40.28	60.95	141.46	0.576	Low

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
Medium	UP	Pilibhit	28.88	4.93	39.75	0.892	Medium
Medium	UP	Rae-Bareily	65.03	6.94	61.84	0.812	Medium
Medium	UP	Sant Ravidas Nagar	141.28	6.95	118.61	0.638	Low
Medium	UP	Shahjahanpur	28.53	2.33	45.10	0.890	Medium
Medium	UP	Sonbhadra	44.55	1.48	15.61	0.923	High
Medium	UP	Sultanpur	68.49	9.76	58.74	0.806	Medium
Medium	UP	Varanasi	130.29	16.06	99.59	0.657	Low
Medium	Uttarakhand	Bageshwar	25.36	2.51	18.77	0.936	High
Medium	Uttarakhand	Chamoli	12.65	3.83	6.21	0.967	High
Medium	Uttarakhand	Haridwar	41.13	54.16	86.98	0.680	Low
Medium	Uttarakhand	Tehri Garwal	13.68	2.99	28.22	0.932	High
Medium	West Bengal	24-Paraganas (South)	77.46	5.01	0.71	0.902	High
Medium	West Bengal	Cooch Behar	174.49	9.47	0.52	0.786	Medium
Medium	West Bengal	Jalpaiguri	95.20	12.27	1.21	0.864	Medium
Medium	West Bengal	Midnapore	183.28	9.93	1.27	0.774	Medium
Medium	West Bengal	Purulia	59.90	2.98	2.78	0.923	High
Low	AP	Adilabad	30.57	0.61	19.80	0.933	High
Low	AP	Anantapur	22.03	20.52	24.45	0.885	Medium
Low	AP	Chittoor	56.66	76.53	7.78	0.734	Low
Low	AP	Cuddapah	5.28	23.26	28.92	0.889	Medium
Low	AP	Kurnool	11.81	1.04	31.88	0.933	High
Low	AP	Mahabubnagar	19.91	7.47	20.23	0.927	High
Low	AP	Medak	20.72	4.22	36.48	0.908	High
Low	AP	Nalgonda	17.45	4.51	45.17	0.897	Medium
Low	AP	Prakasam	2.06	2.91	61.16	0.892	Medium
Low	AP	Rangareddy	18.24	14.16	30.02	0.896	Medium
Low	Chhattisgarh	Bastar	20.42	1.35	1.71	0.972	High
Low	Chhattisgarh	Sarguja	20.84	2.35	5.10	0.963	High
Low	Gujarat	Ahmedabad	20.92	8.34	37.94	0.895	Medium
Low	Gujarat	Amreli	17.15	4.19	24.23	0.932	High
Low	Gujarat	Banaskantha	40.08	26.33	77.34	0.766	Low
Low	Gujarat	Bharuch	9.44	22.74	20.49	0.900	High
Low	Gujarat	Bhavanagar	20.16	4.18	30.12	0.919	High
Low	Gujarat	Gandhinagar	54.61	53.69	155.41	0.556	Low
Low	Gujarat	Jamnagar	10.59	0.58	16.69	0.960	High
Low	Gujarat	Jungadh	26.41	3.88	38.54	0.899	High
Low	Gujarat	Kutch	6.29	2.21	4.22	0.981	High
Low	Gujarat	Mehsana	39.39	52.27	119.07	0.634	Low
Low	Gujarat	Panchmahal	43.12	14.60	103.62	0.749	Low
Low	Gujarat	Patan	16.69	7.72	58.06	0.869	Medium

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
Low	Gujarat	Porbander	15.19	3.84	43.37	0.904	High
Low	Gujarat	Rajkot	21.75	6.98	29.32	0.912	High
Low	Gujarat	Sabarkanta	46.52	39.66	92.73	0.701	Low
Low	Gujarat	Surendranagar	24.45	1.25	24.46	0.931	High
Low	Haryana	Bhiwani	13.48	24.61	87.30	0.783	Medium
Low	Haryana	Fatehabad	17.14	38.60	105.01	0.715	Low
Low	Haryana	Gurgaon	9.65	44.12	42.13	0.811	Medium
Low	Haryana	Jhajjar	17.03	32.99	110.37	0.721	Low
Low	Haryana	Kaithal	21.35	36.15	136.85	0.666	Low
Low	Haryana	Karnal	40.68	72.79	126.43	0.570	Low
Low	Haryana	Kurukshetra	45.34	79.56	141.67	0.523	Low
Low	Haryana	Mahendragarh	14.24	27.13	106.58	0.745	Low
Low	Haryana	Panipet	24.69	42.06	158.54	0.612	Low
Low	Haryana	Rewari	14.74	34.14	96.39	0.743	Low
Low	Haryana	Sirsa	34.32	46.72	67.93	0.736	Low
Low	Haryana	Sonipet	25.34	36.85	134.79	0.663	Low
Low	Karnataka	Bagalkot	26.28	15.95	34.87	0.875	Medium
Low	Karnataka	Bangalore (Rural)	62.44	54.11	11.45	0.778	Medium
Low	Karnataka	Bangalore (Urban)	50.92	84.06	4.75	0.727	Low
Low	Karnataka	Belgaum	22.86	31.27	58.73	0.802	Medium
Low	Karnataka	Bellary	23.63	7.34	21.84	0.921	High
Low	Karnataka	Bidar	27.91	7.43	28.71	0.905	High
Low	Karnataka	Bijapur	12.45	0.78	16.03	0.959	High
Low	Karnataka	Chamarajanagar	36.47	48.85	4.96	0.830	Medium
Low	Karnataka	Chitradurga	18.99	13.83	20.44	0.912	High
Low	Karnataka	Davanagere	39.42	41.21	33.48	0.800	Medium
Low	Karnataka	Dharwad	23.64	34.38	21.08	0.854	Medium
Low	Karnataka	Gadag	15.38	18.77	15.22	0.912	High
Low	Karnataka	Gulbarga	30.73	2.23	13.37	0.939	High
Low	Karnataka	Haveri	29.05	35.24	22.10	0.845	Medium
Low	Karnataka	Kolar	45.67	73.73	11.59	0.747	Low
Low	Karnataka	Koppal	18.67	10.51	13.60	0.931	High
Low	Karnataka	Raichur	33.21	4.29	27.45	0.909	High
Low	Karnataka	Tumkur	38.08	33.78	21.02	0.840	Medium
Low	Maharashtra	Ahmednagar	58.37	73.29	12.56	0.733	Low
Low	Maharashtra	Akola	22.71	8.29	10.22	0.938	High
Low	Maharashtra	Amravati	19.78	9.13	8.88	0.941	High
Low	Maharashtra	Aurangabad	22.17	36.60	8.65	0.870	Medium
Low	Maharashtra	Beed	29.15	43.27	20.60	0.827	Medium
Low	Maharashtra	Buldhana	23.52	16.15	14.02	0.911	High

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
Low	Maharashtra	Dhule	20.35	23.46	12.61	0.899	High
Low	Maharashtra	Jalgaon	20.81	18.88	20.39	0.897	High
Low	Maharashtra	Jalna	19.40	14.25	9.77	0.927	High
Low	Maharashtra	Latur	22.69	11.52	30.85	0.897	Medium
Low	Maharashtra	Nagpur	26.99	24.35	8.49	0.896	Medium
Low	Maharashtra	Nanded	30.82	3.90	20.52	0.924	High
Low	Maharashtra	Nandurbar	27.15	5.85	13.51	0.934	High
Low	Maharashtra	Nasik	29.07	27.75	11.88	0.880	Medium
Low	Maharashtra	Osmanabad	25.62	45.67	19.51	0.826	Medium
Low	Maharashtra	Parbhani	25.90	3.30	19.07	0.933	High
Low	Maharashtra	Pune	33.14	72.89	17.61	0.753	Low
Low	Maharashtra	Raigad	18.04	4.28	8.02	0.957	High
Low	Maharashtra	Sangli	20.62	49.86	54.86	0.764	Low
Low	Maharashtra	Satara	22.45	63.23	30.57	0.768	Medium
Low	Maharashtra	Solapur	30.56	52.61	23.97	0.796	Medium
Low	Maharashtra	Washim	26.01	3.98	13.79	0.940	High
Low	Maharashtra	Yavatmal	25.29	4.48	8.26	0.948	High
Low	MP	Barwani	30.73	0.39	19.18	0.935	High
Low	MP	Betul	25.05	7.89	13.94	0.931	High
Low	MP	Bhind	24.69	4.81	62.50	0.860	Medium
Low	MP	Chhindwara	29.31	3.63	11.66	0.940	High
Low	MP	Dewas	29.15	7.93	30.14	0.900	High
Low	MP	Dhar	32.74	4.64	24.30	0.914	High
Low	MP	Guna	37.30	1.10	23.92	0.918	High
Low	MP	Indore	36.60	30.04	49.76	0.805	Medium
Low	MP	Jhabua	38.92	2.07	34.26	0.897	High
Low	MP	Khandwa(East Nimar)	21.89	1.19	13.22	0.952	High
Low	MP	Khargone(West Nimar)	30.45	0.93	21.58	0.930	High
Low	MP	Mandsaur	36.35	12.49	32.72	0.876	Medium
Low	MP	Neemuch	38.38	7.31	25.96	0.898	High
Low	MP	Rajgarh	45.86	1.88	80.56	0.815	Medium
Low	MP	Ratlam	35.24	6.83	29.24	0.897	High
Low	MP	Rewa	84.82	1.59	30.55	0.854	Medium
Low	MP	Satna	80.02	1.88	24.65	0.868	Medium
Low	MP	Shahdol	33.63	1.66	8.91	0.945	High
Low	MP	Shajapur	37.42	4.89	38.58	0.885	Medium
Low	MP	Shivpuri	37.93	0.93	29.97	0.908	High
Low	MP	Sidhi	47.00	2.29	17.67	0.915	High
Low	MP	Ujjain	36.75	8.12	46.90	0.864	Medium
Low	Punjab	Bathinda	20.70	62.98	72.26	0.703	Low

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
Low	Punjab	Faridkot	24.79	76.21	80.17	0.653	Low
Low	Punjab	Firozpur	29.60	67.59	68.23	0.689	Low
Low	Punjab	Jalandhar	31.99	99.95	80.78	0.585	Low
Low	Punjab	Kapurthala	28.82	96.12	77.99	0.602	Low
Low	Punjab	Ludhiana	32.00	87.59	133.28	0.531	Low
Low	Punjab	Mansa	15.00	43.71	92.91	0.725	Low
Low	Punjab	Moga	32.48	78.64	99.07	0.608	Low
Low	Punjab	Nawan Shehar	27.45	90.50	89.06	0.600	Low
Low	Punjab	Patiala	18.89	72.98	82.86	0.663	Low
Low	Punjab	Sangrur	26.56	72.50	134.50	0.573	Low
Low	Rajasthan	Ajmer	35.98	5.11	34.82	0.892	Medium
Low	Rajasthan	Alwar	19.05	6.54	103.94	0.795	Medium
Low	Rajasthan	Banswara	51.06	1.62	48.35	0.862	Medium
Low	Rajasthan	Baran	34.00	0.77	26.92	0.918	High
Low	Rajasthan	Barmer	17.92	0.06	4.69	0.973	High
Low	Rajasthan	Bharatpur	20.65	9.11	82.33	0.822	Medium
Low	Rajasthan	Bhilwara	39.06	14.16	25.36	0.881	Medium
Low	Rajasthan	Bikaner	19.97	6.48	4.11	0.955	High
Low	Rajasthan	Bundi	28.61	2.24	42.12	0.895	Medium
Low	Rajasthan	Chittorgarh	42.50	7.08	37.66	0.875	Medium
Low	Rajasthan	Churu	12.94	4.93	11.39	0.955	High
Low	Rajasthan	Dausa	29.41	11.80	108.18	0.764	Low
Low	Rajasthan	Dholpur	16.18	1.81	91.33	0.831	Medium
Low	Rajasthan	Dungarpur	45.94	0.59	55.48	0.859	Medium
Low	Rajasthan	Ganganagar	43.65	16.35	23.16	0.874	Medium
Low	Rajasthan	Hanumangarh	34.25	10.24	30.30	0.888	Medium
Low	Rajasthan	Jaipur	37.83	35.16	75.83	0.749	Low
Low	Rajasthan	Jaisalmer	7.09	0.18	0.06	0.992	High
Low	Rajasthan	Jalore	20.75	0.09	34.69	0.921	High
Low	Rajasthan	Jhalawar	41.32	0.29	39.72	0.890	Medium
Low	Rajasthan	Jhunjunu	25.65	52.23	56.70	0.750	Low
Low	Rajasthan	Jodhpur	23.54	5.65	9.89	0.944	High
Low	Rajasthan	Karauli	14.91	2.30	63.97	0.875	Medium
Low	Rajasthan	Kota	34.00	1.73	36.65	0.900	High
Low	Rajasthan	Nagaur	19.68	3.50	22.11	0.934	High
Low	Rajasthan	Pali	21.91	1.55	22.52	0.936	High
Low	Rajasthan	Rajsamand	47.08	10.53	50.91	0.840	Medium
Low	Rajasthan	Sawai Madhopur	17.16	1.62	48.50	0.899	High
Low	Rajasthan	Sikar	26.97	30.06	59.29	0.800	Medium
Low	Rajasthan	Sirohi	26.99	0.56	29.13	0.922	High

Natural Resource Index (NRI)	State	District	Cow density	% Cross bred cows	Buffalo density	Milk production index	Potential
Low	Rajasthan	Tonk	23.47	2.30	37.85	0.908	High
Low	Rajasthan	Udaipur	34.56	3.46	34.05	0.899	High
Low	Tamil Nadu	Ariyahur	78.26	55.24	6.65	0.766	Low
Low	Tamil Nadu	Coimbatore	35.91	94.87	4.00	0.717	Low
Low	Tamil Nadu	Dharmapuri	38.43	67.50	5.85	0.780	Medium
Low	Tamil Nadu	Dindigual	36.06	86.20	11.61	0.726	Low
Low	Tamil Nadu	Namakkal	67.57	89.74	52.02	0.618	Low
Low	Tamil Nadu	Salem	85.78	83.50	21.65	0.663	Low
Low	Tamil Nadu	Theni	42.12	88.16	1.42	0.731	Low
Low	Tamil Nadu	Thiruvannamalai	87.26	79.62	2.72	0.701	Low
Low	Tamil Nadu	Thoothukudi	166.23	68.43	52.22	0.564	Low
Low	Tamil Nadu	Vellore	73.27	76.34	4.22	0.722	Low
Low	Tamil Nadu	Villupuram	77.73	54.28	3.30	0.774	Medium
Low	Tamil Nadu	Virudhunagar	50.16	70.41	3.27	0.764	Low
Low	UP	Agra	25.07	22.22	116.59	0.729	Low
Low	UP	Banda	43.14	0.55	50.64	0.870	Medium
Low	UP	Budaun	34.63	5.61	119.90	0.755	Low
Low	UP	Faizabad	76.89	2.97	84.54	0.773	Medium
Low	UP	Hamirpur	32.28	2.87	37.41	0.897	High
Low	UP	Hatharas	31.56	18.49	178.75	0.631	Low
Low	UP	Jhansi	34.31	0.52	29.40	0.914	High
Low	UP	Mathura	33.46	11.27	105.74	0.765	Low
Low	UP	Saharanpur	39.59	25.59	116.45	0.705	Low

Note: Density = No./Sq Km
Districts having medium to high natural resource index and medium to high milk production potential deserve preference over other districts for promotion of dairy as an enterprise.

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