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Jodhpur -342 005, Rajasthan

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Livestock Management in Stress Conditions: Learnings from NICRA

Introduction

The climate-smart livestock system is a comprehensive approach, "that works towards sustainable livestock production systems that fully support, climate change adaptation and mitigation activities, food security, sustainable incomes, animal welfare and reduce the environmental impact". Improving productivity per animal/ group of animals will lead to both improved food security and reduced emissions in livestock production systems, which can be achieved by adapting animal husbandry practices such as selecting more productive breeds, herd management and adopting approaches to enhance animal health (e.g., improving feed ration balancing and digestibility to reduce methane emissions in ruminants). Technical solutions to emissions include several diverse interventions such as rumen modification, by product utilization and sound manure management, adoption of renewable energy (Bio-digester and solar power, solar milk cooling, solar water drinker, etc.) and the use of energy-efficient equipment and machinery, all such interventions minimize the need for non-renewable energy sources along the livestock value chains.

Climatic Stress in Delhi, Rajasthan and Haryana

Water stress: India continued to be the 'top hotspot for terrestrial loss of water', with some regions in northern India losing close to 9 cms on an average from 2002 to 2021. Delhi, Punjab and Haryana, as well as parts of Rajasthan and Uttar Pradesh are most prone to terrestrial water loss. The situation is even more precarious considering only 0.5 per cent of water is usable and is freshwater. As many as 2.3 billion people live in countries considered to be water-stressed; the number is likely to increase to 5 billion by 2050.

Abiotic stress: Salinity, drought, flood, extreme temperature, heavy metals, radiation etc are climatic stress which cause loss to major crop plants worldwide. These stresses will rise due to increasing desertification of world's terrestrial area, increasing salinization of soil and water, shortage of water resources and environmental pollution.

Biotic stress: Pathogens such as fungi, bacteria, oomycetes, nematodes and herbivores and diseases are the serious bottlenecks that account for major yield losses worldwide. The plants often encounter these challenges in one or the other forms. Attempts have been made to inbuilt inheritance and enhance tolerance capacity against such biotic stresses to enable plants to complete lifecycle successfully. The plants develop various mechanisms for getting adapted to such conditions for survival.

Livestock situation in India

India's livestock sector is one of the largest in the world. It contributes 4.11% of nation's GDP and 34% of total agriculture GDP. The sector has been growing at a CAGR of approximately 8% from 2014-15 to 2019-20. About 20.5 million people depend upon livestock for their livelihoods. It also provides employment to about 8.8% work force in India. Livestock contributes 16% to the income of small farm households as against an average of 14% for all rural households. Livestock provides livelihood to 2/3 of rural communities. Total livestock population in country decreased 1.14 percent from 529.6m (in 2007) to 535.7m (in 2019) due to decrease in indigenous cattle (45.21%) population, however, total cattle population also decreased 3.31% during this period. However, poultry population increased significantly 45.62 percent from 584.93m (in 2007) to 851.81m (in 2019) due to demand of non-vegetarian food.

Table-1: Livestock & Poultry Population in Different Census in India, Rajasthan, Haryana & Delhi

Livestock Category	Population (m) 2007	Population (m) 2012	Population (m) 2019	% Growth (2007-2019)
India				
Exotic/ CB cattle	33.06	39.73	00	20.17
Indigenous cattle	275.8	151.1	00	-45.21
Total Cattle	199.08	190.90	192.49	-3.31
Buffalo	105.34	108.70	109.85	4.28
Sheep	71.56	65.07	74.26	3.77
Goat	140.5	135.17	148.88	5.96
Poultry	584.93	729.21	851.81	45.62
Total Livestock	**529.696**	**512.057**	**535.789**	**1.14**
Rajasthan				
Exotic/ CB cattle	8.15	17.9	00	00
Indigenous cattle	14.81	15.7	00	00
Total Cattle	22.96	33.6	13.9	-39.45
Buffalo	11.09	12.9	13.7	5.53
Sheep	11.90	9.10	7.90	-12.95
Goat	21.50	21.67	20.84	-3.81
Poultry	53.13	60.65	38.41	-27.70
Total Livestock	**49.14**	**57.74**	**56.77**	**15.52**

Livestock Category	Population (m) 2007	Population (m) 2012	Population (m) 2019	% Growth (2007-2019)
Haryana				
Exotic/CB cattle	0.566	1.03	00	90.2
Indigenous cattle	1.38	1.89	00	121.0
Total Cattle	1.946	2.92	1.93	-0.82
Buffalo	5.953	6.08	4.367	-19.9
Sheep	0.601	0.362	0.288	-.048
Goat	0.538	0.369	0.334	-37.9
Poultry	64.10	55.0	88.66	38.31
Total Livestock	**8.88**	**8.82**	**6.94**	**-21.84**
Delhi				
Exotic/CB cattle	0.44	0.61	00	38.6
Indigenous cattle	0.47	0.25	00	-46.8
Total Cattle	0.91	0.86	0.86	-5.49
Buffalo	2.78	1.62	1.62	-41.7
Sheep	0.59	0.90	0.90	52.5
Goat	0.21	0.30	0.30	52.4
Poultry	3.44	7.70	7.62	121.51
Total Livestock	**3.73**	**3.60**	**3.16**	**-15.28**
G. Total in Zone-II	**61.75**	**70.16**	**66.87**	**8.29**
Total Poultry in Zone-II	**120.67**	**123.35**	**134.69**	**11.62**

Rajasthan: Rajasthan contribute about 11.3% of the livestock population and contributes 12% of the total milk and 32% of the wool production of the country. In Rajasthan Agriculture and allied activities continues to be chief source of livelihood in rural region. About 55% of total area of Rajasthan is desert and livestock of Rajasthan is one of the main source of livelihood. Other than providing source of livelihood livestock also provides food security and insulate against poverty. Development of livestock sector has a significant beneficial impact in generating employment and reducing poverty in rural areas.

Livestock is the main source of animal protein for the majority of population. It is estimated that more than 80% of rural families keep livestock in their households. Contribution of animal sector to GDP of the state has been estimated around 10.21%. About 35% of the income of small and marginal farmers come from dairy and animal husbandry. In arid areas the contribution may be as high as 50 percent. Total livestock population increased 15.52 percent from 49.11m (in 2007) to 56.77m (in 2019) due to increase in buffalo (5.53%) population in Rajasthan. However, poultry population decreased significantly 27.70 percent from 53.13m (in 2007) to 38.41m (in 2019) due to vegetarian food habit of residents.

The state has majority of arid region and there is inadequate availability of feed and fodder resources. Livestock is an unorganized sector and holdings are very small, further much of the livestock belongs to the economically weaker section which restricts it to being source of livelihood. Inadequate availability of quality breeds in the state. Lack of health and nutrition support, along-with frequent occurrence of natural calamities that results in high diseases and mortality in livestock.

Haryana: Haryana has a prominent place on the livestock map of the country in spite of being one of the smallest (1.3% of total geographical area) States of India. The animal husbandry activities in the state play a pivotal role in the rural economy through a variety of contributions in the form of income generation, draft power, socio-economic upliftment, employment avenues and better nutrition to the human population through livestock products like milk, eggs & meat etc. Total livestock population decreased 21.84 percent from 8.88m (in 2007) to 6.94m (in 2019) due to decrease in buffalo (-19.9%) and goat (-37.9%) population in Haryana. However, poultry population increased immensely 38.31 percent from 64.10m (in 2007) to 88.66m (in 2019) due to huge demand of meat in NCR near Delhi.

Haryana is the home tract of world famous 'Murrah' buffaloes popularly known as 'black gold' and the dual purpose 'Hariana' cow. The State has since long been the prime source of Murrah germplasm for other states and abroad for up-gradation of their low yielding, nondescript buffaloes. Certainly, the state is proud of its position, achievements, livestock wealth and the significant contributions of this sector to the state economy. Itis also a major source of employment throughout the year and livelihood to small farmers, including women. The importance of this sector is ever increasing with the production saturation in crop husbandry and the shrinking of availability of cultivable land.

Delhi: Delhi has less livestock population in comparison to Haryana and Rajasthan states. Total livestock population decreased 15.28 percent from 3.73m (in 2007) to 3.16m (in 2019) due to decrease in buffalo (-41.7%) and cattle (-5.49%) population in Delhi. However, poultry population increased immensely 121.5 percent from 3.44m (in 2007) to 7.62m (in 2019) due to huge demand of non-vegetarian food.

Overall in Zone-II, total livestock population in Zone-II increased 8.29 percent from 61.75m (in 2007) to 66.87m (in 2019) due to increase in indigenous cattle and buffalo population, respectively in Rajasthan and Haryana states. Similarly, poultry population increased significantly 11.62 percent from 120.67m (in 2007) to 134.69m (in 2019) due to demand of non-vegetarian food in Haryana and nearby NCR.

Animal Based Food Production

Total milk production in country increased by 23.29 percent from 154.75MT (in 2007) to 190.8MT (in 2019). Similarly, meat and wool production also increased respectively by 114.51 percent (from 4009 tonnes in 2017 to 8599.9 tonnes in 2019) and 113.54 percent (from 535650 kg in 2007 to 1143830.7kg in 2019). However, total egg production decreased by 16.22 percent from 43881lakh in 2007 to 36760 in 2019.

Table-2: Milk, Meat, Egg, Wool Production in Different Census in India, Rajasthan, Haryana & Delhi

Category	Year 2007	Year 2012	Year 2019	% Growth (2007-2019)
India				
Milk (MT)	154.75	192.2	190.8	23.29
Meat (tonnes)	4009	5514.25	8599.97	114.51
Wool (kg)	535650	697307.17	1143830.74	113.54
Egg (Lakh)	43881	44734.47	36760.57	-16.22
Rajasthan				
Milk (MT)	15.22	18.89	19.79	30.0
Meat (tonnes)	80	122.22	199.59	149.48
Wool (kg)	6730	9605.43	26962.40	300.62
Egg (Lakh)	15451	13192.24	12716.83	17.69
Haryana				
Milk (MT)	6.21	8.06	4.31	-30.6
Meat (tonnes)	193.9	336.94	553.87	185.6
Wool (kg)	41031	41141.91	66153.17	61.22
Egg (Lakh)	1121	1332.86	729.52	-34.92
Delhi				
Milk (MT)	5.42	6.11	6.11	12.7
Meat (tonnes)	32	45.00	0.00	40.6
Wool (kg)	0.0	0.00	0.00	00
Egg (Lakh)	0.0	0.00	0.00	00
G. Total in Zone-II				
Milk (MT)	26.85	33.06	30.21	12.51
Meat (tonnes)	305.9	504.16	753.46	146.3
Wool (kg)	47762	50748.5	93115.5	95.15
Egg (Lakh)	16572	14525.1	13446.3	-18.86

In Rajasthan total milk production increased by 30.0 percent from 15.22MT (in 2007) to 19.79MT (in 2019). Similarly, meat and wool production also increased respectively by 149.48 percent (from 80 tonnes in 2007 to 199.59 tonnes in 2019) and 300.62 percent (from 6730 kg in 2007 to 26962.4kg in 2019). Total egg production also increased by 17.69 percent from 15451lakh in 2007 to 12716 in 2019.

In Haryana total milk production decreased by 30.6 percent from 6.21MT (in 2007) to 4.31MT (in 2019) due to decrease in buffalo population during the corresponding period. However, meat and wool production increased respectively by 185.6 percent (from 193.9 tonnes in 2007 to 553.97 tonnes in 2019) and 61.22 percent (from 41031 kg in 2007 to 66153.2kg in 2019). However, total egg production decreased by 34.92 percent from 1121lakh in 2007 to 729 lakh in 2019.

In Delhi total milk production increased by 12.7 percent from 5.42MT (in 2007) to 6.11MT (in 2019). Similarly, meat and wool production also increased respectively by 40.6 percent (from 32 tonnes in 2007 to zero tonnes in 2019) and 23 percent (from 1.0kg in 2007 to zero 1.234kg in 2012). No wool and egg production data recorded in Delhi for the reported livestock census.

Overall in Zone-II total milk production increased by 12.51 percent from 26.85MT (in 2007) to 30.21MT (in 2019). Similarly, meat and wool production also increased respectively by 146.3 percent (from 305.9 tonnes in 2007 to 753.46 tonnes in 2019) and 95.15 percent (from 47762 kg in 2007 to 931154kg in 2019). However, total egg production decreased by 18.86 percent from 16572 lakhs in 2007 to 13446 lakh in 2019.

Seasonal variation in milk and meat production

Annual period for milk production and distribution has been divided into two seasons -flush period from the month of November to April and the lean period from the month of May to October. During summer season the non-availability of green fodder causes a drastic reduction in milk production of lactating animals, however, provision of supplemental feeding may help in maintain the milk yield of such animals in a sustainable way. After rainy season the grass grows luxuriously in all the community grazing places which is easily available for all type of livestock. During winter season, the green fodder is available in sufficient quantity due to fodder cultivation with assured irrigation facilities, hence, the milk production increase is sustained for all the lactating animals for longer periods and results higher economic gains to livestock owners.

National Innovations on Climate Resilient Agriculture: Rajasthan and Haryana and Gujarat

Climate change is a global phenomenon affecting all resources of people and planet. Indian agriculture is also experiencing the major threat due to several adversaries caused owing to extreme events like enhancing cropping in water stressed ecologies drought, flood, cyclone, heat wave and cold wave etc. Agriculture contributes about 14% of the total Greenhouse Gases emissions in India. The Climate vulnerabilities have threatened the food security and livelihood of millions of people in India. As bulk of water is common in agriculture, the groundwater climate change impacts groundwater availability particularly in low rainfall and high groundwater development regions. India has

experienced explosive growth in groundwater utilization for irrigations during recent decades. In view of the escalating pressure on groundwater, recharging groundwater has been adopted as one of the priority intentions under NICRA being implemented in India by Indian Council of Agricultural Research across all vulnerable districts, the NICRA adopted a concept of whole village intervention and institutional development. Altogether a lists of 151 NICRA villages spreading to our 400 villages adopted so far. These villages have become hubs of learning on climate resilient agriculture in a short span and opened up opportunities for horizontal and vertical diffusion of the successful interventions in other parts of the districts. The rainfall pattern in Rajasthan has witnessed changes during last ten years' with more dry spells are accompanied by uneven distribution of rains. This necessities enhancing resilience to climate variability for major product supplies including livestock sector, which is the backbone of arid agriculture. Livestock sector is an important sub-sector of agriculture of the Indian economy. It acts as a supplementary and complementary enterprise especially in in arid fringes of Rajasthan. They not only contribute to their income but also provide the best insurance against any natural calamity.

Area of Coverage

The project was initiated in March 2011 with seven vulnerable districts from Gujarat (Kutch, Rajkot, Valsad) and Rajasthan (Bharatpur, Jodhpur, Jhunjhunu, Kota). In second phase of NICRA project Amreli and Banaskantha districts from Gujarat and Barmer district from Rajasthan were added as additional KVKs. After restructuring of ZPD in to ATARIs during 2016 the Zones were re-classified and Delhi, Haryana, Rajasthan states were allotted to ICAR-ATARI, Zone-II, Jodhpur. During the year 2017 only 7 KVKs (Bharatpur, Barmer, Jodhpur, Jhunjhunu, Kota from Rajasthan and Sirsa, Yamunanagar from Haryana) were selected under different vulnerabilities identified by ICAR-CRIDA Hyderabad. Since 2021 onwards total 18 districts were finalized under NICRA Project from Rajasthan (13) and Haryana (5) states. The details of the districts and their vulnerability are depicted in table-3.

Table-3: Major climatic vulnerability in identified villages

State/District	Name of identified village	Climatic variability	Annual Rainfall (mm)
Rajasthan			
1. Alwar-I	Gurapur Khurd	Frost/ Heat wave/Drought	500-650
2. Barmer-I	Junapatrasar	Drought/ Heat wave	240-320
3. Bharapur	Gagrasoli	Floods/ Heat wave	500-700
4. Bhilwara-I	Dholikhera	Heat wave/ Dry Spell	640- 800
5. Bikaner-I	Kanasar	Drought/ Heat wave/ Frost	250-265
6. Churu-I	Miitasar	Heat wave/ Cold wave/ Erratic rainfall	200-300
7. Hanumangarh-I	Hiranwali	Heat wave/ Cold wave/ dry	250-300
8. Jaisalmer-I	Jogidas ka Goan	Heat wav/ Frost/ Unseasonal rainfall	420-480
9. Jhunjhunu	Bharu	Frost/ Drought	300-420

State/District	Name of identified village	Climatic variability	Annual Rainfall (mm)
10. Jodhpur-I	Purkhawas	Heat wave /cold wave	300-350
11. Nagaur-I	Deshwal	Heat/cold wave & Drought	350-380
12. Pali-I	Gajangarh	Drought/ Heat wave	300-350
13. Sirohi	Dhanta	Heat wave /cold wave	300-350
14. Kota	Chomakot	Floods/ Heatwave	600-750
Haryana			
1. Bhiwani	Lohani, Dhareru	Erratic rainfall	250-300
2. Fatehabad	Banmandori, Bodiwali	Heat wave/ Cold wave	360-400
3. Hisar	Bhodia Bishoniyan	Heat/ Cold wave/ Erratic rainfall/ Frost	400-500
4. Mahendergarh	Gadania, Bairawas	Heat wave/ dry spell/ Frost	300 -500
5. Sirsa	Rupana Khurd	Erratic Rainfall	170-250
6. Yamunanagar	Radauri, Bakana	Heat, Clod wave	800-950
Gujarat			
1. Amreli	Karjala	Drought/Hot wave	500-550
2. Banaskantha	Fatepura	Drought/Hot wave	550-750
3. Kutch	Bhalot	Drought	250-350
4. Rajkot	Magharwada	Drought/Hot wave	350-600
5. Valsad	Khuntli	Floods	1500-2000

Key Interventions Modules

NRM based: Water has been the central point for all interventions related to NRM based modules. The interventions included; *in-situ* moisture conservation, biomass mulching, residue incorporation instead of burning, brown and green manuring, water harvesting and recycling for supplemental irrigation, improved drainage in flood prone areas, conservation tillage, artificial ground water recharge and water saving irrigation methods.

Crop based: All climate resilient practices and various varieties were the part of crop based modules. Drought or high temperature tolerant varieties, advancement of planting dates of rabi crops in areas with terminal heat stress, water saving paddy cultivation methods (SRI, aerobic, direct seeding), frost management in horticulture through fumigation, community nurseries (for optimal sowing in delayed monsoon), farm machinery 'custom hiring centres' for timely completion of farm operations, location specific intercropping systems with high sustainable yield index.

Livestock and fodder production: Improved breeding, feeding, health and hygiene and shelter management. Augmentation of fodder production through improved planting materials, improved fodder and feed storage methods, fodder enrichment, prophylaxis, improved shelters for reducing heat stress in livestock and promotion of livestock taken up as climate change adaptation strategy.

Institutional interventions: To make the village resilient active participants of the various interventions rather than remaining passive recipients several institutional building activities were initiated. They included strengthening of the existing ones or initiating new ones, such as; community seed bank, fodder bank, commodity groups, establishment of custom hiring centre, collective marketing group, introduction of weather index based insurance and climate literacy through a village weather station etc.

Climate Resilient Livestock Technologies

There are recognized livestock breeds of cattle, buffalo, sheep, goat, swine, camel, mithun, yalk and poultry in different parts of the country. Rajasthan is bestowed with has Tharparkar, Kankrej, Rathi, Sahiwal in cattle. Among bovine breeds, Murrah, Surti, Mehsana. Among sheep, Marwari, Bikaneri, Pugal, Kheri, Malpura, Chokla, Magra, Kheri; while in goat breeds; Marwari, Sirohi, Jakhrana, Mehsani, Jamunapari, Jalwadi, Kathiawad) which are well adapted to harsh climate of Rajasthan owing to their resilience against stresses. The performance of these breeds were evaluate in adopted villages. under In Haryana potential breeds of cattle are; Haryana, Rathi, Jersey, Holstein Friesian, Karan Fries, Karan Swiss, Brown Swiss, Red Dane, and buffalo are; Murrah), among sheep are; Hisardale, Chokla Sonadi, Munajl, Kheri, Magra; while goat are; Jamnapari, Beetal, Barbari. They performed well even under stressed conditions. The demonstrations conducted on these breeds have led to very encouraging results and feedback of the farmers across the various vulnerabilities shown in the tables).

Table-4 Prominent Livestock breeds in India, Rajasthan and Haryana

Region	Cattle	Buffalo	Sheep	Goat
India	Tharparkar, Kankrej, Rathi, Red Sindhi, Sahiwal. Gir, Kankrej, Haliker, Amritmahal, Deoni	Murrah, Surti, Mehsana, Nili-Ravi, Jaffarabadi, Banni, Bhadawari, Nagpuri, Toda	Bikaneri, Marwari, Magra, Pugal, Malpura, Kutchi, Jaiselmeri, Zalawadi, Munjal, Shekhewati, Chokla, Sonadi, Patanwadi	Marwari, Sirohi, Jakhrana, Barbari, Mehshani, Jamunapari, Beetal, Black Bengal, Kutchi, Surti, Kathiawadi
Rajasthan	Tharparkar, Kankrej, Rathi, Red Sindhi, Sahiwal. Gir, Kankrej, Jersey, Holstein Friesian	Murrah, Surti, Mehsana, Jaffarabadi, Banni	Bikaneri, Marwari, Magra, Pugal, Malpura, Jaiselmeri, Shekhewati, Chokla, Kheri	Marwari, Sirohi, Jakhrana, Mehsani, Jamunapari, Jalwadi, Kathiawadi
Haryana	Haryana, Rathi, Jersey, Holstein Friesian, Karan Fries, Karan Swiss, Brown Swiss, Red Dane	Murrah	Hisardale, Chokla Sonadi, Munajl, Kheri, Magra,	Jamnapari, Beetal, Barbari

The breed improvement interventions were carried out in 65 villages of Rajasthan and Haryana during 2012 to 2022. All together 1161 demonstrations were conducted on 2532 animals of various categories including small ruminants (goat and sheep), cattle (both indigenous and crossbred) and bovine (buffaloes). The feed management interventions included mineral deficiency, establishment of azolla unit, green fodder management. The shelter management activity included use of locally available low priced thatching material to be sued as insulation between an iron shade and cattle. The animal health and hygiene were addressed through health camps, deworming and vaccination. The details of these interventions are presented in Table-5.

Table-5. Demonstrations of interventions on climate resilient in adopted villages

Intervention	Demo/ Farmers	Farmers/ Animals	Output/ % increase in milk production
Breed improvement programme - Murrah and Tharparkar bulls, Jamnapari and Sirohi bucks	1161	2532 animals	Buffalo & goat breed upgradation
Animal Feed management - mitigate mineral deficiency	5064 farmers	12503 animals	19.4%
Azolla Units	154	154	Alternative to Green fodder & improved milk production
Green Fodder	2183	420.26ha	
Improved shelter management	190	190	20.4 to 22.5%
Animal Health Camps	180 camp	26072 animals	15.5 to 22.0%
De-worming in Livestock	4198	10595 animals	12.7 to 20%

Total number of households covered from 2012 to 2023 under different livestock activities are shown in table-6. In Gujarat total 5676 households were covered in 5 selected vulnerable districts; while in Haryana total 26655 households were covered in 6 selected vulnerable districts for different climatic resilient activities. In Rajasthan total 36511 households were covered in 14 selected vulnerable districts for different climatic resilient livestock activities in adopted NICRA villages. Overall total 68842 households were covered in 25 selected vulnerable districts of Gujarat, Haryana and Rajasthan states for different climatic resilient activities for improving livestock production and productivity.

Table-6: Households / adopted for introduction of technology related to climate resilient

Year	Gujarat	Haryana	Rajasthan	Total
2011-12	00	00	00	00
2012-13	826	00	995	1821
2013-14	826	00	995	1821
2014-15	826	00	1063	1889

Year	Gujarat	Haryana	Rajasthan	Total
2015-16	1599	00	1511	3110
2016-17	1599	00	1774	3373
2017-18	00	1446	2774	4220
2018-19	00	1571	3337	4908
2019-20	00	2321	3612	5933
2020-21	00	3546	3612	7158
2021-22	00	5129	5016	10145
2022-23	00	6321	5911	12232
2023-24	00	6321	5911	12232
G. Total	**5676**	**26655**	**36511**	**68842**

Total 358 animals of breed were improved using pure breed animals and mineral mixture deficiency was mitigated in 968 animals of different categories. Improved animal shelters were provided to 72 livestock owners to protect their animals form inclement weather conditions; while 1056 green fodder demonstrations were conducted in adopted NICRA villages. Total 7305 animals of different species were vaccinated, dewormed and treated in several animal health camps organized by KVKs in collaboration with District Animal Husbandry department at Amreli, Banaksantha, Kutch, Rajkot and Valsad in Gujarat.

Table-7: No of livestock covered for activity/demo in different districts under NICRA Project

District name	Breed Improve	Mineral Mixture	Animal shelter	Green fodder	Azolla units Estab	Animals in Health camp
Gujarat						
Amreli	0	45	0	15	0	596
Banasakantha	58	0	0	266	0	1924
Kutch	0	300	10	37	0	122
Rajkot	300	315	62	716	0	2988
Valsad	0	308	0	22	0	1765
Total	**358**	**968**	**72**	**1056**	**0**	**7395**
Haryana						
Bhiwani	0	40	0	50	0	0
Fatehabad	0	100	0	0	0	0
Hisar	0	50	0	22	0	0
M. Garh	16	40	0	0	0	0
Sirsa	0	410	0	0	0	230

District name	Breed Improve	Mineral Mixture	Animal shelter	Green fodder	Azolla units Estab	Animals in Health camp
YNagar	0	50	0	40	0	90
Total	**16**	**690**	**0**	**112**	**0**	**320**
Rajasthan						
Alwar-I	0	50	0	2	0	0
Barmer-I	410	340	10	29	5	14315
Bhilwara-I	62	10	4	10	0	460
Bharatpur	20	1834	0	253	25	2967
Bikaner-I	11	0	0	0	10	0
Churu-I	0	200	0	20	0	547
Hanunmangarh	12	0	0	25	0	89
Jaisalmer-I	11	10	0	0	0	0
Jhunjhunu	592	1184	0	645	72	4713
Jodhpur-I	2885	1026	57	52	18	6390
Kota	101	2132	11	335	5	3865
Nagaur-I	10	0	0	0	0	0
Pali-I	0	0	0	0	0	0
Sirohi	2	50	0	0	0	0
Total	**4116**	**6836**	**82**	**1371**	**135**	**33346**
G. Total	**4490**	**8494**	**154**	**2539**	**135**	**41061**

In Haryana total 16 animals were improved using pure breed animals and mineral mixture deficiency mitigated in 690 animals of different categories. Total 112 green fodder demonstrations were conducted in adopted NICRA villages. Total 320 animals of different species were vaccinated, dewormed and treated in several animal health camps organized by KVKs in collaboration with District Animal Husbandry department at Bhiwani, Fatehabad, Hisar, Mahendergarh, Sirsa and Yamunanagar in Haryana.

In Rajasthan total 4116 animals were improved using pure breed animals and mineral mixture deficiency mitigated in 6836 animals of different categories. Improved animal shelters were provided to 82 livestock owners to protect their animals form inclement weather conditions; while 135 Azolla units were established successfully and 1371 green fodder demonstrations were conducted in adopted NICRA villages. Total 41061 animals of different species were vaccinated, dewormed and treated in several animal health camps organized by KVKs in collaboration with District Animal Husbandry departments of Alwar, Barmer, Bhilwara, Bharatpur, Bikaner, Churu, Hanumangarh, Jaisalmer, Jhunjhunu, Jodhpur, Kota, Nagaur, Pali and Sirohi in Rajasthan.

Overall in Zone-II total 4490 animals were improved using pure breed animals and mineral mixture deficiency mitigated in 8494 animals of different categories. Improved animal shelters were provided to 154 livestock owners to protect their animals form inclement weather conditions; while 135 Azolla units were established successfully and 2539 green fodder demonstrations were conducted in adopted NICRA villages. Total 41061 animals of different species were vaccinated, dewormed and treated in several animal health camps organized by KVKs in collaboration with District Animal Husbandry departments in Gujarat, Haryana and Rajasthan states.

Balanced Feeding Management

A balanced ration is a ration, which provides the essential nutrients to the animal in such proportion and amounts that are required for the proper nourishment of the particular animal for 24 hours for various physiological functions. It contains green fodder, dry fodder, concentrate feed, mineral mixture and salt in proportionate quantities.

Demonstrations were conducted on 12503 livestock owing to 5064 farmers which recorded an increase of 19.4% in milk production over the farmers' practice during 2012-2022. A study had been conducted in selected villages (through KVKs) of Rajasthan under NICRA Project to evaluate the impact of climate resilient interventions implemented for improving the production and productivity of lactating cows maintained under stress and normal conditions. Daily milk yield was recorded, analysed and found that MNFB lick improved the milk production by 20.5% during normal days and 12% during stress year. During May-June decrease in milk was much higher in control group i.e. 15.0% as compared to treatment group i.e. 6.25%, respectively. On the similar trend, data also pointed out that mineral mixture feeding improved the milk production by 17.8% during normal days and 9.90% during stress period. Difference indicated that mineral mixture feeding improved animals capacity to combat the stress of high ambient temperature and dry spell period during experimental period. The composition and constituent percent of Multi Nutrient Feed Block are given below in table-8.

Table-8: Composition of Multi Nutrient Feed Block (MNFB)

SN	Composition %		Constituent %	
1	Molasses	44.5	Dry matter	97.3
2	Urea	4.3	Organic matter	78.3
3	Common salt	4.3	Crude protein	22.9
4	Dolomite	4.3	Ether extract	4.1
5	Vit. mineral mixture	4.3	Minerals	21.7
6	Wheat bran	32.1	Total carbohydrates	51.3
7	Guar gum dust	1.0	Gross energy, kcal	381
8	Guar meal	5.1		

Formulation of Novel Feed Supplement for cattle and buffaloes reared in arid regions of India

- Multi Nutrient Feed Block (MNMB)
- Compressed Complete Feed Blocks (CCFB)
- Urea Molasses Liquid Diet (UMLD)
- Molasses based multi nutrients liquid supplements (MMLS) for ruminants
- Micro-encapsulation of *Lactobacillus* Probiotic

The mineral mixture composition for 100kg and nutritive value per kg is shown below in table-10. In all balanced animal feed mineral mixture is added @ 2 percent of total feed to be prepared.

Table-9: Mineral Mixture composition for 100Kg and Nutritive Value per kg

Mineral Mixture Composition		Nutritive Value per Kg		Nutritive Value per Kg	
Component	Quantity (kg)	Component	Quantity	Component	Quantity
Zinc Oxide	3.73	Vitamin-A	5 to 7 lack IU	Iron	1500mg
Ferrous Sulphate	17.41	Vitamin-D	40000 to 70000 IU	Magnesium	6000mg
Manganese Sulphate	6.60	Vitamin-E	100 to 250g	Manganese	1500mg
Copper Sulphate	2.0	Nicotinamide	1000g	Potassium	100mg
Potassium Iodate	0.0289	Cobalt	100 to 150mg	Sodium	5.9mg
Sodium Selenite	0.0328	Copper	1200 to 1500mg	Sulphur Calcium	0.9% 25.5%
Cobalt Carbonate	0.106	Iodine	325mg	Zinc	9600mg
DORB (to make 100kg)	70	Iron	1500mg	DL-Methionine Phosphorous	1000mg 12.75%

Note: For Regular supplementation: Large Animals – 50g daily and Small Animals – 5-10g daily.

Harit Dhara

Harit Dhara and Tamarin Plus is an anti-methanogenic feed supplement prepared from tannins and saponins containing natural phyto-sources. This product is found very effective in reducing enteric methane emission by 20% when incorporated in livestock feed and commercialized in 2019. Animals below three months of age are not advisable to be fed with Harit Dhara. For adult cattle & buffalo, it should be given along with normal feed in three equal doses of 192g in the morning, midday and evening time. Growing cattle and buffalo calves can be given 150g in two equal doses of 75g in the morning and evening. For adult sheep, the content of recommended 50g should be given in two equal doses of 25g in the morning and evening.

Established Azolla units (154) and feed and fodder banks (215) which benefitted 2183 farmers providing green fodder grown over 420.26ha area during the scarcity period of 2012 to 2022. it was observed that Azolla could be used as a feed ingredient, with milk yield and fat percentage remaining at the same levels as when fed conventional feed. Results indicated in increase of 12 to 20 percent in milk production of lactating cows provided Azolla (1.5 to 2.0kg per day per animal) and buffaloes (2.0 to 2.5kg per day/ per animal) as regular supplemental feed. Moreover, feed banks of CCFBs were set up by the Government to prohibit burning of crop residues under field conditions by the farmers and also as a pre-emptive disaster management measure.

Azolla is already grown commercially in India and China, where its utility has long been recognised. The fern's use was once limited due to propagation issues, but it is now used in larger growing areas. It was first used in India in the 11th century. These are the only two countries that have long been cultivating Azolla. The practise most likely began when it was discovered that growing wild Azolla in paddy fields was beneficial for harvesting. However, until reliable methods of over-wintering and over summering the fern were developed, organised use of the fern would be impossible. Because Azolla can only be grown from vegetative material, it requires protection during seasons when the weather is too harsh to grow.

The Azolla-Anabaena symbiosis is distinguished by its high productivity and ability to fix nitrogen at high rates. Azolla derived from water can be used as human food, animal feed, green manure, organic fertiliser and to increase soil fertility, as well as for biological wastewater remediation and salt soil reclamation. Because of its high nutritional quality and protein content, Azolla is suitable for human consumption as well as a feed additive for a variety of animals such as fish, ducks, cattle, poultry and others to reduce feed costs. It is also used in the production of biogas and hydrogen, as well as astronaut food in space.

Azolla's possible benefits

- It grows easily in the wild and under controlled conditions.
- It is simple to produce in large quantities as green manure.
- It can fix atmospheric CO_2 and nitrogen to produce carbohydrates and ammonia and after decomposition, it provides soil accessible nitrogen for plant uptake as well as organic carbon content.
- The oxygen produced by oxygenated photosynthesis helps plant root systems and other soil microbes respire.
- It dissolves Zn, Fe and Mn in water, making them available to rice.
- Azolla can be used to supplement chemical nitrogen fertilisers (20 kg/ha) and improve crop yield and quality. It improves the efficiency with which chemical fertilizers are used.

- It reduces the rate of evaporation in irrigated paddy fields.
- Lower disease prevalence.
- Increase the number of flowers and fruits.
- Improve seedling or transplanted plant establishment and survival.
- Improve drought tolerance by watering less frequently.
- Azolla produces more total yield (1000kg) with more dry matter (80%) and protein (24%) in comparison to other fodders like; lobia, Hybrid napier, subabul, green fodder, Kolkatta grass etc.

Table-10: Proximate composition of Azolla fern on DM basis

Nutrient	% DM	Nutrient	% DM
Dry Matter	89.73	Nitrogen Free Extract	33.84
Organic matter	75.73	Total Ash	24.26
Ether Extract	3.70	Acid Insoluble Ash	7.94
Crude Protein	23.49	Calcium	2.58
Crude Fibre	14.7	Phosphorus	0.26

The utilization of Azolla as food, as well as any remaining significant purposes, contribute fundamentally to the conservation or improvement of the world's biological system. There is a reasonable need to boost oceanic potential. Biotechnological medicines could utilize Azolla all the more productively later on. The utilization of maintainable and earth sound farming practices can make a significant commitment to the biological steadiness of the planet. The utilization of Azolla as a bio-manure for rural harvests, to decrease or supplant substance composts, as a human dietary enhancement, as a feed for poultry and creatures can assume a huge part in keeping up with or further developing the utilization status of Azolla in the worldwide climate.

Improved Housing Shelters

High ambient temperature, intensive solar radiations, high wind velocity, low precipitation and erratic rainfall are affecting the productivity of the desert livestock. Present studies have revealed that longer heat stress period prevailing in arid zone and the THI values ranged from 78 to 90 in hot & dry and 81 to 85 in hot & humid season during peak day time; where THI values ranged from 50 to 59 during night hours and the effect increased with the increase of wind velocity. Adult animals maintained their body weights in summer with slight decrease but the slight increase in body weight was observed during rainy and winter season. The feed and fodder intake was not influenced by heat stress, however, water intake increased. Tharparkar cattle was influenced by heat stress at low level; as the correlation between daily milk yield of Tharparkar cows and THI value was negative (r = -0.11) but non-significant. The designing of underground animal house (30 feet long, 15 feet wide and 7 feet depth) was developed for better comfortable micro-climate to the animals. Roof insulation in animal shelter

through thatched panels improved the micro-climate by reducing the temperature from 3 to 4 ºC. Steaming up increased body weight gain of goats during advanced pregnancy. The kids reared in improved animal shelter with extra nutrition performed better in terms of higher body weight gain in summer months (THI= 71.3 in morning to 81.6 in the afternoon). Based on present findings it may be inferred that effect of climatic stress on arid livestock could be ameliorated through balanced nutrition and improved housing.

Total 190 demonstrations were conducted on improved animal shelter management owing to 190 farmers which recorded an increase of 20.4 to 22.5% in milk production over the farmers' practice. For the shelter management of dairy animal, demonstrations on E-W scientific housing (CAZRI Model) were conducted to minimize the thermal as well cold stress. It decreases the temperature 5^{0}C in comparison to traditional housing system. It also increased the 20 to 22 % milk production and B:C ratio is 1:1.6 as compared to traditional housing system.

Improved Animal Health

It has been observed that warming and changes in rainfall distribution may lead to changes in spatial or temporal distribution of diseases such as anthrax, haemorrhagic septicaemia and vector borne diseases. Changes in winds could affect the spread of certain pathogens and vectors. Climatic changes could affect the frequency and extent of livestock disease outbreaks such as foot and mouth disease and haemorrhagic septicaemia in certain areas. The immunity of animals is also lowered due to inclement weather conditions.

Total 180 animal health camps were organized in which 26072 animals were treated for different ailments in various categories of livestock in NICRA villages adopted by KVKs of Haryana and Rajasthan states; which recorded an increase of 15.5 to 22.0% in milk production. Similarly, camps were arranged for de-worming & vaccination of 10595 animals for control of various internal and external worms, and different prevailing diseases of different categories of animals owing to 4198 livestock owners in adopted villages by NICRA KVKs during 2012 to 2023. Percent increase in milk production ranged from 12.7 to 20% in different categories of livestock.

Package and practices for vaccination: The details of routine Prophylactic schedule for domestic animals has been given in table-11.

- Animal diseases cause huge losses to livestock industry. Prevention of these diseases is possible by protecting the animals by prophylactic and strategic vaccination.
- Prevention is better than Cure; is age old proverb which proves its worth by routine vaccinating
- Vaccination is done at specific age and at definite time interval against specific disease(s) using 'vaccine' to give optimal protection to the animals.
- Preferably deworming should be ensured at least one week in advance before vaccinating.
- Vaccination schedule may vary depending on the prevalence of disease.

- Deworm must be done at least one week before vaccination and follow schedule.
- Use sterilized disposable syringes, needle & administer SC or IM only.
- Always follow instructions given by the manufacturer.
- Ensure vaccine is not expired and cold chain (2 to 8A^{0}C) is not broken.
- Avoid vaccinating sick and weak animals.
- Avoid stressing animals until 2 weeks' post-vaccination.

Table-11: Routine Prophylactic schedule for Domestic animals

Disease & Animal	Vaccine	Dose & Method	Age & Time of Vaccination
FMD: Cattle, buffalo, sheep, goat, swine	FMD polyvalent Vaccine	Cattle, buffalo, sheep 2ml; goat & swine 1ml	1st dose at 4 months, Booster at 6 months, Repeat at every 6 months. Mar- April & Sept- Oct
PPR: Goat & sheep	Live accentuated PPR vaccine	Sheep & goat 1 ml SC	1st dose at 4 months. Revaccinate once in 3 yrs. Avoid advance pregnancy
Rabies: in all domestic animals	Inactivated cell culture	1 ml for all species IM	Start from zero day of dog bite, 3, 7, 14, 28, 90 days
Sheep & Goat Pox: Sheep and Goat	Sheep & Goat Pox Vaccine	0.3g triturated vaccine mixed with 30 ml glycine for 100 animals. SC or IM	First dose at 3 months and Booster repeat every year
Swine Fever: Swine	Lapinized SF Vaccine	1ml through IM route	First dose at 2 months' interval. Booster repeat every year
HS: Cattle, buffalo, sheep, goat, swine	HS oil adjuvant vaccine	Cattle & buffalo- 3ml. Sheep, Goat, swine 2ml through IM or SC	First dose at 4 -6 months and Booster repeat every year during May-June
Anthrax: All domestic animals	Anthrax live spore vaccine	Cattle, buffalo, horse 1ml. Sheep, goat, swine 0.5ml by IM	First dose at 6 months and Booster repeat every year during May-June
Black Quarter: Cattle, buffalo, sheep, goat	Polyvalent A BQ vaccine	Cattle & buffalo- 35ml. Sheep, Goat, swine 2-3ml through SC	First dose at 6 months and Booster repeat every year during May-June
Brucellosis: Cattle & buffalo	*Brucella abortis* strain live vaccine	2ml through SC. Aviod male calf & pregnant	Single dose at 4 to 8 months age
Tetanus: All domestic animals	Tetanus Toxoid Vaccine	Cattle, Buffalo, Horse- 1500 to 3000A units. Sheep, goat, swine- 500 to 1500A IU through IM	1st dose at 1 month. Booster at 6-month interval. Pregnant cattle, buffalo, horse at 6 to 7 month of gestation. Swine at 2-3 month. Pregnant sheep, goat, swine at 3 to 4 months of gestation.
Enterotoxmia: Sheep & goat	*Salmonella abortis equi* vaccine	3 to 5 ml through SC	2 doses at 21 days' interval. Repeat annually with 2 doses of vaccine at 21 days interval

Package and practices for control of endoparasite: Deworming Schedule for Different Livestock species has been shown in table-12.

- Endoparasites in general are responsible for poor weight gain, depraved appetite, reduced fertility and stress to the animals.
- Control of endoparasite is possible by regular prophylactic deworming of animal using potent anthelmintic.
- Anthelmintic should be used based on age, gestational status and species of the animal.
- Preferably, anthelmintic should be changed at frequent interval, to avoid resistance in animals.
- Therapeutic deworming should be done based on faecal examination and eggs per gram.
- Maintaining good hygiene and sanitation of animal houses and feeders is very important to control parasitic load in stall-fed animals.
- Rotational grazing is important in control of parasite in pasture grazed animals.
- Vector and intermediate host control is also important aspect for control of endoparasite.

Table-12: Deworming Schedule for Different Livestock species

Endoparasite & Parasite Name	Anthelmintic	Oral Dose	Remarks
Roundworms: Ascaris	Piparzine (45mg/100ml)	30 ml: For all animal species	1st dose within 5 to 6 days of birth. Repeat at 45 days interval
	Tetramisole	1.5mg/kg BW	-do-
	Morantel Citrate	10mg/kg BW	-do-
	Livsmesol	7.5mg/kg BW	-do-
Flat (Fluke) worms: Liver fluke: Amphiostom	Oxiclozanide	10-15mg/kg BW	Deworm at 4 to 6 months interval
	Fenbendazole	5 to 7.5mg/kg BW	-do
	Albendazole	5 to 10mg/kg BW	-do-
	Tricalbendazole	10 to 12mg/kg BW	-do-
	Rafoxanide	7.5mg/kg BW	-do-
Tape worms: Cestodes	Diclorophen	05mg/kg BW	Deworm at 4 to 6 months interval
	Albendazole	5 to 10mg/kg BW	-do-
	Fenbendazole	5 to 7.5mg/kg BW	-do-

Package and practices for control of ectoparasite: The details of common pesticides used for control of ectoparasite in animals are depicted in table-13.

- Ectoparasites are responsible for economic losses to livestock producers
- Direct losses are as a result of distress and damage to hides and fleeces caused by the parasite

- Distress results in decrease in milk production and poor growth rate
- They can also cause direct damage to hides and wool
- Indirect losses are from diseases transmitted by the ecto-parasites
- Annually in a farm pesticide application should be carried out at 4 month's interval.
- The pesticides used of ectoparasite control are poisonous and should be kept away from reach of children and farm animals.
- Avoid application in adverse weather
- Provide plenty of drinking water before application to prevent animals from licking after application

Different ecto-parasites transmit different diseases in livestock species. Ticks transmits babesiosis, anaplasmosis, Theileriosis; Flies transmits Mastitis, Kerato conjunctivitis, Trypano somiasis and Midges transmits Bluetongue, African Horse Sickness.

Table 13: Common pesticides used for control of ectoparasite in animals

Pesticides	Uses	Doses
Cypermthrin 10% w/v	Ticks, lice, flies, mites, midges and keds	Dilute 1 ml to 2ml in 1 litre of water and apply on whole body as spray or bath. Repeat after 15 days to kill the newly emerged larva and adults from egg **For Animal Houses: Dilution rate is 20ml/lit of water.
Deltamethrin 12.5mg/ml	Tick, lice, mite, flies, keds, etc.	For Tick: Dilution rate 2-3 ml/Lit of water For Mites: 4-6ml/lit of water For Lice: 1-2ml/lit of water For Fly: 2-3ml/lit of water
Amitraz 12.5% w/v	Tick, Fleas, Mange, lice	Dilute 2-4ml per lit of water and spray or wash all over the body. Repeat the application 3 times at 15 days interval
Ivermectin 1% w/v	Sarcoptic Mange	Dog: 0.2 ml/33kg/body weight Pig: 1ml/33 kg/body weight Other Animals: 1ml/50 kg/ body weight by S/C route

Outcomes

Milk production which ranged from 12.5 to 22.8% in lactating cattle and buffaloes in adopted villages of Gujarat, Rajasthan and Haryana. Farm Income increased due to adoption of climate resilient agriculture in NICRA villages. Total monetary advantage also ranged from Rs 450/day/animal to Rs 700/day/animal which resulted due to implementation of different climate resilient technologies at farmers' animals in comparison to those livestock owners who were not include under NICRA-TDC modules. The increase in growth of calves and milk production sustained for longer periods due to significant impact of different climate resilient technologies adopted by the livestock owners. The risk of climate stress on different livestock species also reduced due to climate adaptation strategies followed by the selected livestock owners in vulnerable districts of Gujarat, Rajasthan and Haryana.

Major improvement in livestock breeds, feeding, milk yield and health has been recorded at field level (12-25%). Number of cattle, buffalo, sheep and goat units of improved breed have been established. More number of Backyard poultry units (240) have been started by 240 rural unemployed youth. Fodder and seed availability has been improved due to establishment of feed and fodder banks in NICRA villages. Azolla feeding to animals has found beneficial in ADG (220g) in goats & milk yield of cattle & buffalo (15%). Income level of farmers has increased significantly in adopted villages (more than double).

Cost of cultivation and post-harvest losses have been minimized due to Custom Hiring Centres (25 to 70%). Farming community has been enabled to practice climate resilient agriculture using different contingency measures.

Adoption of Livestock intervention

Supplementation of area specific mineral mixture for enhancing productivity

Details of technology: Dairy animals often face mineral deficiency and metabolic disorders due to insufficient and poorly absorbed minerals in their feed. To address this issue, we recommend supplementing dairy animals with region-specific mineral mixtures. These mixtures contain the necessary minerals in optimal amounts. This supplementation offers several benefits. Provided the mineral mixture @ 50g per animal per day, ideally alongside their regular feed. This simple addition significantly improved the well-being, productivity, and immunity of dairy animals.

Performance and Impact of technology: In Alwar district, Rajasthan, the use of mineral mixtures has led to significant improvements. These benefits include increased milk yield, reduced issues with anestrus and repeat breeding. In a demonstration involving 130 farmers and 210 animals in Gurjarpur Khurd, as part of NICRA, animals supplemented with balanced mineral mixture showed a 25% increase in daily milk yield as compared to local practices. This translated to higher net return (33.33% increase) and a better benefit-cost ratio (6.25%) when compared to the local approach. Additionally, buffalo calf body weight increased by 12.50% in the NICRA village of Alwar district. As a result of these significant outcomes, the adoption of mineral mixtures among farmers in NICRA villages has up-scaled significantly, from 5-10% to 60-70%. This intervention has been well-received and embraced by farmers in Gurjarpur Khurd and adjoining villages of Alwar district.

Table-14: Performance of balanced mineral mixture supplementation to cow and buffalo in Gurjarpur Khurd

Year	Interventions	Milk yield (lit./day)	Gross Cost (Rs./day)	Gross returns (Rs./day)	Net Return (Rs./day)	B:C ratio
2021-22	Farmers Practice	6	200	300	100	1.5
	Demo- Mineral mixture	8	250	400	150	1.6

Upscaling: This can be up-scaled widely through the animal husbandry department, National Livestock Mission and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to upscaling. Mineral mixture supplementation to cow and buffalo in Alwar district

Supplementation of area specific mineral mixture for enhancing productivity of cattle

Details of technology: Problem of mineral deficiency and metabolic disorder in all categories of dairy animals have been reported due to lower content and low bioavailability of minerals in feed stuffs. There is need for the supplementation of area specific mineral mixture to dairy animals. Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture will help in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity. It can be given at the rate of 2 kg/animal @50 g/day/animal once in a day along with the animal feed. It will improve overall animal health, immunity and productivity during stress.

Performance and Impact of technology: The use of mineral mixtures has not only helped in increasing the milk yield but also alleviated problems of anoestrus and repeat breeding to a large extent in Barmer District of Rajasthan. In a demonstration involving 64 farmers with 128 animals, conducted in a NICRA village of Juna Ptrasar & Sujan Nagar of Barmer District, increased milk yield per day was observed with the animals being supplemented with balanced mineral mixture to an extent of 12.50% over local practice. It has also recorded increased net returns Rs 36000/farmer and BC ratio 2.40 than local practice (2.14). Apart from this, increased body weight in buffalo calves by 10-15% over local practice was observed in NICRA village of Barmer district. Usage of mineral mixture for animals has increased from 5-7% to 45-55% among farmers in NICRA village of Barmer. This intervention is well adopted by the farmers of NICRA village of Barmer districts.

Mineral mixture supplementation to milch animals (cow and buffalo) in NICRA villages

Table-15: Performance of balanced (Mineral mixture supplementation to milch animals: 2022-23

Intervention	No of farmers	Unit/ani	Milk Yield/d	% increase	Gross cost (Rs/ani)	Gross Return (Rs/ani)	Net Return (Rs/ani)	BCR
Demo Min Mixt	64	128	4.50	12.5	15000	36000	21000	2.40
Farmer Practice	64	250	4.0	00	14700	31500	19000	2.14

Up scaling: This can be up scaled widely through the Department Animal Husbandry, under National Livestock Mission (NLM) and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to up scaling this technology in the District as well as state.

Supplementation of area specific mineral mixture & MNFB for enhancing productivity

Details of technology: Low productivity of animals with higher genetic potential can be primarily attributed to the imbalanced and inadequate feeding. Imbalanced feeding leads to excess feeding of some nutrients whilst others remain deficient. This not only reduces milk production and increases costs per kg milk, but also affects various physiological functions including long term animal health, fertility and productivity. A balanced ration should provide protein, energy, minerals and vitamins from dry fodders, green fodders, concentrates, mineral supplements etc., in appropriate quantities to enable the animal to perform optimally and remain healthy. Livestock are more likely to have lower reproductive and productive performance in summer stress. Feeding high quality forages and balanced rations decrease summer stress and enhance performance of the animals.

Performance and Impact of technology: KVK Bharatpur conducted 50 demonstrations of mineral mixture (3.0kg/demo) involving 50 livestock owners. Major interventions were feeding of mineral mixture to overcome mineral/vitamin deficiency, de-worming of animals (80) for internal worm control. Net returns of Rs 170/ animal/day was earned with B:C ratio of 1.69 as compared to control group (Rs 95/ animal/day with B:C ratio of 1.43). Due to use of health management practices, milk production increased (19.44%) in buffaloes as compared to animals which were not provided balanced feed. Total 30 demonstrations were conducted on Urea Molasses Mineral block bricks for 30 buffaloes which resulted 18.85% more milk yield as compared to buffaloes which were not provided Urea Molasses Mineral block bricks.

Mineral Mixture and Mineral Bricks demonstrated at NICRA Village Gagarsoli

Table-16: Performance of balanced mineral mixture supplementation to cow and buffalo in Gagarsoli (2022)

Year	Interventions	Milk yield (l/day)	Gross Cost (Rs/day)	Gross returns (Rs/day)	Net Return (Rs/day)	BC ratio
2022-23	Mineral mixture	8.60	240	410	170	1:1.69
	Farmers Practice	7.20	220	315	95	1:1.43
	UMB Mineral Bricks	8.70	250	425	175	1:1.70
	Farmers Practice	7.32	230	345	115	1:1.50

Upscaling: The technology can be spread to the entire districts through district line departments.

Introduction of improved breed of Sirohi buck

Details of technology: India occupies first position in terms of goat population and milk production. Chevon (goat meat) is most preferred and widely consumed meat in the country. The body weight in a goat is an important parameter related to selection, feeding and health care. Rajasthan having maximum number of goats (20.84 million) followed by West Bengal (16.28 million) and Uttar Pradesh (14.48 million). The Sirohi breed has predominantly brown coat, with light or dark brown patches and occasionally white in colour. Most Sirohi goats are wattled and have medium size flat leaf like dropping ears. The breed is also known by other names such as Parbatsari, Devgarhi and Ajmeri, reared mainly for meat and milk production. Body weight is an indicator of its physique and economic viability for marginal as well as landless farmers. It is a dual-purpose breed, reared for both meat and milk production, or as meat breed. It is well adapted to the dry tropical climate of Rajasthan. The animals are popular for their weight gain and lactation even under poor quality rearing conditions. The animals are resistant to major diseases and are easily adaptable to different climatic conditions specially in hot places. Demand of Sirohi goat meat is higher than local breeds of goat.

Performance and Impact of technology: Sirohi goat kid was found with higher weight than local goat kid. Higher net return was obtained by dairy farmers from the sale of Sirohi goat kid for meat purpose than local goat breeds. Farmers told that Sirohi breed goat was less frequently ill as compared to local goat breed.

Table-17: Performance of Sirohi buck in order to improve breed (2022-23)

Year	Interventions	Breed	Goat kidding/year	Gross Cost (Rs/year)	Gross returns (Rs/year)	Net Return (Rs/year)	BC ratio
2022-23	Farmers Practice	Local	2	4800	8100	3300	1.68
	Sirohi buck	Sirohi	2	5400	12000	6600	2.22

UP-scaling: This can be up-scaled widely through the animal husbandry department, National Livestock Mission and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to horizontal expansion of this livestock intervention.

Demo on Sirohi improved breed technology in Bhilwara district

Introduction of Sirohi goat breed in the NICRA village

Details of technology: The Sirohi is an Indian breed of domestic goat. It is named for its area of origin, the Sirohi District of Rajasthan, in north-western India. It is a dual-purpose breed, reared for both meat and milk production, or as meat breed. It is well adapted to the dry tropical climate of Rajasthan. The animals are popular for their weight gain and lactation even under poor quality rearing conditions. The animals are resistant to major diseases and are easily adaptable to different climatic conditions specially in hot places. Demand of Sirohi goat meat is higher than other local breeds of goat. Milk production of Sirohi goat is higher than local goat.

Performance and Impact of technology: Sirohi breed was introduced at NICRA village (Kanasar) for breed improvement. Each Sirohi female goat gives on average of about 1 to 1.5 Litter milk/day. Female goat (doe) kids twice a year. In each birth 40%. of single and 60% of twins can be expected from this breed. They gain weight faster as compared to other breeds (9-12 kg body weight in 6-7month kid). Higher income was obtained by the farmer through sale of meat purpose. This breed was also found less susceptible to diseases.

Demo on Sirohi Goat breed at farmer's house

Table 18: Performance of Sirohi goat in Kanasar village (2022-23)

Year	Interventions	Breed	Goat Birth/year	Gross Cost (Rs/year)	Gross returns (Rs/year)	Net Return (Rs/year)	BC ratio
2022-23	Farmers Practice	Local	1	4700	7500	2800	1.59
	Sirohi goat	Sirohi	1	5300	14000	8700	2.64

Supplementation of area specific mineral mixture for enhancing productivity

Details of technology: Problem of mineral deficiency and metabolic disorder in all categories of dairy animals have been reported due to lower content and low bioavailability of minerals in feed stuffs. There is need for the supplementation of area specific mineral mixture to dairy animals. Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture, increases milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity. It can be given at the rate of 50g/day/animal once in a day along with the animal feed. It will improve overall animal health and immunity and productivity during stress.

Performance and Impact of technology: The use of mineral mixtures has not only helped in increasing the milk yield but also alleviated problems of anestrus and repeat breeding in NICRA village Mitasar in Churu district of Rajasthan. In demonstrations involving 200 farmers with 200 animals, conducted in NICRA village of Mitasar, increased milk yield per day was observed from the animals being supplemented with balanced mineral mixture to an extent of 8.53% over local practice. It has also recorded increased net returns (10.92%) and BC ratio (3.24%) than local practice. This intervention is well adopted by the farmers of NICRA village of Mitasar District Churu.

Table-19: Performance of balanced mineral mixture supplemented to cow in Churu District

Year	Interventions	Milk yield (l/day)	Gross Cost (Rs/day)	Gross returns (Rs/day)	Net Return (Rs/day)	BC ratio
2022	Farmers Practice	8.2	205	368	163	1.79
	Mineral mixture	8.9	213	396	183	1.85

Upscaling: This technology can be up-scaled widely through the animal husbandry department. Local entrepreneurship can also be encouraged which can further contribute to upscaling.

Mineral mixture supplementation to cow in Mitasar Village of Churu district

Introduction of Sirohi Buck for Breed Improvement and increase in meat yield

Details of technology: Problem of low productivity in local goats in terms of their body growth and meat yield have been reported due to low productive and reproductive performance of local goat breeds. There is need for the improvement of local breeds i.e. Marwari goat. Crossing of Sirohi buck with local breed thus enhanced body growth and productive performance like increase in body growth rate, live weight, milk yield per lactation length, average milk yield per day etc. The progeny of the crossed breed also showed better reproductive performance like increase in conception rate, twinning percentage, lower kidding interval in days. Natural mating/crossing was done by the farmers in the breeding pens. Also supplementation of Azolla was given to dairy goats that enhanced milk yield and provided resistance to heat stress. It improved overall animals' health and productivity of local breed during stress period.

Performance and Impact of technology: The Introduction of Sirohi buck for breed Improvement has not only helped in increasing the growth rate, meat yield but also alleviated problems of low live weight of local goat breeds in NICRA village Jogidas ka gaon in Jaisalmer district of Rajasthan. In a demonstration involving 10 farmers with 100 animals, conducted in a NICRA village of Jogidas ka gaon, increased body weight which was compared with the animals being crossed with elite Sirohi buck to an extent of 37.50% over local goat breed. It has also recorded higher net returns (Rs 4720/buck) and B:C ratio (1.39) as compared to local farmers' practice. This intervention is well adopted by the farmers of NICRA village as well as by the adjoining villages of Jaisalmer District.

A view of Sirohi buck for breed improvement activities conducted by KVK Jaisalmer

Table-20: Economic feasibility of Sirohi Buck in Jaisalmer district

Year	Interventions	Live Weight (kg/Buck)	Gross Cost (Rs/Buck)	Gross returns (Rs/kg)	Net Return (Rs/Buck)	B:C ratio
2023-24	Famers practice (Local breed)	32	10500	12160	1660	1.16
	Demo on Sirohi buck for breed improvement	44	12000	16720	4720	1.39

Upscaling: This intervention can be up-scaled widely through the animal husbandry department, NGOs and SC-SP plan by RRS CAZRI, Jaislamer. Local commercial goat keeping farmers can also be encouraged which can further contribute to upscaling process in Jaisalmer district.

Breed upgradation in Goats to increase productivity and profitability

Details of technology: Animal based farming is most suitable and profitable in arid regions of Rajasthan. Goatry is a major component of animal based agriculture system. In Jhunjhunu district local breeds of goats are less productive and less profitable. Sirohi breed of goat is well adopted and gain 15-20 % more body weight than local breed. To improve in breed demonstration of Sirohi goat units were established in NICRA villages initially. Later on Sirohi buck were provided to goat owners to improve in breed.

Performance and Impact of technology: Sirohi breed of goats is performing very well in NICRA villages since last 10 years. Data were recorded on the basis of body weight of one-year-old progeny of local breed as well Sirohi breed. During year 2022 result revealed that body weight of year old progeny was recorded 31.18 kg/buck in Sirohi breed while 27.08 kg/buck in local breed. Farmers of NICRA village have adopted this goat breed very well in NICRA village as well as in nearby villages.

Table-21: Performance of Sirohi breed goat in NICRA villages (2022-23)

Year	Interventions	Body weight (Kg/buck)	Gross Cost (Rs/year)	Gross returns (Rs/year)	Net Return (Rs/year)	BC ratio
2022-23	Local breed	31.18	7000	9478	2478	1.354
	Sirohi breed	27.08	7000	10913	3913	1.559

Upscaling: This goat breed can be up-scaled widely through the animal husbandry department, National Livestock Mission and also by providing financial assistance to Goat owners.

Demo on Sirohi Goat breed at farmer's house

Supplementation of area specific mineral mixture for enhancing productivity and reproductive efficiency of cattle and buffaloes

Details of technology: The livestock production is greatly affected by quality and quantity of feed and fodder fed to the animals. However, the productivity of buffaloes is greatly constrained by the lack of green fodder and good quality feed. Though technologies to improve productivity of dairy animals

exist, the awareness and rate of mixed farming system worldwide is consistently low because of the existing research and extension setup and related other constraints. As per research findings revealed that majority of the feed and fodders are deficit in major and micro nutrients which cause mineral and vitamin deficiency in animals that reduces immunity, reproduction and production performance of livestock. This mineral mixture contains appropriate amount of Ca, P, Mg, Cu, Zn, I, Se and other essential minerals apart from vitamin A, D and E. There is need to supplement mineral mixture every day @ 50-100 gm/day / dairy animal along with concentrate feed. It will definitively improve the productivity and reproductive efficiency of lactating dairy animals.

Performance and Impact of technology: Minerals mixture feeding has increased milk production. It also helped in minimising the incidence of anoestrus, retention of placenta, repeat breeding, prolapse of uterus, downer cow syndrome etc. KVK conducted 20 demonstrations on area specific minerals mixture in NICRA-TDC adopted villages of Lawari, Lunawas of Jodhpur district. It was observed that 15-22 percent increase the milk production in buffalo and cross bred cows in comparison to farmers' practice. It has also recorded increased net returns (60-80 %) in dairy animals viz; cows and buffaloes. The B: C ratio of 1:5 and 1:45 recorded, respectively for buffalo and crossbred cows for this technology adopted by the farmers which is higher than farmers' practice. The feeding of area specific minerals mixture feeding has been successfully adopted by 70 percent livestock farmers.

Table-22 : Performance of area specific minerals mixture supplementation to buffaloes and cows

Year	Interventions	Livestock	Milk yield (l/day)	Gross Cost (Rs/day)	Gross returns (Rs/day)	Net Return (Rs/day)	BC ratio
2019-20	Farmers Practice	Buffalo	7	200	270	70	1.35
	Minerals mixture	Buffalo	8.5	260	390	130	1.5
2020-21	Farmers Practice	CB Cow	9	250	330	80	1.32
	Minerals mixture	CB Cow	10.5	310	450	140	1.45

Upscaling: This technology can be up-scaled widely through the animal husbandry department, milk co-operative society etc. Local entrepreneurship can also be encouraged which can further contribute to upscaling in adjoining villages.


Mixing minerals mixture in home-made balance feed

Livestock and Fodder Production: During 2020, KVK Kota organised one animal health camp in which 160 animals owing to 80 livestock farmers were treated i.e. vaccination and health check-up at Chomakot village and also provided mineral mixture for covering 285 farmer families for 150 animals, which showed 14.60 per cent increase in milk yield. Total 86 demonstrations were conducted on balanced ration to pregnant cows involving 105 animals. The results showed an increase of 17.5 percent in milk after calving in these cows as compared to control group.

Demonstrations on fodder: To popularize the green fodder in adopted village, KVK Kota conducted demonstrations on Oat variety (JHO 822) at 20 farmers' field in 2.00ha area in adopted village and observed average green fodder yield of 825q/ha as compared to local practice 710q/ha and got net economic benefit of Rs 85466/ha as compared to local practice Rs 69093/ha. Similarly, the green fodder of berseem variety BL 42 demonstrated at 23 farmers' field in 2.30ha area and recoded 771q/ha green fodder as compared to 640q/ha yield under farmer practice. Farmers got net economic benefit of Rs 76566/ha as compared to Rs 57793/ha in farmers' practice.

Table-23: Performance of green fodder supplementation to buffaloes and cows

Year	Interventions	Livestock	Milk yield (l/day)	Gross Fodder Cost (Rs/ha)	Gross Fodder returns (Rs/ha)	Net Fodder Return (Rs/ ha)	BC ratio
2019-20	Farmers Practice	Buffalo	7.2	40284	100850	69093	2.75
	Oat JHO-822	Buffalo	8.7	39407	125750	85466	3.12
2020-21	Farmers Practice	CB Cow	9.2	40650	96743	57793	2.70
	Berseem BL-42	CB Cow	10.8	38950	117216	76566	3.00

Demo on Sirohi goat unit: KVK Kota

Demo on Oat (JHO-822): KVK Kota

Under livestock module initiated use of prophylaxis of livestock and poultry birds, organized 2 animal health camps in which deworming of 155 animals was done and same animals were injected preventive vaccination. Mitigation of vitamin and mineral deficiency through balanced feeding was offered to 50 farmers' livestock which improved milk yield by 10 to 20% as compared to control group.

Breed Improvement: KVK motivated farmers to improve goat breed in respect to meat and milk yield. Two breeding buck of Sirohi Goat were provided already to goat rearing farmers; Sh. Ramesh Chand S/o Kalu Lal and Rajendra S/o Kalu Lal at TDC-NICRA villages during year 2020. They were also bound to provide buck service to other goats of the village on minimum charges for their breed improvement Programme in NICRA and nearby villages.

Mangers and Chaff cutter: Animal feed mangers were provided to 7 farmers of NICRA village Chomakot, under Jal Grahan Pariyojna in collaboration with KVK Kota to fulfil the purpose of feed arrangement and fodder saving to minimize and avoid losses during feeding to animals. Total 20 chaff cutter had been provided to 20 farmer families in NICRA villages under Jal Grahan Pariyojna for the purpose to increase the fodder use efficiency by chaff fodder instead to previous method of animal feeding as whole green fodder feeding for efficient utilisation of available green fodder.

Sirohi buck introduction for improving local goat breed

Details of technology: Sirohi goat is a dual-purpose breed, reared for both meat and milk production, or as meat breed. It is well adapted to the dry tropical climate of Rajasthan. The animals are popular for their weight gain and lactation even under poor quality rearing conditions. The animals are resistant to major diseases and are easily adaptable to different climatic conditions specially in hot places. Demand of Sirohi goat meat is higher than Marwari and other local breeds of goat. Production of Sirohi goat is higher than Marwari goat.

Performance and Impact of technology: Sirohi goat kid was observed to attain higher body weight gain than Marwari goat kid. Higher net return was obtained by goat farmers through the sale of Sirohi goat kid for meat purpose than Marwari kids. Farmers told that Sirohi breed goat was less frequently ill as compared to Marwari breed goat.

Table-24 : Performance of Sirohi buck in order to improve breed (2022-23)

Year	Interventions	Breed	Goat Birth/ year	Gross Cost (Rs/year)	Gross returns (Rs/year)	Net Return (Rs/year)	BC ratio
2022-23	Farmers Practice	Local (Marwari)	2	4500	8000	3500	1.77
	Sirohi goat breed	Sirohi	2	5000	11000	6000	2.2

Upscaling: This goat breed can be up-scaled widely through the animal husbandry department, National Livestock Mission and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to upscaling.


Mineral mixture supplementation to cow in Mitasar Village of Churu district

Details of technology: Due to the problem of lack of green fodder at farmers' field the demonstration was conducted to the farmers at their field for napier grass. The Napier grass is very nutritive and palatable to animals. Napier is perennial grass and most suitable to Pali district's climate and soil profile. The first cutting of napier was received after 70-80 day after planting and the subsequent cuttings were received 30-40 days after first cutting.

Performance and impact of technology: CO-4 variety of napier grass gives higher production than other fodder crops. It is very good for the animals as it takes less time for digestion.

Economics: Average net profit of Rs 40600/ha and other farmers got only Rs 24400/ha (additional return of Rs 16200/ha under demonstration over local check).

Table 25: Performance of Napier grass at farmers' field under NICRA project (2022-23)

Year	Interventions	Yield (q/ha)	Gross Cost (Rs/ha)	Gross returns (Rs/ha)	Net Return (Rs/ha)	BC ratio
2022-23	Farmers Practice	298	74200	49800	24400	1.9
	Napier grass	382	107900	67300	40600	2.5



Performance of Napier grass at farmers' fields in Pali district of Rajasthan

Up-scaling: In 2022-23 total 04 farmers adopted CO-4 variety of napier grass village. More farmers are willing to procure the napier cuttings from KVK Pali for their field. This fodder variety can be up-scaled widely through the district agriculture department.

Goat Breed Improvement through demonstration of Sirohi Goat breed

Details of technology: Local breed improvement helps farmers to get pure breed of Sirohi goat which is origin breed of Sirohi district which also helps farmers to get additional income through pure goat breed. Problem of mineral deficiency and metabolic disorder in all categories of dairy animals have been reported due to lower content and low bioavailability of minerals in feed stuffs. There is need for the supplementation of area specific mineral mixture to dairy animals. Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture will help in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduces calving interval, increase productive life of animals and improve immunity as well. It can be given at the rate of 50g/day/animal once in a day along with the animal feed. It will improve overall animal health and immunity and productivity during stress.

Performance and Impact of technology: Improvement of local breed and use of mineral mixtures has not only helped in increasing the milk yield but also alleviated problems of anestrus and repeat breeding to a large extent in Sirohi district. Total 57 demonstrations were conducted for breed improvement (7), mineral mixture supplement (50). 7 Sirohi Breed buck were demonstrated to the dairy farmer in NICRA village. Farmers having goat breed and Sirohi buck for improvement of goat breed in adopted village under NICRA project. Improved poultry breed Pratap Dhan were demonstrated to 25 farmers for back yard poultry units. This intervention is well adopted by the farmers of NICRA village of Sirohi districts and also by the livestock owners of nearby villages.

Table-26: Local Breed Improvement and poultry demonstration in NICRA village of Sirohi District

Year	Interventions	Meat Production (kg/Year/Goat unit)	Gross Cost (Rs/year)	Gross returns (Rs/year)	Net Return (Rs/year)	BC ratio
2022	Farmers Practice 10 Goat unit	100	15000	50000	35000	2.33
	Breed Improvement 10 Goat unit	150	16500	75000	58500	3.51
Year	**Interventions**	**Egg Production (No./Year/poultry)**	**Gross Cost (Rs/year)**	**Gross returns (Rs/year)**	**Net Return (Rs/year)**	**BC ratio**
2022	Farmer Practice	40	200	400	200	1.0
	Poultry unit	200	500	2000	1500	3.0

Upscaling: This intervention can be up-scaled widely through the animal husbandry department, National Livestock Mission and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to upscaling.


Local Breed Improvement and poultry demonstration in NICRA village of Sirohi District in Rajasthan

Supplementation of area specific mineral mixture for enhancing productivity

Details of technology: There is need for the supplementation of mineral mixture to dairy animals as the problem of mineral deficiency and metabolic disorder have been reported in all categories of dairy animals due to lower content and low bioavailability of minerals in their feed. Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture will help in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity. It can be suppleented at the rate of 50g/day/animal once in a day along with the animal feed.

Performance and Impact of technology: The use of mineral mixtures has helped in increasing the milk yield of dairy cattle and buffaloes in villages Lohani and Dhareru, district of Bhiwani. In a demonstration involving 40 farmers with 40 animals, conducted in NICRA villages observed an increased milk yield per day from the animals being supplemented with balanced mineral mixture to an extent of 18.75% over local practice. It has also recorded an increase of net returns (32.3%) than local practice. Usage of mineral mixture for animals has increased from 15-20% to 60-70% among livestock farmers in NICRA village of Bhiwani district. This intervention is well adopted by the farmers of NICRA village of Lohani and Dhareru and also by the livestock owners of adjoining villages.

Table-27: Performance of balanced mineral mixture supplementation to cow and buffaloes

Year	Interventions	Milk yield (lit/day)	Gross Cost (Rs/yr)	Gross returns (Rs/yr)	Net Return (Rs/yr)	BC ratio
2022-23	Farmers Practice	8.0	29500	62400	32900	2.01
	Mineral mixture	9.5	35750	79300	43550	2.21

Upscaling: This intervention can be up-scaled widely through the animal husbandry department, National Livestock Mission and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to upscaling.


Mineral mixture supplementation to cow and buffalo in Lohani and Dhareru district

Introduction of new fodder variety: Improved seed of multi cut Sorghum variety MFSH-4 was demonstrted to 50 farmers of Lohani village for 50 demonstrations. Results of this variety yields were observed 610 q/ha as compared to 480 q/ha of local fodder grown by the farmers. Also, an average of Rs 35750 Gross cost, Rs 43550 Net returns and B:C 2.21 was obtained when compared to Rs 29500 of Gross cost, Rs 32900 of Net returns and B:C 2.1 by adopting farmers' practices.

Table-28: Performance of new green fodder variety in Lohani village

Year	Interventions	Fodder yield (q/ha)	Gross Cost (Rs/day)	Gross returns (Rs/day)	Net Return (Rs/day)	BC ratio
2022-23	Farmers Practice	610	35750	79300	43550	2.21
	Introduction of new fodder variety- MFSH-4	480	29500	62400	32900	2.10

FLD on Sorghum (MFSH-4) at NICRA village of Bhiwani district

Supplementation of mineral mixture for enhancing productivity of dairy animals

Details of technology: Problem of mineral deficiency and metabolic disorder in all categories of dairy

animals has been reported due to lower content and low bioavailability of minerals in feed stuffs. There is need for the supplementation of area specific mineral mixture to dairy animals. Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture will help in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity. It can be given at the rate of 20g/day/animal once in a day along with the animal feed. It will improve overall animal health and immunity and productivity during stress.

Performance and Impact of technology: The use of mineral mixtures has not only helped in increasing the milk yield but also alleviated problems of anestrus and repeat breeding to a large extent in Faridkot district of Punjab. In a demonstration involving 100 farmers were conducted in NICRA villages of Fatehabad, increased milk yield per day was observed with the animals being supplemented with balanced mineral mixture to an extent of 14 % over local practice. Usage of mineral mixture for animals has increased from 10% to 60% among farmers in NICRA villages. This intervention is well adopted by the farmers of NICRA villages of Fatehabad district.

Table-29: Performance of balanced mineral mixture supplementation

Year	Interventions	Milk yield (lit/d)	Gross Cost (Rs/yr)	Gross returns (Rs/yr)	Net Return (Rs/yr)	BC ratio
2022-23	Farmers Practice	7.0	60343	91519	31176	1.33
	Mineral mixture	8.0	61850	97300	35540	1.57

Upscaling: This intervention can be up-scaled widely through the animal husbandry and district line departments, National Livestock Mission and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to upscaling.


Demo on Mineral mixture supplementation and green fodder in Bodiwali and Banmandori villages

Supplementation of mineral mixture for enhancing productivity of dairy animals

Details of technology: Minerals are essential for proper metabolic functions. It contains all the essential minerals in required quantities. Helps Better utilization of absorbed nutrients, increases milk production in animals, increases productive life of animals. improves immunity status, prevents

metabolic diseases like milk fever, ketosis, etc. which occur around calving period. The daily requirement of mineral mixture is 100-200g/d/animal (as per milk production).

Performance and impact of technology: Before the start NICRA project a very few farmers were feeding mineral mixture to the animals. Demonstration of the mineral mixture in the animal feeds was carried out to motivate the farmers under the NICRA projects as the result more than 75% of the farmers have started supplementing mineral mixture to animal feed. The incorporation of mineral mixtures in animals' diet increased 15 to 17% of the milk yield and decreased the disease incident resulted into higher net returns and BC ratio.

Up-Scaling: In adjoining village the awareness and demand for mineral mixture has increased. About 75 percent of the livestock farmers have adopted feeding mineral mixture to their animals.

Adoption of climate-resilient forage variety

Details of technology: Sustainable farm animal raising is dependent on the production of sufficient quantities and quality of forages and fodder, especially in rainfed region. So, climate-resilient forage species must be popularized to sustain livestock production under change climate. The short duration and climate-resilient fodder pearl millet variety (HC 20) during kharif and improved variety of Berseem (HB-2) and oats (HJ 8 and Kant) were demonstrated in NICRA villages.

Performance and impact of technology: The short duration Fodder pearl millet variety (HC 20) were demonstrated at 20 famers field in 8.0 ha area. This variety recorded more fodder production as compared to local check. In rabi season 12 demonstrations on improved variety of Berseem (HB-2) were conducted which resulted more fodder production and higher net returns Rs 86725 and B: C ratio (7.1) over local variety (6.2) grown by the farmers. Total 20 demonstrations on improved variety of oats (HJ 8 and Kant) were also conducted which resulted more fodder production and higher net returns Rs 44500 and B: C ratio (2.2) over local fodder grown by the livestock owners (1.8).

Up-Scaling: In adjoining villages 39 % of farmers have adopted climate-resilient forage variety. The seed of variety was made available by CCS HAU Hisar and other state seed agencies.


Demo on green fodder varieties at farmers' fields in adopted NICRA villages

Intervention of mineral mixture for enhancing livestock productivity

Balanced ration plays a pivotal role in attaining the maximum genetic potential of an animal. Feeding proper quantum of all the essential nutrients not only helps an animal to maintain its vital functions at their best, but also helps them to produce and reproduce in a proper physiological manner. The micro-nutrients, especially minerals play an indispensable role in maintaining normal metabolic and physiological functions of body.

Low productive and reproductive performance of livestock is one of the major problems in livestock production in district Mahendergarh, resulting in poor economic returns to the livestock farmers. The deficiency and/or imbalance of micro and macro nutrients are one of the important factors responsible for the low milk production efficiency. The practice of mineral mixture supplementation to livestock is not common in NICRA villages.

Description of technology: A total of 80 demonstrations were conducted in NICRA villages Gadania and Bairawas on improved livestock feeding through mineral mixtures. All the animals were selected at a comparable stage of lactation i.e. within first month of lactation and were maintained under similar management conditions throughout the trial. Animals were fed mineral mixture at the rate of 50g/animal/ day for a period of 6 months. Milk yield of these animals was recorded by the dairy farmers. Apart from this four training programs for women and two animal health camps were organized in these villages for improving of knowledge, skills and practices of farm women and farmers. The selected livestock farmers were trained on importance of mineral mixture practices in livestock before starting of demonstrations.

Performance and Impact of technology: The demonstrated livestock were regularly monitored and periodically observed for the production parameters. The milk yield of these animals was recorded for 6 months of supplementation of LUVAS- Mineral Mixture and animals fed with mineral mixture showed increased milk production of 13.69 % (Gadania village) and 12.68% (Bairawas village) in study period when compared to regular farmers who practice without mineral mixture supplement. Farmers reported low incidence of metabolic disorders and mastitis in their animals by regular supplementation of 50g mineral mixture per day. Hence, by supplementing LUVAS Mineral mixture in livestock ration, economic status of the livestock farmers will be increased by enhancing productivity of the animals.

Table-30: Performance of balanced mineral mixture supplementation to buffalo in NICRA villages

Intervention	Village Gadania			Village Bairawas		
	Production/ year/ animal	Selling price (Rs/lit)	Gross Returns (Rs/ha)	Production/ year/ animal	Selling price (Rs/lit)	Gross Returns (Rs/ha)
Non NICRA Farmers	1570	55	86350	1695	55	93225
NICRA Farmers	1785	55	98175	1910	55	105050

Effect of Dewormer on livestock for improvement in health and milk yield

Details of technology: Low milk yield, low growth rate, and poor reproductive performance (anoestrus, seasonal breeding behaviour, and long inter-calving period) are major constraints of buffaloes and cattle. In India, usually livestock are not regularly treated with dewormers which leads to several health-related problems, thereby reducing the milk yield. The proper use of dewormers at regular intervals not only improves animal health but also enhances life expectancy in animals. The incidences of various secondary infections can be prevented by the use of regular dewormers in livestock.

Performance and Impact of Technology: It was observed from the demonstrations that the use of dewormers in animals increased the milk yield. In the year 2017-18 and 2018-19, total 50 demonstrations each year were conducted at farmers of NICRA villages i.e. Rupana, Ludesar, and Nirban. The milk yield was found to be increased by 10% and 12.9% in the years 2017-18 and 2018-19, respectively, as compared to the farmers' local practice. Despite the cost of dewormers used the B: C ratio was higher in the demonstration group, proving the fact that deworming promotes animal health and increases per unit income along with milk yield. The intervention is well adopted by the several farmers of NICRA villages and the adjacent villages of district Sirsa in Haryana.

Table 31: Effect of Dewormer on livestock for improvement in health and milk yield (2017-2019)

Year	Measurable indicators of yield* (milk)		% increase	Economics of demonstration (Rs/ha)				Economics of Local (Rs/ha)			
	Demo	Local		Gross Cost	Gross Return	Net Return	BCR	Gross Cost	Gross Return	Net Return	BCR
2017-18	3100	2800	10.0	32000	139500	107500	4.30	31000	126000	95000	4.06
2018-19	3500	3100	12.9	34900	154000	119100	4.41	31500	138600	107100	4.40



Demonstration on Mineral mixture and health supplements for livestock in NICRA Villages- Rupana in Sirsa district

Inclusion of mineral mixture in daily diet of livestock for improvement in health and milk yield

Details of technology: Mineral mixture feeding is very important for dairy animals. The deficiency or overfeeding of minerals are cause of many problems in animal body. These are important for growth of calves and clean and more milk production by lactating animals. Problem of metabolic disorders and lower milk yield in all categories of dairy animals have been reported due to lower bioavailability of minerals in feed stuffs. There is a strong need for the supplementation of area specific mineral mixture to dairy animals as it contains all the essential nutrients in right quantities. Supplementing daily feed with mineral mixture will help in improving growth rate and milk production in livestock, reduces heat stress, improves reproductive efficiency and life span. The recommended dose of mineral mixture is 50g/day/animal along with routine the animal feed.

Performance and Impact of technology: It was observed from the demonstrations that the use of mineral mixture in daily diet of animal along with suitable health supplements increased the milk yield. The incidences of mastitis in cattle were also reduced as the overall health of animal was improved in Sirsa district of Haryana. In the year 2020-21, 2021-22 and 2022-23, 50 demonstrations each year were demonstrated to animals of selected farmers of NICRA villages i.e. Rupana, Ludesar and Nirban. The milk yield was found to be increased by 11%, 8.75% and 11% in the year 2020-21, 2021-22 and 2022-23, respectively, as compared to the local farmers' practice who don't provide mineral mixture to their animals. Despites the of cost of mineral mixture the B:C ratio was higher in the demonstration group, proving the fact that inclusion of mineral mixture increased per unit income along with milk yield. The intervention is well adopted by the farmers of NICRA villages and the adjacent villages of district Sirsa.

Table-32: Performance of inclusion of mineral mixture and health supplements in feed

Year	Measurable indicators of yield* (milk)		% increase	Economics of demonstration (Rs/ha)				Economics of Local (Rs/ha)			
	Demo	Local		Gross Cost	Gross Return	Net Return	BCR	Gross Cost	Gross Return	Net Return	BCR
2020-21	3400	3050	11	33600	153000	119400	4.55	31500	137250	105750	4.35
2021-22	3600	3150	8.75	34500	162000	127500	4.69	33500	148000	114500	4.41
2022-23	3400	3050	11	33600	153000	119400	4.55	31500	137250	105750	4.35

Upscaling: The CCSHAU Hisar is producing mineral mixture in large quantities which is being distributed at KVKs of the university. However, the availability of the technology can be enhanced widely through the animal husbandry department, National Livestock Mission and also by supplying subsidised mineral mixture to the livestock owners for improving their sustainable livelihood.

Supplementation of area specific mineral mixture for enhancing productivity

Details of technology: Problem of mineral deficiency and metabolic disorder in all categories of dairy animals have been reported due to lower content and low bioavailability of minerals in feed stuffs. There is need for the supplementation of area specific mineral mixture to dairy animals. Mineral mixture contains all the essential minerals in required quantities. Supplementing mineral mixture will help in improving growth rate in calves, increasing milk production, reduces heat stress, improves reproductive efficiency and reduce calving interval, increase productive life of animals and improve immunity. It can be given at the rate of 50g/day/animal once in a day along with the animal feed. It will improve overall animal health and immunity and productivity during stress.

Performance and Impact of technology: The use of mineral mixtures has not only helped in increasing the milk yield but also alleviated problems of anestrus and repeat breeding to a large extent in Yamunanagar district of Haryana. In a demonstration involving 57 farmers with 117 animals, conducted in a NICRA village Radauri, increased milk yield per day was observed with the animals being supplemented with balanced mineral mixture. It has also recorded increased net returns (50%) and BC ratio (1.47%) as compared to local practice of dairy farmers.

Table-33: Performance of balanced mineral mixture supplementation to cows

Year	Interventions	Milk yield (lit/day)	Gross Cost (Rs/day)	Gross returns (Rs/day)	Net Return (Rs/day)	BC ratio
2017-18 (Normal year)	Farmers Practice	6.0	170	220	50	1.29
	Mineral mixture	7.5	210	310	100	1.47
Stress year	Farmers Practice	5.5	170	198	28	1.16
	Mineral mixture	6.9	210	296	86	1.40

Upscaling: This intervention can be up-scaled widely through the animal husbandry department, National Livestock Mission and also by supplying them on subsidy. Local entrepreneurship can also be encouraged which can further contribute to upscaling.


Demo on mineral mixture supplementation in adopted NICRA villages

Under livestock and fodder production 32 demonstrations were conducted, 346 animals were treated and 951.25q green fodder was produced during the year 2015-16. KVK Amreli promoted livestock fertility improvement programme in NICRA village and got significant success in the treated animals. In order to have around the year production of green fodder and silage making, preventive vaccination and de-worming camps were organized for health management of milking animals. Lucerne Anand-3 and Makhna grass are multi-cut varieties, good source of nutritive and suitable for silage making fodder for animal. Total 5 farmers were benefited through this new fodder variety who got higher yield (12.57%) with nutritive fodder which provided more income (Rs 223863/ha vs 194050/ha) over local variety.

Demo on mineral mixture supplement KVK Amreli

Demo on Makhna grass fodder KVK Amreli

Total 25 demonstrations were conducted on feeding of silage and chelated mineral mixture to milking animals for improving milk production. It was observed that in the lactation period of 310 days the milk production increased by 14.29 and 18.86 per cent, respectively, which provided a net income of Rs 23875 and 16906 with respective B:C ratio of 1.45 and 1.33. Two vaccination camps were organized to immunize the animals against different infectious disease like Haemorrhagic Septicaemia (H.S.) and Foot and Mouth Disease (FMD) with the help of state animal husbandry department. Due to

these follow-up measures animals' health, production and fertility improved and also prevented the major losses from FMD outbreak and other viral animal diseases in the NICRA village.

Upscaling: These climate resilient livestock technologies can be up-scaled widely through the animal husbandry department, milk co-operative society etc. Local entrepreneurship can also be encouraged which can further contribute to upscaling in adjoining villages of Amreli district of Guajrat.

Under livestock and fodder production140 demonstrations were conducted, 133 animals were treated and 625q green fodder was produced which benefitted 158 farmers during the year 2015-16. KVK Banaskantha promoted livestock productivity improvement programme through balanced feeding and clean milk production in NICRA village and got success in these livestock interventions.

Demo on mineral mixture supplement KVK Banaskantha

Demo on Lucerne fodder var Annad-2 KVK Banaskantha

In order to have around the year production of green fodder, majority of the farmers have started growing Lucerne (Anand-2) and sorghum fodder (GFS-5 and GFS-39) fodder varieties. Preventive vaccination and de-worming camps were organized for health management of milking animals in collaboration with Banas Dairy Palanpur. Due to these health measures animals' health, production of milk and fertility improved and also prevented the major losses due to FMD and other viral animal diseases.

Upscaling: These climate resilient livestock technologies can be up-scaled widely through the animal husbandry department, milk co-operative society etc. Local entrepreneurship can also be encouraged which can further contribute to upscaling in adjoining villages of Banaskantha district of Gujarat.

Kutch KVK introduced fodder sorghum Gundri (kharif) production at 170 farmers' field covering an area of 42.5 ha; which produced 26.5% more fodder 60.8 vs 49.2q/ha) with highest B:C ratio (1.67) when compared to local fodder varieties. Green fodder was available during the late rabi and summer months from new sorghum fodder variety (Gundri). This fodder variety is very soft, highly palatable and relished by all livestock species in Kutch region.

Dhaman grass was demonstrated in 4.0ha area using community land for 270 farmers in NICRA village. FMD vaccination camp was organized in collaboration with Department of Gujarat Animal Husbandry and vaccinated 678 animals of 263 livestock owners during the year 2013-14. Farmers are keeping their milking and other animals in open area without shelter. It created highly adverse effect on milk production. Under NICRA Project 10 demonstrations were conducted on models shelter using cement polls and asbestos sheets with manger (Gaman), which helped to reduce the heat stress and fodder wastage as well. This intervention resulted an increase of 18 percent in milk yield and mitigated heat stress significantly in dairy cattle in comparison to local check.

Total 196 demonstrations were conducted, 633 animals were treated and 711.0q green fodder was produced during the year 2016-17. KVK Kutch-I promoted community land for fodder production in NICRA village and 605q Lucerne fodder was produced in 55.0ha area. To create awareness among farmers "Cattle health camp" was organized in coordination with State Animal Husbandry department. Total 620 animals (owned to 320 owners) were involved for preventive vaccination, deworming and treatment of different diseases.

Demo on Lucerne fodder KVK Kutch

Animal health camp organized by KVK Kutch

For balanced nutrition of the cattle 100kg mineral mixture was demonstrated at livestock farmers and 01 silage demonstration unit was established. To fulfil the requirement of the green fodder, farmers were given the demonstration of the fodder sorghum (Gundri var.) and Lucerne, respectively to 100 and 75 farmers for 20.0 and 14.0ha area. From dry fodder of Gundri earned net returns of Rs 44000/ha with the maximum B:C ratio (3.24) as compared to local check. Similarly, the net returns earned from Lucerne and sorghum fodder, respectively were Rs 94600/ha and 15100/ha with B:C ratio of 4.58 and 1.78 as compared to control group.

Farmers are keeping their milch and other animals in open area without shelter. It created highly adverse effect on milk production. Under NICRA project 37 models of shelter with manger (Gaman) and 63 models of pucca structure of animal shelter were demonstrated this year, which helped to reduce the heat stress and fodder wastage with significant increase in milk production. Net

returns earned due to increased milk production was Rs 10828/animal with 1.37 B:C ratio as compared to control group (Rs 7488 with B:C ratio of 1.27). In addition to this, farmers have promoted cow urine collection facility in animal shed. The collected cow urine was supplied with Micro-Irrigation System to their standing crops as liquid fertilizer.

Mineral mixture supplementation and silage feeding had shown significant effect on milk production and health status of livestock. Mineral mixture and silage feeding increased milk production by 9.40 and 12.50% in cattle which resulted net returns of Rs 14598 and 11604/animal, respectively with maximum B:C ratio of 1.69 and 1.47 in comparison to control group.

Upscaling: These climate resilient livestock technologies can be up-scaled widely through the animal husbandry department, milk co-operative society etc. Local entrepreneurship can also be encouraged which can further contribute to upscaling in adjoining villages of Kutch district of Gujarat.

Rajkot KVK initiated about prophylaxis of livestock through organizing two animal health camps covering 147 animals of 189 farm families. Further, vaccinated 214 animals of 320 livestock owners in the vaccination camps organized during the year 2013-14. Ten demonstrations were conducted on Oat (Kent) fodder in 1.0ha area; which produced 12.47% more fodder than locally grown fodder varieties. The oat fodder intervention was successful, because green fodder could be available for milch animals during the late rabi and summer months. Under mitigation of vitamin and mineral deficiency through balanced feeding covered 40 animals of 37 livestock owners which improved milk production by 7.20% with B:C ratio of 1.48 due to above interventions in livestock. Low productivity of milk in cattle due to shortage of glycogenic energy was improved using E-Booster in 20 lactating cattle. It was noticed that milk yield enhanced by 7.52% along-with B:C ratio of 1.44 in comparison to local farmers' practice.

Total 532 demonstrations were conducted, 388 animals were treated and 693.0q green fodder was produced. KVK Rajkot-I promoted improved fodder production through Makhhan grass in NICRA village. Green fodder production from Makhna grass increased by 6.62% over the local check resulting a net return of Rs 175274/ha with maximum B:C ratio of 2.28. The animal treatment camps were

Demo on Makhna grass fodder KVK Rajkot

Demo on improved animal shed KVK Rajkot

organized to treat the animal against different reproductive disorders i.e., repeat breeding, anoestrous, mastitis, silent heat and physiological disorders like; pneumonia, dermatitis, squamous cell carcinoma and unknown pyrexia etc.

The livestock of NICRA village were facing mineral deficiency, as livestock farmers of this village were not supplementing mineral mixture in animal feed. Therefore, mineral mixture was demonstrated to fulfil the mineral requirement of animals. Supplementation with mineral mixture and bypass protein to milch animals had significantly improved the milk production by 6.37 and 5.06%, respectively with net return of Rs 15956/animal and 18510/animal in comparison to control group. Fat percent improved by 10% in milking cattle supplemented with bypass fat when compared to non-supplemented animals.

The farmers do not follow the vaccination schedules for animals. Therefore, vaccination camp was organized to immunize the 388 animals owing to 307 livestock owners against different infectious diseases; like Hemorrhagic Septicemia (H.S.) and Foot and Mouth Disease (FMD). Milk production increased by 5.56% due to deworming which resulted a net return of Rs 17700/animal with B:C ratio of 1.30 as compared to control group.

Upscaling: These climate resilient livestock technologies can be up-scaled widely through the animal husbandry department, milk co-operative society etc. Local entrepreneurship can also be encouraged which can further contribute to upscaling in adjoining villages of Rajkot district of Gujarat.

Organized animal health camps for Prophylaxis of animals through vaccination and deworming which covered 360 animals of 109 farm families during the year 2013-14; which improved both milk yield and overall health of the animals. Total 20 demonstrations were conducted to mitigate the mineral deficiency of dairy cattle owing to 20 livestock owners which increased milk yield by 15 to 18 percent as compared to local farmers' practice. In addition to these fodder demonstrations were conducted on perennial grass at 67 farmers' fields covering an area of 0.25ha in adopted villages of Valsad district.

Total 431 demonstrations were conducted, 516 animals were treated and 1000q green fodder was produced. during. Sugargraze variety of sorghum was demonstrated at 10 farmers' fields in 2.0ha area. It was observed that this variety performed better and obtained 30 percent higher green fodder as compared to others local fodder varieties grown by the livestock owners, which earned a net return of Rs 170000/ha with 5.3 B:C ratio as compared to local check (Rs114000/ha with 4.2 B:C ratio). KVK Valsad promoted livestock fertility improvement programm in NICRA village and got 75 percent success in the treated animals and these interventions have increased milk production by 0.5 lit to 1.5 lit/day.

Demo on Sorghum Sugargraze var. KVK Valsad

Animal health camp organized by KVK Valsad

Interventions under livestock module more focus was on animal health management and preventive vaccination and de-worming camps were organized (treated 504 animals of 411 livestock owners) in collaboration with Vasudhara dairy. Due to these health measures animals' health, production and fertility have improved and also prevented the major losses due to FMD outbreak and other viral animal diseases. Efforts were made to provide continuous and fresh drinking water to livestock which improved dry matter intake and milk production due to animal heat stress management.

Upscaling: These climate resilient livestock technologies can be up-scaled widely through the animal husbandry department, milk co-operative society etc. Local entrepreneurship can also be encouraged which can further contribute to upscaling in adjoining villages of Valsad district of Gujarat.

NICRA established integrated approach for Climate Resilient Agriculture.

Structural Change:

- Demonstrations to upscaling-National-Subnational and International Collaboration- Involvement of Mass Extension System.
- Passive recipient to active participants- Quantifying Interventions for Carbon Credit
- Capacity Building of KVKs- One SMS on Carbon Credit Literacy

Cyclical Change

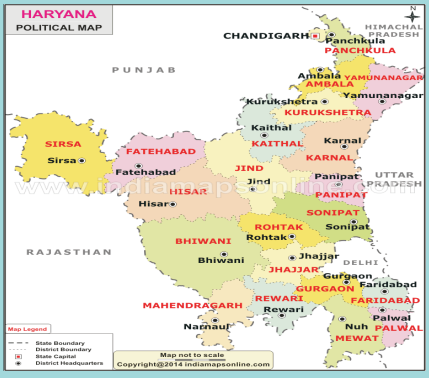
- More quantifiable observations on socio-economic impacts of interventions
- Water saving/economy
- Intensification and diversification
- Socio-economic benefits trickling to community
- Graduate the Custom Hiring Centres into vibrant business unit-PPP Model-new machines and tools.

Conclusion

Promote stress tolerant species and breeds of livestock suitable and acceptable in different bioclimatic zones, scientifically designed shelters and improved management of animals including health management through climate smart livestock villages clusters programme. Community animal housing clusters in grazing areas in arid, semi-arid areas. Community livestock housing and management connect with value chain for smallholder livestock reared in intensive and semi-intensive systems. Balanced / strategic feeding of livestock as per requirement of climatic zone, species and farming system. Integrated land use planning incorporating fodder crops, feed crops, through cross visits to analogue sites and to other areas practising climate smart agriculture, agroforestry and pasture management as per local area requirements and acceptability. Focus on educating and facilitating farmers to cope with climate change and its impacts. Many adaptation and mitigation options can help to minimize the effect of climate change on livestock. Policies and actions that promote sustainable development and reduce poverty will improve adaptation pathways for livestock production and will also pave the way for more effective climate change mitigation. These strategies will also take into account the co-benefits, adverse side effects and risks that may arise from both adaptation and mitigation options.

NOTES

Rajasthan



Haryana

Gujarat

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