ICARDA

Science for resilient livelihoods in dry areas

Report on Promoting cactus (*Opuntia ficus-indica*) as drought resilient feed resource under different agro-ecological production systems across India

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Contents

1. Introduction

The livestock based farming system contributes significantly towards livelihood security of farmers in arid zones of India (Thornton et al. 2009). However, forage production and availability for livestock is not sufficient due to water scarcity and land degradation, which have led to low productivity of grazing lands (Devendra and Thomas 2002). Throughout the arid and semi-arid regions, rangeland feed resources are decreasing, and are often of poor nutritive content (Teklehaimanot and Tritschler 2011). Consequently, livestock are constantly relying on feed supplements from nutritionally poor and inadequate quantities of crop and forage residues during the dry period (Nefzaoui et al. 2010). Thus, finding alternative non-conventional feed resources that can sustain animal production and alleviate the feed-water problem during dry and low productive seasons is critical.

Multi-purpose fodder plants such as spineless cactus (*Opuntia ficus-indica* (L.) Mill) which; adapt to harsh environments; produce cheap energy with minimum inputs have the potential to fill feed gaps and to maintain livestock production and survival during dry and drought periods (Salem et al. 2004). Cactus, an evergreen shrubby or tree-like plant, which grows up to 6 m in height is widely cultivated in arid and semi-arid regions worldwide with increasing importance as a fodder and fruit crop during periods of drought and shortage of forage plants (Salem et al. 2004). Cladodes of cactus are high in soluble carbohydrates, minerals and vitamin A, but are low in fiber and crude protein (Gebretsadik et al. 2013). Cactus cladodes are also considered as a source of water for animals raised in harsh dry and arid environments (Nefzaoui et al. 2010). The overall aim of this project is to promote and increase the availability of cactus as an alternate drought-resilient feed resource under different agro-ecological production systems across India, so as to improve the livelihoods of smallholder farmers.

1.1. Specific Objectives:

- Continue evaluation trials stabilised in 2016 for cactus adaptation across several agro-ecological production systems
- Develop the best agronomic practices for optimum spineless cactus growth to increase yield and quality under different environments
- Develop various cactus based feed rations depending on available feed resources
- Enhance capacity building of all partners, while also disseminating the projects findings to other areas of India.

1.2. Collaborating Partners

- Central Arid Zone Research institute (CAZRI), Regional Research Station, Kukma, Bhuj, Gujarat
- Indian Grassland and Forage Research Institute (IGFRI), Jhansi
- ICARDA
- FAO-ICARDA Cactusnet

2. Activities with Indian Grassland and Forage Research institute (IGFRI), Jhansi

In Jhansi, livestock is an important source of livelihood for the rural population, primarily because a large part of this area is characterized by semi-arid and arid conditions, with very low annual rainfall of about between 150-700 mm (Birthal et al. 2008). Livestock production, dominated by small ruminants (sheep and goats) in Jhansi and surrounding areas is based on a management system where animals are left to roam grazing areas and kraaled when they are brought every night to avoid theft and predators (Murgai et al. 2001). Irrigation is limited to small cultivated areas; thus, agriculture is largely dependent on rain and the major crops cultivated are wheat, barley, maize, and millet (Murgai et al. 2001). Because communal smallholder farmers have limited resources to improve the supply of animal feeds, alternative and readily available feed sources are needed so as to ensure sustained livestock production, and this project seeks to address this gap in Jhansi.

Although the project started late in Jhansi (since the agreement with IGFRI was only signed in October), significant achievements have, however, taken place within this short period:

2.1. Planning and review meeting

Drs. Ashutosh Sarker (Regional Coordinator, South Asia & China Program, ICARDA) and Sawsan Hassan visited ICAR-IGFRI, Jhansi during 21 to 23 November, 2017 to discuss the progress and further planning of IGFRI-ICARDA's Collaborative Project on Cactus. A brief interaction cum progress discussion meeting was held with Dr. R.V. Kumar (Director IGFRI), ICARDA scientists and the IGFRI project team (Drs Sunil Kumar, A. K. Misra, Shahid Ahmed, D. R. Palsaniya and Vikas Kumar) on 21 November 2017. Again the project team meeting with ICARDA scientists, under the chairmanship of IGFRI Director, was held on 22 November 2017, where the participants agreed on activities and the project's deliverables.

2.2. Research projects within the CAZRI-ICARDA cactus initiative

2.2.1. *Cactus performance evaluation*:

The agronomic trial was conducted in IGFRI research station to determine the best time (in terms of season) for planting the cactus with two fertilizer treatments and a control as the treatments. Cladodes were placed in the soil during months of July, October, February and April. Fertilizer was applied as 2 kg FYM and 1 kg FYM at planting time in each season (3 times), whereas irrigation was done at the time of planting and thereafter, as per need (determined through visual shrinking of pads and their yellowing). In the control treatment, no fertilizer and irrigation were done, except one irrigation applied just after planting (same day). The trial started in 2016 in a randomized block design with three replications and continued for two years. The performance of trial at the end of one year is shown in Table 1.

Table 1: Effect of planting time, fertilizer application and irrigation on growth of cactus (November, 2017).

Treatment	Plant height (cm)	Horizontal plant spread (cm)	Cladode length (cm)	Cladode width (cm)	Number of cladodes
July 2016, control	108.4	103.8	33	13.9	17.9
July 2016, Fertilizer & Irrigation	112.3	108.6	34.3	17.6	18.2

October 2016, control	93.9	82.1	32.9	15.7	13.1
October 2016, Fertilizer & Irrigation	96.3	88.2	33.1	17.6	14.6
February 2017, control	77.3	49.2	29.6	12.7	7.4
February 2017, Fertilizer & Irrigation	79.3	58.3	34.4	14.7	8.4
April 2017, control	67.9	45.7	25.9	13.3	6.6
April 2017, Fertilizer & Irrigation	74.4	60.8	28.6	14.6	7.4

2.2.2. *Cactus based feeding trial in heifers*

A cactus-based feeding cum digestibility trial was conducted on 18 heifers to investigate the nutrient intake and utilization of cactus (Fig. 1). Heifers were fed on sorghum forage with wheat straw (T1, control) and cactus mixed with wheat straw (T2). All experimental animals were supplemented with a concentrate diet (58 parts groundnut cake, 40-parts maize grain, 1-part mineral mixture and 1-part common salt) per head daily, to provide adequate protein and other essential nutrients. Spineless cactus cladodes contained 7.51 dry matter (DM) and 6.1 crude protein (CP) on DM basis. The results of the trial indicate that cactus was relished by the heifers and intake of total DM remained 3.15 kg per 100 kg body weight in both the T1 and T2 groups. The digestibility of DM and organic matter were slightly higher in the T1 animals (69.42 and 66.15%) compared to the T2 animals (67.44 and 61.83%). Similarly, digestibility of protein was also slightly higher in T1 animals (76.84%) compared to cactus fed animals (72.17%). However, the digestibility of the fiber fraction did not vary much when the two treatments were compared, while water intake was lower in the T2 treatment due to higher water content in cactus. (Table 2).

Table 2: Dry matter intake, nutrient digestibility and nutritive value of diets containing sorghum MP Chari + wheat straw + concentrate mixture (T1) and cactus + wheat straw + concentrate mixture (T2) in heifers

Particulars	Diets	
	T1 (control)	T2 (cactus-based diet)
Body weights (Kg)	148.88	147.92
Total Dry matter intake (DMI, g/day)		
Total DMI (kg/day)	4.74	4.56
DMI (kg/ 100 kg BW)	3.15	3.15
DMI (g/kg $w^{0.75}$)	66.15	61.83
Digestibility (%)		
Dry matter	66.15	61.83
Organic matter	69.42	67.44
Crude protein	76.84	72.17
Neutral detergent fiber	65.95	64.78
Acid detergent fiber	57.95	59.34
Cellulose	70.38	70.21

Nutritive value		
Digestible crude protein % in ration	6.89	5.96
TDN % in ration[1]	61.86	62.15
Water intake (lit/day)	14.96	11.69

Figure 1. The investigation of the effects of feeding heifers with a cactus-based diet on digestibility and total dry matter intake.

2.2.3. *Performance of cactus planted in different land use systems*

Cactus cladodes were planted and evaluated in different land use types, which included a Leucaena based silvipasture, an Aonla based hortipasture, boundary plantation/bio-fence and in waste land plantation (Fig. 2). The survival, growth and fresh biomass yield of cactus at one-year old under these land uses are shown in Table 3. In general, the survival, growth and fresh biomass yield of cactus was higher in boundary plantation and reduced drastically under silvipasture and hortipasture, possibly due to the shade effect and competition for nutrients and water in the silvipasture compared to the boundary plantation/biofence (Fig. 2).

Table 3: Performance of cactus in different land use systems

Land use	Survival (%)	Cladodes /plant	Average weight of cladode (kg)	Green fodder (Kg/plant)
Leucaena based silvipasture	62-81	2-7	0.75	1.5-5.25
Aonla based hortipasture	67-86	3-10	0.8	2.4-8.0
Boundary plantation/ bio-fence	84-96	4-14	1.2	4.8-16.8
Waste land plantation	73-92	3-12	0.9	2.7-10.8

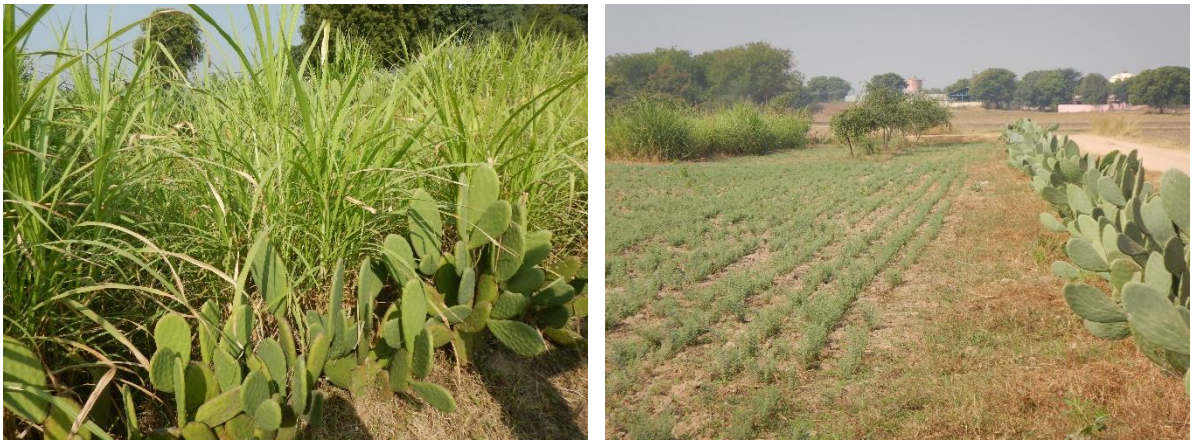

Figure 2. The survival, growth and weight of cactus planted in different land use systems in

2.3. Adaptation and dissemination of spineless cactus

Spineless cactus is being promoted in more than 50 villages in Jhansi, UP and Datia and Sahdol, and MP through capacity building programs and demonstrations (Fig. 3). These programs are targeting various stake holders, such as farmers, cow shelter owners (Gaushalas), state line departments, Village Panchayat Representatives, Common Property Resources, etc. Many farmers adopted the technology and cactus was planted in 2 x 3 m spacing with a plot size of 20 x 30 m. Different fodders like sorghum, oat and NB hybrid and some grain crops/vegetables were also sown along with cactus. A large number of farmers are also planting cactus at small scale (few cladodes) in and around their farm lands and homes.

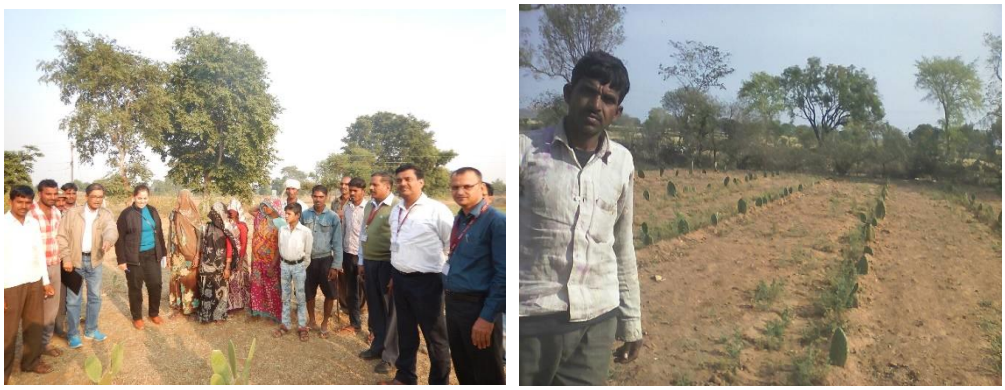

Figure 3. On farm trial and promotion of cactus in different villages of India

2.4. Raising awareness and capacity building

Three field days were organized to promote cactus as a fodder:

2.4.1. *Dhobia, Datia (MP) village field day*

The first field day was organized on the 21st of November, 2017 in Dhobia, Datia (MP), which saw more than 60 farmers, including women, participating (Fig. 4a and b). Dr Sarker appreciated the cactus farmers for incorporating cactus in their production systems and urged more farmers to adopt cactus, especially under rainfed conditions and areas considered as waste land. He emphasized that cactus can meet the fodder requirements during low rangeland production periods. The cactus team was happy to see that some of the farmers were already feeding chopped cactus mixed with straw to their animals (Fig. 5a and b). The team also visited the fodder and cactus demonstration block and cactus research plots at the Central Research Farm of the IGFRI and interacted with farmers for further improvement in the cactus research programme. Later, the team visited village Palinda, Jhansi to identify new cactus farmers and encourage farmers to cultivate cactus. The possibility of growing cactus on village Common Property Resources (common pastures) was also explored.

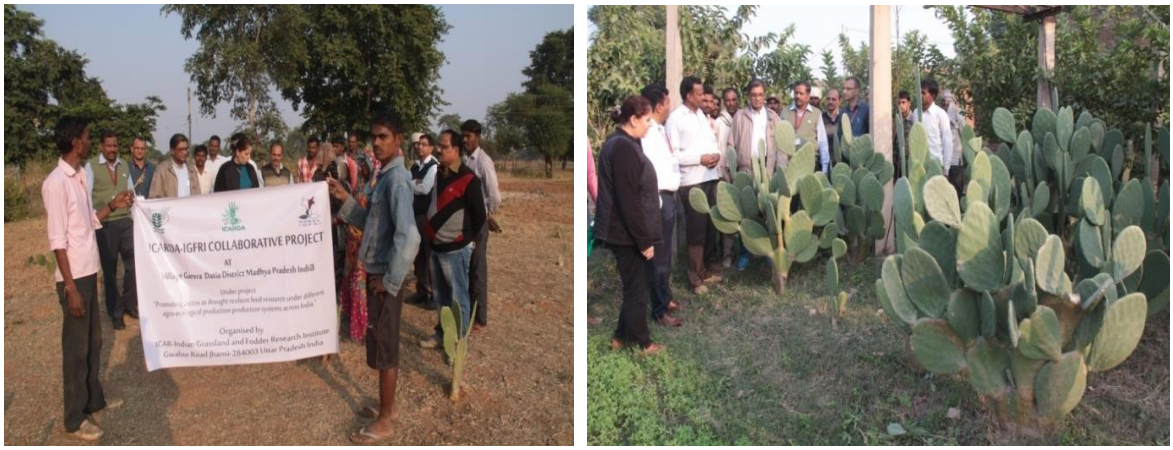

Figure 4. a) Field Day at Village Dhobia, Datia (MP) and b) cactus planted in a farmer's field

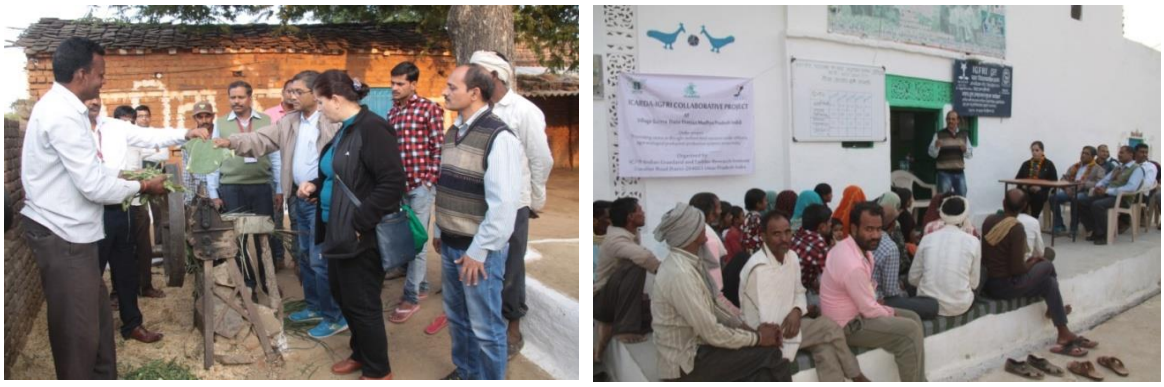

Figure 5. a) Cactus chaffing and feeding by farmers and b) interactive meeting at village Garera, Datia (MP)

2.4.2. *Field day on Cactus at village Sakrar, Jhansi (Uttar Pradesh)*

The third Cactus Field Day was organized on 02.04.2018 at Sri Kamdhenu Gaushala (Cow Shelter), Sakrar, District Jhansi (UP) located in Bundelkhand part of central India. The scientists, namely Drs Hassan (ICARDA, Jordan), Kumar, Shahid Ahmed, D.R. Palsaniya and Vikas Kumar (IGFRI, Jhansi) participated in interacting and exchanging information with a total of 35 farmers during this field day. Scientists informed farmers about the importance of cactus as an alternative fodder and water source in dry areas. In view of changing climate and more competition for water, species like cactus need to be promoted for solving the fodder and water crisis. During this field day, farmers' concerns and questions about its nutritional quality, its palatability and utilization were adequately answered through scientists providing all relevant evidence and information about positive performance of animals fed cactus in other parts of the world. The participating farmers were also taken for a visit to a nearby cactus plantation at Gaushala (Fig. 6a). Farmers were highly enthusiastic and cactus cladodes were also distributed to farmers. In total 15 demonstrations have been executed in the vicinity of village Sakrar, Jhansi (Fig. 6a and b). More and more farmers are willing to plant cactus and to be associated with this project, as evidenced by willingness and participation of women in planting and maintaining cactus (Fig. 7 a and b). In Gaushala, about 1-acre of a cactus plantation has been completed and the expectation is that there will be an expansion in the near future. Local media persons (Hindi Local Daily-Dainik Jagran & Amar Uljala) were also present during the interaction and gave good media coverage of the event (News clipping in appendix 3).

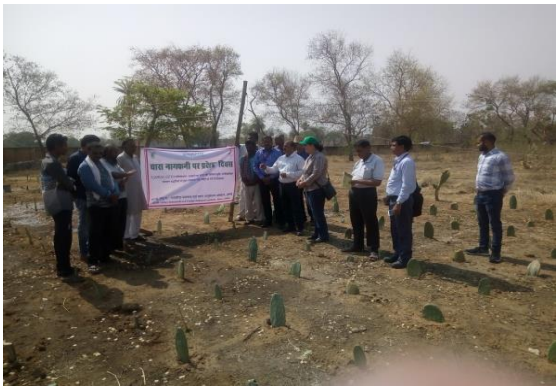

Figure 6. a) Field day at Sri Kamdhenu Gaushala and b) interaction with farmers at Sakrar

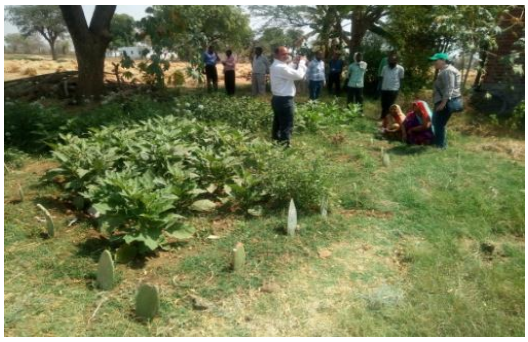

Figure 7. a)Cactus plantation by Smt Bhagwati at Sakrar and b) cactus plantation by Smt Ram Kuwar at Sakrar

3. Collaboration with the Central Arid Zone Research Institute (CAZRI), Regional Research Station, Kukma, Bhuj, Gujarat.

The low and erratic rainfall renders the majority of the rural population vulnerable to income shocks of crop loss in Gujarat (Murgai et al. 2001). Consequently, livestock act as an insurance against crop failure, and help consumption smoothening in the periods of food scarcity. This has resulted in the region of Gujarat being an important smallholder farmer milk producing area (Birthal et al. 2008). In spite of the prevailing moisture stress and subsequent low crop productivity, mixed crop-livestock agricultural systems constitute an important source of income (Robbins 1998). Depending on farm structure and objectives, off-farm activities and livestock enterprises supplement farm households' revenue. Therefore, it is important to develop technologies, such as the feeding of livestock with cactus, which seek to promote the sustainable production of livestock in these natural resource limited environments.

3.1. Hosting Dr Hassan, planning and review meeting

A two-day visit (April 4-5) by Dr Sawsan Hassan (Scientist from ICARDA-Jordan) focused on the scope of spineless cactus as fodder resource for the Kachchh region. During the visit, organized by CAZRI, Dr Sawsan held meetings with CAZRI Bhuj scientists and also visited the farmer's fields where cactus has been planted (Fig. 8). During the visits to the farmers, Dr Devi Dayal (Head of CAZRI), explained the activities undertaken by CAZRI RRS Bhuj on spineless cactus during the last three years. He mentioned that a total of 64 accessions of spineless cactus are currently being maintained and evaluated at CAZRI. Out of these, Dr Dayal added that 5 accessions have been identified as the most ideal for higher production of cactus as fodder. The selected accessions are currently being multiplied at CAZRI RRS Bhuj and given to farmers for planting as a fodder crop. At present, at least 10 farmers have already planted some of these cactus accessions on their fields and their performance has been reported as very good.

A review and planning meeting was held to discuss the progress and effective implementation of the project. The meeting was attended by Drs Sawsan Hassan (ICARDA), Devi Dayal, Ramniwas, Sitaram Jat, and Mr. M. Sureshkumar (CAZRI, Bhuj). The purpose of the meeting was to discuss about the cactus project (running from 2017-2022) funded by ICARDA. The progress of the project was discussed, and one of the agreements was to utilize the unspent amount ($10 000) in 2018-19. These funds were to be utilized for activities initially assigned to be carried out 2017, but now shifted for effective implementation of the project during 2018-19. Also, a discussion and agreement about the workplan and project activities to be done for effective implementation of project took place during this meeting.

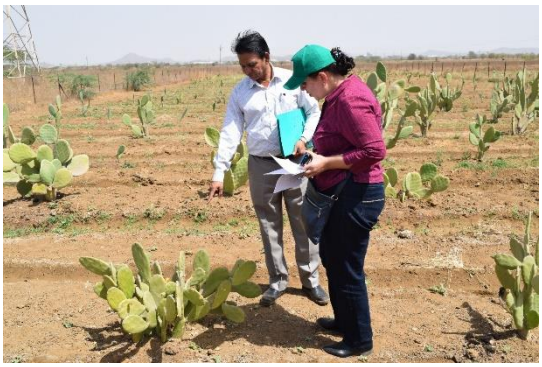


Figure 8. The visit of Dr. Sawsan to the cactus in Bhuj Research station (April 4-5).

3.2. Raising awareness and capacity building

A field day was organised on the 05th of April, on farmer Mr Girraj Singh Balwant's field in the Singh Jadeja village, Jambudi, where about 60 farmers, including high numbers of women, participated (Fig. 9). The participants also included farmers who had either grown cactus on their farms or were interested to grow it as fodder crop. Mr Hargovind Kunpara (CAZRI) welcomed the farmers and elaborated on the importance of cactus as a fodder crop. He also highlighted the fact that besides cactus being a fodder crop, it has many uses as a fruit crop, medicinal crop and as a vegetable crop. Dr Dayal (Head of CAZRI) discussed about the particular importance of cactus as a fodder crop for the Kachchh region, and it can be planted even on highly degraded soils with limited amount of soil moisture. Cactus can be harvested as fodder very easily by breaking its cladode from the stem, chopping the cladode and then fed directly to livestock.

Cactus has high amount of carbohydrate, mineral and water, but is deficient in protein (Nefzaoui et al. 2010). Therefore, a protein supplement is required if livestock will rely solely on cactus-feeding (Middleton and Beinart 2005). As the growth of cactus is very high from February to June, its green fodder is available when there is an acute shortage of the rangeland forage during the summer season in Jambudi. A film showing cactus cultivation, its harvesting/chopping and how to feed it to animals was shown to the farmers. Dr Hassan (ICARDA Scientist) also discussed and provided more detail about cactus, informing farmers that its growth is currently being evaluated at Jhansi, Bhopal and Kachchh, while its performance has been reported as very good at Kachchh. Because cactus is very popular in South America as well as other countries in arid and semiarid environments around the world, both as a fodder crop and as a fruit crop (Lemma et al. 2009), Dr Hassan indicated her confidence regarding the adoption of cactus by Kachchh farmers. The visit of Dr Hassan and the field day were reported by the local newspaper (Appendix 2 and 3). Dr Ramniwas (CAZRI) thanked all the farmers and Dr Sawsan for their participation during the meeting.

Figure 9. Field Day at held on the 05th of April on farmer Mr Girraj Singh Balwant's field in the Singh Jadeja village, Jambudi.

The MOA with CAZRI –Bhuj has been signed on March 4th, and the funds were transferred to CAZRI immediately after the signing. Due to this late signing of the MOA, no activities took place in 2017.

4. Farmers' day (Bhopal)

4.1. Bhopal field day (23 November 2017)

The farmer's day in Bhopal, India was organized on Saturday, 23 November, 2017. Attending the farmers' day were Drs. Ashutosh Sarker and Sawsan Hassan (ICARDA representatives), and 31 farmers (Fig. 10). Dr. Sarker, Regional Coordinator (ICARDA South Asia & China Regional Program) highlighted the importance of cactus as green fodder for animal feed and as an ideal alternative to control water erosion. He gave a detailed outline of the activities being carried out by ICARDA and encouraged farmers to actively take part in the planting of spineless cactus on their land. The research conducted by ICARDA and national partners in India has proven the suitability of cactus as a crop and animal feed in the Jhansi region. He highlighted the role of ICARDA in increasing efforts to promote spineless cactus, as well as encouraging farmers to grow spineless cactus for feeding animals during the dry periods. He mentioned that cactus dissemination started four years ago and since then, the number of farmers growing cactus has steadily increased. This reflects the great potential of cactus as both a crop and livestock feed resource in India.


Figure 10. Scientists of ICARDA and IGFRI sharing their experience of cactus in India.

Dr. Sarker mentioned that ICARDA already disseminated cactus to few farmers in Bhopal, and he invited all the participants to a field tour to witness the cactus plantation performance in the farmer' fields (Fig. 11).

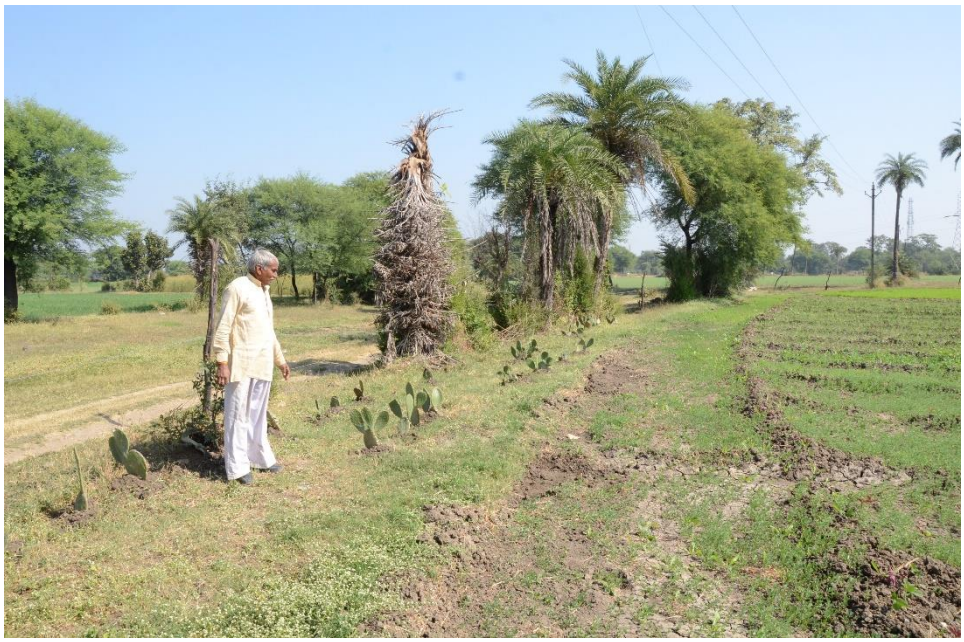

Figure 11. Cactus planted in the farmer field in Bhopal, India.

Dr. Sawsan welcomed the participants and explained ICARDA's mission to target poor farmers in the dry areas in order to improve their livelihoods, through the importance of cactus as a multipurpose crop for the dry areas. Both Drs Sawsan and Sarker also mentioned that the adoption of cactus is now worldwide as it has been proven that cactus has the potential to mitigate climate change, to reduce the green fodder gap and to also enhance farmers' income. They also stated ICARDA's objective to give full support to farmers, who should also maximize ICARDA's and IGFRI's research initiatives aimed at improving their food security and livelihoods. Dr. Sawsan explained the benefits of cactus as a green fodder, and highlighted how it has shown growth adaptability to the dry conditions. She mentioned the fact that cactus is very easy plant to establish and that it grows well with very little inputs. She explained how to use cactus as green fodder, and how positive impact on the growth and survival of animals and she concluded that cactus can be tool to generate more income.

The farmers showed interest in planting cactus, and they thanked ICARDA for the efforts to introduce new technologies that will help them enhance their livelihoods.

4.2. Field day in Amlaha ICARDA research station in Bhopal (30 March 2018)

A total of 24 farmers (8 females and 16 males) representing five villages: Bheelkledi, Amlaha, Bhadnkheeli, Dhamanda and Rainayal visited the ICARDA Research Station in Amlaha on March 30th 2018. Dr. Surendra Kumar Barpete (ICARDA scientist) welcomed the participants and gave an overview about ICARDA activities in India and the research in Amlaha Station. Dr. Barpete indicated that the purpose of this field day was to give the farmers the chance to witness projects in progress and discuss with the researchers involved in these projects. Such an approach is ideal as it equips farmers with the necessary information and also creates a working relationship between farmers and researchers, which is important for the adoption and further dissemination of cactus. After welcoming the

participants, Dr. Sawsan (ICARDA-Jordan) explained ICARDA's mission to target poor farmers in the dry areas in order to improve their livelihoods.

In her presentation, Dr. Hassan highlighted the importance of cactus as a multipurpose crop for the dry areas that can withstand harsh conditions such as low soil moisture and nutrient levels. She mentioned the fact that cactus is a very easy plant to establish and that it grows well with very limited inputs. She explained how to use cactus as green fodder, and that cactus is beneficial as a source of water to animals during water scarce periods. Dr Sawsan concluded by highlighting the fact that cactus can also be tool to generate more income through selling it to other livestock owners. She stated that ICARDA has already disseminated cactus to few farmers in Bhopal. After this a quite number of questions were asked by participants about the use of this plant, the impact on the livestock and the value-added potential in terms of fruit production. The farmers showed interest in adopting cactus and were keen to find means of obtaining cactus cladodes for them to plant in their fields. The participants thanked ICARDA for the efforts to introduce new technologies that will help them enhance their livelihoods.

5. Publications:

5.1. Research papers in ISI-peer-reviewed journals

a. Kumar, S., Palsaniya, D. R., Kumar, T. K., Mishra, A. K., Ahmad, S., Ghosh, P. K., Sarker, A., Ates, S., Louhaichi, M. and Hassan, S. (2018). Prospects of edible spineless cactus (*Opuntia ficus-indica*) as non-conventional fodder in central Indian Semi-Arid Tropics. Current Science. Submitted.

b. Mishra, A. K., Kumar, S., Kumar, T. K., Ahmad, S., Palsaniya, D. R., Ghosh, P. K., Louhaichi, M., Sarker, A., Hassan, S. and Ates, S. (2018). Nutrient intake and utilization in sheep fed opuntia [(*Opuntia ficus-indica* (L.) Mill.] in conjunction with conventional green and dry fodders. Range Management and Agroforestry. Accepted.

5.2. Non ISI publications

a. Louhaichi, M., Yadav, O.P., Dayal, D., Kumar, S., Islam, M., Hassan, S., Qamar, I.A., Sarker, A. 2018. The adoption and utilization of cactus in Pakistan and India- smallholder communal farmers' perceptions. Acta horticulturae Accepted

b. Ahmed, S., Kiran Kumar T., Palsaniya, D. R., Misra, A. K., Sunil Kumar and Ghosh, P. K. 2017. Evaluating the performance annual fodder legume Vicia for arid regions of India. In: Abstracts, National Symposium on New Directions in Managing Forage Resources and Livestock Productivity in 21st Century: Challenges and Opportunities (Eds: M. K. Srivastava, R. Srinivasan, C. K. Gupta, H. V. Singh and Sunil Kumar), March 3-4, 2017, RVSKVV, Gwalior, India. pp 69.

c. Kumar, S., Ahmed, S., Kumar, T.K., Palsaniya, D. R., Misra, A.K., Sarker, A., Hassan, S., Louhaichi and Ghosh, P.K. 2017. Initiative at IGFRI on Cactus Research. Indian Grassland and Fodder Research Institute, Jhansi – 284003, Uttar Pradesh, India. Pp 1-31. (Technical Bulletin)

d. Sunil Kumar, D. R. Palsaniya, T. Kiran Kumar, A. K. Misra, S. Ahmad, S. R. Kantwa and P. K. Ghosh. 2017. Non-conventional Fodder Resources. In: Approaches Towards Fodder Security in India (Eds: Ghosh, P.K., Mahanta, S.K., Singh, J.B., Vijay, D., Kumar, R.V., Yadav, V.K. and Kumar, S.). Studera Press, New Delhi, India. pp. 35-55. (Book Chapter)

6. Unplanned publications

6.1. Research papers in ISI-peer-reviewed journals

a. R. N. Kumawat, A. K. Misra, L. Mounir, S. S. Mahajan, K. Venkatesan. 2017. Seed germination behaviour as influenced by physical and chemical treatments in Grewia tenax (Forssk.) Range Mgmt. & Agroforestry 38 (1): 134-138.

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3. Appendices

Appendix 1- Abstract presented in a conference in Chile

SESSION 7: Rural development and marketing

CHANGING PERCEPTION OF SMALL HOLDERS ABOUT CACTUS PEAR IN SOUTH ASIA

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Increasing demands on already-scarce water resources across the world's dry areas require alternative sources of animal feed – specifically crops that have more efficient uses of water. One alternative with the potential for widespread production is cactus pear (*Opuntia ficus indica*). This species originated in the tropical and subtropical Americas. It can be found in a wide variety of agro-climatic conditions across the entire American continent. The plant has spread to new areas where it continues to provide a myriad of benefits to human and animals. Until recently, cactus was not always accepted in South Asia (particularly India and Pakistan). It was associated with its close cousin *Opuntia stricta* with big thorns and invasive propagation, having rumors of being associated with the underworld. Recent projects lead by the ICARDA to introduce cactus pear were initiated in 2012. The projects aim to promote the plant as a feed for livestock as it is a drought resistant succulent plant that is thorn free and holds lots of water. Several accessions from various origins have been evaluated for their adaptation under local conditions. The most promising ones are being disseminated to farmers. This study examined the adoption of cactus pear across projects in South Asia with social and ecological diversity. Over 300 households were targeted and offered cactus pads to plant in their home garden along with necessary technical backstopping. Several field days were organized to increase to build awareness about the spineless cactus. Preliminary findings show that fear has changed to acceptance. Farmers have become enthusiastic about its multipurpose uses, income generating potential, and adaptability to climate change. As a result, demand is higher than the current supply. The potential gains from cactus production across the world's dry areas could be immense. However, efforts are still needed to ensure the plant's potential is effectively realized. Properly executed, these efforts offer an opportunity to not only raise incomes and improve livelihoods, but strengthen resilience. As dry areas are forced to contend with higher temperatures and more variable rainfall resilience will become more important in the years ahead.

Keywords: Dry areas, livelihood, poverty alleviation, climate change, spineless cactus

IX INTERNATIONAL CONGRESS ON CACTUS PEAR AND COCHINEAL
"CAM crops for a hotter and drier world"
Coquimbo, Chile, March 26th - 30th, 2017

Appendix 2- The visit of ICARDA scantiest to Bhuj research station

કાઝરી દ્વારા કાંટાવિહોણા થોર અંગે બે દિવસીય સેમિનાર યોજાયો

જોર્ડનથી આવેલાં તજજ્ઞાએ કચ્છના ખેડૂતોને માર્ગદર્શન પૂરું પાડ્યું

ભાસ્કર ન્યૂઝ. ભુજ

કાઝરી દ્વારા કાંટાવિહોણા થોરના ચારા તરીકેના ઉપયોગની શક્યતાઓ ચકાસવા વિષયક બે દિવસીય સેમિનાર તાજેતરમાં યોજાઈ ગયો જેમાં બહોળી સંખ્યામાં ખેડૂતો હાજર રહ્યા હતા.

કાઝરીના હેડ ડો. દેવીદયાલના અધ્યક્ષપદે યોજાયેલા સેમિનારમાં જોર્ડનથી આવેલાં ઈકાર્ડા (ધી ઈન્ટરનેશનલ સેન્ટર ફોર એગ્રીકલ્ચર ઈન ડ્રાય એરિયાઝ)ના વૈજ્ઞાનિક ડો. સોસમ હસને આ મુદ્દે વિશદ માર્ગદર્શન આપ્યું હતું. પ્રારંભમાં ડો. દયાલે કચ્છમાં 64 પ્રકારના કાંટાવિહોણા થોર ઉછેરાઈ રહ્યા હોવાની અને તેમાંથી 5 જાત ચારા તરીકે યોગ્ય રીતે ઉપયોગમાં આવી શકે એવા હોવાનું જણાવ્યું હતું. આ પાંચ જાતોને વધુ વિકસાવાઈ રહી છે અને ખેડૂતોને ચારા તરીકે ઉગાડવા માટે અપાઈ છે. 10 ખેડૂતોએ પોતાને ત્યાં એ વાવ્યા છે અને સારું પરિણામ મળ્યું છે. કાઝરીના ડો. સુરેશકુમારે કચ્છમાં થોર, પીલુ અને ખીજડા જેવાં ઝાડ અને ઘાસની વાવણી થકી ખેતીના ચિત્રમાં બદલાવ આવી રહ્યાની વાત કરી હતી. સેમિનારના બીજા દિવસે જાંબુડીના કૃષિકાર ગિરિરાજસિંહ જાડેજાના ખેતરની મુલાકાત લીધી હતી જ્યાં 60થી વધુ ખેડૂત ભાઈઓ-બહેનોએ કાંટાવિહોણા થોરની ખેતીનું નિદર્શન જોયું હતું. ડો. હસને થોરના ચારા ઉપરાંત ફળ, ઔષધ અને શાકભાજી તરીકેના ઉપયોગ પર પ્રકાશ પાડ્યો હતો. કચ્છમાં આ પ્રકારના થોરની ઉપયોગિતા એટલે પણ છે કે તદ્દન ખરાબાની જમીનમાં અને સાવ ઓછાં પાણીની જરૂરિયાત વચ્ચે પણ તે ઊગી નીકળે છે. પ્રોટીન સિવાય તેમાં કાર્બોહાઈડ્રેટ, મિનરલ અને પાણી પૂરતા પ્રમાણમાં હોવાથી આ ચારા સાથે પ્રોટીન આપૂર્તિ કરવાની રહે છે. આ થોર ફેબ્રુઆરીથી જૂન વચ્ચે સૌથી વધુ પ્રમાણમાં થતો હોઈ ઊનાળામાં જ્યારે સામાન્ય રીતે લીલાચારાની અછત સર્જાય છે ત્યારે તે વધુ ઉપયોગી બને છે. આ થોરનો ઝાંસી, ભોપાલ અને કચ્છમાં ઉછેર કરાયાની અને કચ્છમાં શ્રેષ્ઠ પરિણામ મળ્યું હોવાની વાત કરી હતી. ખેડૂતોને થોરની વાવણીથી પશુધનને નીરણ સુધીની પ્રક્રિયા પર પ્રકાશ પાડતી દસ્તાવેજી ફિલ્મ પણ બતાવાઈ હતી. ડો. રામનિવાસ, ડો. ત્રિલોકી સિંધ, મોહર સિંધ, ડો. સીતારામ, વિપિન રાજ, ભરત વિરપુરિયા, મહેન્દ્રકુમાર, હરગોવિંદ કુંપારા સહિતના ઉપસ્થિત રહ્યા હતા.

અનુસંધાન

જેકેટ 3 પાનાનું

ICICIનાં ચંદા...

જો કે સીબીઆઈ અથવા ઉડ્ડયન મંત્રાલય તરફથી આની પુષ્ટિ થઈ નથી. વીડિયોકોનના 3250 કરોડની લોન વિવાદમાં સપડાયેલા આઈસીઆઈસીઆઈ બેન્કના એમડી અને સીઈઓ ચંદા કોચર, તેમના પતિ દીપક કોચર અને વીડિયોકોન જૂથના પ્રમોટર વેણુગોપાલ ધૂત વિદેશ ભાગી ન જાય તે માટે ઓથોરિટીએ બધા જ એરપોર્ટ પર તેમના વિરુદ્ધ લુકઆઉટ નોટિસ જાહેર કરી છે. સીબીઆઈની આ નોટિસ તેમનો પાસપોર્ટ કબજામાં લેવા સમકક્ષ છે. સીબીઆઈએ શુક્રવારે મુંબઈમાં ચંદા કોચરના દિયર રાજીવ કોચરની સતત બીજા દિવસે 9 કલાક સુધી પૂછપરછ કરી હતી. સીબીઆઈ ઓફિસમાં હાજર થયેલા રાજીવ કોચરને વીડિયોકોન લોનના રિસ્ટ્રક્ચરિંગના વિવિધ પાસા અને ધૂત સાથે તેની લિન્ક અંગે પૂછવામાં આવ્યું હતું. રાજીવની ગુરુવારે મુંબઈ હવાઈમથકેથી અટકાયત કરાઈ હતી. દક્ષિણ પૂર્વ એશિયન દેશમાં જવા માટે વિમાનમાં બેસવા જતો હતો ત્યારે તેની અટકાયત કરાઈ હતી.

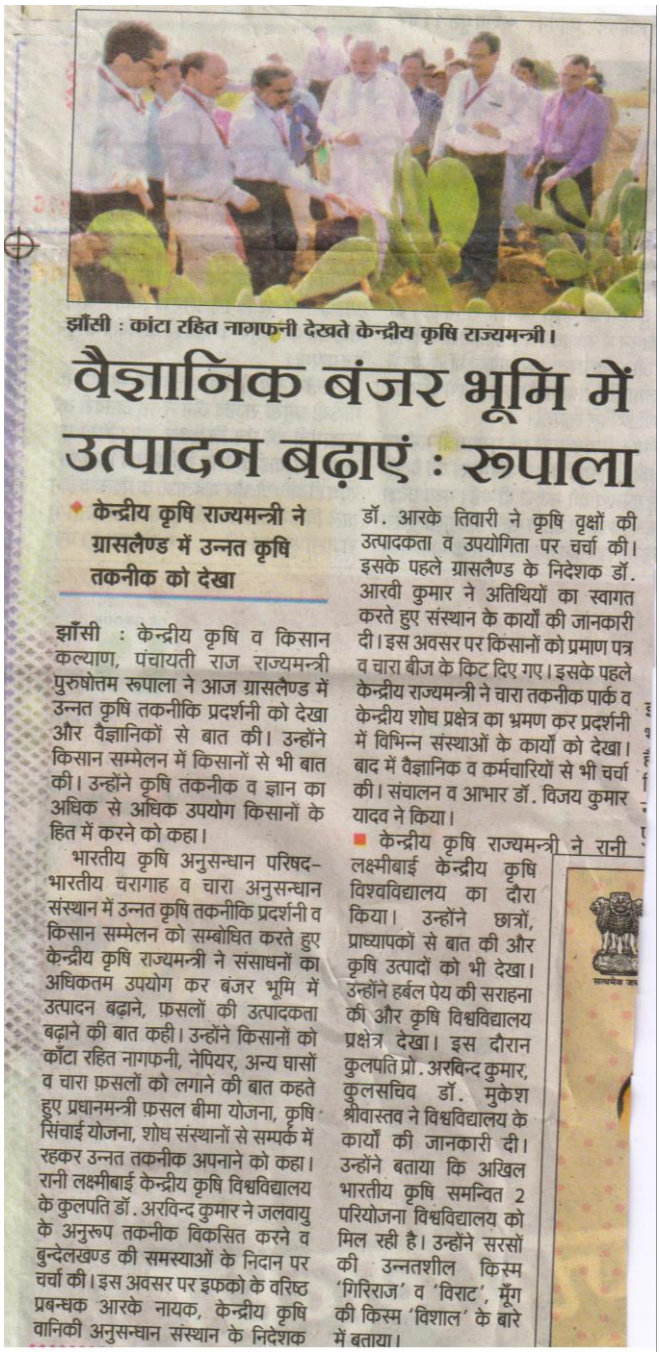
પહેલા પાનાનું...

સલમાનની સુનાવણી...

તે અભયારણ્ય કે રાષ્ટ્રીય ઉપવનમાં શિકારના કિસ્સામાં લાગુ પડે છે. સાક્ષીઓના લોકેશન પણ અલગ-અલગ છે. નિવેદનો પણ એકસરખા નથી. સલમાન 20 વર્ષથી ટ્રાયલનો સામનો કરી રહ્યો છે. જામીનની શરતોનો પણ ભંગ નથી કર્યો. તેમને રાહત આપી શકાય.

બીજી તરફ ફરિયાદી પક્ષના વકીલ પોકરરામ બિશ્નોઈએ કહ્યું કે બચાવપક્ષે જે મામલાઓનો ઉલ્લેખ કરીને રાહત માગી છે તેનાથી આ કેસ અલગ છે. આમાં નજરે જોનારા સાક્ષીઓ છે. ટ્રાયલ કોર્ટનો રેકોર્ડ

Appendix 3- Visit of Shri Purushottam Rupala, Union Minister of State to Jhansi research station



झाँसी : कांटा रहित नागफनी देखते केन्द्रीय कृषि राज्यमन्त्री।

वैज्ञानिक बंजर भूमि में उत्पादन बढ़ाएं : रूपाला

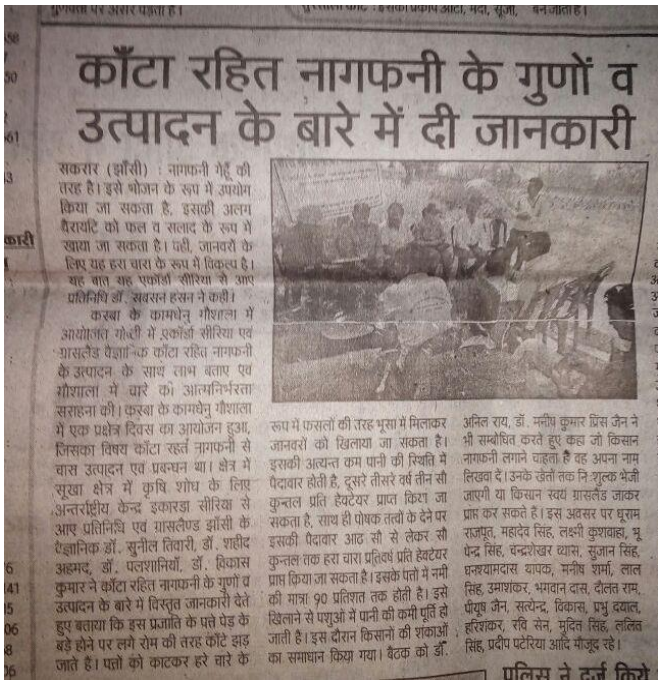
केन्द्रीय कृषि राज्यमन्त्री ने ग्रासलैण्ड में उन्नत कृषि तकनीक को देखा

झाँसी : केन्द्रीय कृषि व किसान कल्याण, पंचायती राज राज्यमन्त्री पुरुषोत्तम रूपाला ने आज ग्रासलैण्ड में उन्नत कृषि तकनीकि प्रदर्शनी को देखा और वैज्ञानिकों से बात की। उन्होंने किसान सम्मेलन में किसानों से भी बात की। उन्होंने कृषि तकनीक व ज्ञान का अधिक से अधिक उपयोग किसानों के हित में करने को कहा।

भारतीय कृषि अनुसन्धान परिषद-भारतीय चरागाह व चारा अनुसन्धान संस्थान में उन्नत कृषि तकनीकि प्रदर्शनी व किसान सम्मेलन को सम्बोधित करते हुए केन्द्रीय कृषि राज्यमन्त्री ने संसाधनों का अधिकतम उपयोग कर बंजर भूमि में उत्पादन बढ़ाने, फ़सलों की उत्पादकता बढ़ाने की बात कही। उन्होंने किसानों को काँटा रहित नागफनी, नेपियर, अन्य घासों व चारा फ़सलों को लगाने की बात कहते हुए प्रधानमन्त्री फ़सल बीमा योजना, कृषि सिंचाई योजना, शोध संस्थानों से सम्पर्क में रहकर उन्नत तकनीक अपनाने को कहा। रानी लक्ष्मीबाई केन्द्रीय कृषि विश्वविद्यालय के कुलपति डॉ. अरविन्द कुमार ने जलवायु के अनुरूप तकनीक विकसित करने व बुन्देलखण्ड की समस्याओं के निदान पर चर्चा की। इस अवसर पर इफको के वरिष्ठ प्रबन्धक आरके नायक, केन्द्रीय कृषि वानिकी अनुसन्धान संस्थान के निदेशक डॉ. आरके तिवारी ने कृषि वृक्षों की उत्पादकता व उपयोगिता पर चर्चा की। इसके पहले ग्रासलैण्ड के निदेशक डॉ. आरवी कुमार ने अतिथियों का स्वागत करते हुए संस्थान के कार्यों की जानकारी दी। इस अवसर पर किसानों को प्रमाण पत्र व चारा बीज के किट दिए गए। इसके पहले केन्द्रीय राज्यमन्त्री ने चारा तकनीक पार्क व केन्द्रीय शोध प्रक्षेत्र का भ्रमण कर प्रदर्शनी में विभिन्न संस्थाओं के कार्यों को देखा। बाद में वैज्ञानिक व कर्मचारियों से भी चर्चा की। संचालन व आभार डॉ. विजय कुमार यादव ने किया।

■ केन्द्रीय कृषि राज्यमन्त्री ने रानी लक्ष्मीबाई केन्द्रीय कृषि विश्वविद्यालय का दौरा किया। उन्होंने छात्रों, प्राध्यापकों से बात की और कृषि उत्पादों को भी देखा। उन्होंने हर्बल पेय की सराहना की और कृषि विश्वविद्यालय प्रक्षेत्र देखा। इस दौरान कुलपति प्रो. अरविन्द कुमार, कुलसचिव डॉ. मुकेश श्रीवास्तव ने विश्वविद्यालय के कार्यों की जानकारी दी। उन्होंने बताया कि अखिल भारतीय कृषि समन्वित 2 परियोजना विश्वविद्यालय को मिल रही है। उन्होंने सरसों की उन्नतशील किस्म 'गिरिराज' व 'विराट', मूँग की किस्म 'विशाल' के बारे में बताया।

Appendix 4- Field day on Cactus at village Sakrar, Jhansi (Uttar Pradesh)



काँटा रहित नागफनी के गुणों व उत्पादन के बारे में दी जानकारी

सकरार (झाँसी) : नागफनी गेहूँ की तरह है। इसे भोजन के रूप में उपयोग किया जा सकता है, इसकी अलग वैरायटी को फल व सलाद के रूप में खाया जा सकता है। पशु, जानवरों के लिए यह हरा चारा के रूप में विकल्प है। यह बात यह एकॉर्डो सीरिया से आए प्रतिनिधि डॉ. सबसन हसन ने कही।

करबा के कामधेनु गौशाला में आयोजित गोष्ठी में एकॉर्डो सीरिया एवं ग्रासलैंड वैज्ञानिक काँटा रहित नागफनी के उत्पादन के साथ लाभ बताए एवं गौशाला में चारे की आत्मनिर्भरता सराहना की। करबा के कामधेनु गौशाला में एक प्रक्षेत्र दिवस का आयोजन हुआ, जिसका विषय काँटा रहित नागफनी से चारा उत्पादन एवं प्रबन्धन था। क्षेत्र में सूखा क्षेत्र में कृषि शोध के लिए अन्तर्राष्ट्रीय केन्द्र इकारडा सीरिया से आए प्रतिनिधि एवं ग्रासलैण्ड झाँसी के वैज्ञानिक डॉ. सुनील तिवारी, डॉ. शहीद अहमद, डॉ. पलशानियाँ, डॉ. विकास कुमार ने काँटा रहित नागफनी के गुणों व उत्पादन के बारे में विस्तृत जानकारी देते हुए बताया कि इस प्रजाति के पत्ते पेड़ के बड़े होने पर लगे रोम की तरह काँटे झड़ जाते हैं। पत्तों को काटकर हरे चारे के रूप में फसलों की तरह भूसा में मिलाकर जानवरों को खिलाया जा सकता है। इसकी अत्यन्त कम पानी की स्थिति में पैदावार होती है, दूसरे तीसरे वर्ष तीन सौ कुन्तल प्रति हेक्टेयर प्राप्त किया जा सकता है, साथ ही पोषक तत्वों के देने पर इसकी पैदावार आठ सौ से लेकर सौ कुन्तल तक हरा चारा प्रतिवर्ष प्रति हेक्टेयर प्राप्त किया जा सकता है। इसके पत्तों में नमी की मात्रा 90 प्रतिशत तक होती है। इसे खिलाने से पशुओं में पानी की कमी पूर्ति हो जाती है। इस दौरान किसानों की शंकाओं का समाधान किया गया। बैठक को डॉ. अनिल राय, डॉ. मनीष कुमार प्रिंस जैन ने भी सम्बोधित करते हुए कहा जो किसान नागफनी लगाने चाहता है वह अपना नाम लिखवा दें। उनके खेतों तक निःशुल्क भेजी जाएगी या किसान स्वयं ग्रासलैंड जाकर प्राप्त कर सकते हैं। इस अवसर पर घूराम राजपूत, महादेव सिंह, लक्ष्मी कुशवाहा, भू पेन्द्र सिंह, चन्द्रशेखर व्यास, सुजान सिंह, धनश्यामदास थापक, मनीष शर्मा, लाल सिंह, उमाशंकर, भगवान दास, दौलत राम, पीयूष जैन, सत्येन्द्र, विकास, प्रभु दयाल, हरिशंकर, रवि सेन, मुदित सिंह, ललित सिंह, प्रदीप पटेरिया आदि मौजूद रहे।

पुलिस ने दर्ज किये

Appendix 5

Workplan for Indian Grassland and Fodder Research Institute (IGFRI)

Activity ref. no	Activity name Deliverable	Deliverable*	Delivery Date	Annual Budget ($)
1	Continue trial on agronomic practices for optimum cactus establishment to increase forage production	1- Semi-annual technical progress report 2- Final report by end of year 3 3- Draft ISI paper ready for submission by year 4	1. September 2017 and March 2018 2. September	4,000

			2019 3. December 2019	
2	Wide dissemination of cactus at farmer's field and across several agro-ecological production systems	1- Semi-annual technical progress report on cactus dissemination 2- Final Report 3- Submit ISI paper	1. Semi-annual technical progress report (June and December of each year) 2. Final report by end of 2021 3. 2021	4000
3	Develop and conduct new trials using new feed rations in combination with Cactus each year	1. Report on background and material & methods 2. Final report about the results of the feeding trial 3. ISI paper to be submitted	1. March of each year 2. Sept of each year 3. By December of each year	5000
4	Enhance capacity building of all partners and increase awareness about the importance of spineless cactus	1. Organize 2-3 field days each year (record list of participants, photos, and main points raised) 2. Produce one factsheet for each trial on cactus as feed 3. Prepare at least 3 proceeding papers and participate in the international Cactus Congress in Tunisia	1- By December of each year 2- By August of each year 3- Fall 2020 (need extra budget for international travel)	2000
5	Financial report	Semi-annual financial statements with supporting documents are due each year	June and December of each year	

Appendix 6

Workplan for ICAR-CAZRI (Central Arid Zone Research Institute)

Activity ref. no.	Activity name Deliverable	Deliverable*	Delivery Date

1	Conduct a trial on agronomic practices for optimum cactus establishment to increase forage production	1- Semi-annual technical progress report 2- Final report by end of year 3 3- Draft ISI paper ready for submission by year 4 3- Draft ISI paper ready for submission	1. September 2017 and March 2018 2. September 2020 3. March 2021
2	Wide dissemination of cactus at farmer's field and across several agro-ecological production systems	1- Semi-annual technical progress report on cactus dissemination 2- Final Report 3- Submit ISI paper 4- Demonstration of cactus pear to farmer	1. Semi-annual technical progress report (September and March of each year) 2. Final report by end of 2022 3. March 2022 4- 2017-2022
3	Enhance capacity building of all partners and increase awareness about the importance of spineless cactus	1. Organize 2-3 field days each year (record list of participants, photos, and main points raised) 2. Prepare at least 2 proceeding papers and participate in the International Cactus Congress in Tunisia	1. By March of each year 2. Fall 2020 (need extra budget for international travel)
4	Financial report	Semi-annual financial statements with supporting documents are due each year	September to March

Appendix 7- Bhopal 23 November 2017 Field day Participants list

No	Name	Signature
1.	Sangram singh s/o kamal singh	
2.	Govind Singh s/o Keshar singh	
3.	Jeewan singh s/o kamal singh	
4.	Narsingh mewada s/o Ratansingh	
5.	Pahlad s/o pranam anand	
6.	mohan s/o Harnath singh	
7.	prakash s/o madho singh	
8.	Bheem singh s/o Ramnath singh	
9.	Inder singh s/o Jagannath singh	
10.	Vikram singh s/o yashvant singh	
11.	Kuldeep s/o Shambhu singh	
12.	Raghvendra s/o Vikram	
13.	Dharmendra s/o Dashrath	
14.	Premnarayan s/o Devi patel	
15.	Jashmanth s/o Kamal singh	
16.	Ram singh s/o Jaymath singh	
17.		
18.	Raghveersingh s/o Jagnath singh	
19.	Govind s/o Ranjit singh	
20.	mehrban s/o Narayan	
21.	Virendra s/o Dulera singh	

Appendix 8- Jhansi 21 November 2017 Field day Participants list

No	Name	Signature
1.	श्री कृपाराम पाल Kripa ram Pal	कृपाराम
2.	श्री कमल किशोर Kamal Kishore	कमल किशोर
3.	श्रीमति क्रांति Smt Kranti	क्रांति
4.	" दयावती " Dayawati	दयावती
5.	" वती " Vati	वती
6.	" कलावती " Kalavati	कलावती
7.	श्री लक्ष्मीनारायण Sri Laxminarayan	लक्ष्मीनारायण
8.	श्री भगवत Sri Bhagwat	भगवत
9.	श्री राहुल " Rahul	राहुल
10.	श्री रामदयाल " Ramdayal	रामदयाल
11.	श्री मंजीराम " Manjiram	मंजीराम
12.	श्री राजू " Raju	राजू
13.	श्री अनिल " Anil	अनिल
14.	श्री हरगोविन्द " Hargovind	हरगोविन्द
15.	श्री शिवांश यादव	शिवांश यादव
16.	श्री राम यादव	राम यादव
17.	श्री महेश पाल	महेश
18.	श्री वीरसिंह	वीरसिंह
19.	श्री लखन पुरोहित	लखन सिंह
20.	श्री नावल यादव	नावल किशोर
21.	श्री सुन्दर	सुन्दर सिंह

No	Name	Signature
22.	Ramnath singh s/o Hari singh	
23.	Mukesh s/o Sawai singh	
24.	Mohan s/o Kamal Singh	
25.	Dev Raj s/o Bahadur singh	
26.	Mahesh vyas s/o Bihari lal	
27.	Amar singh s/o Ganpath	
28.	Dulhe singh s/o Takhat singh	
29.	Virendra s/o Sangram singh	
30.	Reena Mehra	
31.	Vivek Singh Tomar	
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Appendix 9- Participant's list for Amlaha Field Day (30 March 2018)

भाकृअनुप
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Science for resilient livelihoods in dry areas

Promoting cactus (*Opuntia ficus-indica*) as drought resilient feed resource under different agro-ecological production systems across India

Amlaha March 30th 2018

Participants list

#	NAME	SIGNATURE
1	Raghuveer singh	रघुवीर सिंह
2	Verendra singh	
3	Dharmendra singh	धर्मेन्द्र सिंह
4	Manoj choahan	Manoj
5	Saeval singh	
6	Devi Lagwan	
7	Rakes Verma	
8	Kedar mewada	
9	Arjun Verma	Arjun
10	pratap	प्रताप
11	Dolat mewada	
12	Maan singh	मान सिंह
13	Chandar	
14	Ramkala Bai	
15	Geeta Bai	—
16	Sampat	
17	Kalsha Bai	
18	Maanshy	
19	Devkaran	
20	Chanderlal	चन्द्र सिंह

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Appendix 10- participants list for the farmer's day (5 April 2018)

Promoting cactus (*Opuntia ficus-indica*) as drought resilient feed resource under different agro-ecological production systems across India

Bhuj April 6th 2018

Participants list

#	NAME	SIGNATURE
1	રતી તુલસીભાઈ માકાણી	[illegible]
2	દમયંતીબેન તુલસીભાઈ	D.T.M.
3	સગુણા બેન અશ્વિનભાઈ	સગુણા બેન અ, માકાણી
4	દમયંતી બેન કલ્યાણજીભાઈ	દમયંતી બેન કે. માકાણી
5	દમયંતીબેન કાંતિલાલ	દમયંતી બેન કે માકાણી
6	કમળાબેન અરવિંદભાઈ	કમળા બેન અરવિંદ [illegible]
7	પ્રભા બેન નારણભાઈ	પ્રભા બેન નારણભાઈ માકાણી
8	ભગવતીબેન તુલસીભાઈ	ભગવતી બેન T. [illegible]
9	ઉર્મિલા બેન અમૃત લાલ	ઉર્મિલા બેન અમૃતલાલ ભગત
10	તુલસી દાસ ભાણજી	TPatel
11	દેવરામ સામજી [illegible]	દેવરામ સામજી [illegible]
12	મોહનભાઈ માવજી [illegible]	મોહન માવજી [illegible]
13	અમૃત લાલ શામજી ભગત	અમૃત લાલ શામજી ભગત
14	કાન્તિભાઈ રામજી માકાણી	કાન્તિ લાલ રામજી
15	નારણ રામજી માકાણી	નારણ રામજી માકાણી
16	મંગલ રામજી માકાણી	મંગલ લાલ રામજી
17	[illegible] સિંહ	[illegible]
18	સીતારામ ગોર	Sitaramj[illegible]
19	હરગોવિન્દ [illegible]	[illegible]
20	MAHENDRAKUMAR	[illegible]

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Promoting cactus (Opuntia ficus-indica) as drought resilient feed resource under different agro-ecological production systems across India

Bhuj April 5th 2018

Participants list

#	NAME	SIGNATURE
21	Ahir Tarun	Tarun b.
22	[illegible]	[illegible]
23	Khuvet Dinesh. J	Khent. D. J.
24	Rajesh V. Gadhavi	Rgadhavi
25	Anil. M. Gadhvi	Anil. M Gadhvi
26	Khodidan V. Gadhavi	K V G
27	Arvindshin G Jadeja	[illegible]
28	[illegible]	[illegible]
29	[illegible]	[illegible]
30	[illegible]	R. H. Jadeja
31	Jadeja Giriraj sinh B	Jadeja
32	Jaysinh Bhuj B. Patel	Jaysinh
33	[illegible]	[illegible]
34	Chabiya Amruta N.	Anpatel
35	[illegible]	[illegible]
36	[illegible]	[illegible]
37	અર્જુન સિંહ	A. M jadeja
38	DIPEN DHOLU	Dholu
39	Ramniwas	Rniwas
40	Sita Ram Jat	SRJat

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