RESEARCH PROGRAM ON Dryland Systems

CGIAR

Implementation report on

"Farm Typology specific intensification and diversification"

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Farm Typology specific intensification and diversification

Improving land and water productivity in arid regions for sustainable livelihoods: Farm typology specific intensification and diversification options including agro-silvi-horticulture with traditional rainwater harvesting systems (tanka & khadin): Based on farm typology analysis, total six large agri horti units has been established and linked with RWHS (Rain water harvesting structures) to ensure the nutritional and livelihood security of resource poor households. Besides of this a total of twenty five 20 plants agri-horticulture kitchen gardens linked to women have been also established in six villages with Pitcher system and Survivability in large unit observed 90% and 60 % in 20 plants units till end of May. In two large units, the seasonal vegetable production has been also taken by women in Dhirasar village. This has resulted in changing farmers attitude and has increased their confidence to produce fruits under water scarcity conditions.

Soil Systems

Status of soil org. C and available nutrients in target villages

- 320 geo-referenced (using *etrex* GARMIN GPS system) composite soil samples (surface) were collected from target villages covering all the prominent land uses *i.e.* crop land (rainfed and irrigated), fallow, community pasture and forest land and also covering sampling form upper, middle and lower parts of landscape.
- Collected soil samples are poor in fertility *w.r.t.* to soil organic carbon, available nitrogen, phosphorous, potassium, sulphur and micronutrients (cations).
- Highest soil organic carbon and soil fertility is observed in *Khadin* system (Damodara and Dhedha villages) which is due to addition of organic matter with runoff water coming from nearby areas. This system is a typical example of subsistence farming in arid western plains of India.
- Soil samples were low in soil organic carbon (99%), available nitrogen (100%), available phosphorous (84%), available potassium (42%), available sulphur (49%) and DTPA extractable Zn (93%), Cu (65%), Fe (90%) and Mn (60%) (Table 3.).
- No soil is having salinity problem.
- Soils from higher altitude in villages are low in fertility due to aeolian deposition.
- In general, soil samples collected from Jodhpur are high soil fertility as compared to soils of Jaisalmer and Barmer.
- **Sodic soil was also observed in *Khadins* (Damodara and Dedha) and small areas in Govindpura, Mansagar and Dhok villages of varying level (GR 2.38-21.33 tha^{-1}).**
- Salinity build-up is also observed in groundwater irrigated soils in comparison to unirrigated soils.

Table 3. Physico-chemical properties of soil collected from different land uses in target villages

Soil Properties	Rainfed	Irrigated	*Khadins*	*Oran/Gochar*
Soil pH	8.54	8.62	8.52	8.42
EC (dS m^{-1})	0.169	0.310	0.276	0.098
O.C. (%)	0.143	0.166	0.174	0.156
Available N (kg ha^{-1})	69.2	81.7	74.3	72.9
Available P (kg ha^{-1})	7.66	11.49	8.18	7.45
Available K (kg ha^{-1})	197.2	183.1	324.2	195.8
Available S (µg g^{-1})	12.1	11.3	16.2	9.2
DTPA extractable Zn (µg g^{-1})	0.42	0.54	0.36	0.35
DTPA extractable Cu (µg g^{-1})	0.39	0.41	0.78	0.42
DTPA extractable Fe (µg g^{-1})	0.82	0.77	2.36	0.92
DTPA extractable Mn (µg g^{-1})	0.93	1.09	1.54	1.17
DHA (µg TPF/g soil/d)	41.05	74.19	68.83	46.57

Characterization of groundwater in Target villages

1	Groundwater is highly saline (>2 dS m^{-1})	Didhoo > Mansagar > Govindpura
2	High in Sodium Adsorption Ratio (>12)	Govindpura > Mansagar > Didhoo > Dhok
3	High in Residual Sodium carbonate (>2.5)	Mansagar > Didhoo
4	Sodicity /salinity build-up is noticed due to irrigation with groundwater in all villages	
5	Groundwater samples from Damodara is highly saline (>11 dSm^{-1}) (Fig. 1a -1 c).	

Fig.1 a.Electrical Conductivity (% distribution)

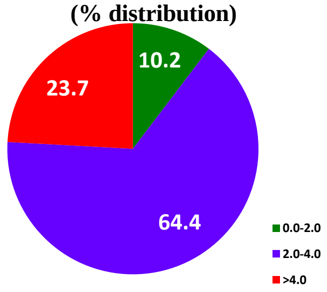


Fig. 1 b.RSC (% distribution)

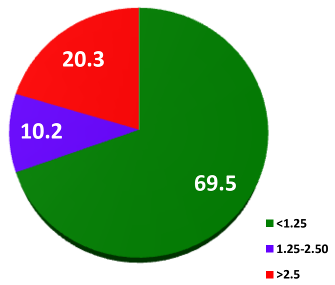
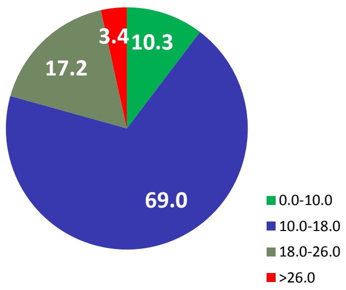


Fig. 1 c.Sodium Adsorption Ratio (% distribution)



Biomass Estimation of *Rabi* Season Crops

In eight target villages of three districts viz. Jodhpur, Jaisalmer and Barmer, the *Rabi* season crop biomass data was recorded. In Damodara, Dedha and Sakaria villages wheat, chick pea and mustard were cultivated by farmers. In Damodara and Dedha cultivation of crops were under *khadin* system. Sakaria village had canal irrigation. In Didhu village there was tubewell irrigation and in addition to wheat and mustard, famers cultivated isabgol and cumin also. In Dhirasar village of Barmer district *Rabi* crops were not sown due to non availability of any irrigation sources. In Dhok village, farmers cultivated wheat, isabgol, cumin and mustard. In Govindpura and Mansagar villages of Jodhpur district wheat, cumin, isabgol and mustard were grown by farmers in *Rabi* season. The data was collected from the field of five farmers in each and every village covering all the directions and landforms of the village. Five quadrates of 1m ×1m were taken from each farmer's field for each crop. From Table 4 it can be inferred that average biomass yield of wheat was 2770.42 kg/ha across all the villages. The biomass yield of chick pea ranged between 1603.2 kg/ha to 2217.8 kg/ha in Jaisalmer district. isabgol yield was recorded maximum in Didhu village (1671.66 kg/ha) and minimum in Dhok village (1596.00 kg/ha).The average yield of cumin was 728.19 kg/ha across all the villages. Whereas, the yield of mustard varied between 1720 kg/ha (Dhok) to 2225 kg/ha (Sakariya).

Mansagar village contributed maximum crop biomass (i.e 18 per cent to the total *Rabi* crop biomass) followed by Didhu village (17 per cent) and minimum contribution was from Dedha village (i.e. 11 per cent). Further analysis of Rabi crop data is in progress. Moreover, partitioning of edible and non-edible biomass of trees, shrubs, herbs and grasses is also in progress.

Table 4.Biomass yield of different crops (kg/ha) in villages under study

District	Village/Crop	Wheat	Chick pea	Isabgol	Cumin	Mustard
Barmer	Dhok	2647.84 ± 221.09	-----	1596. 00 ±252.09	703.29± 112.63	1720 ± 348.38
Jaisalmer	Damodara	2390 ±421.06	2070.76±305.04	-----	-------	1829 ±232.45
	Dedha	2543.56±345.67	2217.8±368.68	-----	------	------
	Sakariya	2708±574.63	1603.2±171.29	-----	-----	2225 ±252.48
	Didhu	2918.40±440.85	------	1671.66±273.77	742.16± 124.5	1990±232.47
Jodhpur	Mansagar	3297.14±450.23	-----	1619.00±67. 40	743.33± 22.56	1943.33± 175.04
	Govindpura	3036±260.8	------	-------	724.00± 27. 50	1954±107.84

A Gender-responsive Approach to Participatory Action Systems Research

The Challenge

The social and environmental costs of poor management of **common property resources** are varied. Located in the extreme north-west of India, the state of Rajasthan is a hot arid region with scanty rainfall. Thar desert spreads over an area of 320,000 square kilometers and covers 60% of the state. The region faces water scarcity for up to 11 months a year and droughts occur once every 2.5 years.

Common property resources such as grazing pastures are the lifeline for rural dryland communities because they provide fodder, fuel, timber, water and medicinal plants. While livestock depend heavily on common pasture lands for feed, most lands are severely degraded due to over-grazing, over extraction and lack of effective mechanisms for **sustainable resource management**. Moreover, increased grazing pressure has led to the disappearance of many species and a decline in biomass.

Rural dryland communities in this area are extremely poor and marginalized. With very little opportunity to make a living in their village, men are forced to migrate and look for jobs elsewhere in the urban areas, while women and children are left behind, struggling to survive in a harsh environment characterized by lack of water, food and constant threat of droughts or flash floods.

The women cite lack of water and food for their children, elderly and livestock to be one of the biggest challenges they face. The costs of securing water and food for their families and animals are significant, but the **social costs** are even higher. Families are forced to live apart due to economic hardship, and children are often left on their own and unsupervised by adults.

"When my children were small, I would leave them unattended at home and walk five to six kilometers every day to fetch water," says Manibai, a woman living in Dhirasar village.

*"I have 5 goats and 7 heads of cattle, - says Rameshwari Devi. "If it rains then there will be fodder for the animals. Otherwise, the animals will die. Buying fodder is really expensive for us as a **maund** (40 kg) costs 400 ruppees (6.6 USD). This year it did not rain at all. I spent 700 rupees (US$11.6) on drinking water, which lasts us three months. For cooking and other needs, we use brackish water."*

A gender-responsive approach to bring together a whole community

To address these challenges, scientists at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) are working closely with local communities in Jaisalmer, Jodhpur and Barmer - three districts in the western part of Rajasthan – to develop best practices and technologies on water conservation and regeneration of degraded common pasture lands. Under the framework of the **CGIAR Research Program on Dryland Systems**, these scientists have teamed up efforts with Gramin Vikas Vigyan Samiti (GRAVIS), a local grassroots organization in order to ensure rural dryland communities are an integral part of the solutions being tested and developed. Areas of 10 hectares each have been established on three different sites - Dhok in the Barmer district, Damodara in the Jaisalmer district and Govindpura in Jodhpur district - where various fodder grasses, horticulture and agroforestry trees have been planted.

To manage these **common silvio-pastures,** a **Village Development Committee** was established with four women and seven men serving as community representatives.

"First we had to gain the confidence of the community that the land would not be misused. Our main task was to make the villagers aware of the benefits they would enjoy by joining in. It took a lot to convince them about the fact that they themselves would be the direct beneficiaries. Therefore, the committee has put in place several transparent management processes, such as the process villagers follow for cutting fodder for their cattle," says Kump Singh Rajpurohit, Chair of Dhok Village Development Committee.

Once the community understood the benefits, the scientists, GRAVIS representatives and members of the Village Development Committee worked together to develop an **appropriate intervention package** consisting of: (a) wire fencing the land; (b) soil and water conservation structures (c) planting of trees and (d) sowing of improved grasses.

"In the new institutional arrangement, the involvement of women livestock keepers in operationalizing the cut-and-carry fodder system was critical and we expect it will contribute significantly to the sustainable management of common property resources," says Dr. Shalander Kumar, ICRISAT scientist and South Asia Flagship Coordinator for Dryland Systems.

The **fencing** was essential to prevent stray cattle, small ruminants and camels from entering the area. Two local grass species and more than 7,000 multi-purpose fruit and fodder trees were also planted in the common silvio- pastures. In addition, **rainwater-harvesting structures** such as closed wells with water catchment area (locally known as ***taankas***) and open structures were constructed to provide supplementary irrigation. On the other hand, a series of three **embankments** were constructed in Govindpura to check the runoff water in order to **avert flash floods** that had previously devastated the community, damaging houses and property and endangering lives.

"At night the flood waters entered our house and destroyed everything. Our fields were damaged and livestock carried away. Now the runoff water is controlled and stored for use by humans and animals and also provides water for the trees that have been planted in the common pasture in our village," says Pooro Devi, victim of a flash flood.

"These kind of solutions basically prevent flash floods and also help improve the ground water table in the long run. We want the water table to rise since ground water is being exploited and these solutions have helped us achieve that," says Ram Bhajan Nagpuria, Area Coordinator, GRAVIS.

Participatory Action Research for Sustainable Local Solutions

Past efforts by public and private agencies and NGOs to regenerate and rehabilitate degraded common property resources through community efforts have hardly produced any sustainable results. This is because solutions were often sought within a **limited analysis of biophysical factors**. In order to ensure a **comprehensive understanding of the social-ecological systems** around common property resources, ICRISAT scientists focused their analysis on both the biophysical conditions and the socio-economic attributes of the community, the rules determining use of common resources, and the **patterns of interactions** among various actors which seemed to produce different outcomes in different scenarios. The research was designed in an innovative fashion so as to allow the local community itself to experiment with different technological and institutional options for **sustainable resource management**.

Researchers believe it may take a couple of years to properly assess and understand the likely **system level impacts**. However, early results of this developed model for sustainable management of community silvio-pasture systems show considerable promise for scaling this approach out and up with appropriate policy recommendations and advocacy efforts at local, regional and national level. The selection of the research sites was made on the basis of **close consultations with the local communities**, and the process was informed by an analysis of secondary and geo-spatial data. A variety of **data collection tools** to solicit community participation were utilized, such as a field-survey (70 farmers), participatory rural appraisals (PRA) including transect walks, focus group discussions and key-informants interviewed in three villages.

The **scientific findings of this process** - published in a paper entitled *Assessing different systems for enhancing from income and resilience in extreme dry regions of India* - were shared and discussed with the local community stakeholders in an innovation platform setting in order to fill data gaps and align scientific understanding with local priorities and needs. **Extensive community consultations** were also organized in order to improve and advance equitable by-laws and institutional arrangements for the sustainable development and management of the silvio-pasture lands. The table below provides a timeline of the research in action activities that took place.

A Systems Perspective with Wide-ranging Results for Sustainable Resource Management in Drylands

The application of **integrated systems research** in close collaboration with rural dryland communities in India has led to a **significant increase** in biomass productivity and reduced land degradation.

Local communities, especially smallholder farmers, are benefiting directly from **increased access** to water and food resources, which invariably affects their food security and incomes. The local NGO partner GRAVIS has already started to scale out this inclusive research-in-development intervention to 20 other locations in western Rajasthan that face similar challenges of water and fodder scarcity, and degraded lands.

As our research results are shared with more and more major stakeholders through various **innovation platforms,** there is a greater likelihood that **community-led solutions** developed as a result of **integrated systems research** will be the new model for ensuring sustainable natural resource management in millions of hectares across this vast dry region, where some of the world' poorest live.

Lessons Learned

- **Institutional interventions** are as important as **biophysical interventions** for improving productivity and managing common property resources in a sustainable way
- **Governance structures** should be inclusive of local stakeholders, especially vulnerable groups of livestock keepers.
- Institutional arrangements must ensure a **fair representation** of stakeholders.
- The small **yearly benefits** to users, especially smallholder livestock keepers, will accrue over several years – users must understand/share this **long-term view** or may become disenchanted.
- There may be a need to have different by-laws to manage common property resources across villages in the same region depending on the **differentiated local situations** for example social norms, livestock composition, feed and fodder supplies.

References:

Shalander K., Amare H., Ramilan T., Suhas P. W. (2014) Assessing different systems for enhancing farm income and resilience in extreme dry region of India, International Crop Research Institute for Semi Arid Tropics, Patancheru, INDIA 502 324

- See more at: http://drylandsystems.cgiar.org/content/community-led-solutions-india's-drylands

RESEARCH PROGRAM ON Dryland Systems

The CGIAR Research Program on Dryland Systems aims to improve the lives of 1.6 billion people and mitigate land and resource degradation in 3 billion hectares covering the world's dry areas.

Dryland Systems engages in integrated agricultural systems research to address key socioeconomic and biophysical constraints that affect food security, equitable and sustainable land and natural resource management, and the livelihoods of poor and marginalized dryland communities. The program unifies eight CGIAR Centers and uses unique partnership platforms to bind together scientific research results with the skills and capacities of national agricultural research systems (NARS), advanced research institutes (ARIs), non-governmental and civil society organizations, the private sector, and other actors to test and develop practical innovative solutions for rural dryland communities.

The program is led by the International Center for Agricultural Research in the Dry Areas (ICARDA), a member of the CGIAR Consortium. CGIAR is a global agriculture research partnership for a food secure future.

For more information, please visit

drylandsystems.cgiar.org

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