Institutionalizing Systems Approaches for Improving Agricultural Livelihoods in an Arid Ecoregion of South Asia

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1 Introduction

The arid agro-ecosystems of South Asia are affected by severe resource degradation, low and unstable farm-based livelihoods and persistent poverty. In these environments, a major research program, the CGIAR Research Program (CRP) Dryland Systems, is underway that utilises multi-disciplinary and systems approaches that build on the indigenous coping and adaptation strategies. The objectives of this study were: to identify relatively homogeneous farm typologies among dryland farmers in the extensive to intensive agricultural systems of Indian Thar desert to target context specific technologies for increased impacts, and prioritize interventions across different farm typologies and facilitate appropriate institutional machenism for future trajectory development for resilience building and or intensification.

2 Materials and Methods

In a study based in Western Rajasthan in India, 250 farm households were randomly selected along the rainfall gradient (Jodhpur, Barmer, Jaisalmer districts) and surveyed using survey techniques and focussed group discussions (FGDs). Built farm-system typologies based on key livelihood assets that helps to explicitly understand the potential, expectation and the limitations of farms and thus develop a "recommendation domain", which can be defined as: "a group of farm-systems, relatively homogenous, with similar circumstances, and for which we can make more or less the same recommendation (Giller 2013). A multivariate approach was used to exploit the large number of recorded variables in the most efficient way. Statistical analysis was carried out by using Principal Component Analysis (PCA) and Cluster Analysis (CA) (Usai et al., 2006; Rufino et al., 2013; Riveriro et al., 2013). Prior to building the farm typologies the major constraints to the farming systems for the each selected village were identified based on FGDs with farmers and stakeholders consultations. Corresponding possible interventions based on the available resources and technologies were identified during the multistakeholder Innovation Platform workshop. In the next stage, the major factors constraining agricultural production and farmers' livelihoods were prioritized for each farm typologies by using pairwise comparisons of different constraints with farmers (men and women) group. The corresponding interventions identified by the multistakeholders innovation platform and the farmers groups were also prioritized using the same method. Thereafter ex-ante assessment of priority options was carried out on farm typologies. Based on the above analysis the best fit options were assessed on-farm as components of the integrated agro-ecosystem, targeting resilience and intensification at different scales: field, farm and landscape. Enabling institutional mechanism, enhance stakeholders' capacity to innovate and strengthening value chains were the key components of the systems approach.

3 Discussion

The values of coefficient of variation (CV) in the crop yields and net returns per standard animal unit indicated very high variability across farm households during the same agricultural year; which was not related to landholding size. It indicates that there might be a number of livelihood assets other than landholding-size which could differentiate farm households in terms of their capacity to make proper use of resources to produce and to adopt new interventions and technologies. As part of characterization we looked at both the farm structure and function. The socially diverse and spatially heterogeneous households were grouped into four broad farm typologies based on multiple livelihood assets using multivariate analysis: 1) Rainfed extensive crop-livestock medium farms; 2) Semi-irrigated intensive diversified medium; 3) Rainfed extensive livestock off-farm income based small; 4) Irrigated semi-intensive off-farm income based small. For each typology, the common structures and functions were developed (Table 1) and constraints prioritized using participatory tools. The magnitude of most of the 32 livelihood assets was significantly different across the farm typologies underlining the need for such clustering. Based on ex-ante assessment and farmers' preferences for promising options/system components, potential interventions were prioritized and implemented in participatory mode engaging innovation platform and community. Farmers' perceptions of constraints and priorities for potential interventions differed across typologies. For example an ex-ante analysis of agro-silvi-horticulture systems demonstrated higher net-returns by 1.5 to 2 times in typology 2 and 4 and 2 to 4.5 times in typology 1 and 3.

Besides the typology specific-technical interventions which were implemented through >250 on-farm trials, other important system interventions are underway including: institutional mechanisms for managing natural resources base

(e.g. common property resources- pastures and water); value chain approaches for improving market access (fruits and medicinal plants) and information; the establishment of long term multi-institutional partnerships to influence policy and up-scaling. A village development committee facilitated to be evolved in each action village was involved in planning and implementing interventions as part of systems approach. At districts/region level, a multiple stakeholders Innovation platform contributed in planning of need based interventions and enhancing linkages and convergence for upscaling. All relevant actors; farmers, government departments, researchers, NGOs, industry and development institutions were appropriately involved for enhancing economic viability and resilience of the farming systems.

Table 1. Structural and functional characteristics of households under different farm typologies

Characteristics	Typology 1	Typology 2	Typology 3	Typology 4	Probability value
Structural characteristics					
Landholding size cultivated, ha	6.2	6.0	3.3	3.2	0.0696^{ns}
Land labour ratio, ha per adult person	1.7	1.4	0.7	1.0	0.0417*
Standard animal Units (SLU), No.	5.0	6.2	5.1	5.1	0.0112*
Number of months own produce support farm family	5.4	10.4	3.8	5.9	<.0001**
Number of crops grown	2	5	4	2	<.0001**
% income from off/non-farm earnings	56	25	52	46	<.0001**
Number of livelihood strategies	3.1	2.9	3.3	3.5	0.0423*
Status of feed availability (months of sufficiency)	6	10	5	8	<.0001**
Amount borrowed from bank/financial institutions, US$	313	3196	2999	853	<.0001**
Average distance of input market, km	15	17	7	3	<.0001**
Total investment in past 5 years, US$	319	7876	758	1324	<.0001**
No. of times the farmers visit the extension officials/office	0.3	0.2	0.0	0.4	0.4623^{ns}
Women headed households (%)	14	0.0	17	0.0	0.0211*
Households opt for out migration (%)	24	3	33	13	0.0121*
Functional characteristics					
Manure Applied, Kg/ha	71	2035	297	122	<.0001**
Quantity of Fertilizer-Urea used kg/ha	1	82	11	16	<.0001**
Quantity of Fertilizer-DAP used kg/ha	1	65	7	17	<.0001**
Access to bore-well for irrigation (% households)	14	94	15	0	<.0001**
Access to khadins (% households)	28	0	0	0	<.0001**
Access to canal for irrigation (% households)	4	0	0	100	<.0001**

Note: NS- Not significant at 0.05; * significant at 0.05 level; ** significant at 0.01 level

4 Conclusions

This paper aims to share the methods and processes of designing resilient farming systems to improve livelihoods under the drylands in South-Asia. Our analysis proved that the dryland smallholder farming systems occur within diverse agro-ecological and socio-economic environments and develop different livelihood strategies driven by opportunities and constraints encountered. Multiple livelihood assets determine different land use patterns and agricultural management practices in dryland systems in south Asia. Well-designed household survey on socio-economic and agro-ecological variables and statistical approach helped capture the diversity of livelihood assets to categorize households into homogenous farm typologies. The follow up FGDs with farmers were equally important to validate the farm typologies and prioritizing the constraints in each typology. The analysis makes a strong case for revisiting the method/ criteria for grouping the farmers for targeting technological and livelihood interventions in arid and semi-arid ecoregions of South Asia. Engaging the innovation platform for identification of possible options and their prioritization at district level; farmers for each farm typology, and ex-ante assessment of promising options led to the on-farm assessment of farm typology specific most appropriate interventions in the action villages. The institutional mechanism being experimented at village to regional level has strengthened the capacity of the community/stakeholders to improve the farming sysytems resilience and economic viability. An ex-post assessment will be undertaken in these communities to assess the impact. This study contributes to the understanding of how research for development through technology targeting for trajectory development can contribute towards stabilizing farm incomes, sustainable intensification and smoothening livelihood of resource poor farmers in vulnerable dry regions.

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