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Co-designing profitable and resilient crop-livestock systems in Niger and Burkina Faso using a household modelling approach

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1. Introduction

The West Africa Sahelian (WAS) countries of Burkina Faso and Niger face serious challenges of water scarcity, frequent droughts, high vulnerability to climate change, food insecurity, gender inequality and widespread unemployment. More than 80% of the population depend on low input- low output rain-fed agriculture and agro-pastoralism for their livelihoods. Prevalence of undernourishment is very high for all section of peoples. Context specific integrated crop-livestock systems are suggested as a key strategy for enhancing resilience of the livelihood systems. The present study therefore undertakes integrated farming system assessment using whole farm modelling to identify the leverage points for achieving higher profitability and resilience under different crop-livestock farm types in the study regions.

2. Materials and Methods

A total of 400 households, 200 from each Niger and Burkina Faso, were surveyed using a detailed survey instrument. These randomly selected households were from Maradi (103) and Tillaberi (97) regions of Niger and Centre-nord (100) and Sahel (100) regions for Burkina Faso. Table 1 describes the basic characteristics of the regions. The cropping systems, agricultural practices and livestock integration differed across regions however both the regions have unfavourable climatic conditions. To develop relatively homogeneous farm typologies, we considered six important livelihood assets (Family size, Number of cattle, Number of small ruminants, Technology adopted, Land size and Access to animal traction). We used principal component analysis (PCA) and k-cluster mean method to categorise households into three relatively homogenous farm types each for both the countries. Afterward using Integrated Assessment Tool (IAT)[1] also known as whole farm modelling tool, the baseline as well as different alternative intervention scenarios were generated.

Country	Region	Characteristics
Niger	Maradi and Tilabery	✓ Mixed crop-livestock systems ✓ More than 41% of the country's livestock are located on the transect Maradi-Zinder ✓ Livestock diseases, seasonal feed shortage and water scarcity particularly during the dry season. ✓ Crop-livestock systems are gradually changing from the traditional extensive system to semi-intensive and intensive system
Burkina Faso	Centre-nord and Sahel	✓ Agro-pastoral activities account for nearly 90% of the labor force ✓ Low availability of labour for agriculture activity ✓ Unfavorable climatic conditions, poor access to improved technologies and market ✓ Seasonal fluctuation in feed resources with acute shortage in the dry season, lack of water for animals, high mortality of animals, problem in livestock services delivery

Table 1. Study locations and basic characteristics

3. Results and discussion

3.1. The Base model

Initially the study considered baseline household situation for the three farm types over a 5-year period (Table 2). It was found that cowpea, sorghum, millet and groundnut are the major annual crops for both locations, whereas tree crops were more important in Niger households for their livelihood. Table 3 describes the average net income and share of different components in details. In Niger the cattle rearing contributed more than one third of household's total income for all farm types. Besides annual crops, the tree crops were also an important source of farm household income in Niger. The small ruminants contribute about 8% to 12%. The share of annual crops to household income in Burkina Faso was much higher at 37 to 49%. The tree crops were not so economically important in the study area in Burkina Faso. The potential impact of different scenarios on households' income is discussed in the following section.

Country	Farm type	Cultivated land (Ha)	Tree crops	Annual crops	Livestock (No)		
					Cattle	Goat	Sheep
Niger	1	1.890	Balanites (Balanites aegyptiaca), Diney (Sclerocarya	Cowpea, Millet, Sorghum	4	3	2

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[1] For further details about IAT please go through https://research.csiro.au/livegaps/tools/integrated-analysis-tool-iat/

	2	2.734	birrea), Farou (Lannea acida), Doum palm tree (Hyphaene thebaica), Tokoye (Diospyros mespiliformis)	Cowpea, Millet, Sorghum	5	5	3
	3	6.525		Cowpea, Millet, Sorghum, Groundnut	8	7	6
Burkina Faso	1	4.080	Karité (Vitalaria paradoxa) and Néré (Parkia biglobosa)	Cowpea, Millet, Sorghum	7	4	4
	2	4.661		Cowpea, Millet, Sorghum, Groundnut	6	4	4
	3	6.320		Cowpea, Millet, Sorghum	16	12	10

Table 2. Key characteristics of three farm household types for Niger and Burkina Faso

Country	Particulars	Farm type1	Farm type2	Farm type3
Niger	Tree crop	473 (39)	571 (39)	597 (23)
	Annual crops	192 (16)	286 (19)	597 (23)
	Cattle	444 (37)	512 (35)	1144 (44)
	Small ruminants (SR)	97 (8)	105 (7)	275 (11)
	Total net farm cash flows	1204 (100)	1474 (100)	2611 (100)
Burkina Faso	Annual crops	519 (49)	571 (48)	850 (37)
	Cattle	425 (40)	482 (41)	1190 (52)
	Small ruminants (SR)	120 (11)	128 (11)	270 (12)
	Total net farm cash flows	1062 (100)	1178 (100)	2309 (100)

Table 3. Baseline farming system cash flows under three farm household types in Niger and Burkina Faso (USD/annum)
Note: Values in the parenthesis indicate percentage to household's total farm cash flows

3.2. The scenarios
To find out the most important and feasible strategies for enhancing profitability and resilience as compared to baseline farming system situation, the present study considered thirteen different alternative intervention scenarios for both the countries. We have run the scenarios separately for all three farm groups and the change in profit (%) as compared to the baseline have been depicted in Table 4. In Niger, scenarios 1 to 4 and scenario 13 were the most profitable five best scenarios which would result in highest increase in income. The farm household income is likely to increase by 11% to 80% for farm type-1, 21% to 76% for farm type-2 and 27% to 84% for farm type-3 as compared to base scenario. Scenario 1 to 3, scenario 10 and scenario 13 were the five most profitable scenarios for Burkina Faso. In these scenarios the increase in income as compared to baseline ranged from 30% 45% for farm type-1, 25% to 37% for farm type-2 and 10% to 24% for farm type-3.

	Niger farm type			Burkina Faso farm type		
Alternative intervention scenarios	**1**	**2**	**3**	**1**	**2**	**3**
1. Improved Cattle (replaces the local cattle)	64.6	44.2	44.3	5.0	14.2	4.6
2. Improved (Cattle+Millet)	75.7	72.1	78.8	31.5	25.2	16.4
3. Improved (Cattle+Millet+SR)	76.9	72.0	82.9	31.9	25.6	16.8
4. Improved (Cattle+Millet+SR) + 15% extra price of livestock	80.4	75.8	84.3	44.6	31.4	24.2
5. Improved Millet	9.3	21.2	27.3	24.4	19.9	7.2
6. Improved small ruminants (ISR)	5.8	6.1	3.2	0.4	0.4	0.4
7. Prophylaxis (SR)	1.0	8.1	1.1	2.2	2.0	1.8
8. ISR + Prophylaxis	6.4	9.3	4.5	2.7	2.5	2.2
9. ISR + Prophylaxis + 15% increase in price of ISR	8.6	10.8	6.4	4.8	4.2	4.5
10. 50% local Cattle + 50% improved Cattle	10.1	9.8	8.7	29.7	37.2	14.0
11. 30% legume area shifted to millet	0.0	7.1	1.2	1.7	1.0	-0.8
12. 30% millet area shifted to legumes	-0.7	3.6	-2.5	-3.0	-0.5	1.0
13. 30% legume area shifted to improved millet	10.9	25.8	32.3	30.8	28.4	9.9
14. Improved cowpea	1.6	1.2	8.0	6.5	16.2	1.0

Table 4. Potential impact of different interventions on farm household cash flows (% change from the baseline scenario)

4. Conclusions
The study identifies a number of potential intervention scenarios for enhancing the household cash flows and resilience as compared to their respective baseline scenarios in Niger and Burkina Faso. For specific farm types, the models reveal the most promising crop and livestock value chain interventions. Introducing improved cattle, improved millet cultivars and appropriate allocation of area between legume and millets, prophylaxis in livestock and increased price through market linkages were the most effective interventions to enhance farm household cash flows, however each intervention will not work for all farm types. The study concludes that not only crops but the context specific integrated crop-tree-livestock value chain interventions will be the most effective strategy for improving rural livelihoods and food security in these vulnerable regions.

References
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