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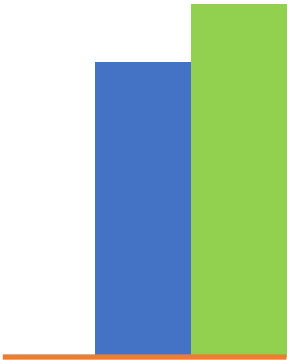

# **Crop-livestock integration and technology choices for improving fodder availability,** livestock productivity and famers' income in West Africa

Shalander Kumar, Soumitra Pramanik, Clarisse Umutoni, Karl Rich, Vincent Bado, Anthony Whitbread

RESEARCH PROGRAM ON Policies, Institutions, and Markets

FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

RESEARCH PROGRAM ON Grain Legumes and Dryland Cereals

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This work has been undertaken as part of the

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## Abstract

The present study generates evidence to better understand the interactions and tradeoffs between crops and livestock enterprises in a whole-farm systems context in West Africa. Hardly any literature is available on the effect of different crop-livestock integration and technology choices on the livestock value chains in a whole-farm way in the region. This study uses diverse primary and secondary sources of data, such as focussed group discussions with different crop-livestock value chain actors, published literature and personal interviews with 390 farm households in Niger and Burkina Faso. We developed scenarios applying model-based, whole-farm crop-livestock method to illustrate possible benefits and impacts of integrating dual-purpose crops and cultivars on farm productivity and income, and availability of animal-sourced food. Whole-farm scenarios developed with assistance from stakeholders and experts consultations were used to measure and illustrate possible impacts, testing different technical (livestock breeds, health intervention), and institutional innovations (markets, policies). Finally, the analysis helped in identifying strategies for integrating suitable dual-purpose crops and cultivars, and type of livestock to improve livestock productivity, marketability, and income for improving rural livelihoods, and increasing availability of animal-sourced food in Niger and Burkina Faso.

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# Crop-livestock integration and technology choices for improving fodder availability, livestock productivity and famers' income in West Africa

## 1. Introduction

In Niger and Burkina Faso mixed farms combining crop production and livestock farming dominate the farming systems. Mostly naturally occurring multi-purpose trees dotting the landscape also make significant contribution to the farming and livelihood systems. The West Africa Sahelian (WAS) countries of Burkina Faso and Niger, however, 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. Nevertheless, the animal-source-food production in terms of quantity and diversity in these low income countries have high potential to enhance resilience of the farming and livelihood systems (OECD/FAO 2016). Livestock contributes to 39% of the income of rural households in Burkina Faso, whereas in Niger, livestock contributes to 25% of food needs, 15% of household incomes and 40% to agricultural GDP (Minot 2020). However, the livestock sector is facing major problems that hamper the development of the sector. The growing human and livestock populations generate high pressure on cultivated lands and rangelands. This pressure, together with increasing climatic stress, results in increased tension between pastoral and agricultural communities. The main constraints of the livestock sub-sector in the two countries include variability of crop and pastoral feed resources, leading to regularly negative feed balances (FAO 2018). Feed deficit is one of the big challenges faced by livestock farmers in the two countries. For example, in Burkina Faso about 40% of the feed deficit is compensated by crop by-products, indicating the importance of crop-livestock integration in improving the productivity of the farming systems for sustaining rural livelihoods (Van Horn 2010; Enahoroa et al. 2018). Increased demand for livestock feed is one of the critical challenges in developing a crop-livestock system (Umutoni et al. 2015; Adegoke and Abioye 2016; Ayantunde et al. 2014). Degraded rangelands and poor crop productivity result in low feed availability; attention to and improvements in these problem areas can increase the production of livestock feed substantially (Amole and Ayantunde 2016; Ayantunde et al. 2017).

Despite the high importance of increased crop-livestock integration to meet the basic human needs for nutrition and income generation in these fragile regions, the agricultural R&D investment from governments and international donors has remained very limited, and that too has mainly focused on crops. Moreover, there are two important emerging trends in agricultural development in sub-Saharan Africa's mixed smallholder farming systems: (1) a severe degradation of the natural forage resources exploited by pastoralism due to excess and uncontrolled stocking density linked to increasing demographic pressure; and (2) development and intensification of arable cropping sectors within irrigated perimeters based on mono-cropping systems directly linked with market pressure, but leading to important negative impacts on environments (Moritz 2010). In between these two systems, there is good scope for development of more sustainable and integrated smallholder crop-livestock systems which may result in increased resilience and profitability from the synergies provided by diversification of production systems. Therefore, it is of utmost importance to strengthen the integration of livestock into farming systems because of its great potential to make a significant contribution towards enhancing farming and livelihood systems' resilience, nutritional

security, and also to become a catalyst in helping rural households achieve improved wellbeing (Thornton and Herrero 2014). However, to support stakeholders in designing appropriate crop-livestock integration, there is a need to generate systematic information on synergies and trade-offs arising out of different crop-livestock integration strategies bearing in mind agro-climatic conditions, markets and the household's family labor. Hardly any literature is available on the effect of crop-livestock integration and technology choices on livestock productivity and famers' income in West Africa, particularly examining the importance of residue fodder supplied through dual-purpose crops and their improved cultivars in a whole-farm way.

The present study attempts to contribute towards filling the critical literature gap by narrowly focusing on understanding how the quantity and quality of fodder residues from dual-purpose crops affect whole-farm productivity and profitability given the climatic conditions, market prices and labor availability. Firstly, the present study constructed the multiple livelihood assets based/farm household typologies. Then it developed scenarios by applying a model-based, whole-farm crop livestock method involving stakeholders through an innovation platform to demonstrate the role of feed and fodder through appropriate integration of dual-purpose crops and cultivars in a whole-farm way. The farm household type specific information generated can guide decisions for future investments on crop-livestock integration to improve livestock productivity, marketability and income for improving rural livelihoods and increasing the availability of animal-sourced food in Niger and Burkina Faso. This study is part of the Livestock Innovation Lab project on 'Enabling Value Chains to Create Sustainable Income for Vulnerable People in Crop-Livestock Systems of Burkina Faso and Niger'.

# 2. Methodology

## 2.1 The study area

The present study was conducted in Burkina Faso and Niger, and the study locations were selected based on agro-ecological zones and market opportunity. The study sites in Burkina Faso were Kaya (Centre-nord region) and Dori (Sahel region). Torodi, a rural site in the region of Tilabery and Maradi, an urban city in the region of Maradi were the study sites in Niger. These study sites in both the countries fall in similar agro-ecological regions, which are water scarce with low rainfall (400-700mm per annum), highly food insecure, and also present marketing opportunities for livestock. The details of the geographical location of study sites are mentioned in the map and depicted in Figure 1. Further, a multi-stakeholder innovation platform which was established in the study region as part of the project facilitated useful engagements with different stakeholders during the course of the study. Mixed crop and livestock systems were the dominant farming systems where nearly all rural farm households have at least some heads of sheep and goats or bovines (Amole and Ayantunde 2016). Livestock husbandry has been a very important component of the farming systems in both the project sites. The livestock production systems are mainly extensive and the seasonal fluctuation in feed resources, compounded by the acute fodder shortage in the dry season, was a major constraint across the regions. In both the study regions, livestock production was a significant and the most stable source of food and income for smallholder farmers. Many households often sold their animals to buy grains for household consumption (Ickowicz et al. 2012).

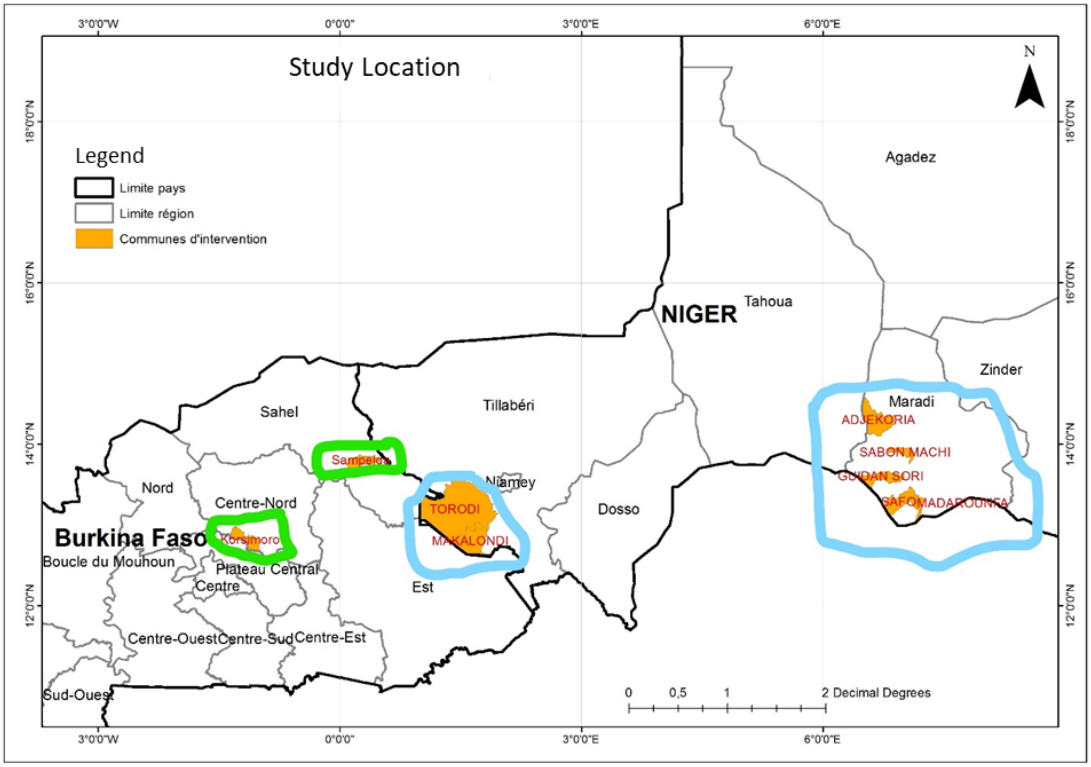


**Figure 1. Map of the project study locations in Niger and Burkina Faso**

*Source:* Baseline Report - Enabling Value Chains to Create Sustainable Income for Vulnerable People in Crop-Livestock Systems of Burkina Faso and Niger (Umutoni, 2020).

## 2.2 Survey method

A structured survey instrument was developed and implemented collaboratively by the multidisciplinary project team from August to November 2018. Quantitative and qualitative data were collected from 390 households randomly selected from the four study regions in Niger and Burkina Faso. Personal interviews at the household level were used to collect information on different covariates, such as crop production, fodder production, inputs used, technology adoption, marketing and livestock production and marketing, and also to understand the constraints of the existing farming systems, explored the views of individual farm households on marketing channels, households' food security and insecurity, and potential opportunities for improving crop and livestock value chains. The survey was carried out in the dominant local language in each study site by the survey team including two researchers and five enumerators in Niger, and four enumerators in Burkina Faso. Tablets, with CS-pro software, were used for data collection. Information on crop-livestock production and its constraints, existing farming practices, possible interventions to improve the farming systems, marketing channels, roles in households' decision making, respondents' perception of their household food security and insecurity was also collected through focussed group discussions (FGDs) involving key informants and members of the innovation platform (IP) established as part of the Feed the Future Innovation Lab on Livestock Systems. In reference to IP many stakeholders were consulted who ranged from farmers to traders to researchers and others. After detailed stakeholders' consultations various alternative scenarios were developed and analyzed for different farm household types.

## 2.3 Construction of farm household typology

The smallholder crop-livestock systems in West Africa are highly complex and heterogeneous in their characteristics: access to land, soil fertility, cropping systems, livestock assets, off-farm activities, labor, cash availability, socio-cultural traits, farm development trajectories, and livelihood strategies. The characteristics of two regions are given in Table 1.

Table 1. Basic characteristics of study locations in Niger and Burkina Faso

| Country | Region | Characteristics |
|---|---|---|
| Niger | Maradi and Tilabery | ✓ Mixed crop-livestock systems<br>✓ More than 41% of the country's livestock is present on the transect Maradi-Zinder transect<br>✓ Livestock diseases, seasonal feed shortage, and water scarcity particularly during the dry season<br>✓ 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<br>✓ Low availability of labor for agricultural activities<br>✓ Unfavorable climatic conditions, limited access to improved technologies and markets<br>✓ Seasonal fluctuations in feed resources with acute shortage in the dry season, lack of water for animals, high mortality of animals, problems with livestock services delivery |

*Source:* Based on field survey

Recognizing the heterogeneity within and among farms and across localities is the first step in designing interventions and policies for improving technology uptake and appropriate crop-livestock integration for increased farm income and resilience (Mutoko et al. 2014). Capturing this heterogeneity is an essential first step in the analysis of potential technological interventions and policy support and to develop recommendation domains (Tittonel et al. 2010; Kumar et al. 2019). Therefore, we grouped the selected farm households into relatively homogeneous farm household typologies considering 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[1] methods to categorize households into three relatively homogenous farm household types each, for both the countries (Niger and Burkina Faso). Firstly, the PCA was carried out on the variables mentioned as described in Table 2, and we considered only those components whose eigen value was equal to or greater than one. Afterwards applying k-cluster mean methods the households were categorized into three homogenous clusters which are defined as farm household types. The farm household type wise basic information from Burkina Faso and Niger are presented in Table 2.

[1]Principal component analysis (PCA) is a widely used statistical technique for unsupervised dimension reduction. K-means clustering is a commonly used data clustering for performing unsupervised learning tasks.

Table 2. Basic characteristics of the different farm household types in Niger & Burkina Faso

| Locations | Farm Typology | Age of respondent (years) | Family size (no.) | Percent of male headed households | Number of technologies used[2] | Total land (Ha) | Cattle holding (no.) | Small ruminants holding (no.) | Animal for traction (no.) |
|---|---|---|---|---|---|---|---|---|---|
| Burkina Faso | 1 | 56 | 8.52 | 30.77 | 1.06 | 1.52 | 2.29 | 3.87 | 0.37 |
| | 2 | 45 | 11.37 | 99.17 | 1.7 | 3.41 | 1.93 | 5.58 | 0.88 |
| | 3 | 54 | 23.89 | 100.00 | 1.21 | 5.66 | 11.68 | 19.79 | 1.25 |
| Niger | 1 | 48 | 7.84 | 70.31 | 1.97 | 1.87 | 0.97 | 5.94 | 0.67 |
| | 2 | 51 | 10.17 | 81.25 | 1.33 | 2.71 | 1.55 | 9.56 | 0.28 |
| | 3 | 54 | 14.65 | 93.65 | 1.16 | 6.5 | 7.76 | 19.67 | 0.13 |

*Source:* Author/s' calculation based on field survey

In Niger, the farm household type 3 had relatively larger land and livestock holding size as well as a large family, but low number of traction animals and least adoption of improved technologies. On the other hand, the farm household type 1 although having a smaller size of land and livestock holding had relatively a greater number of traction animals and used a higher number of improved technologies (Table 2). In Burkina Faso, the farm type 1 were mostly women headed households with relatively much lower size of land and livestock holding, traction animal, as well as lower technology adoption. The farm household type 3 was relatively resource rich, the farm household type 2 had relatively medium level of resources such as land, livestock and traction animals, however, they were relatively more progressive in adopting improved technologies for farm production (Table 2).

## 2.4 Whole farm system model for scenario analysis

The existing extensive livestock production systems in West Africa are facing a number of challenges, such as high pressure on rangelands, reduction of natural pasture as a consequence of the high demand for feeds and fodder, increasing restriction on livestock mobility, and seasonal fluctuations in feed quantity and quality. At the same time new market opportunities are emerging due to the increasing demand for animal-sourced food (ASF). It is a challenge for smallholder crop-livestock producers as they have to optimally allocate their limited resources including capital, farm land and family labor if they are to capture the emerging market opportunities for ASF as well as enhance resilience of the farming systems.

In this study we collected information through baseline household surveys, FGDs, and the visioning exercises done with the members of the Innovation Platforms (IPs) on potential intervention options for crop-livestock integration so as to enhance farming systems' profitability and resilience. With the aim of identifying farm household type specific crop-livestock integration and technology options that improve farm family income and farming system's climate resilience, we analyzed different intervention scenarios using farm household level systems model - Integrated Assessment Tool (IAT) McDonald, 2015; (Lisson et al. 2010; Komarek et al. 2012; McDonald et al. 2019). The scenario analysis helped in assessing the competitiveness of a range of competing crop-livestock enterprises/combinations, and best management/marketing strategies and their impacts on whole household incomes/cash flows and on risk management plans given the climatic variability, family labor and consumption preferences, farmers' capacity, land holdings and other socio-economic constraints and conditions (Whitbread et al. 2010). These scenarios were evaluated and further refined during a participatory process with the farmers and IP members. Based on the stakeholders'

[2]Technology means improved agronomic methods and inputs used such as high yielding varieties (HYV), drip irrigation, sprinkler, micro-nutrient application, etc.

consultations and FGDs with farmers, we considered seven scenarios: i. farmers' current practices; ii. introducing higher yielding cattle; iii. introducing improved dual-purpose millets cultivars; iv. improved dual-purpose millets cultivars and improved cattle; v. 30% area under legumes replaced with existing millet cultivars; vi. 30% area under millets shifted to legumes; and vii. 30% area under legumes shifted to improved dual-purpose millets cultivars.

From this whole farm bio-economic analysis the present working paper uses only a part of the model outputs with a narrow focus to evaluate the impact of crop cultivars and technology choices on availability of quantity and quality of the residue fodder at household level, and its impact on livestock growth, production, and its market value. Finally, also to understand how the availability of quantity and quality of the residue fodder under different intervention scenarios impacts household cash flows through livestock enterprise. These 'what if' scenarios developed through participative model parameterization are likely to result in stakeholders' increased knowledge and acceptance of interventions proposed for improving crop-livestock systems resilience and livestock value chains. It would help in understanding what happens (in an integrated household way) when changes in various aspects of crop-livestock management and market access are carried out.

# 3. Results

## 3.1 Fodder availability and level of its feeding to livestock under existing farming systems

It is common in the study regions that livestock rearing households mostly use grazing as the main source for feeding their animals, and this is complemented with home-produced fodder especially in lean seasons. The analysis of our field survey data found that crop residues, purchased feed, and available grass from the grazing fields were the major sources of animal feed and fodder in Niger and Burkina Faso. Table 3 shows that the most important livestock fodder was the residue from millet, sorghum, groundnut, cowpea and maize. Majority of households under these mixed crop-livestock systems used own-produced fodder and crop residues as major sources of animal feed in both the countries. The common fodder used by households to feed their animals in addition to grazing, were sorghum and millet residues, cowpea hay and groundnut haulms. Grasses were mainly fed to animals during the rainy season in Burkina Faso (Table 4). In Niger, the millet and sorghum residues and cowpea hay were the most common own-produced fodder fed to animals (Table 4). The most common purchased fodder by livestock farmers were cowpea hay and sorghum residues in Burkina Faso, and cowpea hay and dry grasses in Niger. The purchase of fodder by livestock keepers even in the lean season was an occasional practice. The fodder deficit often leads to livestock morbidity losses (Adegoke and Abioye 2016). This also clearly reveals that the mixed crop-livestock farmers and agro-pastoralists were more likely to use the fodder produced from the crops grown in their own fields. Our findings on the type of fodders fed to livestock in the region align with a number of studies conducted in West Africa (FAO 2014; Ayantunde et al. 2014; Umutoni et al. 2015).

Table 3. Availability of different types of fodder (Kg per household per year)

| Fodder names | Burkina Faso | Niger |
|---|---|---|
| Cowpea | 260 | 301 |
| Groundnut | 346 | 295 |
| Maize | 83 | 41 |
| Millet | 2410 | 4917 |
| Sesame | 52 | 7 |
| Sorghum | 11814 | 1639 |
| Others | 6 | 1 |
| Total | 14971 | 7201 |

*Source:* Author/s calculation based on field survey

Table 4. Details on sourcing of different fodders by livestock keepers, Burkina Faso & Niger (% households)

| Location | Name of fodder | Home produced | Home produced and purchased | Purchased |
|---|---|---|---|---|
| Burkina Faso | Millet stover | 52 (n=104) | 1 (n=2) | 1 (n=2) |
| | Sorghum stover | 71.5 (n=143) | 10 (n=10) | 2.5 (n=5) |
| | Rice straw | - | - | 0.5 (n=1) |
| | Cowpea hay | 84.5 (n=169) | - | 4.5 (n=9) |
| | Groundnut haulms | 32 (n=64) | 0.5 (n=1) | 1.5 (n=3) |
| | Grass | 6.5 (n=13) | | 3 (n=6) |
| | Others | 4 (n=8) | | 0.5 (n=1) |
| Niger | Millet stover | 70.68 (n=135) | 5.24 (n=10) | 0.05 (n=1) |
| | Sorghum stover | 49.21 (n=94) | 2.1 (n=4) | 1.57 (n=3) |
| | Rice straw | 0.05 (n=1) | - | - |
| | Cowpea hay | 70.68 (n=135) | 4.18(n=8) | 4.18 (n=8) |
| | Groundnut haulms | 27.74(n=53) | - | 3.66 (n=7) |
| | Grass | 25.65(n=49) | 1.57 (n=3) | 5.24 (n=10) |
| | Others | 1 (n=2) | - | 7.85 (n=15) |

*Source:* Baseline Report - Enabling Value Chains to Create Sustainable Income for Vulnerable People in Crop-Livestock Systems of Burkina Faso and Niger

## 3.2 Model-based fodder availability scenarios and its impact on livestock production and household cash flows

### 3.2.1 Annual fodder availability and livestock weight gain

The stakeholders' consultation, FGDs with IP members and women and men farmers led to designing of multiple intervention scenarios for evaluating the potential impact of various technologies and crop and livestock choices on livestock growth and household cash flows for different farm types. The impact potential of seven different farming systems scenarios on livestock productivity and whole-farm profitability is presented in Table 5. These whole-farm scenarios estimate the model-based fodder availability in terms of quantity and quality (protein %), and its contribution to livestock productivity and production. The livestock growth model and economic model as part of the whole-farm model provides level of the household's whole-farm income under different scenarios as compared to the actual baseline situation for both Burkina Faso and Niger regions. The household whole-farm integrated crop-livestock economic model known as Integrated Assessment Tool (IAT) was applied for a five-year- time horizon to estimate the change in residue fodder availability (quantity and quality), resulting changes in livestock weight gain, and how it contributes to change in gross margins as compared to the existing farming systems (base period) bearing in mind the whole-farm situation including labor availability and market prices. As illustrated in Table 5, the highest potential for increasing the residue fodder availability was found under scenario-7 where 30% area of legumes is shifted to improved dual purpose millet, and scenario-3 and scenario-4 were the next best scenarios for enhancing residue fodder availability at the household level in both the countries. The increased fodder availability – in these scenarios – would result in significant increase in the annual weight gain of the cattle. The scenario results from the livestock growth model within the whole-farm model showed that the level of nitrogen content in the crop residue fodder, which indicates the percent of protein, also had an impact on the animal's

weight gain. The improved dual-purpose millet resulted in increased animal weight gain, not only because of additional quantity of the biomass available as fodder but also due to its higher nitrogen content (protein). The whole-farm analysis showed that the adoption of improved dual-purpose millet cultivars would be a suitable option to increase fodder availability and cattle weight gain compared to the base scenario.

Table 5. Fodder availability and cattle weight gain across typologies and across scenarios in Burkina Faso

| Scenario Name (No.) | Farm household type | Burkina Faso | | Niger | |
|---|---|---|---|---|---|
| | | Cattle weight gain (Kg/year) | Residue fodder available (Kg) | Cattle weight gain (Kg/year) | Residue fodder available (Kg) |
| Base (1) | 1 | 160 | 9454 | 220 | 3031 |
| Base (1) | 2 | 187 | 11583 | 248 | 3247 |
| Base (1) | 3 | 549 | 22620 | 413 | 7723 |
| Introducing higher-yielding Cattle (2) | 1 | 123 | 9454 | 189 | 3031 |
| Introducing higher-yielding Cattle (2) | 2 | 144 | 11583 | 217 | 3247 |
| Introducing higher-yielding Cattle (2) | 3 | 437 | 22620 | 311 | 7723 |
| Improved (Cattle + Millet) (3) | 1 | 122 | 11850 | 195 | 3156 |
| Improved (Cattle + Millet) (3) | 2 | 147 | 12278 | 246 | 4152 |
| Improved (Cattle + Millet) (3) | 3 | 444 | 24973 | 321 | 10300 |
| Improved dual-purpose Millet (4) | 1 | 168 | 11850 | 222 | 3156 |
| Improved dual-purpose Millet (4) | 2 | 221 | 12278 | 272 | 4152 |
| Improved dual-purpose Millet (4) | 3 | 561 | 24973 | 428 | 10300 |
| 30% Legume area shifted to millet (5) | 1 | 160 | 9679 | 220 | 3116 |
| 30% Legume area shifted to millet (5) | 2 | 187 | 12318 | 227 | 3352 |
| 30% Legume area shifted to millet (5) | 3 | 582 | 22783 | 412 | 7888 |
| 30% millet area shifted to legume (6) | 1 | 161 | 9077 | 219 | 2821 |
| 30% millet area shifted to legume (6) | 2 | 188 | 11220 | 260 | 2977 |
| 30% millet area shifted to legume (6) | 3 | 550 | 22302 | 413 | 7298 |
| 30% legume area shifted to improved dual-purpose millet (7) | 1 | 167 | 12505 | 223 | 3252 |
| 30% legume area shifted to improved dual-purpose millet (7) | 2 | 224 | 13436 | 289 | 4350 |
| 30% legume area shifted to improved dual-purpose millet (7) | 3 | 562 | 25501 | 432 | 10739 |

*Source:* Author/s' calculation based on field survey

### 3.2.2 Changes in households' cash flow

Our analysis helped in examining how the changes in fodder availability under various alternative scenarios of crop and cultivar choices impact the farm household's cash flows through cattle productivity changes. Nevertheless, we also ran scenarios evaluating the potential impact of introduction of higher yielding local cattle along with the fodder interventions on the households' cash flows as compared with the base scenario. It was revealed that under scenarios 3, 4 and 7 (Table 6), the changes in gross household cash flows were positive and significantly higher than that of the base-level cash flows across all three farm household types in both Niger and Burkina Faso. The increase in the household cash flows was highest in scenario-3 across all farm types as a result

of the combined effect of introducing the improved dual-purpose millet along with the higher-yielding cattle. The whole-farm scenario analysis also clearly shows the heterogeneity of potential impact of any interventions across different farm types. In this analysis one of our aims was to examine the impact of the change in quantity and quality of the residue fodder on livestock productivity and farm household income keeping all other feeding practices constant. The major reasons for differentiated impact of various interventions in different farm types was on account of existing quantity and quality of residue fodders, labor availability, number of livestock (herd size). The shifting of the area from legumes to improved millets would significantly benefit the mixed crop-livestock households. The improved millets provide not only the additional residue fodder but also the higher protein content in its fodders – thus resulting in higher livestock productivity.

Table 6. Potential impact of different interventions on household cash flows (% change from the baseline scenario)

| | Niger | | | Burkina Faso | | |
|---|---|---|---|---|---|---|
| | Farm household types | | | Farm household types | | |
| Alternative intervention scenarios | 1 | 2 | 3 | 1 | 2 | 3 |
| Higher-yielding cattle (2) | 64.6 | 44.2 | 44.3 | 5.0 | 14.2 | 4.6 |
| Improved (cattle + millet) (3) | 75.7 | 72.1 | 78.8 | 31.5 | 25.2 | 16.4 |
| Improved dual-purpose millet (4) | 9.3 | 21.2 | 27.3 | 24.4 | 19.9 | 7.2 |
| 30% legume area shifted to millet (5) | 0.0 | 7.1 | 1.2 | 1.7 | 1.0 | -0.8 |
| 30% millet area shifted to legume (6) | -0.7 | 3.6 | -2.5 | -3.0 | -0.5 | 1.0 |
| 30% legume area shifted to improved dual-purpose millet (7) | 10.9 | 25.8 | 32.3 | 30.8 | 28.4 | 9.9 |

*Source:* Author/s' calculation based on field survey

# 4. Conclusions and policy implications

Livestock as a part of smallholder mixed farming systems in West Africa has been one of the most stable sources of food and livelihood security, especially for the rural people living in these marginal environments. However, it faces major challenges around scarcity of feed due to high pressure on rangelands, reduction of natural pasture as a consequence of high demand for feeds, increasing restriction on livestock mobility, and seasonal fluctuations in feed quantity and quality. This working paper focuses on understanding the interactions between crops and livestock components of the farming systems in a whole-farm context and provides new insights that are potentially useful to design livestock intensification strategies in the region. The whole-farm modeling scenarios demonstrated the role of feed and fodder through appropriate integration of dual-purpose crops and cultivars, and its importance in improving livestock productivity, households' income and availability of animal-sourced food in Niger and Burkina Faso. Various scenarios clearly showed how important it is to consider the whole-farm context when designing crop-livestock sustainable intensification strategies. The introduction of the improved dual-purpose millets resulted in increased household cash flows also because of increased availability of fodder biomass in terms of quantity and quality, and as a result the animal weight gains. Legumes are often considered to be more profitable than millets; however, the whole-farm analysis showed that a shift of 30% cropped area from legumes to millets would increase income of the farm households for certain farm household types via increased livestock weight gain because of increased and better quality fodder biomass available from improved dual purpose millets. But it is also evident that each of these interventions has different impacts for different farm household types. The fodder-enhancing interventions will be particularly beneficial for those household types that have larger livestock holding size (e.g., farm type 2 and 3) and face fodder scarcity. Our study reports that the choice of

technologies and cultivars that enhances availability of fodder and integrates higher yielding cattle present the best options for improving farm household cash flows, farming systems' productivity and stability in the drylands of Niger and Burkina Faso. Our analysis suggests that it is possible to enhance livestock productivity as part of mixed crop-livestock systems in Africa by adopting appropriate strategies. Encouraging farmers' collectives and multi-stakeholder platforms could underpin the adoption of context-specific options enabling increased access to fodder through own-farm production from suitable crop combinations and fodder markets, access to output markets, improved crop cultivars and animal breeds, as well as livestock prophylaxis. Finally, we conclude that there is a need to consider the whole-farm situation and interactions among its components while designing interventions for improving crop-livestock systems under drylands. There is a need to build local capacity for increased use of such whole-farm household modeling tools to support context-specific intensification strategies. These findings also have implications for the crop improvement programs of dual-purpose crops that can also improve the quality of crop residues. This is equally important for sustainable intensification of crop-livestock systems.

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