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Food Security in Crop, Livestock and Mixed Farming Systems in Mali

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Food security in crop, livestock and mixed farming systems in Mali

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Key words: food security; farming systems; livestock; nutrition

Abstract

This study evaluates the food security status, its determinants and the coping strategies in crop, livestock and mixed crop-livestock systems in southern Mali. Interviews were conducted with 258 households that were categorized into the three farming systems based on the revenue from livestock and crop production. A linear mixed model was used to analyse the effects of household characteristics on food security using the food consumption score (FCS), household dietary diversity score (HDDS), a modified household food insecurity access scale (mHFIAS) and coping strategies as indicators. Food consumption score was significantly influenced by the farming system with highest FCS for the livestock system (88) followed by the mixed system (77) and the crop system (69). Moreover, FCS was positively influenced by the number of crops cultivated, total farm milk production, off-farm income and number of raised chickens ($p<0.1$). The main difference in food intake between systems was for milk with average daily consumption of 201 ml, 110 ml and 60 ml in the livestock, mixed and crop systems, respectively. HDDS was also significantly influenced by the farming system with highest HDDS values for the livestock system (8.9), followed by the mixed system (8.2) and the crop system (8.0). Further, HDDS was positively influenced by crop diversity and number of chickens, and negatively influenced by the number of family dependents. During the food shortage period of August, households from the crop system were more food insecure than households from the mixed and livestock systems with mHFIAS values of 0.9, 1.5 and 4.3, respectively. Livestock and mixed systems were more resilient to food insecurity situations than the crop system. This study confirms the direct effect of milk production on milk consumption and the importance of livestock for enhancing food security and livelihood resilience.

Introduction

Despite many political and financial efforts in recent decades, the prevalence of food insecurity, undernourishment and (hidden) hunger in developing countries is still increasing. Projections show that the world is not on track to achieve Zero Hunger by 2030, or to meet global nutrition targets. This is particularly valid for Africa. Reasons include political, health and climate change crises (FAO et al. 2020).

Farming systems are fundamental for achieving food security by increasing the quantity and diversity of food within the household, providing the primary source of income and enhancing biodiversity to support the resilience of agroecosystems. Smallholder farmers are therefore the backbone of food security as well as economic, environmental, social and political stability in many regions. Food supply in less developed countries of the tropics and subtropics is dominated by small-scale mixed crop-livestock agriculture. In African agriculture, mixed crop-livestock systems provide most of the staples consumed: 90% of the milk, 80% of the meat, and 41-86% of grains like maize, rice, sorghum and millet (Thornton and Herrero 2014). Though smallholder farmers produce much of the food in Africa, they are also those most affected by food insecurity (Herrero et al. 2010). Improving food production, in terms of quantity and quality, is needed to improve food security.

Research results suggest that agricultural diversification towards integrated crop-livestock systems is most promising in many aspects of sustainability such as resilience to climatic and environmental extremes, food security and sustainable livelihoods (Waha et al. 2018). The synergies of livestock husbandry and crop production present a wide range of possibilities to increase productivity, resource efficiency, farmer income and food security while maintaining environmental services (Herrero et al. 2010). However, whether adaptation towards diversification, intensification or specialisation is taking place, is feasible or is recommendable depends on the region and context (Chen et al. 2018). Scientific evidence with respect to the impacts of specialised and diversified farming systems on food security is still limited. Therefore, this study aims to assess the food security status, its determinants, and the coping strategies of farmer households in crop, livestock and mixed crop-livestock systems in southern Mali.

Methods and Study Site

A survey was conducted with 258 households from October to December 2012 in the communes of Sibirila and Garalo, located within the district of Bougouni in the Sikasso region of southern Mali. The region has a sub-humid climate, with an annual rainfall of between 1,000 and 1,200 mm. Interviews with sets of semi-structured questionnaires were used to collect socio-economic data on households, livestock holdings, cropping, household assets, inputs and outputs of animal and crop production for the previous 12 months, and coping strategies during the period of food shortage in August. Household heads and their wives were interviewed once during the harvest period between October and December in order to list, qualitatively describe and quantify food items prepared at home and consumed by household members during previous periods. These data were used to calculate the household dietary diversity score (HDDS), food consumption score (FCS), and a modified household food insecurity access scale (mHFIAS) as food security indicators.

HDDS was investigated according to the FAO guidelines for measuring household and individual dietary diversity (FAO 2011). FCS data were generated based on WFP (2008). mHFIAS was derived from a guideline proposed by Coates et al. (2007). Details of data collection methods for HDDS, FSC, mHFIAS and coping strategies are described by Traoré et al. (2018). Sampling of households was based on cattle and breed ownership as described by Traoré et al (2018). Households were re-categorized into three farming systems based on the share of farm income per year that was generated by livestock and crop production: 1) the livestock production system was characterized by farms with ≥ 90% of farm income derived from livestock production; 2) the mixed crop–livestock system was characterized by farms with ≥ 10% and ≤ 90% of farm income derived from crop or livestock; 3) the crop production system was characterized by farms with ≥ 90% of farm income derived from crops and with ≤ five tropical livestock units (TLU).

A linear mixed model was used to analyse the effects of household characteristics on food security using HDDS, FCS, mHFIAS and coping strategies as indicators. The considered effects on the food security indicators included farming systems (livestock, mixed and crop), number of crop species cultivated, number of livestock (i.e. TLU) and number of chickens raised by the household, dependency ratio, wealth index, milk production per farm in liters, by the household, cultivation of cotton, education of the household head, off-farm income and the random effects of communes (Sibirila, Garalo) and eight villages.

Results

Socioeconomic characteristics of households in farming systems

Age, education of the household head and dependency ratio were similar between the farming systems (p>0.1). All further socioeconomic characteristics differed significantly (p<0.1) between the farming systems (Table 1). The crop system had lowest values for livestock numbers, milk yield per farm, farm and household size and wealth index and the highest value for off-farm income. The livestock system showed highest values for milk yield, cattle number and TLU and lowest values for food crop species diversity and cotton cultivation.

Table 1: Means and standard deviation of socioeconomic characteristics of households by farming system

	Livestock (N=49)		Mixed (N=112)		Crop (N=97)	
Socioeconomic characteristics	Mean	SD	Mean	SD	Mean	SD
Milk yield per year per farm (L)	1907.1[a]	1436.4	1149.8[b]	1383.9	9.7[c]	71.2
Education of household head	0.1[a]	0.3	0.2[a]	0.4	0.1[a]	0.3
Household size (members)	14.0[a]	9.0	16.0[a]	7.4	10.7[b]	4.2
Farm size (hectares)	8.4[a]	10.5	13.1[b]	7.5	7.7[a]	5.3
Food crop species diversity (n)	2.8[a]	1.4	3.7[b]	1.4	3.5[b]	1.5
Dependency ratio[1]	1.3[a]	0.8	1.3[a]	0.7	1.2[a]	1.1
Wealth index[2]	0.4[a]	1.2	0.4[a]	0.9	-0.7[b]	0.5
Off-farm income*	0.4[a]	0.5	0.4[a]	0.5	0.6[b]	0.5
Cotton cultivation*	0.1[a]	0.4	0.7[c]	0.5	0.5[b]	0.5
Chicken number	19.1[a]	17.7	22.6[a]	24.8	9.3[b]	10.6
Cattle (actual number)	48.1[a]	36.7	31.7[b]	21.5	1.1[c]	1.4

Tropical Livestock Units (TLU)	36.2[a]	26.9	24.8[b]	16.0	1.5[c]	1.4

* Indicates dummy variables (yes = 1, no = 0); [1] Ratio of household members, who are aged 0–14 and above 65 years to the productive age group; [2] Based on number of motorcycles, phones, radios, ploughs, total livestock units and total revenue; a, b, c - means within a row with different superscripts differ significantly at P < 0.10.

Food security in farming systems

Figure 1 shows that the frequency of consumption of vegetables as well as that for high energy foods such as oils and fats, cereals and sweets were similar among households of the three farming systems. Largest differences in the frequency of consumption among systems was for milk. Moreover, the share of households that consumed milk was 90% for livestock, 65% for mixed and 30% for crop systems. Average daily milk consumption was 201 ml in livestock, 110 ml in mixed and 60 ml in crop systems. With respect to meat consumption, beef, mutton, goat meat and poultry meat were consumed less frequently in crop systems. Beef was consumed almost once per week in crop and less than twice per week in livestock systems. Dry fish was consumed in the majority of households in all systems about 5 times per week. However, the quantity of dried fish was very low (data not shown). Fresh fish was most frequently consumed in the mixed system (about once per week) and least frequently in the livestock system. Almost no eggs were consumed in none of the households of the different systems. The protein sources milk, meat and legumes were consumed least frequently in crop systems.

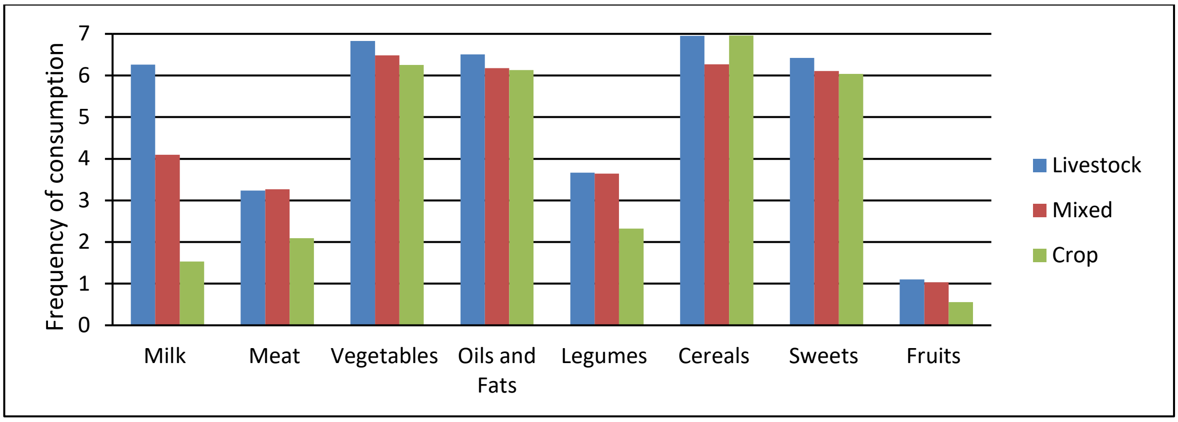

Figure 1: Frequency of consumption of different food types in the past seven days by farming system.

Table 2 shows that all food security indicators differed significantly between farming systems. Livestock systems had highest and crop systems lowest values for FCS and HDDS. Moreover, crop systems had highest values for food insecurity indicators.

Table 2: Least square means (LSMs) and standard errors (SE) of FCS, HDDS and mHFIAS and food shortage length by farming system

	Livestock (N=49)		Mixed (N=112)		Crop (N=97)	
Food security indicator	LSM	SE	LSM	SE	LSM	SE
FCS	87.93[a]	2.5	76.29[b]	1.5	68.72[c]	1.8
HDDS	8.91[a]	0.3	8.15[b]	0.2	8.07[b]	0.2
mHFIAS for harvest period	0.66[a]	0.36	0.47[a]	0.27	1.97[b]	0.25
mHFIAS for lean period	0.90[a]	0.45	1.49[b]	0.29	4.27[c]	0.32
Food shortage length (months)	0.88[a]	0.14	0.74[a]	0.09	1.25[b]	0.11

[a, b, c] Within rows, least square means with different superscripts differ significantly (p<0.10).

Table 3 shows determinants of HDDS and FCS. FCS was positively influenced by the number of crops cultivated, total farm milk production, off-farm income and number of chickens raised in the farm (p<0.1). HDDS was positively influenced by crop diversity, number of chickens and negatively associated with the number of family dependents. Cotton cultivation showed no significant effect on FCS or HDDS.

During the food shortage period of August, households from livestock and mixed systems were less affected and had significantly lower mHFIAS than those belonging to the crop system. The length of the food shortage period was higher in the crop system than in the livestock and mixed systems and was negatively associated to the number of TLU. For the crop system, 27% of households were suffering from severe food insecurity and 84% had food shortage for at least one month. Only 38% of households in the crop system were food secure whereas 73% of households in the livestock system were food secure. During the food shortage month selling livestock was the main coping strategy for households of the livestock and mixed system, while the households of the crop system had to buy food by borrowing cash. In general, the crop system showed the most deleterious coping strategies.

Table 3: Regression analysis of determinants of HDDS and FCS

	HDDS			FCS		
Agricultural system (ref=mixed)	Estimate	SE	P-value	Estimate	SE	P-value
Livestock system	0.75	0.27	0.0069	10.54	3.00	0.0005
Crop system	-0.09	0.25	0.7162	-7.85	2.60	0.0030
Food crop species diversity	0.39	0.07	<.0001	2.25	0.70	0.0015
Chicken number	0.01	0.01	0.0216	0.13	0.06	0.0167
Dependency ratio	-0.25	0.11	0.0241			>0.1
Milk production			>0.1	0.0034	0.0010	0.0004
Off-farm income			>0.1	3.72	2.10	0.0774

Estimates are presented only for household characteristics found to satisfy a P<0.1 significance level.

Discussion [Conclusions/Implications]

The farming system played a significant role in all investigated food security indicators. Households from the livestock and mixed systems performed better with respect to food access and food diversity, had lower household food insecurity, higher resilience to food shortages and had less deleterious coping strategies compared to households of the crop system, especially during the lean period. The quantity and quality of food produced influenced the quantity and quality of food consumed. The diversity of produced food crops was positively associated with the food diversity of the households. The high differences in FCS between systems were largely influenced by differences in milk consumption. Higher milk and chicken production improved food security. The study confirms that crop diversification and increasing livestock production (milk and chicken) could improve food security. Site-adapted strategies should be prioritized to improve production of and access to high quality food in crop systems. Further studies are needed to reveal FCS and HDDS during the food shortage period.

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References

Chen, M., Wichmann, B., Luckert, M., Winowiecki, L., Förch, W. and Läderach, P. 2018. Diversification and intensification of agricultural adaptation from global to local scales. PLoS ONE 13(5): e0196392. https://doi.org/10.1371/journal.pone.0196392

Coates, J., Swindale, A. and Bilinsky, P. 2007. Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide: Version 3: (576842013-001).

FAO, 2011. Guidelines for measuring household and individual dietary diversity. FAO, Rome.

FAO, IFAD, UNICEF, WFP and WHO, 2020. The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets. FAO, Rome.

Herrero, M., Thornton, P.K., Notenbaert, A.M., Wood, S., Msangi, S., Freeman, H.A., Bossio, D., Dixon, J., Peters, M., van de Steeg, J., Lynam, J., Rao, P.P., Macmillan, S., Gerard, B., McDermott, J., Sere, C., Rosegrant, M. 2010. Smart Investments in Sustainable Food Production: Revisiting Mixed Crop-Livestock Systems. *Science,* 327: 822–825.

Thornton, P.K. and Herrero, M. 2014. Climate change adaptation in mixed crop–livestock systems in developing countries. *Glob. Food Secur*., 3: 99–107.

Traoré, S.A., Reiber, C., Megersa, B. and Valle Zárate, A. 2018. Contribution of cattle of different breeds to household food security in southern Mali. *Food Secur.,* 10: 549–560.

Waha, K., van Wijk, M.T., Fritz, S., et al. 2018. Agricultural diversification as an important strategy for achieving food security in Africa. *Glob Change Biol*., 24: 3390–3400.

WFP, World Food Programme 2008. Food consumption analysis: Calculation and the use of the food consumption score in food security analysis. World Food Program, Vulnerability Analysis and Mapping Branch. Rome, Italy.