Assessment of the potential food security benefits of increased income from crops, livestock and off-farm employment in Burkina Faso

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Mark T. van Wijk, Viviane Yameogo and Augustine Ayantunde

International Livestock Research Institute

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The overall goal of this project on Sustainable intensification through better integration of crop and livestock production systems in the Sahelian zone of Burkina Faso is to improve household food production and nutrition and enhance ecosystem services through better integration of crop and livestock production systems in the region. The project seeks to: 1. Increase crop and livestock integration in these mixed systems through improved crop production, soil fertility, water harvesting and livestock feed enhancing interventions; Assess the economic, social, nutritional and environmental benefits and tradeoffs of the productivity-enhancing interventions, and the potential for cost-efficient outscaling; and 3. Build the capacity of smallholder farmers and researchers on sustainable intensification and improved nutrition through multi-stakeholders' platforms.

The research activities are solution-focused to meet the needs of farmers and are being implemented at both household and community levels in Seno and Yatenga provinces in the Sahelian zone of Burkina Faso with rainfall between 300 and 600 mm per year. The main underlying hypothesis is that there is a great potential for the smallholder farmers currently engaged in crop-livestock systems to produce more in a given area of land, thereby improving productivity, food security and nutrition while preserving ecosystem services. The project partners include Institut de l'Environnement et de Recherches Agricoles, Burkina Faso; University of Wisconsin, Madison; The International Union for Conservation of Nature, the Central and West Africa program; the Fédération Nationale des Groupements Naam, Burkina Faso, and the Association pour la Promotion de l'Elevage en Savane et au Sahel, Burkina Faso.

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Summary

Sustainable intensification of agricultural production has become a predominant theme in development agendas in West Africa, but despite the availability of a wide range of technologies adoption of these technologies in targeted projects has often been disappointing. One reason for often disappointing uptake of technologies could be the poor targeting. Technologies are often widely promoted, while they might only be relevant and sufficiently beneficial for few. This report presents the results of analyses quantifying the potential food security impact of production intensification on individual households, to better identify which technology would fit the characteristics of what household. This work is part of the Feed the Future Sustainable intensification innovation laboratory-funded project 'Sustainable intensification through better integration of crop and livestock production systems for improved food security and environmental benefits in Sahelian zone of Burkina Faso', led by the International Livestock Research Institute.

We evaluate through ex-ante analyses a set of sustainable intensification options that is currently being evaluated in experimental trials and in participatory approaches with farmers. Four different interventions were evaluated in this study: sorghum yield up by 50%, cowpea yield up by 50%, off farm income increase by USD200 per year per family and goat production (milk and off take) up by 50%. These interventions were chosen for the impact assessment because these are currently being assessed through on-farm experimental trials (sorghum, cowpea and goats), and in participatory evaluation exercises together with farmers (increased involvement in off farm activities).

For the most vulnerable group, the severely food insecure farm households, the best options are to increase sorghum productivity and to increase possibilities to generate further off farm income. Sorghum (together with millet) is the most important food consumption crop for these households, and beneficial yield effects improve their food self-sufficiency and food security. The off farm income affects food security by increasing income, thereby generating cash with which farmers can buy food. Cowpea is an important crop grown by all farmers for cash production. Goats play an important role in most farm households, but more because they are for sale and slaughter as needs arise, rather than as an overall year round important factor in food consumption and cash generation. Increasing their currently very low productivity by 50% therefore only improves food security and income to a minor extent. The analyses showed that different interventions have different effects for different groups of households: the targeting of interventions through a clear definition of the target population and the desirable effects on food security are therefore essential.

Introduction

Despite decades of development investment, the region of West Africa continues to be plagued by high levels of poverty and food insecurity (UNDP 2014). Climate change and projected population growth are expected to increase both production variability and demand for agricultural products through 2050 (Graziano da Silva 2012), putting further pressure on these agricultural systems to keep pace. Sustainable intensification of agricultural production has become a predominant theme in development agendas in the region (Garnett et al. 2013). It has been defined as the ability to produce more food on the same amount of land for an indefinite duration into the future while maintaining the integrity of ecosystems and the environmental resource base supporting that production (Pretty et al. 2011). Despite the availability of a wide range of technologies to achieve sustainable intensification (e.g. Ayantunde et al. in press), adoption of these technologies in targeted projects has often been disappointing

One reason for often disappointing uptake of technologies could be the poor targeting. Technologies are often widely promoted, while they might only be relevant and sufficiently beneficial for few. Targeting dissemination on these would be far more efficient (e.g. Ritzema et al. 2017). One approach to better understand potential benefits for different groups of farm households is to simulate the effects of interventions on critical livelihood indicators, such as income and nutrition. Instead of a comprehensive model, which would be difficult to generalize and populate with data efficiently, an intermediate indicator has been proposed – potential food availability (e.g. Frelat et al. 2016; Ritzema et al. 2017; Wichern et al. 2017; Paul et al. 2018).

This report presents the results of analyses quantifying the potential food security impact of production intensification on individual households. This work is part of the Feed the Future Sustainable Intensification Innovation Laboratory funded project 'Sustainable Intensification through better integration of crop and livestock production systems for improved food security and environmental benefits in Sahelian zone of Burkina Faso', led by the International Livestock Research Institute. We evaluate through ex-ante analyses a set of sustainable intensification options that is currently being evaluated in experimental trials and in participatory approaches with farmers. We use a simple energy-based Food Availability Index as a partial indicator for food security. The index is calculated for individual farm households in two regions in Burkina Faso to assess the baseline food availability status and to quantify the contribution of various on and off-farm activities. We then present results of possible effects of interventions on food security at population level, and for contrasting individual households; we will also discuss how in future work we will expand on these analyses and study in more detail how dietary diversity might be improved through interventions

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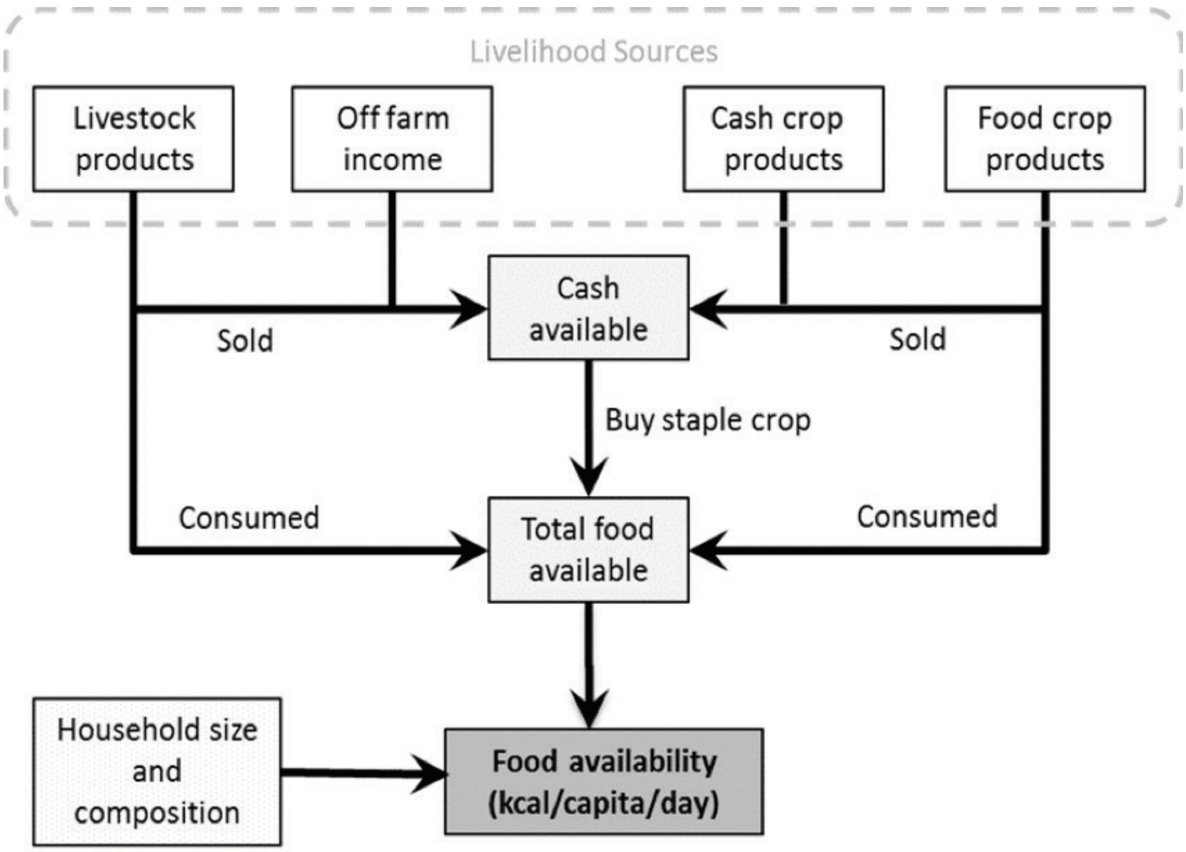
Approach

As described in the 'Introduction' we will make use in this study use of the intermediate complexity indicator for food security—potential food availability (PFA—e.g. Frelat et al. 2016; Ritzema et al. 2017; Wichern et al. 2017; Paul et al. 2018; Waha et al. 2018). We will quantify this indicator for all individual households in two sites in Burkina Faso, and subsequently, we investigate the PFA scores in the sample populations: composition, curve, and shares within three food security categories. Next, intervention scenarios are introduced, built on priority commodities. The effect of these scenarios on PFA as well as component indicators (e.g. total agricultural production, sales, total cash revenue). Finally, results of the two individual households are used to illustrate the PFA composition under the various intervention scenarios. The different steps in the analyses and the data used are now explained in more detail.

Potential Food Availability–a Food security indicator

A simple food security indicator was used based on Frelat et al. (2016) and Ritzema et al. (2017). The indicator, called potential food availability (PFA; Figure 1) is calculated from on-farm consumption of food crops, and food that could be purchased on the basis of money earned through on-farm and off-farm activities. This indicator of food security does not cover all of the complexity contained in the concept of food (in)security. Our indicator estimates the potential annual amount of energy available at household level, and we therefore refer to it as 'potential food availability'. The indicator provides a continuous "food-availability scale" that allows us to quantify the contribution of key determinants of PFA for individual households within and across sites, and to perform intervention analyses quantifying the potential food security benefits of different groups of agricultural or non-agricultural interventions (see Ritzema et al. (2017) and Paul et al. (2017) for examples).

Figure 1: The calculation scheme of the potential food availability indicator



The way the intervention analyses work is through adapting the yield values and price values used in the calculation scheme (Figure 1) depending on the likely effects of certain interventions. For example, if through improved manure management in experimental trials we find that cereal yields increase by 40%, we can include these yield increases for certain groups of farmers in our calculations, and quantify the likely effects on the potential food availability indicator (e.g. see Ritzema et al. 2017). Thereby we assess the likely effects on overall food security (as PFA is normally quite well related to other indicators of food security, for example the Household Dietary Diversity Score (HDDS) and the Hunger and Food Insecurity Access Scale (HFIAS) (Hammond et al. 2017a).

Farm household characterization data

In the analyses presented in this report we make use of farm household characterization data collected in May 2016 in Burkina Faso, within the Feed the Future Sustainable Intensification Innovation Laboratory funded project 'Sustainable Intensification through better integration of crop and livestock production systems for improved Food Security and Environmental Benefits in Sahelian zone of Burkina Faso', led by the International Livestock Research Institute. In two sites, Seno and Yatenga provinces, a farm household characterization survey was executed. The two sampled sites are located in the Sahel and sub-Sahel region, an arid zone of northern Burkina Faso. The sites' elevation ranges from 250 to 350 masl., receiving between 300 and 600 mm of rainfall per year, in a unimodal pattern (based on publicly available GIS data). Soils in northern Burkina Faso are characterized as poorly evolved, granite and migmatite derivatives, with poor soil fertility (FAO 2002).

The north-eastern most site was located in Seno province, incorporating villages surrounding the provincial capital Dori. Sampling from Yatenga province, incorporated villages surrounding Ouahigouya. Both sites have good access to road infrastructure and markets. Households in the Seno province are largely from the Fulani tribe, who have a rich pastoralist and broader livestock keeping tradition, and; households in Yatenga are largely of the Mossi tribe—the largest ethnic group in the country. Both sites rely largely on rainfed agriculture.

Fifty households were randomly sampled from each of four villages in each site, giving a total sample size of 400 households. Data collection took place in May 2016, with an extended version of the RHoMIS survey tool approach (Hammond et al. 2017), administered in French by trained enumerators at the respondent's homestead. Respondents were asked detailed questions on household demographics, plot utilization, livestock holdings, crop yields, farm product utilization, income, diet, food security, poverty level and labor allocation. Where relevant, households were asked to recall circumstances from both the growing period and dry period.

Analyses

Results of the following analyses will be presented:

1. The basic Potential Food Availability (PFA) indicator results for both Seno and Yatenga
2. Cross-checking of the PFA indicator results with other indicators of Food Security
3. Intervention analyses by assessment of the likely effects of adoption of new technologies on PFA results for each of the sites
4. Assessment of the likely effects of adoption of new technologies on PFA results of several contrasting farm households in Seno and Yatenga

Four different interventions were evaluated in this study: sorghum yield up by 50%, cowpea yield up by 50%, off farm income increase by USD200 per year per family and goat production (milk and off take) up by 50%. These interventions were chosen for the impact assessment because these are currently being assessed through on-farm experimental trials (sorghum, cowpea and goats), and in participatory evaluation exercises together with farmers (increased involvement in off farm activities). The likely effect sizes of yields and prices used in the impact assessment were based on the first results obtained in the experimental trials, expert knowledge and other findings on similar interventions reported in the scientific literature.

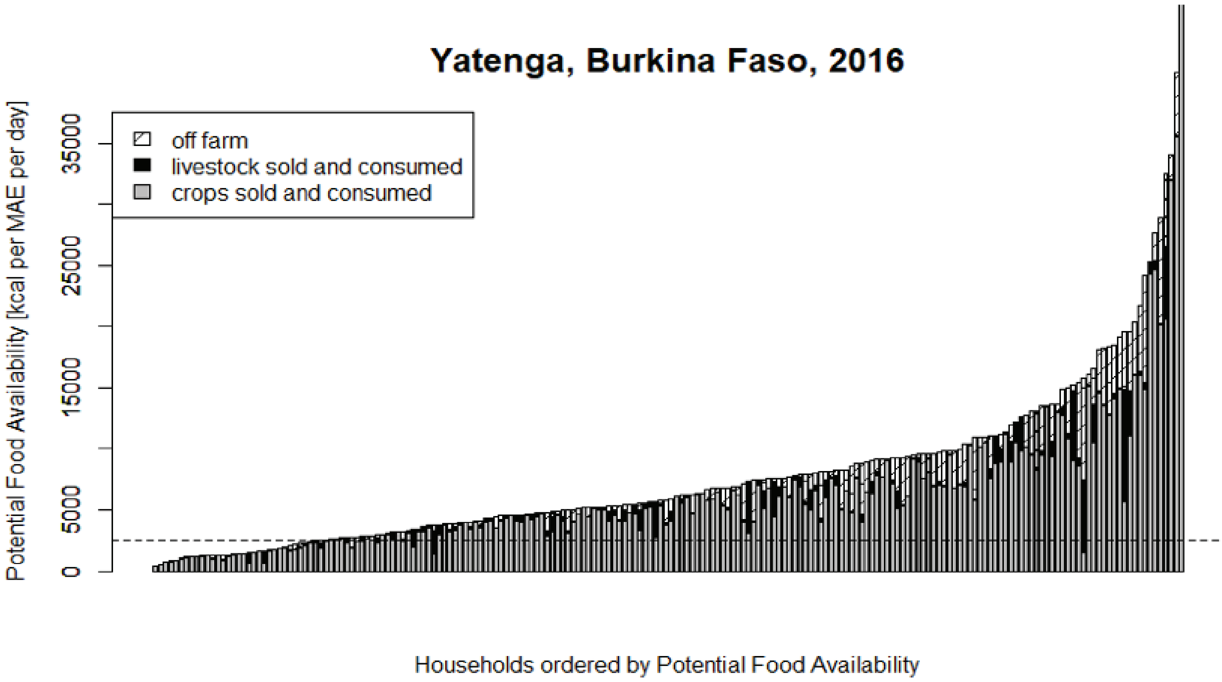
Besides looking at the Potential Food Availability indicator (either in its direct form in terms of kcal per capita per day, or as a ratio by dividing it by the daily energy requirements of a Male Adult Equivalent), we also quantify the following indicators in the scenario analysis: food self-sufficiency (which is similar to the calculations of the PFA indicator, but only takes into account the consumed parts of crop and livestock production and ignores the marketed production and off farm income generated); agricultural based income (in USD per family per year, which calculates the revenue generated by the sales of crop and livestock products); total income (in USD per family per year, which is the sum of the agricultural income and off farm income); and total value of production(in USD per family per year, which is total income plus the value of the consumed parts of crop and livestock production).

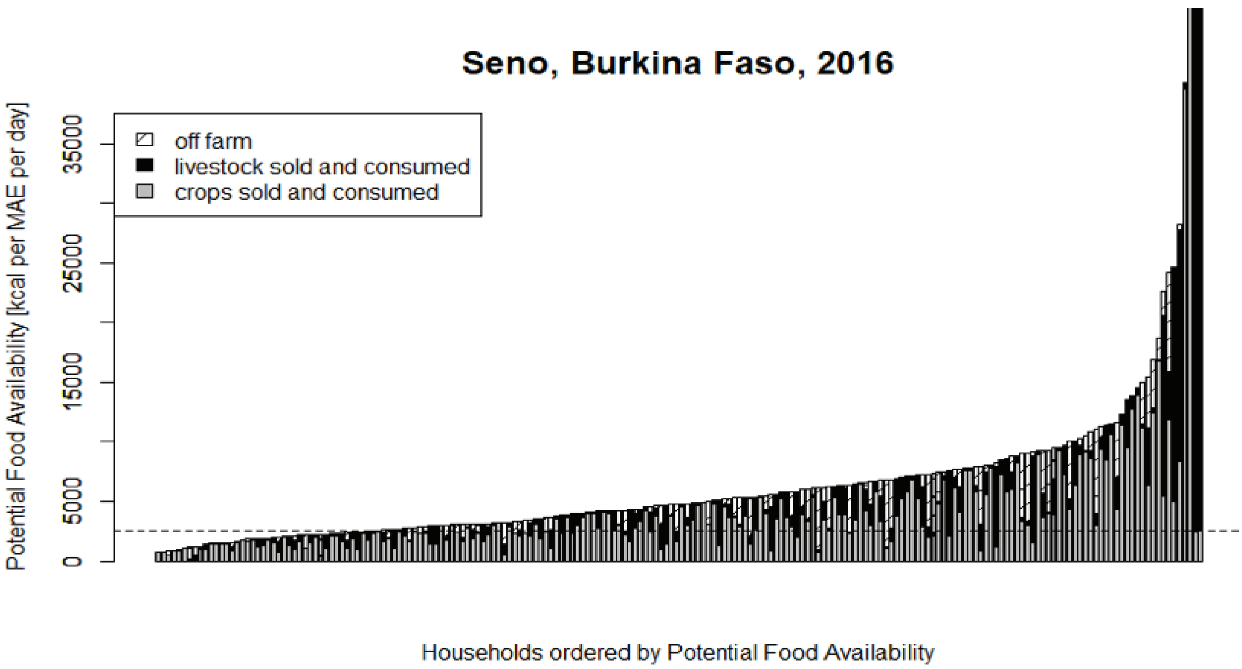
In the scenario analyses the potential impacts of the interventions (assuming that all farmers will adopt a technology leading to a certain amount of production or off farm income increase) are presented not for all individual farm households, but as aggregated values for different food security classes. Three classes were defined, following a similar classification in Wichern et al. (2017) taking into account that earlier research in Hammond et al. (2017a) showed that the potential food availability indicator correlated well with other food security indicators, including the Household Dietary Diversity Score (HDDS) and the Household Food Insecurity Access Scale (HFIAS) up to values of 5,000 kcal cap^{-1} day^{-1}, but not beyond. Hence, we split our dataset based on the following thresholds: Class 1 included households with food availability below 2,500 kcal cap^{-1} day^{-1} (severely food insecure); Class 2 comprised households with food availability between 2,500 and 5,000 kcal cap^{-1} day^{-1} (moderately food insecure); and Class 3 included households with food availability above 5,000 kcal cap^{-1} day^{-1} (food secure).

Results

The results of the Potential Food Availability (PFA) analysis for the Yatenga and Seno regions are presented in Figure 2. Both sites showed a large variation in PFA scores between households. In both sites consumption of crop produce is the key determining factor underlying PFA. The systems in Yatenga are more crop determined, while in Seno livestock production plays a key role as well. In both sites off farm income supplements the on-farm activities, but in contrast to other similar analyses in East Africa (e.g. Frelat et al. 2016; Ritzema et al. 2017) it does not seem to be a key factor to achieve food security.

Figure 2: Potential Food Availability (PFA) results for Yatenga and Seno.





On the x-axis 200 individual households are represented, ordered along their PFA status (on the y-axis). In the different colors the contribution of crop consumption and sales, livestock product consumption and sales and off farm income are shown. MAE is Male Adult Equivalent; the dashed line is the FAO standard actual intake of 2,500 kcal per MAE per day.

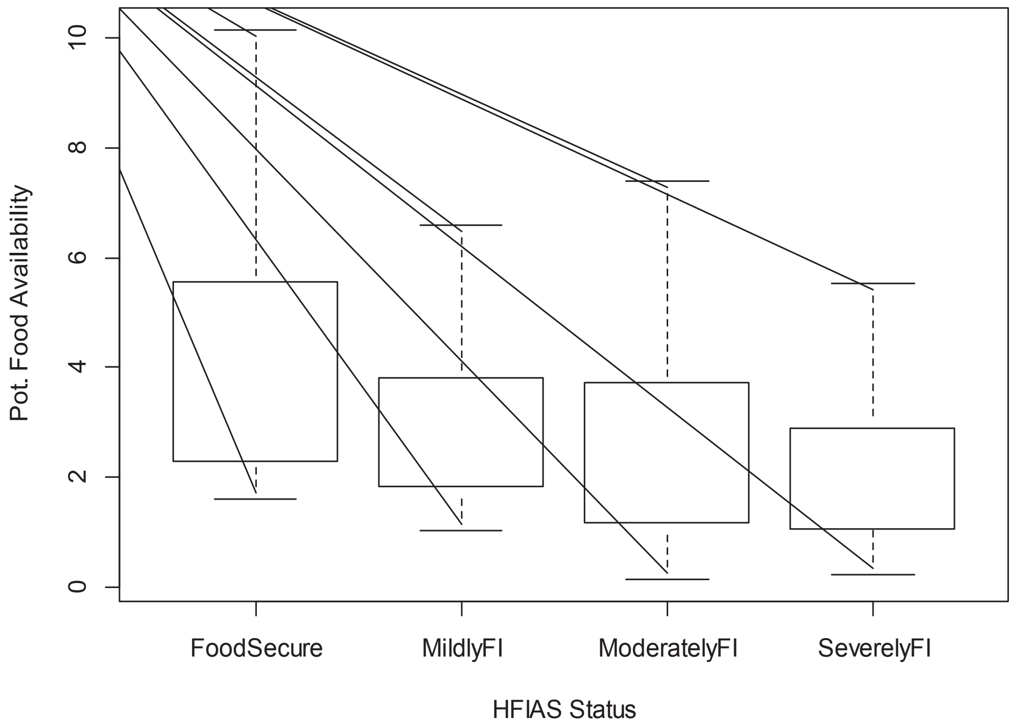
The PFA indicator is strongly related to other indicators of food security such as the Hunger and Food Insecurity Access Scale (HFIAS) and household level dietary diversity scores (HDDS) at the end of both the dry and the harvest seasons (Figure 3). These results show that increases in PFA are generally associated (in a statistically significant manner) with improvements in HFIAS and HDDS status, although the variation around these generic relationships is large. Also similar to Hammond et al. (2017a) the relationships are not linear, but indicate a saturation of the food security measures at potential food availability ratio values of around 2–3, which matches well the reported saturation value of around 5,000 kcal per capita per day of Hammond et al. (2017a).

In Table 1 we present the results of some rapid intervention analyses, and their possible effects on the income and food security of different farm household groups (from severely food insecure to food secure). Across the 2 sites there is a series of consistent findings. For the most vulnerable group, the severely food insecure farm households, the best options are to increase sorghum productivity and to increase possibilities to generate further off farm income. Sorghum (together with millet) is the most important food consumption crop for these households, and beneficial yield effects (slightly) improve their food self-sufficiency and food security. In both sites increasing the sorghum yield improves food self-sufficiency, but not the agricultural income: basically all sorghum production is now used for own consumption. The off farm income affects food security by increasing income, thereby generating cash with which farmers can buy food. Cowpea is an important crop grown by all farmers for cash production. Surprisingly enough the land allocation to cowpea is rather consistent across the different farm groups (ranging between 0.25 and maximum 1 ha), and therefore beneficial effects are almost equal for all food security groups. Although the area under cowpea is rather small compared to the cereal crops, improving yield does lead to substantial increases in food security, especially for the most food insecure farm households because it is one of the few crops they have to generate cash income. Goats play an important role in most farm households, but more because they are for sale and slaughter as needs arise, rather than as an overall year round important factor in food consumption and cash generation. Increasing their currently very low productivity by 50% therefore only improves food security and income to a minor extent.

Differences between the sites in terms of the effects of the interventions reflect the results of Figure 2, with average food security and income numbers being substantially lower than in Yatenga. In Seno the farm population is more dependent on livestock production, and goats play a major role in this. Increasing goat productivity has therefore a stronger effect (increasing the agricultural based income with on average USD30, but for individual households with more goats this can a multiple of this number). Results of increasing crop productivity are similar for both sites, and also in both sites off farm income is a key entry point for improving income and food security of the poorest and most food insecure households. This effect is strongest in Seno, where production is more subsistence oriented, and income values are much lower than in Yatenga, where market orientation of crop production is stronger.

Figure 3. Relationships between the Potential Food Availability (Pot. Food Availability) indicator (expressed here as a ratio to the daily requirement of a Male Adult Equivalent) and other indicators of Food Security: the HFIAS status (Hunger and Food Insecurity Access Scale) (A) and Household level Dietary Diversity Scores (HDDS) after the crop harvest period (B) and at the end of the dry season / early growing season (C). The correlations with HDDS after harvest and at the end of the dry season were both significant at p < 0.001.

A



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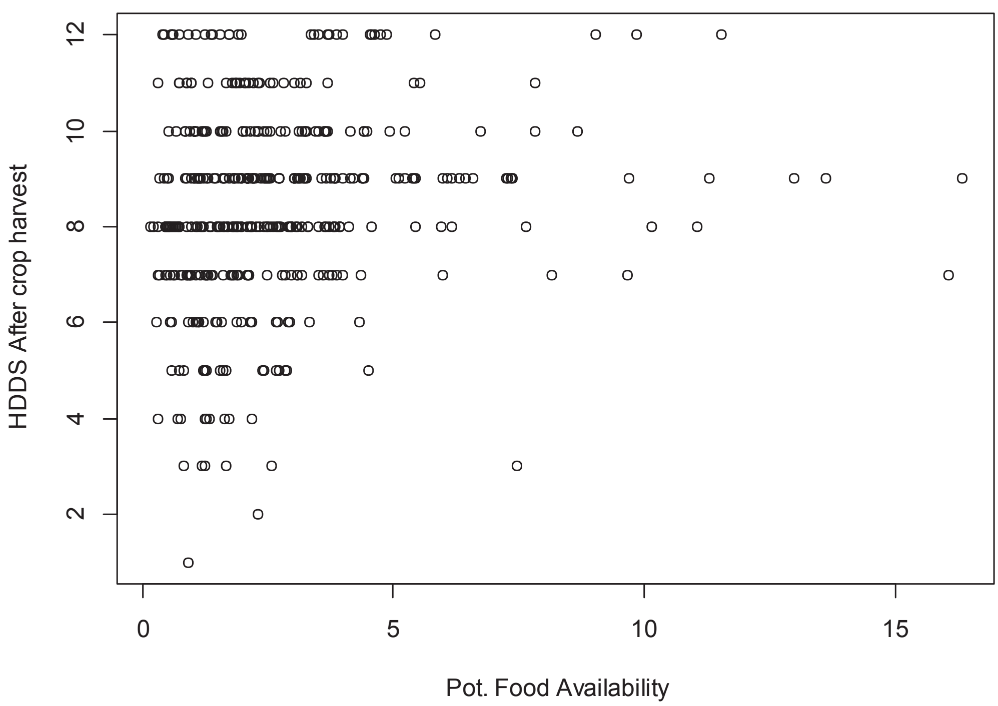

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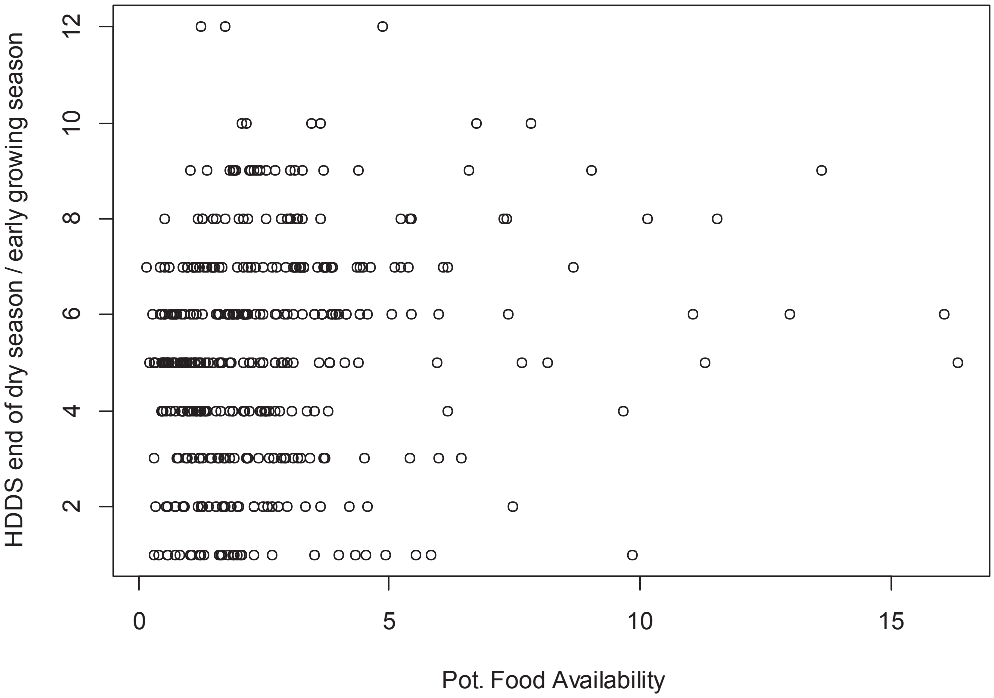


Table 1: Results of the intervention analyses per site. PFA ratio is the PFA divided by the intake standard of 2,500 kcal per male adult equivalent per day.

A. Yatenga

Scenario	Food security group	Food self-sufficiency ratio	PFA ratio	Agricultural based income [USD per family per year]	Total income [USD per family per year]	Total value of production [USD per family per year]
Baseline	Food secure	2.7	4.4	850	1,533	2,967
	Moderately food insecure	1.3	1.9	398	600	1,526
	Severely food insecure	0.47	0.56	117	152	551
Sorghum yield +50%	Food secure	3.0	4.5	850	1,533	3,161
	Moderately food insecure	1.5	2.0	398	600	1,680
	Severely food Insecure	0.50	0.61	117	152	597
Cowpea yield +50%	Food secure	2.9	4.6	938	1,620	3,108
	Moderately food insecure	1.3	2.0	452	647	1,710
	Severely food insecure	0.48	0.58	127	162	575
Off farm income +USD200 per year	Food secure	2.7	4.5	850	1,733	2,967
	Moderately food insecure	1.3	2.1	398	800	1,526
	Severely food insecure	0.47	0.77	117	352	551

Scenario	Food security group	Food self-sufficiency ratio	PFA ratio	Agricultural based income [USD per family per year]	Total income [USD per family per year]	Total value of production [USD per family per year]
Goat production +50%	Food secure	2.8	4.5	854	1,540	3,105
	Moderately food insecure	1.4	2.0	424	604	1,629
	Severely food insecure	0.56	0.65	121	156	589

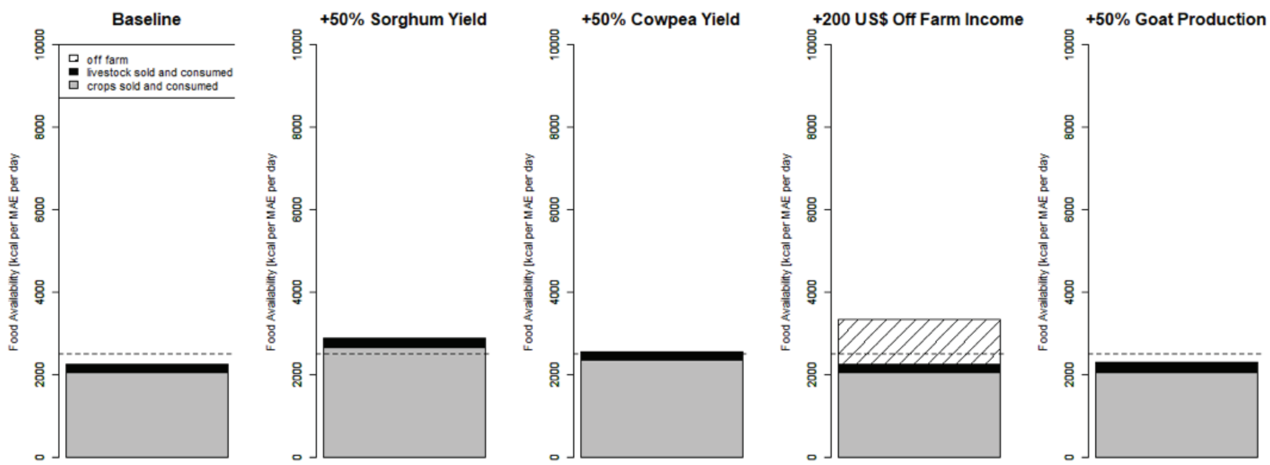
B. Sen

Scenario	Food security group	Food self-sufficiency ratio	Food security ratio	Agricultural based income [USD per family per year]	Total income [USD per family per year]	Total value of production [USD per family per year]
Baseline	Food secure	2.7	4.0	314	589	1,705
	Moderately food insecure	1.2	1.9	202	349	1,140
	Severely food insecure	0.54	0.74	35	111	726
Sorghum yield +50%	Food secure	3.0	4.4	314	589	1,955
	Moderately food insecure	1.3	2.0	202	349	1,238
	Severely food insecure	0.65	0.85	35	111	788
Cowpea yield +50%	Food secure	3.0	4.2	314	589	1,705
	Moderately food insecure	1.2	1.9	206	352	1,198
	Severely food insecure	0.56	0.78	38	111	776
Off farm income +USD200 per year	Food secure	2.7	4.6	314	789	1,705
	Moderately food insecure	1.2	2.3	202	549	1,140
	Severely food insecure	0.55	0.98	35	311	726
Goat production +50%	Food secure	2.7	4.1	330	592	1,743
	Moderately food insecure	1.2	1.9	215	372	1,237
	Severely food insecure	0.56	0.77	52	118	827

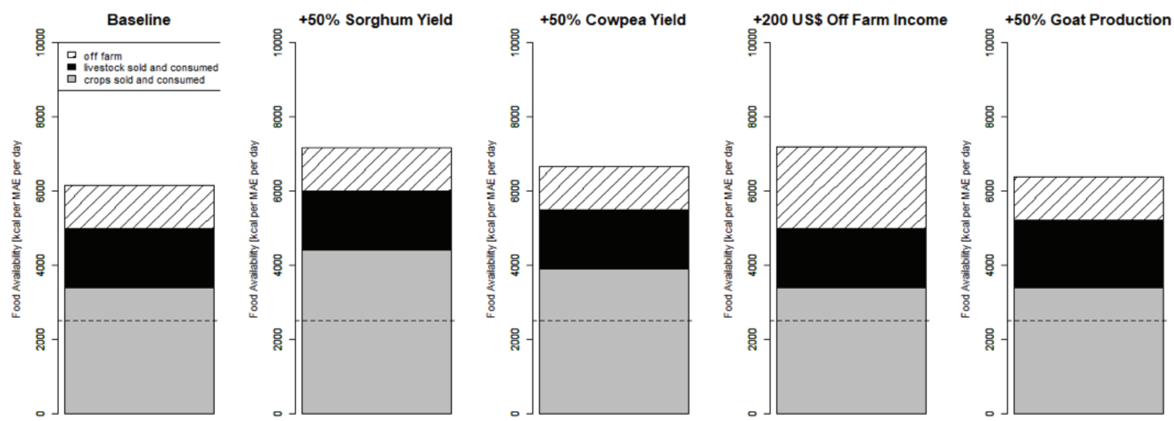
We also analysed the effects of the interventions for several individual contrasting households. Figure 3 shows the results of these analyses for two households in Seno. One household is relatively poor and food insecure, and especially focuses on subsistence crop production, while the second household is more food secure and less poor, and has a much more varied basket of livelihood activities. As expected, the different interventions work out differently for these households, showing that the overall analyses results presented earlier at population level can show generic patterns, but hide the large diversity in household level responses within the same community of farm households. Logically for the poorer household the sorghum and off farm interventions showed the biggest response (but even a 50% yield increase in sorghum yield does not make food security increase drastically given the current lower yields per area), whereas for the less poor household all interventions showed an increase in food security as a consequence, although also for this household the sorghum and off farm income interventions showed the biggest effects.

Figure 4. Intervention effects on two contrasting households in Seno, Burkina Faso. Household A is food insecure and poor, and only depends on crop subsistence production, with some livestock production for sales. Household B is less food insecure and less poor, and has more diverse livelihood strategies. The same interventions are analysed as in Table 1.

Household A



Household B



Discussion and conclusions

The analyses presented in this report quantify the main activities for individual households while they try to achieve food security and escape from poverty in two contrasting regions in Burkina Faso. Whereas in Yatenga the livelihood activities are dominated by crop production, supplemented by livestock and off farm activities, in Seno, livestock plays a much more important role. The analyses also stress the large within site variation, and that variations in food security between households in one site are larger than the differences between sites. The analyses also showed (comparable to results obtained by Ritzema et al. 2017 and Paul et al. 2017) that different interventions have different effects for different groups of households: as stressed in the earlier mentioned articles: the targeting of interventions through a clear definition of the target population and the desirable effects on food security are therefore essential.

The analyses quantified the potential effects on a simple indicator of food security. Two key aspects need to be taken into account when interpreting the results of this study and translating them into a prioritization exercise for interventions. One, all effects are potential effects, the analysis quantifies the effects if all farmers would adopt the intervention of interest. Recent work has shown that farms' interest in adopting (sustainable) intensification options is much lower and more likely to be in the range of 40-–60% of the farm household population (Hammond et al. 2017b). Further studies need to differentiate these numbers, and it will be interesting to see whether there is a match between the households that could profit most from intensification for their well-being and their motivation to adopt. This is often assumed in ex-ante analyses, but no detailed studies exist that combine ex-ante work and motivation to adopt studies to see whether this is true.

Second, we only used a simple indicator of food security, and did not try to capture effects on other (food security related) indicators. This work made use of data collected using an adapted version of the RHoMIS tool (Hammond et al. 2017a) that tries to capture a more integral picture of the well-being of farm households, with a special focus on food security. This means that in further, more in-depth, analyses the other aspects of food security can be explored in more detail. With a targeted monitoring plan of the farm households this would give an unique opportunity to bring ex-ante analyses and M&E together in an integrated analysis framework. Here we could also build on the work on a sustainable intensification indicator framework within the Feed the Future Sustainable Intensification Innovation Laboratory (e.g. Smith et al. 2017; Snapp et al. 2017).

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