Exploring transformative pathways towards sustainable farming systems in the cotton zone of West Africa

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Food security and poverty alleviation through improvements in the agricultural sector are high on the agenda across sub-Saharan Africa. Similar to other West African countries, much is expected from the high-potential zone in southern Mali in terms of generating income and feeding the country. Yet, climate, demography and market trends create uncertainty about future conditions. Our objective was to identify policy and agricultural interventions to underpin a transition towards sustainable farming systems. Looking 20 years ahead, we built five contrasting scenarios based on plausible future trends in climate change, birth and migration rates, market conditions, and agricultural services and practices (Figure 1). Effects on indicators of food security, agricultural productivity, income, nutrient losses, greenhouse gas emissions and labour constraints were calculated by running an integrated farm-level modelling framework for current and future conditions. By simulating all 411 households of two representative villages in southern Mali, differentiated effects in a heterogeneous farm population were analysed. In the business-as-usual scenario (S1), food security and per capita income dropped due to the increasing population size (Figure 2). Incremental improvements in agricultural practices (e.g. intercropping, crop-livestock integration) in S2 were insufficient to lift a considerable portion of the population above the living income and food self-sufficiency thresholds. A more drastic system transformation was needed by combining policies supporting conducive market conditions, off-farm employment and reduced birth rates, with incentives for increased use of agriculture inputs (S3 and S4). Our analysis confirmed expected trade-offs between increasing agricultural productivity and environmental objectives, as nutrient surpluses and greenhouse gas emissions rose with more intensified fertilizer use. However, mitigation opportunities existed through more intensified animal husbandry with less, but more productive cows (S5). In this scenario, mechanization lessened the reliance on animal draught power. Large differences in effects between farms underscored the importance of analysing entire farm populations, which provided a basis for the development of tailored solutions (S5-div, Figure 3). We conclude that forward-looking scenario analysis is a powerful tool to explore the multi-dimensional effects of transformative pathways towards sustainable farming systems.

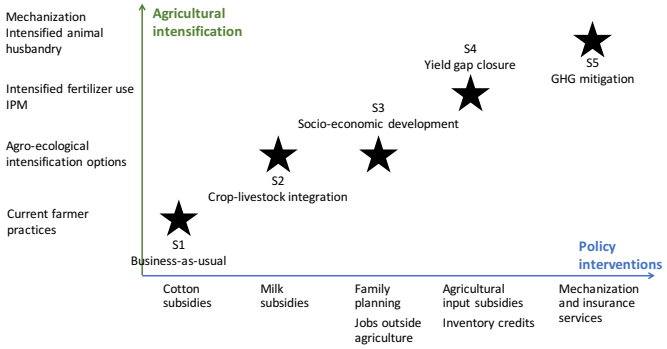

Figure 1: Five contrasting scenarios that combine changes in agricultural practices and changes in the policy and institutional context. IPM: Integrated Pest Management.

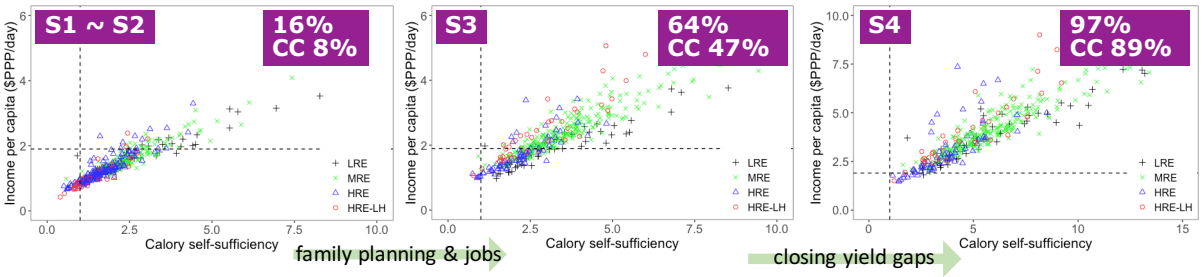

Figure 2: Per capita income and calory self-sufficiency for 411 farms, classified in four farm types (low, medium and high resource endowed (LRE, MRE, HRE) and with large herds (HRE-LH)) for four scenarios. Percentages indicate the proportion of the population that is above the living income line and calory self-sufficient, as compared to 33% in the current situation. CC stands for the scenario with climate change effects on crop yields.

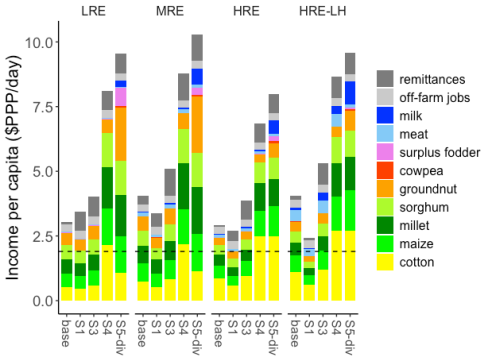

Figure 3: Average per capita daily income for four farm types and four scenarios compared with the baseline. S5-div is a variant of S5, in which LRE and MRE farms replace half of their cotton area with groundnut and cowpea