The crop-livestock subsystem and livelihood dynamics in the Harar Highlands of Ethiopia

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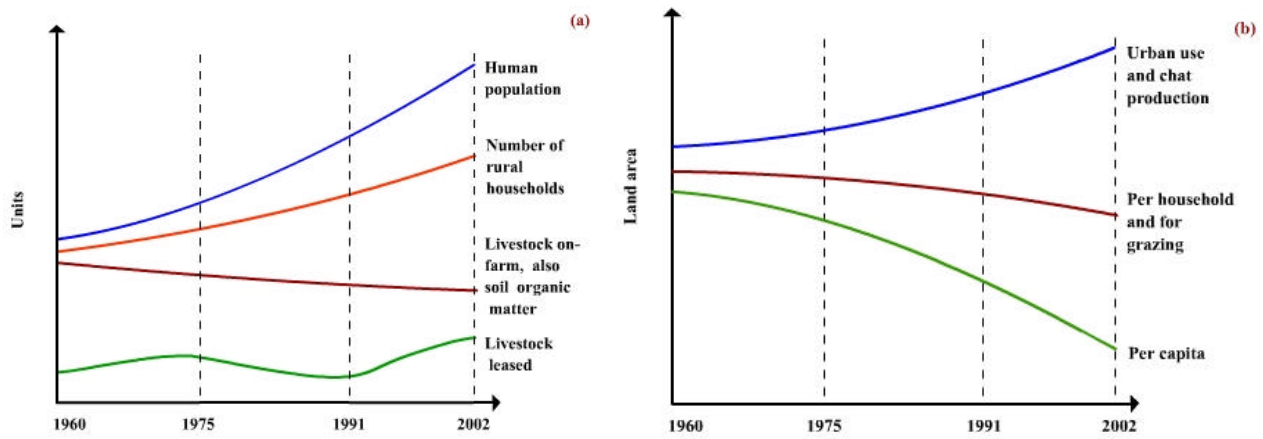
Introduction Policy makers and extension planners often assume smallholder mixed farming systems are incapable of evolving fast enough to meet growing food demands and that livestock are relatively unimportant to household food production or welfare (FDRE, 1994), except for intensive units. The resulting policy promotes substitution of either intensive cropping or livestock production in place of the traditional mixed portfolio. Although widely promoted in the Harar Highlands, farmers resist these recommendations in favour of more diverse and integrated systems with crops, livestock, and non-agricultural activities. The contrast between what policy makers and development practitioners think and what farmers do signifies misunderstanding about interactions that govern farmers' behaviors. The evolution and potential impacts of these agricultural systems on human welfare are also poorly understood, which precludes effective intervention to help achieve farmers' objectives. Understanding the crop-livestock subsystem is an essential part of the bio-economic foundations of rural livelihood systems (Thornton and Herrero, 2001), which requires accounting its component stocks and interactions (Ashley and Carney, 1999). Towards a goal of identifying through simulation "high leverage" interventions that enhance system performance, our objective is to establish a conceptual model framework representing key elements of the livelihood system structure.

Methodology Commonly used biophysical models often ignore interaction in stocks and flows, and economic (e.g., cost-benefit) analyses may not capture dynamic subtleties of technological change (Kruseman, 2000). System dynamics modeling (SDM) captures complex subsystem interactions and expands *ex ante* evaluation by considering inter-temporal responses. Real world scenarios are depicted as nonlinear disequilibria with feedback relationships. We use historical, survey and field research information (Kassa et al., 2002; Mulatu and Kassa, 2001; Wibaux, 1986) and SDM methods (Saeed, 1994; Sterman, 2000) to describe the dynamic behaviour of the Harar system, and to formulate an initial "dynamic hypothesis" (a structure capable of generating the observed behaviours). Major stocks, flows and feedback mechanisms are prerequisites for developing and testing a quantitative model of system behaviour for the evaluation of technology options and policy alternatives.

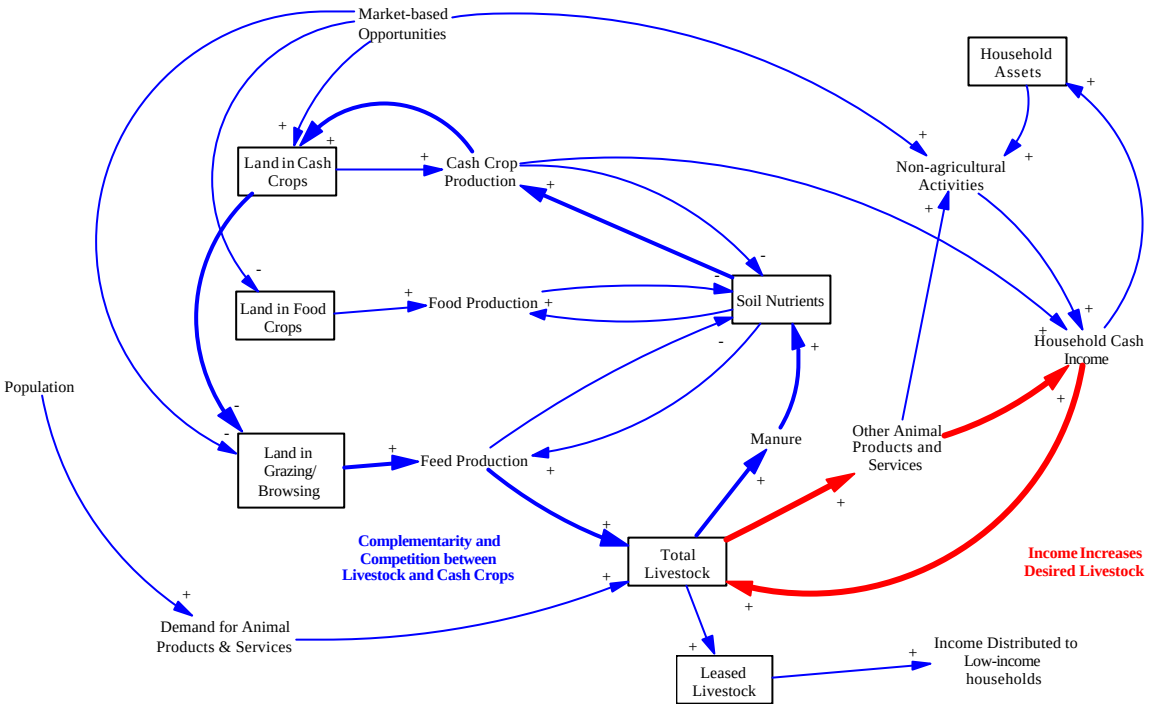
Results Harar agriculture has responded, mostly unaided by government, to market opportunities by shifting from grain-based subsistence production to a market-oriented, cash crop-based (chat—*Catha edulis*—and cattle) mixed farming system. These behaviours, qualitatively depicted for three time periods in Figure 1 (feudalism prior to 1975, Marxism in 1975-1991, and free market economy since 1991), were accompanied by shrinking land holdings, less soil fertility, more drought and crop pests, and policy uncertainty. In such cases, crop-livestock integration is a common intensification strategy (McIntire et al., 1992) and extension efforts to specialize in cropping or livestock through greater input use are largely ignored. This behaviour is often assumed to lead to a decrease in overall productivity and "environmental quality" through direct land use competition with cropping. However, this framework omits certain elements of farmers' management strategies and objectives. In another version of specialization, livestock remain a critical livelihood system component with roles shifted—from providers of food and draft power for tillage to resources for cash income, fertilizer, and transport services. The shift to cash crops has led to greater household income (Mulatu and Kassa, 2001). More land in chat reduces animal feed and food crops while increasing manure demand. Farmers respond by leasing out or selling animals instead of overstocking farmsteads. Regionally, livestock

Figure 1. Trends in key factors affecting livelihood system behaviours in the Harar Highlands.



leasing distributes wealth and services, increases income and the availability of manure. Key factors influencing crop-livestock performance are in Figure 2, where boxes represent stocks and arrows are causal links. Complementarity (e.g., cash and manure) and resource competition between crop and livestock production and non-farm activities characterize the livelihood system. The figure identifies two of the key feedback loops operating in the system, the relationships between livestock holding and income and inherent complementarity and competition between livestock and cash crops.

Figure 2. Major stocks, flows and relationships in the livelihood system.



Conclusions This effort aided understanding smallholder system structure, where farmers have resisted recommendations to specialize with greater external input use in favour of more integrated systems. With certain role shifts, livestock remain a key system component. Sale and leasing out are keys to regulate livestock inventories by contracting off-farm feed and labor resources. More study is planned to examine inherent tensions and identify high leverage interventions because of complementary and competitive relationships between cash crop and livestock production. This information would also help inform deliberations about poverty alleviation and sustainable use of natural resources in the study area.

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