Strategies for Systems Intensification

AHI brief

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Boosting Human Nutrition through Land Use Modeling: An Alternative to Biofortification

Even in food sufficient regions, about 45% of children are stunted, underweight, or deficient in Zinc, Calcium and Vitamin A.

Current nutrient and vitamin deficiencies in cereal and root crop systems can be ameliorated through the modification of cropping strategies.

Many residents in highland cereal and root crop systems face food shortages as well as imbalanced nutrition. Even in food sufficient regions, about 45% of children are stunted, underweight, or deficient in Zinc, Calcium and Vitamin A. Some blame food shortages on land shortage or on land degradation and its negative effect on agricultural productivity.

This research aims to understand the potential of these farming systems and current landholding size to supply the required nutrients to farming households if farmer decision-making on enterprise allocation is adjusted. The hypothesis for this work is that highland root crop farming systems found in Areka (in Woliata, Southern Ethiopia) and cereal-livestock-fallow crop systems found in Ginchi's high altitude plateau (NW of Addis Ababa) can feed the existing population and enhance nutrition by modifying cropping strategies.

NUTRIENTS	RDA	AREKA				GINCHI			
Households:		Resource-poor		Resource-rich		Resource-poor		Resource-rich	
		Current	*Optimized*	*Current*	*Optimized*	*Current*	*Optimized*	*Current*	*Optimized*
Energy (kcal)	2000	1294	2000	2284	4758	1398	3329	2082	3696
Protein (g/kg)	38	8	9	17	36	32	40	42	43
Zinc (mg/kg)	15	4	6	7	15	7	15	20	21
Iron (mg/kg)	8	21	37	36	82	26	78	34	69
Calcium (mg/kg)	528	179	362	310	759	163	694	195	547
Thiamine (mg/kg)	0.92	0.21	0.35	0.41	0.89	1.17	1.08	1.52	1.30
Vit. A (ug/kg)	10.00	0.18	10.00	2.54	10.00	0.25	12.51	1.45	20.80
Vit. C (mg/kg)	25.42	2.98	14.95	9.08	2.41	0.54	1.62	0.01	2.61

Figure 1. Household Nutrient Budgets at Areka and Ginchi, Current and after Optimization

Methods

Step 1: Identify households with diverse resource endowments and production systems.

Step 2: Use participatory monitoring to quantify household and farming system parameters (farm size, land allocation to enterprise, household size, food consumed by season).

Step 3: Quantify nutrient amounts and type per farm, and distribution per household consumption unit (CU).

Step 4: Compare nutrient amounts and type available from farm per CU with World Health Organization recommended daily allowance (RDA) and identify excess and deficit nutrients.

Step 5: Consult with health and nutrition experts as to whether deficit nutrients cause health problems.

Step 6: Find land allocation strategies that fulfill nutritional demands throughout the year. Consider cultural preference, resource base and inputs using "optimization models."

Step 7: Negotiate with communities, using health officers as mediators, on possible land reallocation favoring crops providing greater nutrition to farming households.

Findings about System and Residents

Steps 1–5 revealed the following information about the two systems:

✔ Under current cropping practices in both systems, household food production meets nutritional needs of families for only nine months out of the year.

✔ Minerals Zinc and Calcium and vitamins A and C were found to be in deficit. Vitamin C deficiency was most prevalent, even in the root crop system where one would expect to find high levels of this vitamin.

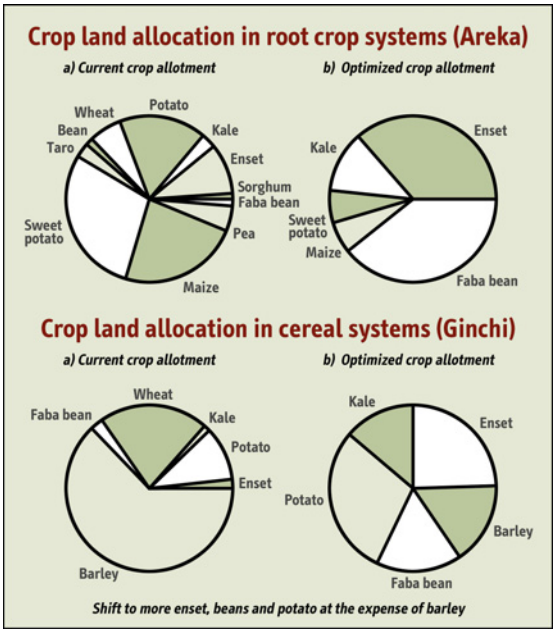

Figure 2. Land Allocated to Diverse Crops under Current and Optimized Scenarios

✔ Poor farmers were found to have energy deficits (in calories), while wealthier farmers had enough energy but mineral and vitamin deficits.

✔ Due to high land pressure and cultivation of all available cropland, the only option for addressing current nutritional deficits is farming system intensification.

Findings from Optimization Models

To determine whether current nutritional deficits could be addressed with existing resource endowments and cropland allocations, optimization models were developed for each system. Findings illustrate important opportunities for improving household nutrition through land reallocation:

✔ Maintaining current farm size but changing the amount of land allocated to different crops can provide a balanced diet and adequate food.

✔ In the root crop system, an increase in the land allocated to beans, enset and cabbage and a decrease in maize and sweet potato can satisfy household nutritional needs. However, yields of these crops must increase, especially for poor farmers.

✔ For cereal-based systems, an increase in the land allocated to enset, beans and potato and a decrease in barley can satisfy household nutritional needs.

Responses from Communities

To determine viability of recommendations in terms of cultural acceptance, farmers were consulted on barriers they would face if they implemented proposed solutions. Their responses suggest future directions for research and development:

✔ Women in Areka said that expansion of enset will demand more labor, and therefore prefer to continue allocating a higher proportion of land to sweet potato.

✔ The model did not favor cash crops such as tef, which can be utilized to purchase food for the household.

✔ There is a need to introduce adaptable crop varieties, particularly for crops to be expanded or introduced.

Implications and Conclusions

Nutrition and food security can be enhanced through cropland reallocation in both types of systems by favoring crops with high nutritional quality. However, recommended crop land reallocations would have both positive and negative spin-offs that should be acknowledged and managed:

✔ A 42% decrease in erosion in the root crop system and 45% decrease in the cereal-based system due to an increase in enset, a perennial, in the system.

✔ Improved distribution of nutrient resources across soil fertility gradients due to expansion of enset, which traditionally receives about 80% of organic resources.

✔ Increased labor burden for women from enset processing, which would have to be offset through the introduction of affordable enset processing implements.

Farmers' resource endowments and livelihood strategies substantially influence cropping decisions, and subsequent welfare and resource management outcomes. Hence, bottom-up negotiations at household and community levels should acknowledge trade-offs inherent in cropping choices and adapt suggestions to local realities.

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