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Farming for Food Security: Probabilistic Simulations of Farm Contribution to Nutrition in Southwest Uganda

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Abstract

Southwestern Uganda's population density, 64 people per square kilometer, is less than half of the national average, however a high growth rate and low average age are likely to exacerbate land scarcity, poverty (per capita GDP 500 USD), and food insecurity. The region is ideal for farming, with fertile soils, 1500–2000 mm annual rainfall, and mean annual temperature range of 12.5–30°C. Uganda's agricultural authorities aim to utilise this strength and industrialise farming systems away from the common traditional homegardens, currently the source of most food. However, robust science-based information to support this decision is lacking. Here we used decision analysis methods for probabilistic simulations of food nutritional implications based on homegardens and the proposed changes.

We compared total nutrient outputs of two scenarios: 1) 102 homegardens (HG) multilayered diverse banana plantations intercropped with fruits and vegetables, based on extensive field work; 2) Ugandan agricultural authority plans (UA) dominated by grains, tubers, Tooke bananas, and legumes. Land area for food production in HG was around 95 %, whereas, UA used 100 % by removing homes and roads, or as little as 75 % with area lost to commercial non-food products. Yield estimates were based on HG observed yields and reports with UA yield increases of 5–60 % with chemical fertilisers. Crops were categorised by food group with nutrient contribution based on yields.

Monte Carlo simulation with 10,000 model runs revealed that, while industrialising farming systems may be a win in terms of energy and some nutrients, homegardens should nevertheless be maintained for key important nutrients. UA significantly outperformed HG in protein production by 50 %, calories, carbohydrates, thiamine and zinc by 40 %, fiber by 30 %, thiamin by 20 %, and folates by 13 %. HG significantly outperformed UA in production of vitamin-C by 170 %, calcium 60 %, riboflavin 40 %, vitamin-A 30 %, beta-carotene and vitamin B6 20 %, total lipids 2 %, and iron and niacin by 10 %. HG also had folic acid and vitamin B12 whereas UA had none.

Partial least-squares regression of Monte Carlo output indicated that gathering more data on the annual yields of roots and tubers would most improve certainty about the nutrition contribution of HG and UA scenarios.

Keywords: Decision analysis, homegardens, Monte Carlo, probabilistic simulation

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