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Title:

Enhancing Dietary Diversity and Climate Resilience through Agroecological Practices in Chad and Niger

Abstract:

Agroecology has increasingly been recognized for its potential to address environmental and social issues within food production systems (Ekomer et al., 2021). Sustainable agricultural methods can improve food security by increasing the availability and accessibility of nutritious food, especially in resource-constrained environments (Pretty et al., 2018). By diversifying crop production and promoting indigenous food varieties, agroecological approaches strengthen resilience to environmental shocks and contribute to local food sovereignty (Altieri, 2019). One key determinant of food and nutrition security is the minimum dietary diversity score, a scientifically validated indicator of dietary quality that reflects the micronutrient adequacy of diets (Martin-Prével et al., 2015). Achieving minimum dietary diversity remains a challenge for many, particularly among vulnerable populations facing socio-economic constraints (Arimond et al., 2010).

Despite some studies indicating that biodiverse farming systems and agroforestry can lead to positive nutritional outcomes, the impact of agroecological practices on food security, dietary diversity, and food sovereignty remains under debate (Méndez et al., 2013). In agricultural areas of Africa, diets often remain of poor quality across various socio-economic settings, even within agroecological environments providing greater food diversity and abundance. However, there is emerging recognition that agroecology, when linked to social inequalities such as gender or class, can lead to significant and systemic improvements in nutrition (Bezner Kerr et al., 2021). Addressing socio-economic factors alongside agroecological practices may therefore contribute to more effective interventions aimed at improving food security and nutrition (FSN).

Data for the study were collected via a survey that included a variety of open-ended and closed-ended questions about system descriptions, motivations and perceptions, agroecological farming practices, crop production, agrobiodiversity assessment, a household-referenced food insecurity scale based on the FIES survey module, and women's empowerment. Farmers were visited personally by trained enumerators, data were collected using the KOBO toolbox, and analyses were conducted using the R software environment. Analyses were performed separately within each country. The dependent variable was whether the woman in the household reached minimum dietary diversity, defined as consuming at least 5 of the 10 inquired food groups. Potential socio-economic indicators for minimum dietary diversity were identified through

bivariate analyses with each variable and the minimum dietary diversity. Indicators included the gender of the household head, education level, income level, number of NUS crops produced on the farm, number of major crops produced on the farm, decision-making on crop production, responsibility for seed management, and the presence of women's associations and organizations in the community. These indicators were further analyzed using generalized linear mixed models (GLMM) with a binomial distribution and region as a random effect to account for regional variability. The correlation of agroecological practices and reaching minimum dietary diversity was measured using Principal Component Analysis (PCA).

Chad and Niger had similar percentages of the survey population achieving minimum dietary diversity, with 64.8% and 62.8%, respectively. In education, the two countries differed significantly. In Chad, 42.2% of participants were illiterate, and 19.7% had a high school education or higher. In Niger, illiteracy was higher at 83.7%, with only 1.1% having completed high school or higher education. Income levels were also higher in Chad, where participants were more evenly distributed across the five predefined income groups. In Niger, most farmers (56.2%) were in the lowest income group, earning less than 20,000 CFA. Crop production patterns further distinguished the two countries. In Chad, farmers produced an average of 5.5 crops, including 3 major cash crops and 1.5 NUS crops. In Niger, the average was 4.2 crops, with 2.9 major cash crops and 1.3 NUS crops. GLMMs indicated that producing more NUS crops was significantly correlated with achieving minimum dietary diversity in Niger ($p = 0.009$) and showed a near-significant correlation in Chad ($p = 0.054$). The production of major cash crops correlated with reaching minimum dietary diversity in Chad ($p = 0.021$) but not in Niger ($p = 0.25$). Higher income levels positively influenced the likelihood of reaching minimum dietary diversity in both countries (Niger: $p = 0.009$, Chad: $p = 0.002$). The presence of women's associations was a significant predictor of dietary diversity in Chad ($p < 0.001$), although it was not significant in Niger ($p = 0.12$).

In Chad, the agroecological practices Exclusive as well as partial application of organic fertilizer, agroforestry and integration of livestock with crop production are associated with reaching minimum dietary diversity. Intercropping, crop rotation and mulching are practices that correlated with high income farmers that did not reach minimum dietary diversity and production of locally adapted seed and crop diversification associated with middle- and low-income households. Farmers with very low income did not correlate with any agroecological practices independent of whether they reached minimum dietary diversity. In Niger, the practices of mulching, fallow, crop rotation and partial application of organic fertilizer were positively correlated with reaching minimum dietary diversity in high income households. Intercropping, crop diversification and partial application of organic pesticides correlated with high income households that did not reach minimum dietary diversity. Low income households did not strongly correlate with any of the most common agroecological practices of the study population, independent of whether they reached minimum dietary diversity. However, these results need to be further scrutinized beyond PCA analysis. Overall, these results suggest that income, crop diversity (both major and non-utilized), and community structures such as women's associations play crucial roles in determining dietary diversity among women in these regions. Additionally, it indicates that agroecological practices have the potential to improve MDD of farming systems in these regions, but is dependent on the country and socio-economic context. Our findings suggest that a comprehensive approach, incorporating economic, agricultural, and social interventions, is essential for improving nutritional outcomes and fostering sustainable agricultural practices.

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