Linkages Between Bioenergy and Nutrition: Literature Review

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Scope of literature review

AIM: Explore the *positive* linkages between bioenergy and nutrition, with a view to bring these to the attention of bioenergy and nutrition communities so that they can be leveraged to ensure nutrition security

- Scope:
  - The literature review explores *existing* research
  - Implications of bioenergy on nutrition are explored; implications of nutrition (e.g. changing diets, reduced/enhanced nutrition) on bioenergy are *not* considered
  - Other co-benefits/potential necessary safeguards may be briefly mentioned but are not the focus of the research
  - Bioenergy and food security in general is *not* addressed
- Gaps in the current research and areas for future research on the nexus between bioenergy and nutrition have been identified

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Methodology

- Exploratory review of peer-reviewed literature and technical papers on the relationship between bioenergy and nutrition
- 47 total articles were used in the development of the literature review:
  - 42 were found through internet searches, e.g. using Google Scholar
  - Remaining five articles were shared/ recommended by GBEP Partners and Observers

Keywords used included:

bioenergy, nutrition, nutrition security, diet diversity, diet quality, food security, health, indoor air quality, improved cookstoves, biomass, biochar, digestate, soil quality, and climate-smart agriculture, clean cooking, soil amendment, phytoremediation, *among others*

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Overview of findings

Bioenergy value chains

Identified practices

Bioenergy production	Bioenergy by-products	Bioenergy use
• Phytoremediation • Integrated biomass production systems • Income diversification	• Use of biochar and digestate	• Improved cookstoves and clean cooking solutions • Food transport and storage

What could be the implications of these practices on nutrition security…?

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Bioenergy production and nutrition

- Phytoremediation is a mechanism for removing heavy metals and other contaminants from soil and improving soil quality
  - Some **perennial energy crops** have been shown to be capable for use in phytoremediation → *Miscanthus, Ricinus species, Jatropha curacas, Populus species,* and other members of the *Salicaceae* family
  - **Wetland species**, such as water hyacinth, may also be used to remove heavy metals from livestock wastewater, allowing for its use in irrigation of cropland
- Nutrition implications:
  - Phytoremediation can have positive impacts on nutrition by reducing soil contamination, e.g.:
    - Soil-plant-human or soil-plant-animal-human heavy metal interactions
    - Drinking of contaminated ground water
    - Food quality (safety and marketability)
    - Land usability for agricultural production causing food insecurity
- Safeguard: Can have adverse effects, including biodiversity loss, nutrient loss, and intensive water requirements for plants

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Bioenergy production and nutrition

- Integrated biomass production systems for concurrent production of **biomass for multiple purposes** (including bioenergy): include crop rotations, flexible crops, intercropping and agroforestry (IRENA, IEA Bioenergy, and FAO 2017)
- Nutrition implications:
  - These integrated systems in some cases can mitigate land use impacts and enhance ecosystems services, thus improving the potential of the agricultural ecosystem to produce nutritious food.
  - Can also lead to improved soil quality:
    - Minimizes weeds that draw large amounts of nutrients and water from the soil
    - Cash crops with nitrogen-fixing crops can enhance soil fertility, reducing soil degradation (e.g., the short rotation coppicing tree, *Gliricidia sepium*)

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Bioenergy production and nutrition

- Bioenergy production can *indirectly* impact nutrition through the diversification of income within rural and low-income communities
  - Growth of energy crops, in addition to crops for food
  - Growth of energy crops on marginal or degraded land
  - Leasing marginal or degraded land for energy crop production
  - Own use/sale of residues and wastes for bioenergy production can decrease household energy expenditure and/or increase income
- Nutrition implications: Additional income could enable households to afford foods that they previously could not, leading to greater diversity within diets
- Safeguard: interventions should be carefully planned in consultation with local communities. Changes in land use or designation of crops or their residues for different purposes could have undesired impacts, e.g. reduced use of residues for soil management could have impacts on soil quality

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Bioenergy by-products and nutrition

- Byproducts of bioenergy such as biochar and digestate can be used as soil amendment.
- Nutrition implications:
  - Many studies show positive impacts on soil health, such as enhancing chemical and physical properties of soil, promoting biological functioning of soil, and detoxifying soil contaminants
  - Additional studies suggest improvements in crop yield from the addition of biochar
  - Whether there is a difference in crop yield and quality from the addition of biochar and/or digestate versus chemical fertilizers is inconclusive

What are the links between soil quality and nutrition?

- Soil security is necessary for nutrition security
- Without secure soil quality, nutritious food will become harder to produce
- Soil degradation impacts food and nutrition security
  - Directly > reduction in crop yield and decline in nutritional value of crops including protein content and micronutrients
  - Indirectly > reduction in efficiency of inputs and additional land area required to compensate for the loss of production

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Bioenergy use and nutrition

- Transitioning from traditional cookstoves to improved cookstoves or other clean cooking solutions (e.g. biogas/ethanol cookstoves) can significantly improve indoor air quality and improve cooking efficiency
  - Biogas cookstoves and improved cookstoves have been found to reduce concentrations of $PM_{2.5}$, CO, and black carbon, particularly in kitchens
- Nutrition implications:
  - Clean cooking solutions can facilitate diet diversity by reducing cooking times and increasing cooking efficiency, compared to traditional cookstoves

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Bioenergy use and nutrition

- Use of biogas in food transport and the cold chain can present a sustainable alternative to fossil fuels for meeting energy demand of refrigerated agricultural supply chains
- Nutrition implications:
  - Properly refrigerated food transport and storage prevents spoilage
  - Dietary diversity – Allows cold chains to reach where grid electricity does not
  - Available case studies have shown positive economic and financial returns as well as positive impacts on soil quality, indoor air pollution, fertilizer use and efficiency, food loss, GHG emissions and access to energy
- There are limited case studies available and its feasibility at scale still needs to be verified

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Conclusions

- The findings from the articles reviewed show evidence of **multiple indirect or implied linkages between bioenergy and nutrition**
- Potential that bioenergy can indirectly work to improve nutrition and promote healthy diets
  - The literature review identified some bioenergy value chains and/or specific good practices across these value chains that could contribute to ensuring nutrition security
  - Research in this area is still lacking and some linkages still need to be verified

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Suggestions for future research and investigation

1. **General questions**
   - How can we leverage these linkages to ensure that bioenergy production and use is contributing as fully as possible to nutrition security?
2. **Impact of soil quality on nutrition**
   - Do changes in soil quality have a direct impact on the nutritional quality and content of crops?
   - Is there a difference in nutritional quality and content of crops after the addition of biochar fertilizer versus chemical fertilizer?
3. **Improved cookstoves and clean cooking solution**
   - How can improved cookstoves and biogas/ethanol stoves be better deployed to rural communities?
   - How can the replacement of traditional cookstoves with improved cookstoves help facilitate diet diversity?
4. **Use of biogas in food storage and cold chain**
   - How does the use of biogas in the cold chain compare to traditional cold chain technologies (energy efficiency, performance, cost-benefit analysis)?

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Thank you

References and acknowledgements:

References are available in the literature review on the GBEP website.

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