

UTILIZATION OF AGRI-FOOD BY-PRODUCTS WITHIN THE WATER-ENERGY-FOOD NEXUS IN AFRICA. A SYSTEMATIC REVIEW



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Introduction

- Food processing in many African countries generates substantial by-products that are often discarded despite their potential value (Ligarda-Samanez *et.al*, 2025).
- With increasing awareness of food waste, environmental health and resource scarcity, attention has shifted from waste disposal towards by-product utilization pathways. (Okuthe, 2024; Yadav *et al.*, 2024)
- However, these utilization pathways are often studied separately, overlooking opportunities to improve resource efficiency, reduce trade offs and create synergies across the water- energy-food (WEF) nexus.

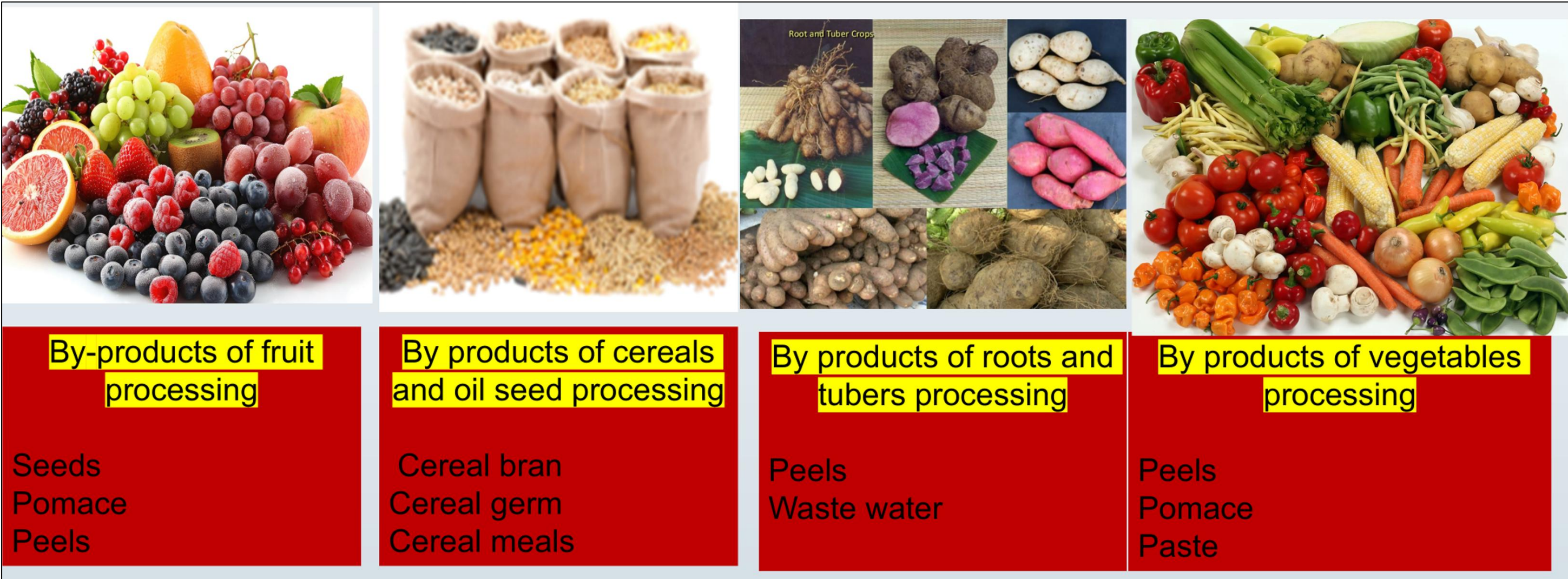


Figure 1: Agri-food by-products

Objectives

- To assess agri-food by-product utilization pathways and their linkages across the water-energy-food (WEF) nexus in Africa
- To identify major agri-food by-products and their utilization pathways
 - To classify the utilization pathways across water, energy, food/feed systems

Methods

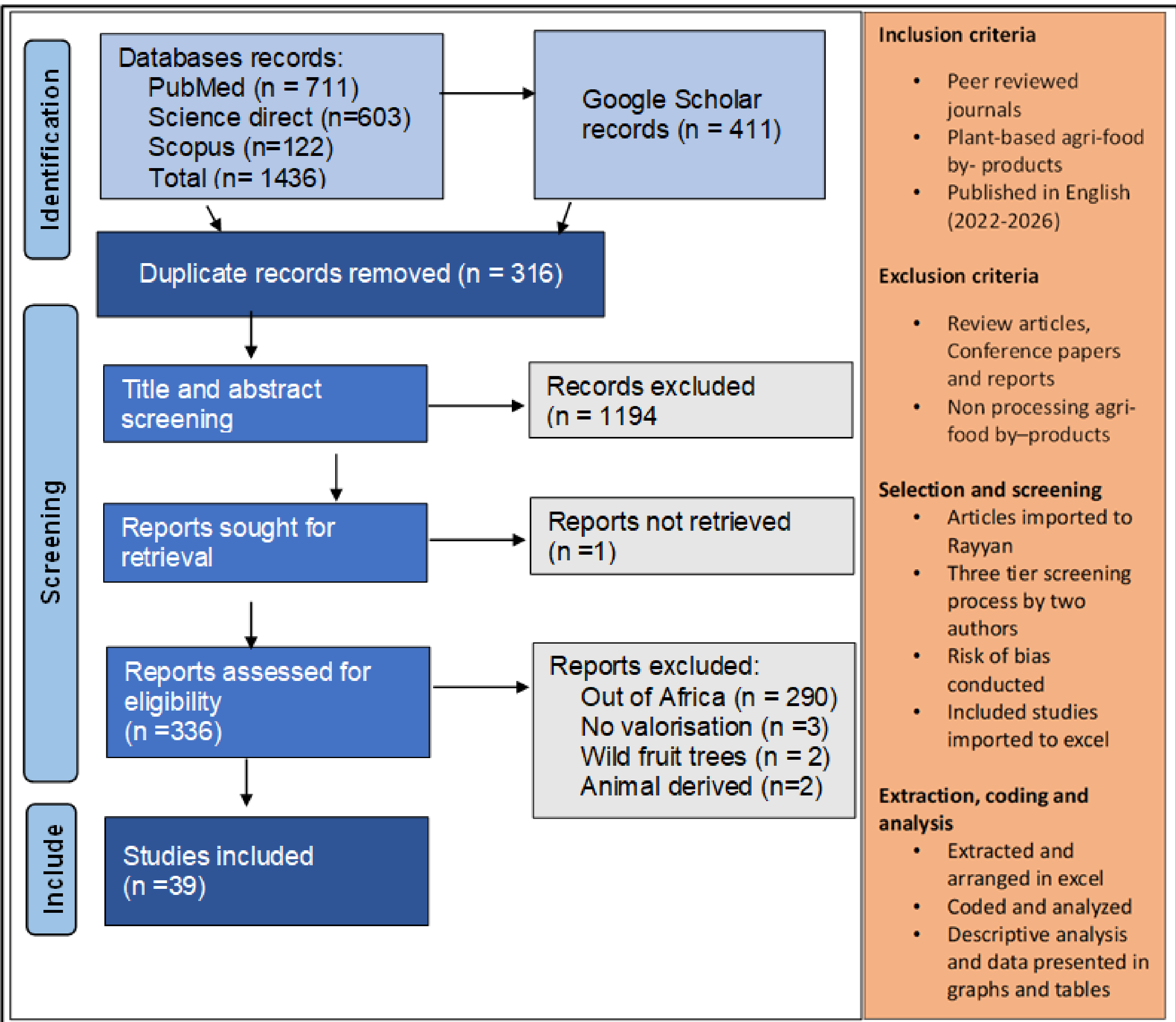


Figure 2. PRISMA Flow chart

Results

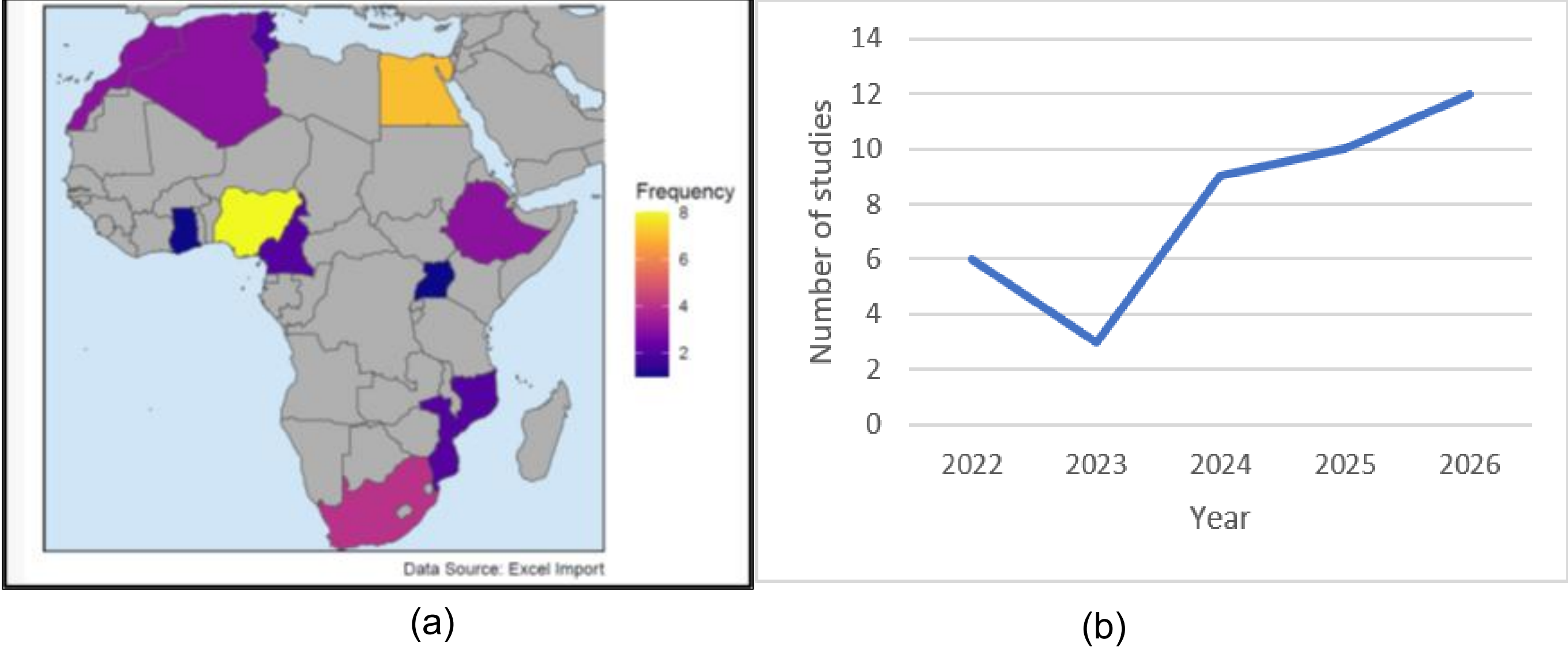


Figure 3: (a) distribution of studies. (b) Years of publication

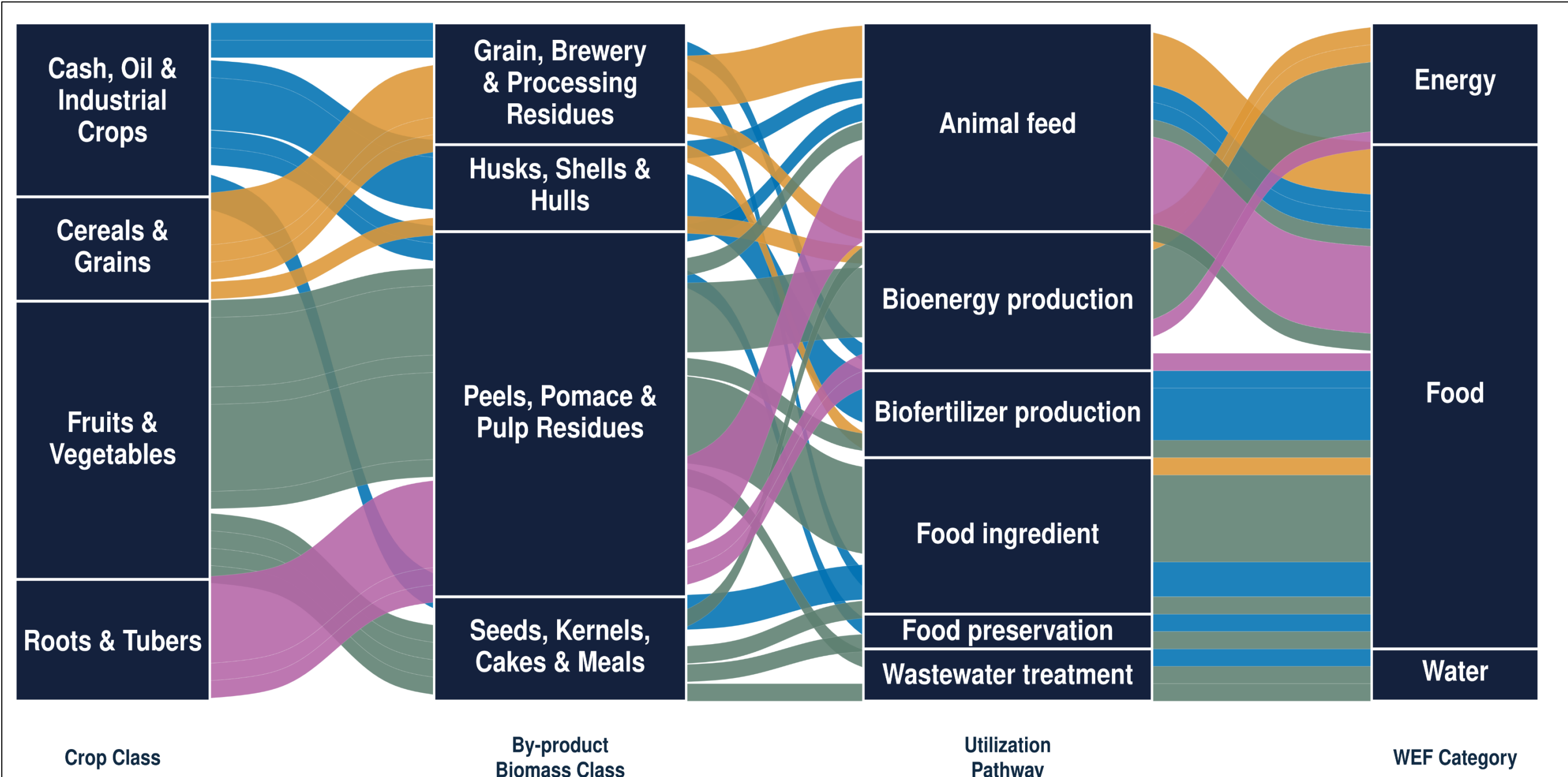


Figure 4. Sankey diagram of crop class, by-product, utilization pathway and WEF category

Key findings

- Studies were more concentrated in Northern Africa, with publications peaking in recent years
- Fruits and vegetable by-products (peels, pomace and pulp) were the most utilized, while cereals were the least (husk, shells and hulls)
- Animal feed production was the dominant utilization pathway, followed by food ingredients indicating a strong focus on food category
- Food preservation and wastewater treatment were the least represented pathways, suggesting that some WEF application remain underexplored
- Food was the most represented WEF category
- Some by-products were linked to multiple utilization pathways and WEF categories, highlighting opportunities for stronger WEF synergies

6. Conclusions

- The review identified diverse agri-food by-product utilization pathways across the water-energy-food systems
- However, these pathways were largely studies in isolation, with utilization concentrated mainly in the food category, particularly animal feed and food ingredient application
- Future research should explore more on integrated utilization approaches to improve resource efficiency and strengthen synergies across the WEF nexus

Acknowledgement and Support



References

1. Ligarda-Samanez *et.al*, (2025). Technological Innovations and Circular Economy in the Valorization of Agri-Food By-Products: Advances, Challenges and Perspectives. In *Foods* (Vol. 14, Number 11). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/foods14111950>
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3. Yadav, S., Malik, K., Moore, J. M. C., Kamboj, B. R., Malik, S., Malik, V. K., Arya, S., Singh, K., Mahanta, S., & Bishnoi, D. K. (2024). Valorisation of Agri-Food Waste for Bioactive Compounds: Recent Trends and Future Sustainable Challenges. In *Molecules* (Vol. 29)