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Editorial

Sustainable Development Agricultural Economics and Policy: Intensification versus Diversification

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Sustainable development of agriculture in both the developed and developing world is not only dependent on economics and policy but also decisions to increase sustainability through either (1) specialization (e.g., sustainable intensification) or (2) diversification (e.g., ecological intensification), as demonstrated in the "Sustainable Development Agricultural Economics and Policy" Special Issue. Understanding the historical context of the region being evaluated is critical to selecting the most promising strategies. For example in the state of Maine USA, agricultural specialization tends to result in longer-term cycles of boom and bust, while historical diversification has been related to social movements such as the back-to-the-land movement of the 1970's and the recent local food movement over the past two decades [1]. Sustainable development can follow different pathways depending on the emphasis on either specialization or diversification.

Specialization during agricultural development is typically concentrated in specific geographic areas with optimal agricultural production compared to other production areas. However, there can be sustainability tradeoffs to such regional comparative advantages. For example California USA generates ~80% of global exports for almonds. However, there is increased global production risk due to drought in addition to the retaliatory trade tariffs [2]. Another example of tradeoffs in agricultural specialization is sugarcane production in southeastern Brazil. Brazil is the world's largest sugarcane producer but sandy soils in this major production area limit crop yields due to the lower water holding capacity of these soils [3].

Agricultural specialization can also be more dependent on external inputs, government support, and interdependence with other countries. China is a great example of this with potential for sustainable agricultural intensification limited by water availability and the need for more investments in irrigation [4]. Additionally, China's shift from more labor intensive to more capital intensive agricultural production requires substantial investments in agricultural mechanization which is influenced by economics, government policies, and environmental goals [5]. Top-down government policies such as Chinese agricultural subsidies can encourage agricultural enterprises to grow more favorably [6], which can alleviate extreme poverty [7]. Agricultural specialization and comparative advantage makes global trade more critical and this is especially the case for countries along China's "Belt and Road" [8]. However, Chinese agricultural economic growth is projected to be stagnant in the future despite substantial recent growth over the past 20 years [9].

Despite the potential for global agriculture to sustainably intensify in the future, such sustainable intensification may not be environmentally sustainable. Environmental impacts of agricultural development include land use change in Brazil's Midwest where native habitat has been converted to commodity crops (e.g., soybeans, maize, cotton) at a rapid rate over the past 25 years [10]. Agricultural row crop expansion and urban development in this region of Brazil has also increased suspended sediment in rivers [11].

Addressing the economic and environmental challenges of specialized agricultural production focuses on detailed models and field experiments to help balance yield and

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profit maximization with reducing adverse environmental impacts. For example, biophysical modeling can be used to evaluate and improve sustainability. In Brazil, use of growth-stage specific regression modeling can identify factors that limit sugarcane yield such as soil water storage during the second growth phase in sandy soils [12]. Agricultural erosion modeling using GeoWEPP for crops, pasture, and natural habitat in Brazil's Midwest can be validated and used to help minimize erosion at the micro-watershed scale [13]. In-field rainfall simulator experiments can suggest which combinations of ground cover and management practices are best in minimizing erosion as was demonstrated in Brazil's Midwest region [14].

Diversification can involve both enterprise diversification as well as ecological intensification both on-farm and around the farmscape. Enterprises diversification can include other crop enterprises such as mung beans and broad beans in China, which are economically promising due to lower labor requirements [15]. Diversification of enterprises can also include non-food crops such as growing and commercializing medicinal plants used for childhood diseases in South Africa [16]. There is consumer support for such indigenous plants in West Province, South Africa [17]. Enterprise diversification can also include activities not related to crops/livestock. For example, Nigerian youth diversifying into non-agricultural sectors can increase rural development and reduce dependency on the agricultural sector [18].

Ecological intensification can involve integration of livestock and agro-forestry with crops. For example in northeast Brazil, bio-fertilization of cactus for food/feed applications in dry climates can be accomplished with cattle manure [19]. Sustainable beef systems in Brazil such as integrated crop-livestock-forest systems can reduce de-forestation pressures as well as sequester global carbon emissions and have been recently encouraged by favorable government policies such as the Brazilian Forest Code, the Low Carbon Agriculture Plan, and the National Integrated Crop-Livestock-Forest Integration policy which have been updated and/or implemented over the past two decades [20].

Sustainable development in agricultural regions also involves agro-forestry as well as preserving native forests and supporting native pollinator populations. Sustainable forest plantations have critical sustainability implications in the Republic of Congo in Africa [21]. Preservation of native forest in China is dependent on ecological forest rangers [22]. Involving government agencies such as the New England USA Department of Transportation in planting native pollinator pastures can help stabilize pollinator populations which can benefit local farmers growing pollinator dependent crops such as cranberry, blueberry, and squash [23].

Despite the promise of maintaining the diversity of small shareholders in the developing world, challenges remain. Expanding chicken production by small shareholders in Nigeria is limited by the high costs of purchased poultry feed making it challenging to produce eggs cheaply without government subsidies [24]. This suggests encouraging more local concentrated feed production for livestock [1]. Farmer outreach and extension are critical for supporting agricultural producers and agricultural professionals in adopting more sustainable agricultural systems, especially in regions where agricultural specialization is dominant such as Brazil's Midwest region [25]. Future agricultural diversification can be inspired by diversified systems of the past such as diversifying into growing livestock feed for cattle and hogs to forage in-field during the fall, as was done in Maine during the mid-20th century [1]. Similar regional case studies can be used to inspire and implement diversified agricultural systems for more sustainable future food systems.

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References

1. Hoshide, A.K. Back to the Future: Agricultural Booms, Busts, and Diversification in Maine, USA, 1840–2017. *Sustainability* **2022**, *14*, 15907. [CrossRef]
2. Ajibade, A.; Saghaian, S.U.S. Almond Exports and Retaliatory Trade Tariffs. *Sustainability* **2022**, *14*, 6409. [CrossRef]
3. Viana, J.L.; de Souza, J.L.M.; Auler, A.C.; de Oliveira, R.A.; Hoshide, A.K.; de Abreu, D.C.; da Silva, W.M. Water Dynamics and Hydraulic Functions in Sandy Soils: Limitations to Sugarcane Cultivation in Southern Brazil. *Sustainability* **2023**, *15*, 7456. [CrossRef]
4. Li, H.; Liu, H. Climate Change, Farm Irrigation Facilities, and Agriculture Total Factor Productivity: Evidence from China. *Sustainability* **2023**, *15*, 2889. [CrossRef]
5. Li, Z.; Zhu, M.; Huang, H.; Yi, Y.; Fu, J. Influencing Factors and Path Analysis of Sustainable Agricultural Mechanization: Econometric Evidence from Hubei, China. *Sustainability* **2022**, *14*, 4518. [CrossRef]
6. Wu, L.; Hu, K.; Lyulyov, O.; Pimonenko, T.; Hamid, I. The Impact of Government Subsidies on Technological Innovation in Agribusiness: The Case for China. *Sustainability* **2022**, *14*, 14003. [CrossRef]
7. Sun, Y.; Yao, S.-N. Sustainability Trade-Offs in Media Coverage of Poverty Alleviation: A Content-Based Spatiotemporal Analysis in China's Provinces. *Sustainability* **2022**, *14*, 10058. [CrossRef]
8. Zhou, L.; Tong, G. Structural Evolution and Sustainability of Agricultural Trade between China and Countries along the "Belt and Road". *Sustainability* **2022**, *14*, 9512. [CrossRef]
9. Guo, X.; Lung, P.; Sui, J.; Zhang, R.; Wang, C. Agricultural Support Policies and China's Cyclical Evolutionary Path of Agricultural Economic Growth. *Sustainability* **2021**, *13*, 6134. [CrossRef]
10. Kraeski, A.; de Almeida, F.T.; de Souza, A.P.; de Carvalho, T.M.; de Abreu, D.C.; Hoshide, A.K.; Zolin, C.A. Land Use Changes in the Teles Pires River Basin's Amazon and Cerrado Biomes, Brazil, 1986–2020. *Sustainability* **2023**, *15*, 4611. [CrossRef]
11. Paulista, R.S.D.; de Almeida, F.T.; de Souza, A.P.; Hoshide, A.K.; de Abreu, D.C.; da Silva Araujo, J.W.; Martim, C.C. Estimating Suspended Sediment Concentration using Remote Sensing for the Teles Pires River, Brazil. *Sustainability* **2023**, *15*, 7049. [CrossRef]
12. Viana, J.L.; de Souza, J.L.M.; Hoshide, A.K.; de Oliveira, R.A.; de Abreu, D.C.; da Silva, W.M. Estimating Sugarcane Yield in a Subtropical Climate Using Climatic Variables and Soil Water Storage. *Sustainability* **2023**, *15*, 4360. [CrossRef]
13. Magalhães, W.d.A.; Amorim, R.S.S.; Hunter, M.O.; Bocuti, E.D.; Raimo, L.A.D.L.D.; da Silva, W.M.; Hoshide, A.K.; de Abreu, D.C. Using the GeoWEPP Model to Predict Water Erosion in Micro-Watersheds in the Brazilian Cerrado. *Sustainability* **2023**, *15*, 4711. [CrossRef]
14. Alves, M.A.B.; Souza, A.P.; Almeida, F.T.; Hoshide, A.K.; Araújo, H.B.; Silva, A.F.; Carvalho, D.F. Effects of land use and cropping on soil erosion in agricultural frontier areas in the Cerrado-Amazon Ecotone, Brazil, using a rainfall simulator experiment. *Sustainability* **2023**, *15*, 4954. [CrossRef]
15. Ma, J.; Qu, J.; Khan, N.; Zhang, H. Towards Sustainable Agricultural Development for Edible Beans in China: Evidence from 848 Households. *Sustainability* **2022**, *14*, 9328. [CrossRef]
16. Ndhlovu, P.T.; Omotayo, A.O.; Otang-Mbeng, W.; Aremu, A.O. Commercialization Potential of Six Selected Medicinal Plants Commonly Used for Childhood Diseases in South Africa: A Review. *Sustainability* **2022**, *14*, 177. [CrossRef]
17. Omotayo, A.O.; Ndhlovu, P.T.; Tshwene, S.C.; Olagunju, K.O.; Aremu, A.O. Determinants of Household Income and Willingness to Pay for Indigenous Plants in North West Province, South Africa: A Two-Stage Heckman Approach. *Sustainability* **2021**, *13*, 5458. [CrossRef]
18. Rufai, A.M.; Ogunniyi, A.I.; Salman, K.K.; Salawu, M.B.; Omotayo, A.O. Rural Transformation and Labor Market Outcomes among Rural Youths in Nigeria. *Sustainability* **2021**, *13*, 13794. [CrossRef]
19. Silva, M.S.; Nóbrega, J.S.; Santos, C.C.; Costa, F.B.; de Abreu, D.C.; da Silva, W.M.; Hoshide, A.K.; Gomes, F.A.L.; Pereira, U.S.; Linné, J.A.; et al. Organic Fertilization with Biofertilizer Alters the Physical and Chemical Characteristics of Young Cladodes of *Opuntia stricta* (Haw.) Haw. *Sustainability* **2023**, *15*, 3841. [CrossRef]
20. Molossi, L.; Hoshide, A.K.; de Abreu, D.C.; de Oliveira, R.A. Agricultural Support and Public Policies Improving Sustainability in Brazil's Beef Industry. *Sustainability* **2023**, *15*, 4801. [CrossRef]
21. Koutika, L.-S.; Matondo, R.; Mabiala-Ngoma, A.; Tchichelle, V.S.; Toto, M.; Madzoumbou, J.-C.; Akana, J.A.; Gomat, H.Y.; Mankessi, F.; Mbou, A.T.; et al. Sustaining Forest Plantations for the United Nations' 2030 Agenda for Sustainable Development. *Sustainability* **2022**, *14*, 14624. [CrossRef]

22. Zhang, Y.; Wang, X.; Wan, S.; Zhu, H. Fuzzy Set Qualitative Comparative Analysis of the Factors Affecting Satisfaction with the Policy of Ecological Forest Rangers. *Sustainability* **2023**, *15*, 6743. [CrossRef]
23. Campanelli, J.; Kuzovkina, Y.A.; Kocurek, S. Current Impediments for New England DOTs to Transition to Sustainable Roadside Practices for Strengthening Pollinator Habitats and Health. *Sustainability* **2023**, *15*, 3639. [CrossRef]
24. Sowunmi, F.A.; Bello, A.A.; Ogunniyi, A.I.; Omotayo, A.O. Delving Deeper into Market Concentration of Poultry Feed and the Driving Factors for Brand Switching: Evidence from Commercial Egg Producers in Nigeria. *Sustainability* **2022**, *14*, 8030. [CrossRef]
25. dos Reis, J.A.V.; Hoshide, A.K.; Vreyens, J.R.; de Oliveira, A.S.; de Barros, V.A.M.; da Silva, W.M.; Molossi, L.; Viana, J.L.; de Abreu, D.C.; de Oliveira, R.A. Training Sources and Preferences for Agricultural Producers and Professionals in Middle-North Mato Grosso, Brazil. *Sustainability* **2023**, *15*, 4712. [CrossRef]