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How to meet the needs of bees? - Diversification of industrial crops cultivation for a more environmentally benign bioeconomy

Moritz von Cossel

University of Hohenheim, Germany

Statement of the Problem: Today, agriculture is facing fundamental ecosystemic crisis such as pollinator losses and land degradation mainly driven by both climate change and declining landscape heterogeneity. Consequently, industrial crops cultivation (ICC) key element of a growing bioeconomy - should both avoid competition with food crops cultivation (FCC) and take environmental aspects into account. In Germany however, ICC for biogas production is still characterized by only a few biogas substrates such as maize or whole crop cereal silage prevalently using non marginal areas strongly competing with FCC. This study reassesses agricultural diversification of ICC to support agrobiodiversity especially considering low-input practices on marginal lands.

Methodology & Theoretical Orientation: Several field trials with amaranth (*Amaranthus hypochondriacus* L.) and perennial wild plant mixtures (WPM) were conducted at three sites in southwest Germany from years 2014 to 2017. Lab scale biogas yield assessments were conducted with milled dry matter samples.

Findings: The diversification of biogas crop rotation systems with amaranth was found promising for increasing ecosystemic functioning of ICC for biogas production. Amaranth provides high amounts of nectar, an essential ecosystemic service towards biodiversity conservation. Additionally, amaranth showed comparable suitability for legume intercropping to maize. However, both better agronomic knowledge and genotypes are required to improve its performance. WPM cultivation showed highest potential for biodiversity conservation due to its high species diversity and long-term soil cover. High biomass yields (> 20 t ha⁻¹) were observed under marginal growth conditions. The long term performance of WPM could be improved using maize as nurse crop in the establishment year. However, low yield stability and variable biogas substrate quality render crucial challenges for practical implementations of WPM.

Conclusion & Significance: This study reports promising temporal and spatial agricultural diversification measures for more environmentally benign industrial crop cultivation and derives basic recommendations for further investigations.



Recent Publications

1. Von Cossel, M., Möhring, J., Kiesel, A. and Lewandowski, I. (2017) Methane yield performance of amaranth (*Amaranthus hypochondriacus* L.) and its suitability for legume intercropping in comparison to maize (*Zea mays* L.). *Industrial Crops & Products* 103: 107-121. Doi: 10.1016/j.indcrop.2017.03.047. URL: <http://dx.doi.org/10.1016/j.indcrop.2017.03.047> [Accessed June 11, 2018].
2. Von Cossel, M. and Lewandowski, I. (2016) Perennial wild plant mixtures for biomass production: Impact of species composition dynamics on yield performance over a five-year cultivation period in southwest Germany. *European Journal of Agronomy* 79: 74-89. Doi: 10.1016/j.eja.2016.05.006. URL: <http://dx.doi.org/10.1016/j.eja.2016.05.006>.

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3. Von Cossel, M., Möhring, J., Kiesel, A. and Lewandowski, I. (2018) Optimization of specific methane yield prediction models for biogas crops based on lignocellulosic components using non-linear and crop-specific configurations. *Industrial Crops & Products* 120: 330-342. Doi: 10.1016/j.indcrop.2018.04.042. URL: <https://doi.org/10.1016/j.indcrop.2018.04.042> [Accessed June 11, 2018].
4. Von Cossel, M., Steberl, K., Möhring, J., Kiesel, A., Lewandowski, I. (2017) Etablierungsverfahren mehrjähriger Biogas-Wildpflanzenmischungen im Vergleich: Ohne Mais geht's nicht? *Mitteilungen der Gesellschaft für Pflanzenbauwissenschaften* (Witzenhausen: Liddy Halm), 58–59. Available at: <https://www.gpw.uni-kiel.de/de/jahrestagung/tagungsbaende/tagungsband-2017> [Accessed June 11, 2018].
5. Elbersen, B., van Eupen, M., Mantel, S., Alexopoulou, E., Bai, Z., Boogaard, H., Carrasco, J., Ceccarelli, T., Ciria Ramos, C., Ciria, P., Cosentino, S.L., Elbersen, W., Eleftheriadis, I., Fritz, S., Gabrielle, B., Iqbal, Y., Lewandowski, I., McCallum, I., Monti, A., Mucher, S., Scordia, D., Verzandervoort, S., von Cossel, M., Zanetti, F. (2018) Mapping marginal land potentially available for industrial crops in Europe. Conference: EUBCE 2018 - 26th European Biomass Conference & Exhibition. Copenhagen. 2018. Available at: https://www.researchgate.net/publication/325272893_Mapping_Marginal_land_potentially_available_for_industrial_crops_in_Europe [Accessed June 11, 2018].

Biography

Moritz von Cossel is a Research Associate and Doctoral candidate at the Department of Biobased Products and Energy Crops at Hohenheim University. Before studying, he trained to become a vegetable grower at Germany's largest vegetable farm, Behr AG where he gained first knowledge on basic agricultural practices and both chances and challenges of diverse cropping systems. After receiving his Master's degree in Crop Science from Kiel University, he moved to southern Germany and started his research on both temporal and spatial diversification measures in biogas cropping systems at Hohenheim University. Over the past four years, he has participated in the GOBI project (General Optimization of Biogas Processes) and revealed valuable insights to the cultivation of amaranth and perennial wild plant mixtures for biogas production. Currently, he is working on low-input agricultural practices for industrial crops cultivation on marginal lands across Europe (EU-28 and Ukraine) as part of the MAGIC project.

moritz.cossel@uni-hohenheim.de

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