Project *brief*

Thünen-Institute of Organic Farming, Thünen-Institute of Agricultural Technology

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Food security for Africa in 2100

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- **The population in Africa will increase four- to fivefold by the year 2100.**
- **Land for food production will then decrease to about 500 to 600 m² per person.**
- **A combination of land-based and landless food production can help.**
- **A research model for a sustainable and circular food chain has been developed.**

By 2100, Africa may only have 500 square meters of land per person available for food production. Billions of people would then be without a secure livelihood. To effectively address this problem, a combination of land-based and landless food production has been developed and described as a model.

Background and Objectives

Already today Africa is a continent of hunger. By 2100 the population is expected to quadruple. Then there will be only 500 square meters of arable land per person for food production, even if all suitable areas are used for it. Sustainable solutions are needed for this. However, previous efforts do not appear to be sufficient or suitable for this.

This is where the project comes in. The aim was to describe the problem and to develop a coherent, sustainable and circular concept for food production in the year 2100. This concept should not only, but especially, do justice to the precarious socio-economic and agro-ecological conditions in Africa:

- Description of the problem.
- Development of a model that provides a solution to the problem.
- Scientific discussion of the model and its assumptions and foundations (validation).
- Publication of the results.

Procedure

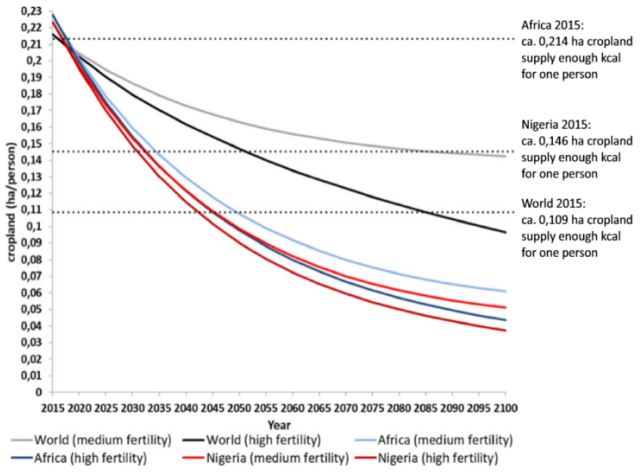
The project was designed as a two-year think tank at the Thünen-Institute. On the basis of literature analyses, the situation was described in scenarios. Solutions were then sought on the basis of rather pessimistic scenarios and a model was developed that combines a land-based with a landless food production technology. This model was discussed and further developed with experts at an international workshop. The results were published in a special scientific issue.

Results

The problem

Previous efforts (intensification of land use, land expansion, international trade, behavioral changes through dietary styles and reduction of waste) will not be sufficient to ensure a secure food supply for people, especially in Africa, but also in India, Pakistan and other countries, by the year 2100. An agriculturally usable area of perhaps only 500 square meters per person is too little for sufficient land-based production.

Land availability for the food supply of a person in the period from 2015 to 2100 under different scenarios.



Source: Rahmann et al. (2020).

In addition to the scarcity of land, there are increasing difficulties such as scarce resources (water, capital, knowledge), climate change and land use that is not geared to food production. Billions of times hunger and migration are logical consequences that will also have an impact in Europe and Germany.

Solution approaches

First of all, research is needed to develop coherent and innovative concepts, such as landless and possibly reactor-based food production, and to integrate them into traditional land-based production. An efficient production and use of energy must be considered.

- Pollutant minimizing or tolerating material flows have to be developed, since contamination has to be assumed.

- The human being as the target of the solution (consumer) is put in the center of the nutrient flows. His faeces and biogenic household waste are integrated.
- In a green chain (see diagram), agricultural production with plants, fungi and animals ensures the qualitative supply (proteins, vitamins, secondary ingredients) of man, which is, however, insufficient in terms of energy.
- The blue chain is reactor-based and uses biomass, which is not used for food and feed, for re-generative energy production (cooking, light) and as substrate for algae or similar. The latter should above all enable the caloric supply of humans.

In addition to biological, mechanical and organizational-technological developments, socio-economic aspects must also be taken into account.
Both levels must ultimately clarify whether and how all people can be adequately supplied with healthy and affordable food that has been sustainably produced.
When deriving measures to reduce food waste and analyzing environmental impacts, rebound effects, nutritional effects and costs as well as social aspects should also be taken into account.

Recommendations

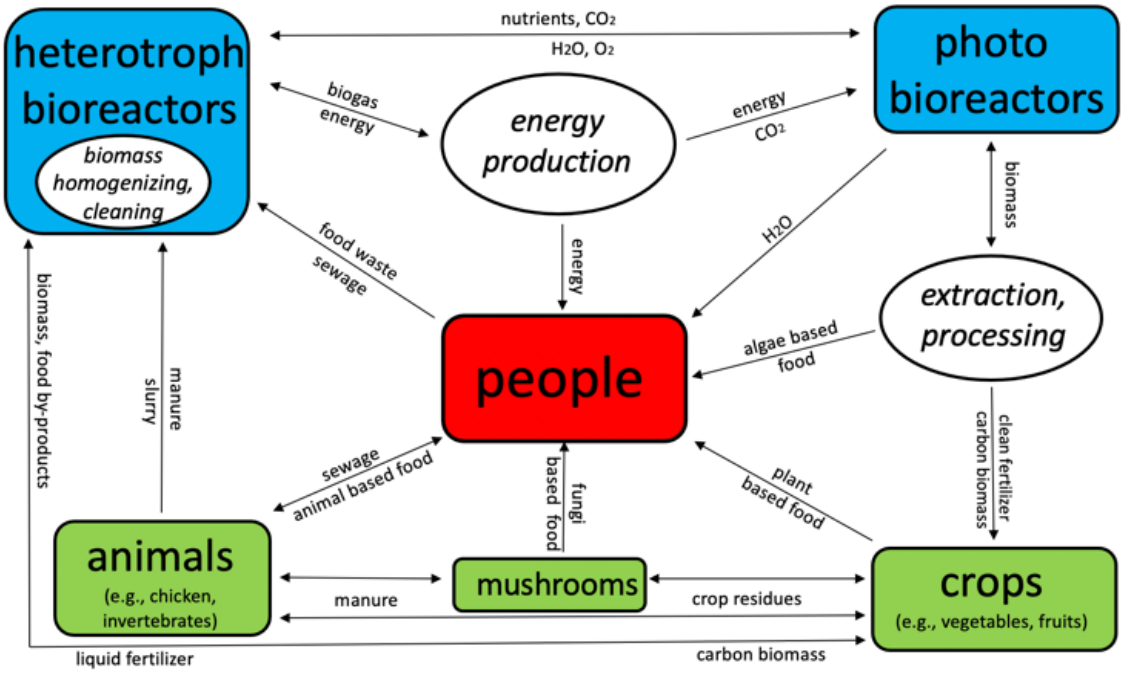
Research in the production and consumption of food has long been called upon to gear existing processes towards greater efficiency, sustainability and performance, and to offer both technological and socio-economic solutions in good time. More coherence of all activities and use of synergy effects through better integration of available technologies (components) are an important basis.
In order to have enough healthy and affordable food available everywhere in the world in 2100, the following activities are proposed for research and implementation:

- Better understand what people eat.
- Maximize agricultural yields in a sustainable way.
- Development of sustainable food chains (production to consumption).
- Define ethical and social standards for food chains.
- Ensure a fair food supply.
- Exploring new food sources.
- Develop food systems with less livestock.
- Intensify education for sustainable consumption and production.
- Promote and protect sustainable, local production of staple foods.
- Integrate landless food production.

Important components that will be further developed at the Thünen-Institute following this conceptual phase:

- Algae production in reactors for the production of energy carriers in nutrition: carbohydrates.
- Fungal production on the basis of biomass suitable for nutrition/feeding: vitamins and proteins.
- Integration of invertebrates to produce essential food ingredients: essential proteins.
- Integration of developed building blocks into a coherent model.
- Feasibility studies on a technological and socio-economic basis.

LandLessFood model: Coherent cycle model for a sustainable and circular food chain



Further information

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Publications

Rahmann, G., Grimm, D., Kuenz, A., & Hessel, E. (2020)

Combining land-based organic and landless food production: a concept for a circular and sustainable food chain for Africa in 2100. *Organic Agriculture*, *10*(1), 9-21,

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