

WaCASA - The Wageningen Centre for Agroecology and Systems Analysis

Vision

The overall aim of *WaCASA* is to generate and integrate knowledge to **analyse** and **design sustainable production systems** for crops, livestock and their interactions, with a focus on resource use efficiency and equitable management of natural resources. *WaCASA* works across multiple spatial and temporal scales, i.e. from crops and livestock to farms, landscapes, regions and globe. Using concepts of **systems analysis**, staff contribute to the development of productive and resource use efficient agricultural systems, and develop methods that allow integrated analysis and design of alternative futures of agricultural production systems.

WaCASA staff develop and use systems analysis approaches and apply key concepts such as resource use efficiency, sustainability and up- and down-scaling of information. The research and education of *WaCASA* contributes to resource-use-efficient agricultural (plant and animal) production systems around the globe that meet the multiple aims of sustainable development at global, regional and local levels.

WaCASA brings together three chair groups with complementary expertise - Animal Production Systems (APS), Plant Production Systems (PPS) and Organic Farming Systems (OFS). Staff work together across the groups on a set of themes, each with a leader who coordinates the work and oversees acquisition. Themes are dynamic and evolve over time in relation to developments in science, in societal demands and in funding opportunities.

Close collaboration is fostered with Agrosystems Research of the research institute Praktijkonderzoek Plant & Omgeving / Plant Research International within the Plant Sciences Group and the Wageningen Livestock Research of the Animal Sciences Group in Lelystad. *WaCASA* is created to stimulate collaboration and we strive to ensure that there are no barriers to collaboration with other Wageningen chair groups and with external partners.

Introducing WaCASA

WaCASA contributes to development of sustainable agricultural systems, which range from environmentally friendly and efficient crop production to sustainable animal production systems and self-reliant, viable organic systems. *WaCASA* is formed from Plant Production Systems (PPS), Animal Production Systems (APS) and Organic Farming Systems (OFS). Within *WaCASA* each group has its own point of departure to address sustainability issues.

PPS approaches are rooted in the tradition of C.T. de Wit, combining empirical knowledge and production ecology with understanding of farming systems derived from survey and databases. Methodology development and application are central to understanding current systems and design of new production systems that

contribute to addressing societal problems of global significance. Various modelling approaches based on simulation of animal and crop production, multiple objective analysis, bio-economic farm modelling are key. An interdisciplinary approach is central, as the issues deal with complex human systems. Qualitative analytical social science contributes to derivation of scenarios for future studies and examining the role of models in communication and co-learning with stakeholders. The issues also require analyses at multiple levels, and a key research issue is scaling from the farm to region to the global level. The main contribution of PPS to *WaCASA* is to provide knowledge of plant production within crop and livestock production systems, and how this knowledge can be scaled up from the farm to higher integration levels.

APS has a firm basis in animal science, and is specialized in integrating knowledge from diverging disciplines to analyse and explore current and future animal production systems to improve sustainable development of animal production. Research efforts focus on systems in both developed and developing countries, at farm or higher aggregation levels, with special emphasis on the environment, animal welfare (including health), economic viability, and food safety and food security. System tools are used to understand and explore relations between biological and ecological processes, and their interactions with society, which is considered to be essential for a solid contribution towards solving complex sustainability problems in animal production. This implies animal production respectful towards people, animals and the environment, worldwide. The main contribution of APS to *WaCASA*, therefore, would be to provide knowledge of the interaction between the animal, other system components (feed, soil), the surrounding environment and society.

OFS focuses on the analysis, design and evaluation of organic and other low-input farming systems, in which the utilization of natural processes is optimized, the use of external inputs and the nutrient emissions to the environment are minimized. The ultimate goal is high-quality agriculture based on cycles that are as closed as possible, taking into account soil functions and quality, crop and animal health and farming practices. The group has its scientific forte in quantitative systems approaches, drawing on disciplinary knowledge from agro-ecology, production ecology and landscape ecology. A quantitative system understanding at field and herd level is synthesized at farm and landscape levels, using surveys, experiments and expertise as information sources. Results demonstrate system performance in terms of sustainability indicators and their trade-offs. The contextual nature of sustainability is addressed by developing co-innovation as an approach for system analysis and redesign with stakeholders, and by studying the interplay between social and technical systems as part of adaptive management thinking. Methodologically the group develops and applies dynamic simulation models, multi-objective optimization approaches, and network analysis at different hierarchical levels. Systems studied include mixed and specialized organic systems and other systems that foster ecological intensification, in an ecosystems context. Special attention is paid to integration of plant and animal production to be able to close nutrient cycles at farm or regional levels. The main contribution to the activities in *WaCASA* is to provide knowledge and methods for analysis and redesign of

ecologically intensive farming systems and their interaction with agro-landscapes to meet societal demands of sustainability.

Through their research and development projects, the three groups aim to incorporate explicitly the socio-economic dimensions of agricultural systems to reach equitable management of resources. On the one hand this is achieved by collaboration with economists and social scientists; on the other hand projects are conducted in close interaction with stakeholders by applying co-innovation approaches. Explicit consideration of contrasting stakeholder perspectives is an integral part of development of soft and hard systems methodology.

Bringing together the three chair groups adds value by fostering the disciplinary scientific and methodological integration for analysis of existing systems and the development of more sustainable alternatives. We thus address the following broad societal and policy themes:

- a) Global food security: Working around issues of global food security in relation to the food crisis and global change and food systems. A global yield gap analysis can support understanding of production potentials and understanding options to increase resource use efficiency and productivity. Drivers investigated include population, poverty and climate – and the impact of other trends such as biofuel demands on food security. *WaCASA* plays a central role in the new IP/OP theme on this issue.
- b) Climate change and climate variability: Playing into the global debate from a food systems perspective, including both plant and animal production. Research will be nested across a range of scales from local to global, and addresses biophysical processes as well as *ex-ante* and *ex-post* evaluation of policies and implications of socio-institutional dynamics. Focus will be on embedding this work internationally to contribute to integrated assessments aiming at better-informed political and societal decision-making.
- c) Bio-based economy - Agriculture beyond food and feed: engaging in the food-feed-fuel debate and other alternative uses for biomass, analysing trade-offs around production goals and uses. Special attention is paid to the agro-ecological variability and special niches for various production goals, the position of smallholders (family farms) and their livelihoods.
- d) Respectful animal production: Intensive animal production continues to receive intense attention in the media and public debate. Integrated assessments of a wide variety of animal production systems around the world ranging in intensity of production are required. Such assessments will include animal welfare alongside a wider range of sustainability indicators.
- e) Viability of rural areas: the livelihoods of rural communities in many parts of the world are threatened by the continuing deterioration of ecosystems, the industrialization and scale-enlargement of production systems and the globalization of markets. To face the additional challenges caused by urban growth and urbanization, a properly functioning rural area is required, for instance to contribute to food security. *WaCASA* will analyse possibilities to

support the livelihoods of those dwelling in rural areas in both north and south. We contribute by developing efficient and adaptable production systems, by exploring options to integrate agricultural production with the urban developments, by focusing on options for less-favoured areas.

- f) Competing claims on natural resources: focusing on the broader role of agriculture within debates around biodiversity conservation and ecosystem services. Going beyond romantic notions of shared agriculture and nature, this theme recognises the struggle for control of land and water for agriculture, for wildlife conservation, and for urban development. The role of power in multiple-scale, multiple stakeholder contests for access and control over natural resources plays out in both North and South. The Millennium Ecosystem Assessment in 2005 suggests that intensive use of ecosystems damages biodiversity and undermines the provision of ecosystem services. Others argue that intensification of production is needed to spare land for nature and avoid indirect land use change (ILUC). Multi-functional land use systems are explicitly assessed or designed for their contribution to functions beyond the provision of food and fibres, such as landscape and biodiversity services. *WaCASA* contributes by identifying land-use systems that are more sustainable, and by assessing and visualizing the interactions among ecosystem services. This can support well-informed decisions on land-use by policy-makers. A spatial ecological approach often comes to the fore in such studies.
- g) Nutrient and water management in agro-production systems: efficient resource use at farm and regional level, optimizing water productivity, minimizing nutrient emissions, preserving soil fertility. Building on knowledge of competing demands for water resources for production activities in relation to other (urban) uses, the contribution of *WaCASA* is to scaling issues concerning efficient water use. Our work also has relevance in terms of the North-South divide – the ‘effluents of affluence’ related to nutrient excess caused by organic ‘wastes’ against ‘recycling poverty’ of organic-resource-poor farming in the tropics. Integrated analysis of crop-livestock systems is key in both cases at the farm and farming system scale. Depletion of phosphorus and other ‘less-renewable’ nutrient resources takes place across scales.

The sustainability and performance of existing or novel agricultural systems is dependent on local contexts. *WaCASA* maintains and fosters the empirical knowledge of agricultural systems around the globe. Thus our analyses are grounded in a deep understanding of agricultural systems and the local sociological drivers that shape them. The agricultural systems that *WaCASA* focuses on can be conceptualized in different ways, depending on their production activities, their performance in terms of various functions or their ability to change and adapt to developments and drivers in the ecological or socio-economic environment.

Thus, the systems under study include:

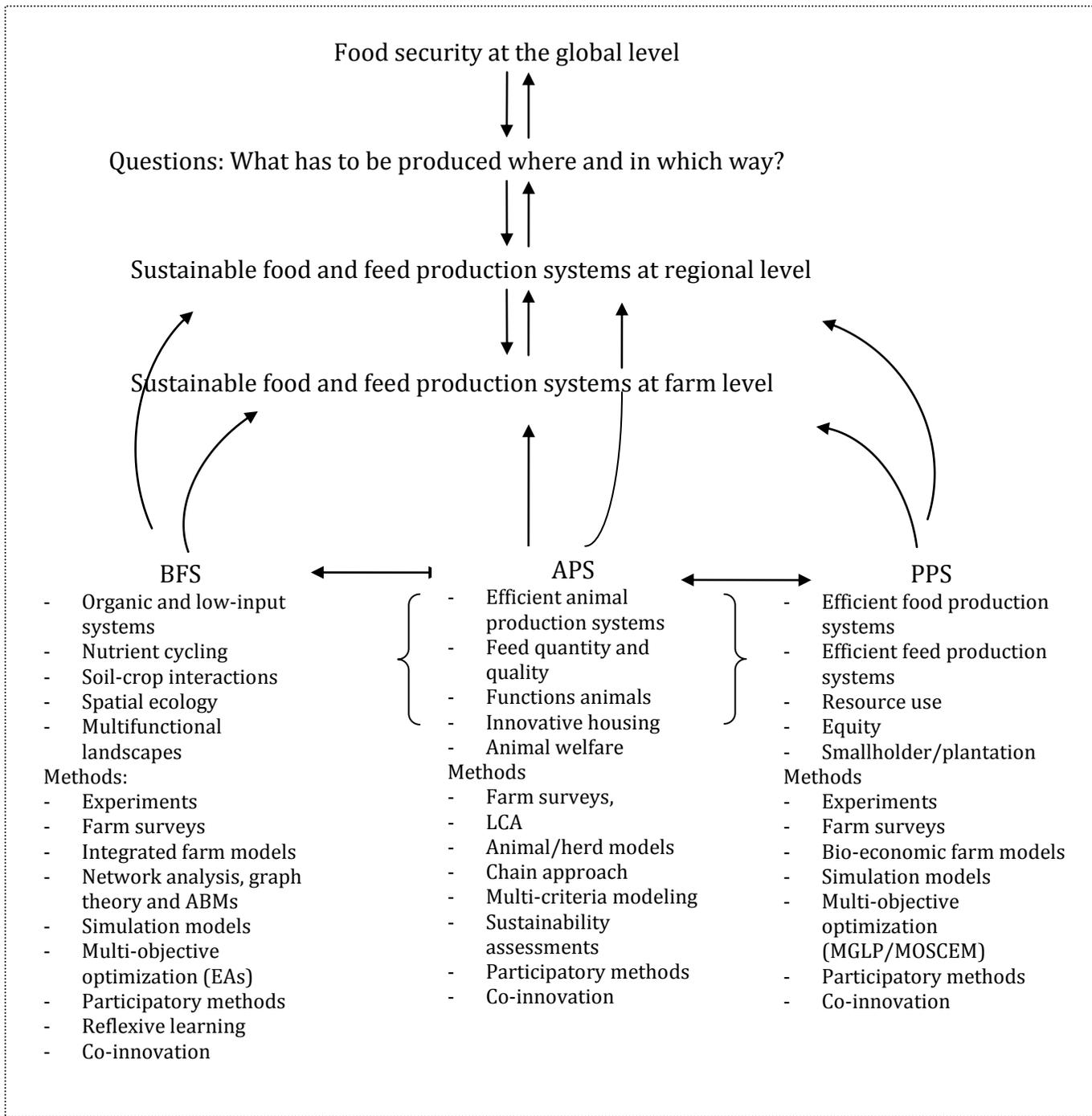
- 1) Adaptive agricultural systems: Focusing on change and evolution in farming systems and *sustainagility* – the resilience, robustness, resistance and responsiveness of systems – focusing on dynamics. A design approach can contribute to novel farm and farming system configurations that maximise adaptive capacity. This theme will bridge possibilities for adaptation across a whole range of intensification – including extensive to intensive cropping and livestock systems, tillage and energy-saving systems and crop-livestock interactions.
- 2) Intensive and sometimes industrialized plant and animal production systems: are strongly dependent on external outputs and are surrounded by concerns on environmental impact and animal health and welfare. Close collaboration with Wageningen UR Livestock Research on this theme is envisaged.
- 3) Mixed crop-livestock systems: Physically integrate crops and livestock within the same (farm) enterprise or among cooperating (farm) enterprises in the same region. These systems potentially play a crucial role in enhanced nutrient and energy cycling.
- 4) Organic farming systems: are developed based on principles of organic agriculture (ecology, health, care, equity). Other alternative, low-input systems and ecological agriculture are also studied.

Methods for Integrated Assessment

WaCASA brings together a rich diversity of methods and approaches. These methods can be re-combined and employed to allow approaches for integrated assessment to be developed, relevant to all research issues and systems described above.

A joint 'Agricultural Systems Methodology Repository' (AMR) is being developed as an open source resource. During recent years, each group has developed and uses its own research tools. Development of methods is tackled in several projects, based in case studies in different parts of the world, each with its own focus on specific sustainability problems. The type of sustainability problems, the data availability and the type of solutions in developing countries often differs from these in the western world and hence, require different or at least adapted methodologies. This has resulted in a wealth of approaches that would be even more effective to tackle the societal themes if developed and applied in a joint effort. The AMR would include tools for:

- a. Soft systems approaches:
 - i. Participatory and action research
 - ii. Reflexive learning
 - iii. Co-innovation
 - iv. Game-based stakeholder/group interaction
- b. Hard systems approaches
 - i. Bio-economic modelling
 - ii. Crop and animal simulation models
 - iii. Life-cycle analysis
 - iv. Farm surveys and typology analysis
 - v. Mathematical programming techniques
 - vi. Heuristic optimization techniques (incl. Genetic and Evolutionary algorithms GAs and EAs, MOSCEM)
 - vii. Trade-off and synergy analysis
 - viii. Chain and network analysis, graph theory
 - ix. Agent based models (ABMs)
- c. Data and databases on
 - i. Weather
 - ii. Soils
 - iii. Farms
 - iv. Agricultural management
 - v. Crop and animal specific information
 - vi. Relevant economic information
 - vii. Policies



The above example illustrates the potential combination of approaches from the three groups to the issue of food security.