Annex 1 Research approach, components, means and budget

Research philosophy and approach
Our research method is action research meaning that research and development go hand in hand aiming to use research to shape or change the reality. This approach differs from a more evaluative type of comparative research that "just" compares existing business models. Our research will immediately feed in the development of context specific business models whereas classical comparative research may lead to the conclusion that one model is preferable over another, but not necessarily change anything on the ground. In our case, action research also implies that the shaping of the business models is taking place in interaction with societal parties (businesses, NGOs, input suppliers, buyers, knowledge institutes) and hence these models cannot be entirely designed beforehand just to be implemented during the project execution. In our terminology the word business model includes both investment models with issues such as initial costs, return on investment and payback time AND agri-food chain configurations with issues such as linkages between chain partners including flows of information, materials and money and the way running costs are covered.

Our approach has three components
1. Literature review comparing business models and making a first assessment of which business models (investment and agri-food chain configurations) are candidates for the aquaponics system. Important elements are institutional (2) and contractual (3) arrangements related to credit, provision of inputs, provision of technical advice, organisation of sales, etc. Specific attention will be given to the potential roles of producer organisations (1), companies, credit organisations, NGOs, governmental organisations and centres of expertise in agri-food chains and networks(5)in rural and peri-urban settings(4).
2. Calculations of costs of investments and payback time taking into account depreciation costs of the installation, interest rates, etc. Monitoring of economic feasibility (cost-benefit analysis: fixed and variable costs) of the running of the aquaponic systems. These data are needed to calculate return on investment and payback possibilities to support decision making on initial investments and on investments in operational costs by aquaponic producers and other societal parties.
3. Dialogue and negotiations with societal stakeholders shaping the business models (investments and agri-food chains) that best fit the context, combining literature review, economic performance of the aquaponic installations and institutional reality.

Means to perform this research
1. In each of the three research locations we have foreseen (and budgeted) one junior Ethiopian scientist to monitor (supervise filling in of the logbooks) the running of the aquaponics systems in technical and economic terms and provide technical and economic advices to the producers. The fourth foreseen (and budgeted) junior Ethiopian staff will do an institutional inventory, identifying potential partners for provision of different services related to investment in an the aquaponics system and the agri-food chain development.

2. Master students will be recruited to do literature research comparing business models and to do the cost benefit calculations based on logbooks under supervision of the main applicant and TGS. The fourth junior Ethiopian staff will also be involved in these issues and benefit from them for his task. For their supervision and especially to guarantee the scientific quality and the usefulness for business the main applicant will draw on additional expertise from Wageningen University and TGS.

   For Wageningen University no additional costs will be involved as under the current system Wageningen staff time will be compensated by a remuneration by Wageningen University itself for each finished thesis. Jos Bijman from the management studies group will be approached for co-supervision of master students because of prior collaboration with main applicant on this subject. Furthermore an Ethiopian PhD student working in Ethiopia on business models and the role and performance of producer organisations (funded by FDOV) is already jointly supervised by Bijman and main applicant and his findings will provide additional and relevant information on existing Ethiopian business models in other sectors.

   TGS has both an aquaponics and a business consultancy department. This department conducts market studies, business research and advices entrepreneurs, companies and other organizations on improving business models and value chains. TGS is already assisting the NGO in Ethiopia developing an aquaponics business model and organizing a

local value chain. This assistance will be expanded to the whole project which will require **some minor budget changes**. Senior staff of TGS will assist developing and studying different investment models and value chain designs. This includes a micro franchise model which is rarely addressed in literature, which with TGS has a lot of experience with in other companies they assist. Another model that is studied is that of a credit scheme where the system owners will slowly repay their system. Various credit scheme designs will be studied. One focus in the research will be in how to make the investments for starting an aquaponics farm as low as possible. TGS will assign two part-time senior staff to this part of the project: Klaas Evers and Rich Swanson, both experts on business models, value chain development, business development and development economics. Besides designing various business models, junior Dutch staff of TGS (already budgeted) will also work alongside the mentioned junior Ethiopian staff who will do data-collection. This data will be analysed and used for evaluating and adjusting business models including supply chain configuration.

3. TGS staff will be engaged in the negotiations leading to the design of appropriate supply chain configuration, in the area where the NGO works. TGS will assist also in the larger project area, where a senior Ethiopian scientist from the university will be responsible for the dialogue and negotiations. TGS will be included in supervising the junior scientist doing the institutional inventory (point 1) to asses with whom potentially to engage for what aspects of the business model (s). This junior will work alongside the senior staff to prepare and finalise the negotiations.

Budget adjustments
In fact little budget adjustments are needed. The above shows that we shift some emphasis towards research question 3 mainly implemented through larger involvement of TGS staff in the total project area and inclusion of a literature research component on investment models and agri-food chain configurations next to the design-in-context component. The profiles of the three junior Ethiopian staff was already on both technical and economics and the fourth junior Ethiopian staff was already designed for business and agri-food chain issues so these costs and their activities stay the same. Because of the shift of emphases towards RQ3 the three junior Ethiopian scientists will have to focus less on technical experimentation and development of technical models (RQ1) and hence have more time to focus on economics supporting business model development (RQ3). We clarified that we count on added value through existing relations and current and future joint activities between main applicant and business model experts in Wageningen University and TGS. The involvement of master students does not lead to additional costs. From the start onwards the task of the main applicant was intended to co-design and co-supervise research, monitoring and evaluation of the technical and the business model research whereby the technical expertise would need less attention as it is the core expertise of the Ethiopian counterparts and TGS, and more efforts would be spend on the business model research. In the above described research approach, components and means to perform the research this task and joint activities related to the task have been made more explicit.

In response to the comments by the International Advisory Committee we decided to benefit more from TGS' expertise and its involvement with the NGO for the entire project. Tickets and stay for TGS assistance in Ethiopia were already accounted for in the budget in the proposal. To cover the additional costs for TGS staff time of 10,340 euro (see table 1 for details) we decreased the investment in research question 1 to 56,600 (see revised budget table 2). This will imply that we will reduce the number of vegetable-fish combinations to be researched on (2 combinations in 4 systems in 3 sites (24) instead of 3 combinations in 3 systems in 3 sites (27) hence a total reduction of 3 systems) and that we will limit research on alternative fish feed and diseases to problem solving issues alone instead of focussing on conducting experiments.

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Impact pathway and indicators

The call for proposals in the Food & Business Global Challenge Programme aims to contribute to food security and in our understanding (knowledge on) business models, like on technically and economically sound aquaponic system, are means to achieve that. They are not the goal of the programme. Therefore the development of business models is presented in causes, underlying knowledge related causes, research outputs and outcomes but NOT in research impact. We reformulated and added to the earlier presented points on business models (both investment and agri-food chain configurations) to emphasize the knowledge component, especially the comparative analysis.

Given the shift in emphasis away from research question 1 we deleted point 3 in *underlying causes* (Need to develop a generic model of water and nutrient cycling in integrated production systems to underpin the design of systems with different components.) and we replaced it by " Need for knowledge on different types of business models and their comparative advantage in relation to aquaponic systems". In *research outputs* this leads than to deletion of point 4 (A model has been made of the aquaponics system to allow for a design of efficient and profitable systems with different fish and vegetable combinations) and replacing it with " Business models have been developed that fit aquaponic systems in the Ethiopian context(s)". See Figure 1 for adapted theory of change GCP table. These changes also lead to a change in impact indicators (see Figure 2). In figure 2 three of the four research outputs are on business models. All changes in table 1 and 2 are put in italic.

References to relevant research expertise on business models in the team

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6. Evers, K.; 2013. Feasibility study on the cashew processing value chain in Côte d'Ivoire. *Internal report TGS Business & development initiatives, available upon request.*
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Figure 1 Theory of Change GCP (changes in italic)

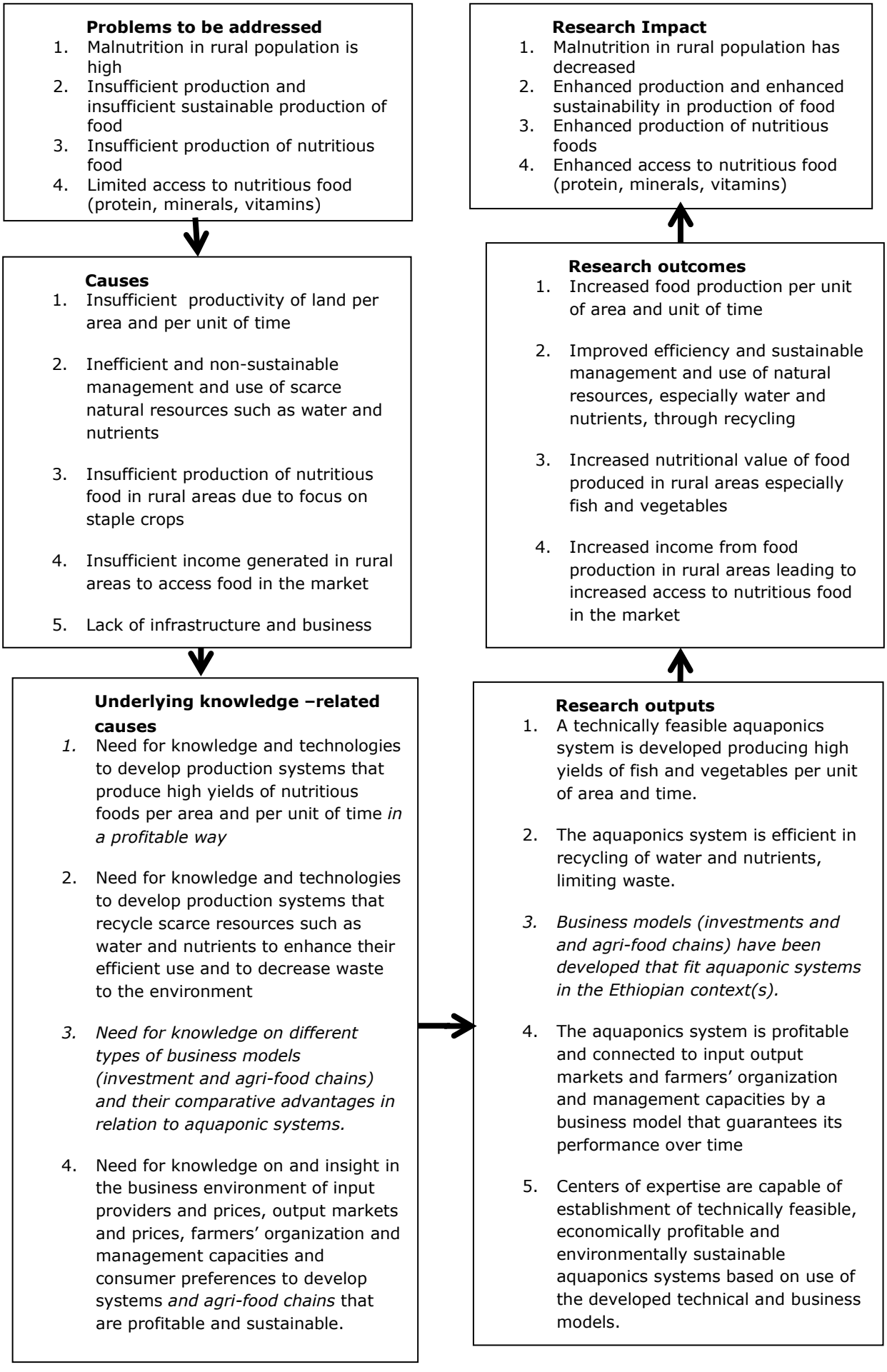

Figure 2 Research Impact Pathway diagram with indicators at output and outcome level (changes in italic)

Research outputs	**Indicators**	**Research outcomes**	**Indicators**	**Impact**
1.A technically feasible *and profitable* aquaponics system is developed producing high yields of fish and vegetables per unit time recycling water and nutrients.	Written guidelines and a calculation *tool* are publicly available for establishment of technically feasible, environmentally sustainable *and profitable* aquaponic systems.	1.Increased sustainable production of nutritious food per unit of area and unit of time.	After 2 years each of the aquaponic systems in *24* households has produced at least once 200 kg of fish per cycle of 6 months and 2000 vegetable plants without use of fertilizer, of which 90% is sold.	Enhanced sustainable production of nutritious food in rural areas leading to increased availability of nutritious food in producing households and in rural markets Enhanced access to nutritious food in rural area through home production and income generation.
2.Business models (for investment and agri-food chain configurations) have been developed that fit aquaponic systems in the Ethiopian context(s).	*Two MSc thesis and one paper published comparing business models and underpinning the selection of business model(s) most suitable for aquaponics in the Ethiopian context(s).*	2.Increased income from food production in rural areas leading to increased access to food in the market.	All *24* aquaponic households make at least 10% profit on investments per production cycle of 6 months.	
3.Business models *(investment and agri-food chain configuration)* available for sustainable and profitable production of nutritious foods.	Written guidelines available on the connection of aquaponics to the business environment including the role of centers of expertise.	3.The aquaponic systems are well connected to input output markets and technical support by a business model guaranteeing their performance over time	All *24* aquaponic producers are sustainably connected to input and output markets by long term oral or written contracts and have at least twice a year contact with centers of expertise.	Enhanced sustainability in the production of nutritious foods in rural areas through systems that are profitable, well connected to market parties, and supported by centers of expertise.
4.Institutions are built to support aquaponic systems using the developed *business* models for production and business development.	The centers of expertise have shown capable to providing technical and market development support through trainings (2 weeks /household in establishment phase) and individual advice.	4.Centers of expertise are capable of establishment and support of aquaponic systems based on use of the developed technical and business models.	All *24* aquaponic households have received a two weeks training, and have at least twice a year contact with a center of expertise.	