Deliverable D1.1 Analytical and Scenario Framework

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VITAL (Viable InTensification of Agricultural production through sustainable Landscape transition)

Task 1.1: Scientific framing of Sustainable Intensification

Deliverable D1.1 Analytical and Scenario Framework

FINAL VERSION

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List of acronyms

CAP	Common Agricultural Policy
ELISA	Environmental Indicators for Sustainable Agriculture
ESBOs	Environmentally and Socially Beneficial Outcomes
EU	European Union
FADN	Farm Accountancy Data Network
FAO	Food and Agriculture Organization
GDR	German Democratic Republic
IPCC SRES	International Panel on Climate Change Special Report on Emissions Scenarios
IRENA	Indicator Reporting on the Integration of Environmental Concerns into Agriculture Policy
PEGASUS	Public Ecosystem Goods and Services from land management – Unlocking the Synergies
PPF	Production Possibility Frontier
SES	Socio Ecological System
SI	Sustainable Intensification
SIP	Sustainable Intensification Pathway
SNA	Social Network Analysis
TO	trade-offs
VITAL	Viable InTensification of Agricultural production through sustainable Landscape transition)
WP	Work Package

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Executive Summary

The challenges of an increasing world population accelerating food demand, biodiversity globally under threat, depleting natural resources, and the need to mitigate the effects of climate change, signal that new food for thought is needed for food and non-food biomass production systems. Sustainable intensification (SI) needs to be one element of the solution. It aims at the development of intensive agricultural systems that have minimal detrimental environmental and social effects. The VITAL project explores the transition process of European agriculture towards sustainably intensified production. This first deliverable report synthesising the results of task 1.1 establishes the scientific framing of SI and the analytical approach of the project.

We therefore analysed the literature using in-depth as well as systematic approaches and developed a conceptual-scenario framework of sustainable intensification. The aim is to establish an anchoring point to assess the implementation of SI at farm and regional scale and to enable an up-scaling of the results to the European level. The conceptual-scenario framework was validated by a group of regional stakeholders in order to ensure its applicability to practice and to develop a common science-practice understanding.

We found that the understanding on what SI is and how it should be achieved varies in the literature and overlap with other concepts of sustainable agriculture, such as ecological intensification or agroecology, is debated. However, in this report we demonstrate that the discussed measures and concepts of sustainable intensification can be clustered alongside two dimensions: from the farm/local to the landscape/regional level and from land-use optimization to structural optimization. Using these two dimensions, we conceptualize four different scenarios of SI which we label sustainable intensification pathways (SIP). SIP I “Agronomic Development” and SIP II “Resource Use Efficiency” address land-use and structural optimization respectively on the farm level. On the regional scale we derive SIP III “Land Use Allocation” and SIP IV “Regional Integration”. The consulted local stakeholders were able to assign local solutions to each SIP. Based on the conceptual-scenario framework, an analytical line is drawn between SI implementation, evaluation and up-scaling defining the process of the project in a common analytical framework.

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1 Introduction

The aim of VITAL task 1.1 is to provide the scientific framing of the concept of sustainable intensification (SI). SI considers the balance between improving productivity and sustainability (see section 2.2). The framework consists of two parts. First, the basis is a conceptual-scenario framework laying the theoretical and terminological foundations to approach SI and its formation into distinct scenarios. Second, the conceptual-scenario framework feeds into an analytical framework which translates theories, concepts and scenarios into operational steps that form the research design of VITAL.

Based on a literature review, the conceptual-scenario framework aims at developing a holistic system-oriented conceptual understanding of generic SI pathways (SIPs), including definitions, concepts and measures discussed in the literature. These pathways form distinct SI scenarios. Scenarios present a technique for investigation of possible future situations and conditions. They can take on different forms of stories (fictional or realistic), models (quantitative or qualitative), images (visual or narrative), or visions (positive or negative). For the purpose of the VITAL project, scenarios represent different (normative, visionary) alternatives to SI. Within the conceptual-scenario framework, a consistent set of these generic future SI alternatives, i.e. scenarios for the transformation to sustainable intensification at farm to EU scale was derived. The SI pathways and scenarios were discussed and validated from the perspective of stakeholders in a regional workshop and adaptations of the common framework were made accordingly. In this way, our normative, visionary scenario approach clearly differs from the development of future context scenarios, which describe and project (possible) future situations in terms of societal-demographic, economic or environmental changes (cf. Ebi et al., 2013; Ewert et al., 2005; Gerland et al., 2014; Nakicenovic et al., 2000; Rockstrom et al., 2009; UN, 2015), as we focus on SI-oriented technological and land use practice changes.

The analytical framework provides an operational procedure, to connect the conceptual-scenario framework with the indicator framework (Task 1.2), qualitative and quantitative analysis on farm and regional stakeholder network level (WP 2, WP 3) and modelling of SI Pathways (SIPs) on

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landscape and EU scale (WP 4, WP 5), including the involvement of stakeholders (M2.4, M5.2). The operational steps of the analytical framework are discussed briefly in order to outline the objectives, approaches and planned outcomes of VITAL.

The conceptual-scenario framework is presented in section 2 and the analytical framework in section 3 of this report.

2 Background: Pressures and Drivers to move towards SI

The agricultural sector is increasingly challenged by different driving forces. On the one hand, due to a growing global population and dietary changes, there will be an increase in demand for agricultural food production. Under conditions of limited land and depleting natural resources, an increase of productivity will be required. On the other hand, ecosystems, ecosystem services and biodiversity are seriously under pressure through intensive agricultural practices, calling for more environmental conservation efforts. With the notion of sustainable intensification new agronomic, but also food chain innovations and techniques should address both the increasing food demand and environmental targets.

2.1 Increasing Food Demand

According to the medium projection of the United Nations (2015), the world population will increase to 9.7 billion people until 2050 (+32%) and to 11.2 billion in 2100 (+53%). Contrary to previous studies, these numbers suggest a further increase of the world population and their food demand (Gerland et al., 2014), which represents a major challenge for food security, especially in developing countries. In parallel with the population growth, also dietary transitions represent a main driver of additional food demand. Energy-dense diets based on meat and dairy products become more prominent, increasingly also in developing and transition countries (which already see the largest population increase) (FAO, 2009b). According to estimations by Thornton (2010), the consumption of meat and dairy products per capita will increase by 38% and 42% respectively by 2050 in developing countries. The average daily caloric intake per capita has increased from 2,300

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in the 1960ies to 2,940 in 2015 with a further projection to 3,050 in 2030 (WHO, 2003). Tilman et al. (2011) have established a strong relationship between income and caloric demand, suggesting a further increase in the future.

2.2 Agricultural Productivity Increase and limited Natural Resource Base

For decades, due to the expansion of cultivated area, technological improvements and agricultural intensification, the agricultural production kept pace with the increasing food demand (FAO, 2002; Stevenson et al., 2013). Between 1961 and 2003, global food production increased by 160% (FAO, 2009a).

Regarding the future crop yield development in the case of Western Europe (EU15), Ewert et al. (2005) have estimated further productivity increases until 2080 based on climate change, atmospheric CO_2 concentration and technology change. Applying the scenario set of the IPCC SRES, the authors projected productivity increases between +25% and +163% relative to the base year 2000, but mainly due to technological change and less due to CO_2 concentration in the atmosphere. However, they expect a decreasing trend of yield growth rates (e.g. to zero in the B2 scenario), due to reaching biological limits (Ewert et al., 2005). The authors also point to the fact that potential negative effects of climate change might have been underestimated in the model.

However, others rather put into question whether this also accounts for all regions and food crops. A study by Ray et al. (2012) revealed that substantial shares of production areas of the main food crops (24–39%) rather show a stagnating of even a decreasing trend in crop yields. As one of the main reasons, the natural resource base, agricultural production is depending on, is in many places seriously degraded (FAO, 2009a). This includes the unsustainable freshwater use for irrigation, which exceeds renewable supply rates. The depletion of nutrients and minerals, such as phosphorus, nitrogen and potassium (Cordell et al., 2009) as well as soil degradation, due to erosion, desertification, and salinization (FAO, 2009a; García-Ruiz et al., 2015).

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2.3 Agricultural Land Availability and increasing Land Competition

Along with the degradation of agricultural land, land use change processes, e.g. re-forestation or bio-energy production, which remain limited, but with some local concentrations (Popp et al., 2014), increase the pressures on agricultural food production through increasing competition for land. The FAO estimates that additional 1.2 million km² of arable land is needed to cope with the future food demand, especially in developing countries. At the same time it is pointed out that this could be provided by a much larger theoretical area potential, but which is unevenly distributed across regions (FAO, 2002).

Another factor here is the continuous urban expansion (development of residential and other urban and infrastructure areas) at the expense of fertile, productive cultivated farm land. This process is most likely to continue in the future, particularly Africa and Asia (Seto et al., 2011). According to a meta-analysis of land use change studies, Seto et al. (2011) have estimated that the worldwide increase of urban land amounts to 1.5 million km² till 2030. In the case of Europe, more than 15,000 km² of land has been transformed through residential and other urban area development between 1990 and 2006 (EEA, 2006; EEA & FOEN, 2016). Altogether, estimates of the availability of agricultural land in Europe range between 10-100 million hectares for cropland, and 300 million hectares including pastures as well (Eitelberg et al., 2015).

2.4 Ecosystems and Biodiversity under Pressure

At the same time, biodiversity, ecosystems and their ability to provide ecosystem services are increasingly under pressure, among others, through intensified agricultural land use. According to the Millennium Ecosystem Assessment, between 10% and 30% of mammal, bird and amphibian species are currently threatened with extinction (MA, 2005). Due to its spatial significance in many regions, agricultural landscapes play an important role for the conservation of biodiversity. But whereas structurally complex landscapes contribute to the local biodiversity through their agro-ecological functioning (T. Tscharntke et al., 2005), the intensification of agriculture, which is accompanied with the application of inputs, field size enlargement and landscape simplification (Ungaro et al., 2017), accounts for severe biodiversity loss (Gamez-Virues et al., 2015).

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3 General Understanding of Sustainable Intensification

The prospects of rising population and food demand on the one hand and depleting natural resources and increasing environmental threats on the other hand gave rise to the discussion on sustainable intensification (SI). SI is an approach to agricultural production that considers intensification as well as sustainability and focuses on setting the right balance between both (Gadanakis et al., 2015). The possibility of a sustainable intensification of agricultural production was first raised by Pretty (1997) using examples from Africa, Asia and Latin America. The primary aim was to support the livelihoods of the rural poor (Loos et al., 2014). Since then, the advantages and disadvantages of SI have been controversially discussed for different production systems, world regions and scales. The emergence of SI coincided with the foundations of the discipline of ecological economics, which claimed that the environmental sustainability in world production has been carelessly neglected (Goodland & Daly, 1996), and the introduction of the concept of multifunctionality in European agricultural policy. The trigger event for a broader discussion of SI was the food price crisis in 2007/2008, which underpinned the need to react to the challenges of global food security (The Royal Society, 2009). The approach also gained support among agribusiness companies (McDonagh, 2014) and was discussed during the 2013 CAP reform. However, a final agreement on how the intensification-sustainability balance should look like, and hence a final definition of SI, has not been reached (Buckwell et al., 2014; Petersen & Snapp, 2015).

In a frequently cited definition, SI is understood as a notion, which simultaneously combines the increase (or maintenance) of agricultural production with an improved contribution to sustainable development, including environmental benefits in a wider sense and the reduction of negative environmental effects or increasing provision of ecosystem services in a more narrow sense (Garnett et al., 2013; Pretty, 1997; The Royal Society, 2009). Buckwell et al. (2014) understand SI as simultaneously improving productivity and environmental management of land. Nonetheless, some perspectives also allow for an disproportionate increase in outputs over sustainability if the harmful effects are compensated at other places (Franks, 2014). This approach is called biodiversity off-setting and implies a global understanding of SI. It would allow a much higher number of farmers to contribute to SI. In contrast, from other points of view, SI at some places might also require a de-

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intensification of agricultural production in favour of environmental benefits (Garnett et al., 2013). Mueller et al. (2012) suggest that especially the production on underperforming land needs to be intensified. Further understandings of SI comprise a social and sometimes even an ethical dimension of sustainability in addition to the environmental dimension (Barnes & Poole, 2012; Garnett & Godfray, 2012; Smith, 2013). Broader definitions require SI to increase the wider social benefits from agricultural landscapes (Barnes & Poole, 2012) or to generate multiple benefits in a sustainable way (Clapp, 2015) alongside with agricultural yields. Another approach focuses on efficiency (Kassam et al., 2011) where farmers are primarily obliged to increase resource use efficiency (Buckwell et al., 2014). In this sense, SI can also be interpreted as new technologies or new management styles that lead to an increase of production possibilities with the same set of inputs which widens the space of efficiency gains in production (Barnes & Thomson, 2014).

Main motivations for SI are often generated on global scale looking at aggregate levels of food production (Buckwell et al., 2014; Loos et al., 2014). However, agreement exists that there have to be local, site-specific solutions for the implementation of SI measures. They can have distinct shapes at different places and for different agricultural systems (Buckwell et al., 2014). There is no finite prescribed set of agricultural technologies, measures or policies that are labelled to be SI (Franks, 2014; Lee et al., 2006; Pretty & Bharucha, 2014) and which, when implemented, imply that a farmer or a region has chosen a SI strategy. Pretty and Bharucha (2014) therefore consider SI as an umbrella term for a wide range of agricultural measures. Studies dealing with SI thus name very different measures and approaches as examples for SI depending on the agricultural system or the region they focus on. The openness of measures and concepts that represent the local SI strategies might also be the reason why the overall definitions of SI remain abstract and broad. Barnes and Poole (2012) even argue for region-specific definitions of SI. One key aspect, however, is knowledge. As framed by Pretty (1997) SI should enable farmers to adapt technologies and methods developed by local knowledge. This implies that the key input farmers need to intensify is knowledge in order to understand the complex causal relationships among agricultural production methods and their influences on the ecosystem and its multiple services (Buckwell et al., 2014; Loos

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et al., 2014). Having such knowledge enables farmers to find the matching strategies to intensify their production in a sustainable way.

Studies that evaluate the feasibility of SI are limited so far, especially in temperate regions (Firbank et al., 2013). Omer et al. (2010) use a stylized theoretical model to show that in principle it is possible for rational actors to finally choose a long-term path of agricultural intensification which at the same time leads to a reduction of ecosystem damage. Empirically, SI mainly has been evaluated at the level of individual farms. For Europe, there are some examples that analyse farms in case study areas in Great Britain (Areal et al., 2012; Barnes & Poole, 2012; Barnes & Thomson, 2014; Gadanakis et al., 2015).

SI shows certain overlap with other concepts (Wezel et al., 2015) that address the challenges of achieving more sustainability in agriculture. Among them are "ecological intensification", implying intensification of biomass production through ecological and biological processes and principles to design sustainable productions systems, efficient use of inputs, and minimal harm to the environment (Caron et al., 2014; Struik et al., 2014; Tittonell, 2014), and "climate smart agriculture", referring to agricultural production that mitigates climate change while enhancing the achievement of national food security and development goals (Barnes & Poole, 2012; Campbell et al., 2014). Agroecology is another approach that is often discussed as forming one possibility of SI. However, its understanding of sustainable agricultural production is narrower implying the application of ecological principles and methods in agricultural sciences to plant production and agricultural land management (Caron et al., 2014). A few authors use the term agro-ecological intensification (Tittonell, 2014). The commonalities and differences of the approaches are still a matter of discussion (Godfray & Garnett, 2014).

To sum up, the debate on definitions and framing of SI already indicates that the perceptions of its final purpose vary. In a rather neutral way, SI is regarded from a dynamic perspective and pictured as a process that offers the possibility to assess change within agricultural systems (Barnes & Poole, 2012; Firbank et al., 2013). It is framed as a guiding principle in the decisions about land use, but with no final aim (Smith, 2013). In contrast, another view addresses SI as an end rather than a mean

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(Garnett et al., 2013; Pretty & Bharucha, 2014) or even a new paradigm (Franks, 2014) of environmental policy. Due to the critique that describes SI as a business-as-usual approach to justify further intensification (Clapp, 2015; Loos et al., 2014), recent literature stresses that it is only one part, however an important one, of a multidimensional strategy to achieve food security and is not advertised as a panacea (Garnett et al., 2013; Godfray & Garnett, 2014).

4 Conceptual-scenario Framework

The discussion on how to understand, conceptualize and implement SI shows that the understanding on how, where and when SI can be implemented is broad. Although there is agreement stating that SI requires site-specific solutions based on local knowledge and the initial situation, the understanding of measures and concepts to implement and assess SI is vague. Therefore, a conceptual and generic understanding of what SI actually entails, covering the diversity of the scientific debate, is needed. We meet this need by developing distinct SI pathways (SIPs).

4.1 Sustainable Intensification Pathways

Following the aim to develop SI pathways (SIP) as alternative scenarios to SI, we start from a comprehensive understanding of SI, instead of focusing on an exclusive narrow definition in order to build a theoretical understanding of the concepts and measures that form SI. This approach allows us to take very different pathways towards SI within the academic debate into consideration. There are rather different views about the way how the ambition of SI can be achieved, as the debates about land sharing vs. land sparing, farm-scale vs. landscape-scale measures or the role of new farm-technological developments vs. local knowledge, solutions and interactions illustrate. We develop a conceptual-scenario framework that includes this diversity of approaches that are subsumed under the notion of SI. Some of these approaches represent specific **measures** of SI implementation, while others are broader **concepts** of which these measures form part of. Assessing their commonalities and differences, we are able to assign them to four distinct clusters that represent ways to improve the balance of sustainability and intensification. We call them SI

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pathways (SIP). Having in mind the presented understanding of scenarios as different normative, visionary alternatives, the SIPs - when implemented - represent conceptual scenarios of SI.

We distinguish four SIPs based on two dimensions:

(i) the spatial scale - local/farm and regional/landscape – at which they take effect, and

(ii) whether optimisation/adaptation is rather land use-related (e.g. agronomic developments and new practices at farm scale; land sharing/sparing or spatial targeting at landscape scale) or of structural, organisational nature (e.g. residual use at farm scale; new cooperation models, value chains at regional/landscape scale).

Figure 1 provides an overview and the allocation of concepts and measures discussed in the literature to the four tentative SIPs:

- SIP I "Agronomic Development" includes agronomic practices and technological developments, many of which belong to good agricultural practice, that make better use of the available space of the production side by adapting the treatment, use and cover of land in order to protect soils and animals.
- SIP II "Resource Use Efficiency" implies that the available resources of an agricultural holding, such as natural and non-renewable inputs, labour and knowledge, are used efficiently, thereby increasing factor productivity. This also includes that production residues are treated as inputs that can be re-used to the maximal possible extent.
- SIP III "Land Use Allocation" addresses targeted and planned land use allocation according to regional needs and capacities of the respective landscape in order to enhance landscape functioning and (agro)biodiversity.
- SIP IV "Regional Integration" encompasses the regional exchange of knowledge and inputs organized in networks of all relevant actors, including consumers, and steered by respective enabling (regional) governance mechanisms. This allows for food and production transparency, innovation diffusion and integrated value chains.

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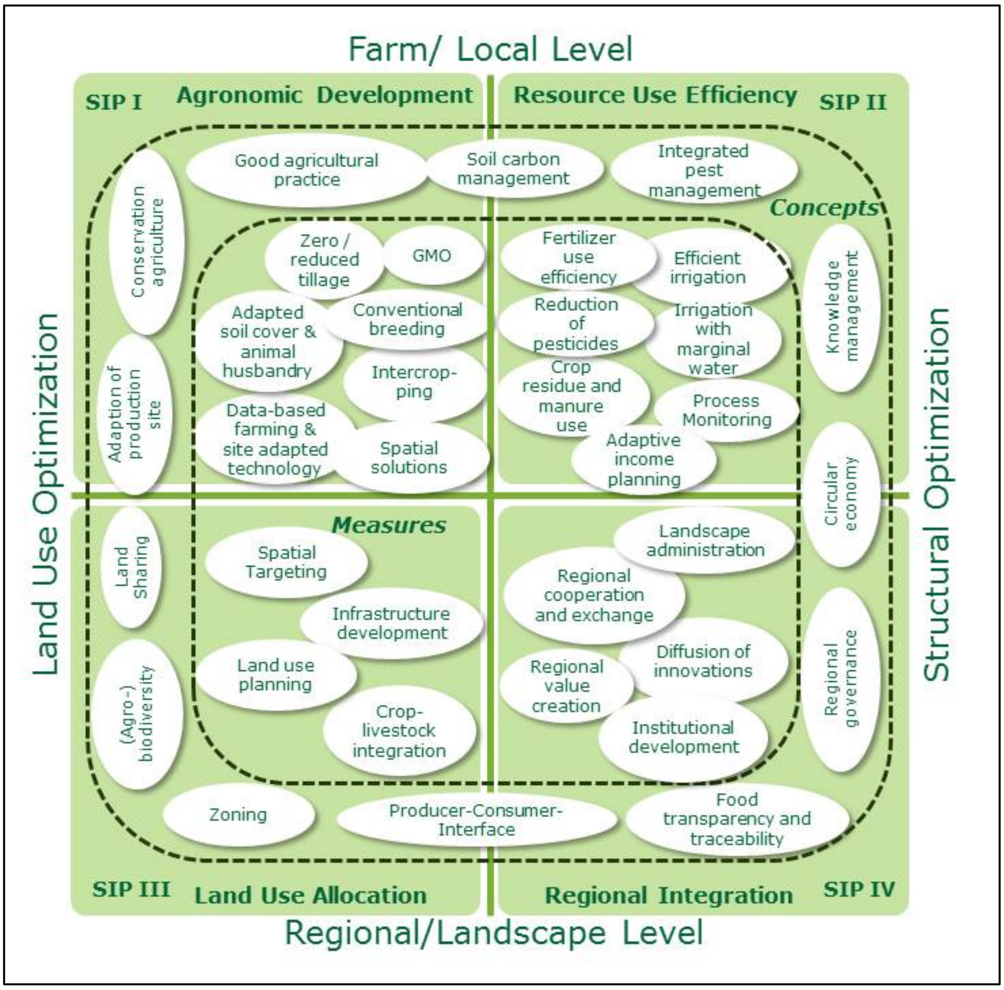

Figure 1: Sets of concepts and measures, discussed in the literature, which can be subsumed to SIPs, depending on the spatial scale and whether they deal with land use or structural optimisation issues.

Figure 1 mainly serves as an illustration of the different components the SIPs are made of. The measures and concepts are selected because they are either frequently cited and/or especially illustrative for the four SIPs. The framework in its final version, as presented here, was constantly adapted in several iterative rounds of discussion among project partners, a structured review of the literature (described in section 4.2.1) and the consultation of local stakeholders (described in section 4.2.2). The conceptual-scenario framework of SI demonstrates that the implementation of the same SIP can look very different for different farms and regions. Nevertheless, we do not claim that this representation is exhaustive. References and more details on the measures and concepts presented in Figure 1 are provided in the Appendix (section 6.2). Boundary setting between the

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four SIPs and exact classifications of measures and concepts is also subject to discussion. We know that there are concepts and measures that could also be classified into other SIPs or lie on the boundary between two pathways. However, here we strive for a generic framework that enables hypothesis building and a design for empirical validation of SIPs within the project VITAL. Therefore, we decided to be rather rigid in classification efforts and assigned measures and concepts clearly to one distinct SIP. The assignment of measures and concepts to SIPs thus might still be subject to change during the process of the project.

A glossary of the terminology that we use within this conceptual-scenario framework is provided in the appendix (section 6.1).

4.2 Evolvement of the conceptual-scenario Framework

The presented conceptual scenario framework is based on an iterative process including a literature review and the consultation of members of the project team. Based on a first in-depth literature review of key scientific papers on SI plus additional green and white papers (e.g. RISE report (Buckwell et al., 2014), we developed the key idea of the SIPs and the two dimensions of SI. This was discussed with all project partners focusing especially on the assignability of concepts and measures to SIPs looking for overlap and discriminatory power of the discussed SIPs.

4.2.1 Procedure of the systematic Literature Review

The conceptual-scenario framework was elaborated and sharpened by a structured literature review on SI. Therefore a total number of 309 academic articles, articles in press and reviews, retrieved from the Scopus Database (retrieval date 16/08/2016), were systematically analysed. All papers containing the term "sustainable intensification" in title, abstract or keywords were selected. The systematic analysis implied that we checked abstracts and conclusions of the papers for the measures and concepts of SI and assigned them to SIPs. Thereby, we sharpened the character and content of each SIP and established the four SIPs across the range of literature dealing with SI. By focusing only on abstract and keywords, we could process a high amount of information. Our working hypothesis was that authors would include those measures and concepts

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at that places which they perceive as most important. Thus our results already contain an implicit weighting to key issues by procedure.

4.2.2 Results of the systematic Literature Review

In order to demonstrate the coverage of the scientific literature and the result of the process, of the structured literature review and framework development, we present the number of papers that mentioned each pathway in Figure 2. The results presented in Figure 2 show that more papers focus on SI at farm level than at landscape level and that SIP I "Agronomic Development" receives the most attention. In comparison SIP III "Land Use Allocation" is comparably underrepresented. Supportive for our conceptual-scenario framework, it can be concluded that all four conceptualised pathways are fairly represented in the scientific literature.

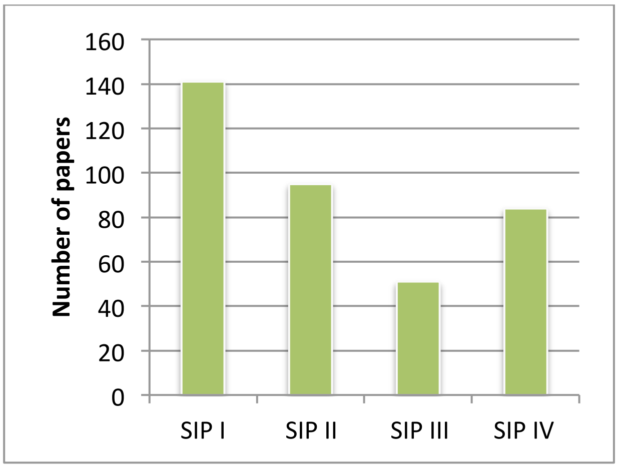

Figure 2: Frequency of papers mentioning SI pathways in abstract or conclusion for each SI pathway

An interesting trend can also be observed for the comprehensiveness of SI research demonstrated in Figure 3. Figure 3 shows how many different pathways a paper refers to in abstract and conclusion, ranging from none (zero) to all four. The majority of 43% papers focus on one SIP whereas a very low share of papers mention more than two different pathways. There is also a bunch (24%) of papers that discuss SI on a rather superordinate perspective not specifying what SI exactly entails. With the suggested conceptual-scenario framework, we are able to structure the majority of scientific papers under a common rationale.

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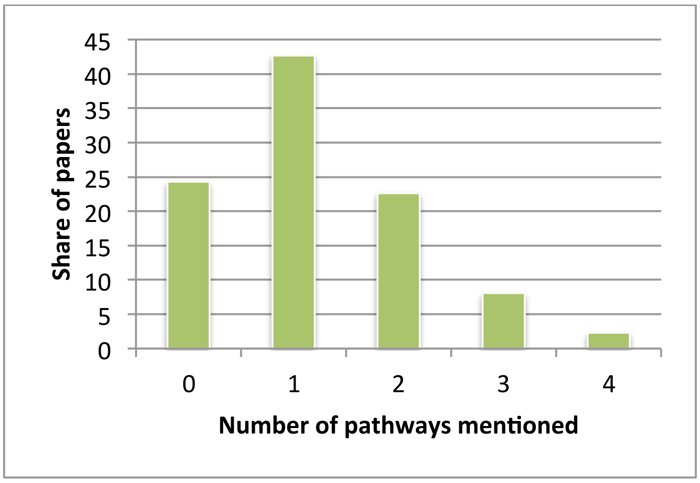

Figure 3: Comprehensiveness of scientific literature on SI Pathways indicated by number of pathways mentioned in abstract or conclusion of SI papers (N=309)

4.3 Validation of conceptual-scenario Framework

The conceptual-scenario framework was further discussed with local stakeholders in the four case study regions to aim at a common understanding (science-practice), to validate and if necessary adapt the results based on the specific local situations and innovation goals. The stakeholder consultation should provide local exemplars of the different SIPs. In the following, we present the results of one of these consultations of local stakeholders in the Rhinluch region in Germany in detail.

4.3.1 Process of Validation by Stakeholders

The draft conceptual-scenario framework was presented to the group of local actors in a condensed way. The focus lied on the practical application and the distinction of the four SIPs. Therefore, we neglected the separation of concepts and measures and introduced the SIPs relating to practical examples. The presentation used for this purpose is included in section 6.3 of the appendix. After this presentation the group of experts was divided in smaller groups. Each group got a blank representation of the framework as a starting point for discussion. The discussion was held in several rounds. At first, the group should describe measures of SI that are already undertaken in the region and assign them to the four SIPs. Secondly, they should name and assign measures that

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should be undertaken in the future. Finally, each participant could mark those measures for which (s)he sees most need for action and support having maximally three votes. Each focus group discussion was moderated by one member of the project team.

4.3.2 Setting of Validation

The Rhinluch region (north-west Brandenburg, Germany) is a landscape originally built from peatlands, through drainage converted into grasslands, which were used as intensive animal farming areas in GDR times. Nutrient cycles became more closed through reduced livestock intensity after the reunification, and in parallel, arable production for food (crops, asparagus) and green biomass (energy) intensified. Currently, semi-intensive livestock and intensive cropping coexists with areas designated for nature protection. However, greenhouse gas emissions due to the drainage required for the grassland make agricultural use challenging from environmental perspectives. Optimizing the water logging system is a key issue for all regional stakeholders which causes conflicts of interests. Rhinluch region harbours one of the main crane resting areas in Europe, a trigger for regional tourism. Although, coordinated activities to attract more tourists, also outside the crane season, still need development. Initiatives to establish short supply chains for quality food exist as well.

The validation workshop was visited by 20 regional stakeholders including 7 farmers, 4 representatives of nature protection agencies, 4 representatives of the local environmental administration, 3 scientists with focus on either the region or the specificities of the agricultural system, and 2 input providers with regional focus. They were divided in three focus groups for discussion.

4.3.3 Result from Stakeholder Validation

The three focus group discussions revealed that stakeholders in general could follow the rationale of the conceptual-scenario framework and used the four SIPs actively in their arguments. A quote of the discussion illustrates that: *"I think that the lower segment of "Regional Integration" is the most important field for action. If improvement is achieved here the other three will follow*

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automatically (quote of a participant)." Stakeholders were able to assign their suggested measures to SIPs. However, for some measures they preferred to place them at the boundaries between two SIPs. This shows that for some SI measures the discriminatory power of the framework is a matter of debate. The framework should thus be characterised as a generic conceptualisation that steers a discussion process across different fields of action addressed by SI. Especially measures on the landscape level were discussed in all three groups. Only in very few cases, different assignment was undertaken between groups showing that the perception that a person has on some boundary issues finally determines allocation.

Figures 4 and 5 summarize the results of the discussion process according to SIPs. They show the suggested measures representing SI solutions named by the stakeholders which are currently applied (inner circles) and should be applied in the future (outer circles) by the frequency they were named (Figure 4) and the number of votes assigned to them when asking for need of action and support (Figure 5).

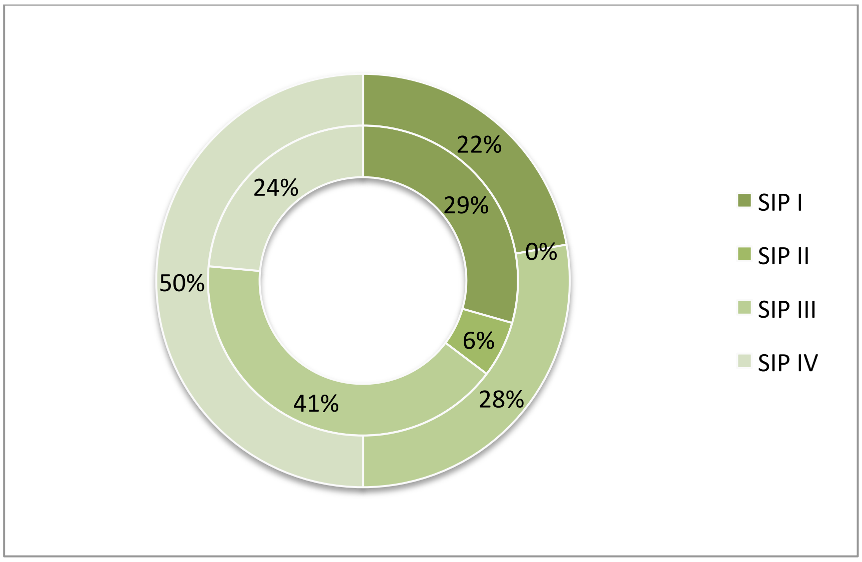

Figure 4: Frequency of named SI measures according to SIPs for Rhinluch region. Inner circle represents already applied measures (N=48) and outer circle measures that will be relevant for the future (N=44).

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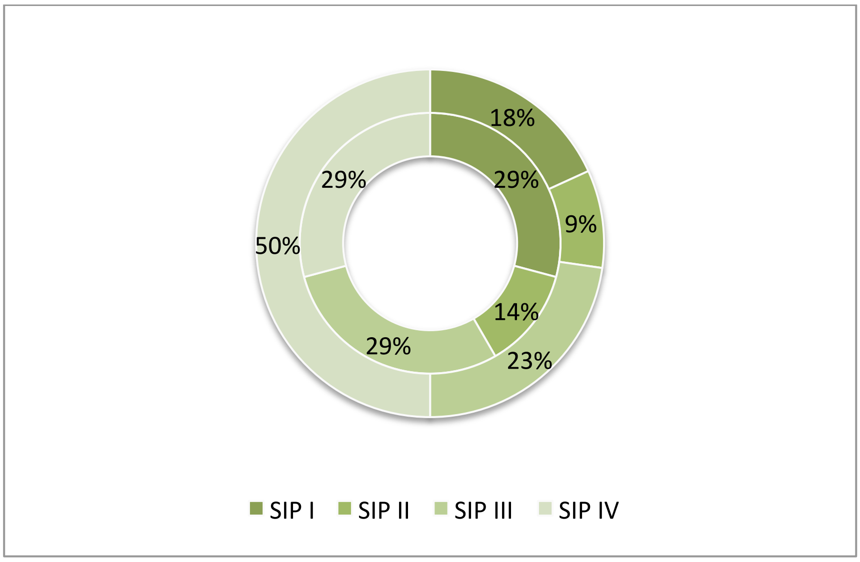

Figure 5: Importance of named SI measures according to SIPs in Rhinluch region. Each participants could assign up to three points to measures for which (s)he sees most need for action and support. Inner circle represents already applied measures (N=17) and outer circle measures that will be relevant for the future (N=27).

Both Figures show a strong focus on SIP IV "Regional Integration" especially for the future. Stakeholders agree that most challenges faced by the region can only be achieved with coordinated action. Under SIP III "Land Use Allocation" the discussions focused especially on the key issue of landscape planning in Rhinluch which is system of drainage and water bodies. Each group developed a regional exemplar on how SI is addressed in the region and should be addressed in the future. Thereby, they validated the applicability of the scientific framework to a practical situation with a clearly defined problem setting. Figure 6 presents the visualisation of the framework for the Rhinluch case. All details are presented in section 6.4 of the appendix.

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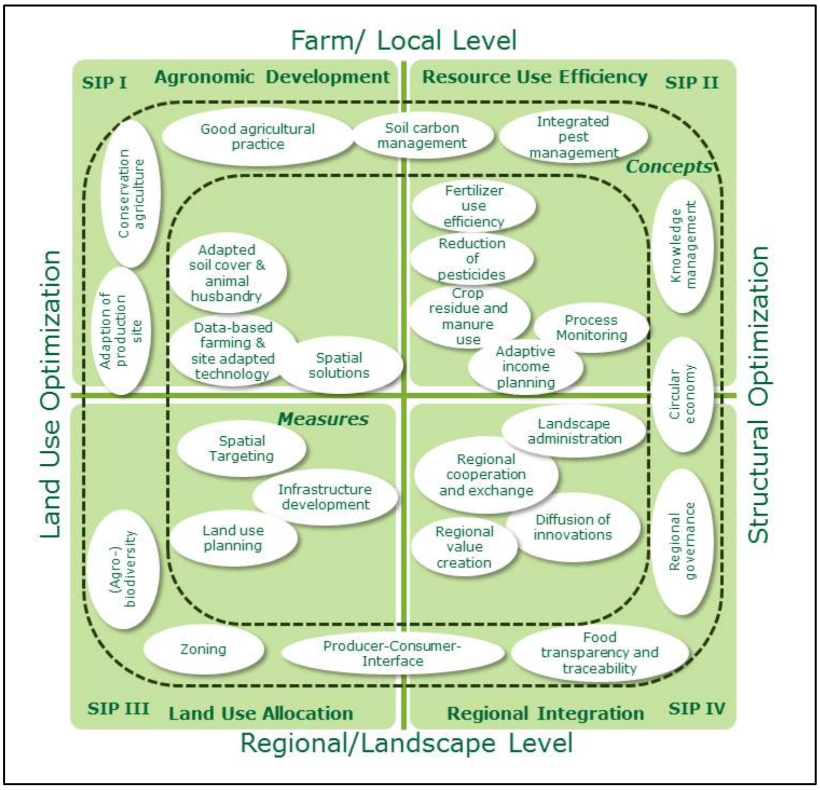

Figure 6: Exemplar of SIP conceptual-scenario framework for Rhinluch region showing all addressed current and future SI measures.

4.4 Final Version of the conceptual-scenario Framework

After including the results from the structured literature review and the stakeholder validation exercise in the framework, the iterative process of framing SI was stopped. The general structure of the four SIPs proved to be consistent in the stakeholder validation and needed no changes. However, some of the represented measures and concepts needed adjustments to reflect all relevant aspects. To demonstrate this evolution the preliminary version is included in section 6.5 of the appendix.

The result is a generic framework that is able to steer very specific practical discussions such as the Rhinluch case and on the same time enables scientific hypotheses building. It presents four scenarios for investigation that need to be included in a comprehensive analysis of SI on various scales.

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5 Analytical Framework

Building on the conceptual-scenario framework, an analytical framework is developed that translates the understanding and theories of SI and the four SIPs into an operational research process for VITAL. Figure 7 gives a consolidated overview of this analytical framework. The conceptual-scenario framework as the starting point is represented as Step 1. In the remainder of this section, the objectives, planned results and methods of the following steps are briefly explained.

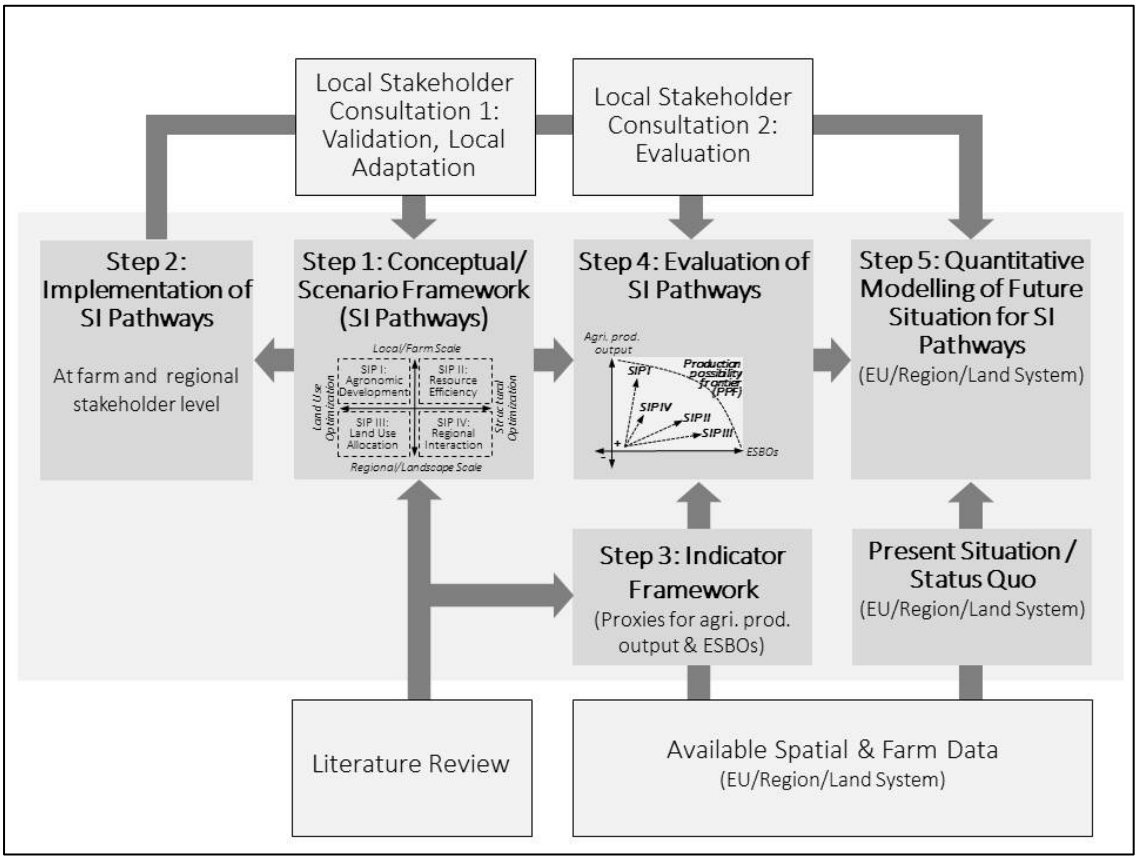

Figure 7: Analytical framework for the operational process for quantitative modelling of agricultural production outputs and environmentally and socially beneficial outcomes (ESBOs) of Sustainable Intensification Pathways (SIPs).

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5.1 Implementation of SI Pathways (Step 2)

The process of transformation and adoption of SI pathways involves the farmers and regional actors and stakeholders and their decision-making. These are characterised by individual capacities, motivations, path dependencies (resistance to change) and mutual interrelations (social networks). To gain a better understanding of the driving forces and constraints of SI implementation, intrinsic to farmers and to regional networks, both aspects are investigated further in the VITAL project. Information on SI pathways on farm level and regional stakeholder scale will be discussed in the two stakeholder workshops of VITAL. The results on triggers and constraints on the individual and collective level to implement SI pathways as well as their specific regional design will provide baseline information for the quantitative modelling of the future situation of SI pathways on larger scales (Step 5).

5.1.1 Actors and Stakeholders Interaction in SI Implementation (WP2)

The research will focus on actor and stakeholder roles and mutual relationships within actor networks. Methodologically, WP2 applies stakeholder mapping and social network analysis (SNA) to identify relevant actors as well as their relative relevance and influence in conditioning local SI pathways. Finally, stakeholders will assess current SI pathways in order to explore ways to overcome shortcomings and exploit potentials in a foresight analysis based on the identified pathways towards SI by WP1.

5.1.2 Farmers' Behaviour towards SI Implementation (WP3)

WP3 identifies causal links explaining the mechanisms behind farm level SI pathways. Based on the conceptual-scenario framework and the insights on stakeholder roles from WP2, WP3 will identify driving forces and innovation environments for pathways towards SI based on farm level empirical data. The data will be collected within the project allowing to test key hypotheses based on the conceptual-scenario framework and the regional case study contexts.

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5.2 Indicator Framework (Step 3) to evaluate SIPs (Step 4)

Steps 3 and 4 comprise the quantification of sustainable intensification in order to evaluate the impact when a certain SIP or measure belonging to an SIP is implemented. Therefore the agricultural production or intensity as well as the sustainability have to be considered. Intensity can be measured based on inputs, often the land area utilized for the production activity, capital and labour, on outputs, the harvests of the production activity, or the relationship between inputs and outputs (Kuemmerle et al., 2013). Whereas it is still debated which indicators should be preferred when assessing intensification, measures for the "sustainable" part of SI are even more contested which is also reflected in the diversity of understandings of SI (see section 2.1). The literature uses the terms environmental effects or externalities, ecosystem services, public goods or include social aspects when addressing the sustainability side. Therefore, we introduce the term "environmentally and socially beneficial outcomes (ESBOs)" developed by the EU research project PEGASUS (Maréchal et al., 2016) in order to keep the terminology comprehensive and encompass all other terms used. The term refers to outcomes in the environmental as well as in the social sphere and includes ecosystem services often having the character of public goods as well as social and cultural beneficial outcomes delivered by agriculture. This includes also the reduction of negative social and environmental impacts. A narrowing down of the term ESBO is then easily possible for specific research questions.

5.2.1 Operational Approach to link the SIP Concept with quantitative Analysis and Modelling

In order to make the SI concept operational to estimate and model effects, it can be broken down to its two dimensions and depicted by the relationship between:

(i) the agricultural production output per area unit, e.g. crop yields, calories, etc.

(ii) the environmentally and socially beneficial outcomes (ESBOs) provided per area unit, e.g. biodiversity increase, carbon sequestration, higher agricultural income, etc.

As mathematical equation, this could be expressed as:

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$$SI_{t_0 \rightarrow 1} = \frac{\Delta \uparrow Output_{agri.\ prod.}}{\Delta \downarrow Impact_{ESBOs.}}$$

The loss of ESBOs is introduced as impact in the formula. In this model, the changes from the present state t=0 (status quo) to a future state t=1 via different SIPs contribute more or less to either an increase in agricultural production, to the provision of ESBOs (see Figure 8) or to both.

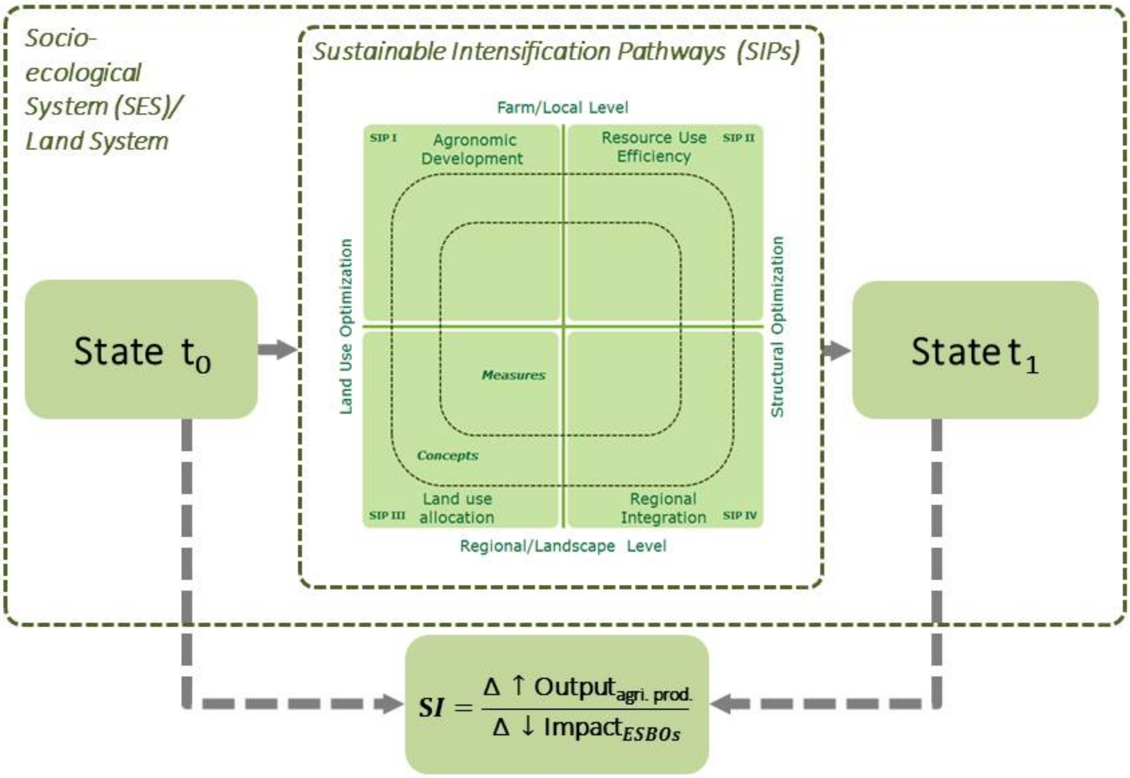

Figure 8: Understanding of Sustainable Intensification Pathways (SIPs) as transitions from state t_0 as status quo to state t_1 as future state.

5.2.2 Indicator Framework (Task 1.2, Step 3)

Before conducting an estimation of the effects of SIPs on agricultural intensity and sustainability (per area unit), an indicator framework is required for the parameterisation of the agricultural

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production and environmentally and socially beneficial output sides. It is important that it is based on the availability of spatial and farm data and variables. These should be used as proxy indicators for agricultural production and sustainability.

The first objective of Task 1.2 is to perform a literature review on SI indicators. There is little convergence on the ways of measuring sustainable intensification: while economic indicators for intensification are well established (income per hectare, crop areas, livestock numbers, use of technology, etc.) and relatively easy to collect (e.g. the FADN - Farm Accountancy Data Network), environmental indicators for agriculture are harder to define. This is due to the fact that they are strongly context-, location- and scale-dependent: the literature showed that even the practitioners of sustainability indicator sets do not build on the systematic approach to indicator development already undertaken, for example by the EU (IRENA and ELISA projects), but they rather prefer to reinvent new sets of indicators for every new study (Buckwell et al. (2014) found 500 indicators in a review of 49 papers). A detailed discussion on the choice of indicator and applicability to the context of the VITAL project will be presented in the upcoming project deliverable report D1.2 “Toolbox for quantifying sustainable intensification”.

In connection with the indicator framework and data availability, system boundaries for the operational approach to quantitative and qualitative analysis and modelling have to be defined. Especially the notion of land systems, their relationship to the socio-ecological systems (SES) approach, their features and spatial extent plays an important role to depict the systemic view on SI.

5.2.3 Evaluation of SI Pathways (Step 4)

Having the indicator framework at hand, SI improvements can be measured. For the representation of the effects of different SIPs, the production possibility frontier (PPF) approach allows combining the production of two different output types for a given set of inputs by a system (e.g. farm, land system, region) by moving from an initial state to another (sustainably intensified) (see for instance in Barnes & Thomson, 2014; Buckwell et al., 2014; Franks, 2014). Figure 9 provides a graphical

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representation of the different SIPs in terms of change in agricultural production and ESBO provision. It includes SI improvements that are beneficial for both agricultural production and ESBOs, i.e. synergies exist in the production of the two goods. This could be regarded as the optimal case we would like to achieve. As we apply an open and comprehensive understanding of SI, the figure also represents two trade-off situations for which either agricultural production or ESBOs are sacrificed in favour for disproportionate improvements in the other good. They represent SI improvements in a broader sense and are not recognized as such by all authors dealing with the topic. However, as these situations are more likely to occur, it is helpful to assess their potential relative to the synergy case instead of ignoring them by keeping the definition narrow. All bundles of agricultural production output and ESBOs beyond the PPF are innovations that would shift the PPF outwards and thus increase the space of production possibilities.

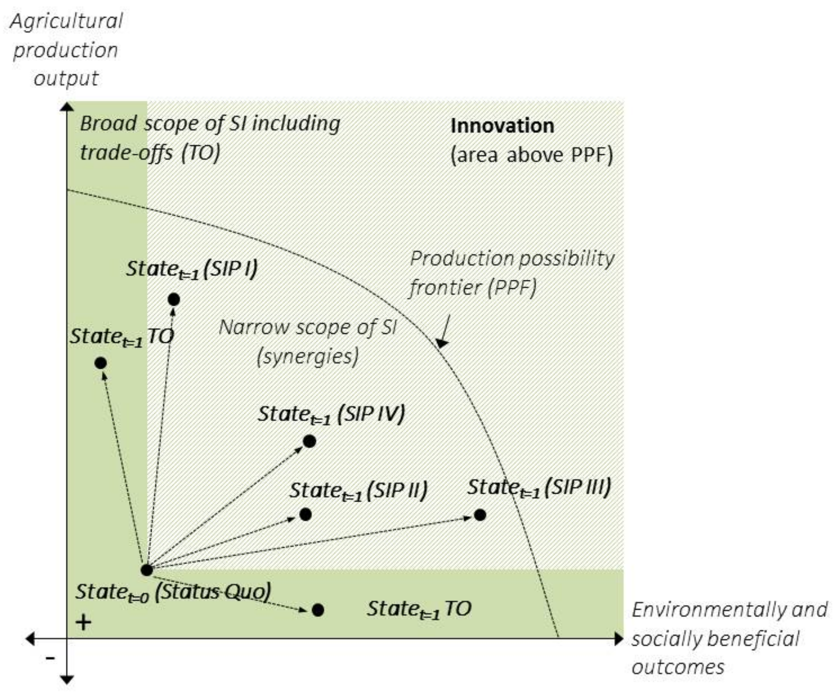

Figure 9: Different SIPs and their contribution to agricultural production and ESBOs provision.

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5.3 Quantitative Modelling of Future Situation for SI Pathways (Step 5)

The objective of this exercise is to estimate the expected contribution of different SIPs to the change of agricultural production and ESBO indicators (for land systems, regions). Improvements towards SI can be assessed and compared across scales based on the measurement developed in steps 3 and 4. Proxy indicators from the indicator framework will be used to provide an interface to the quantitative modelling and mapping exercise on landscape scale (WP4) and the up-scaling to EU level (WP 5). The information from individual and collective behaviour on SI uptake (step 2) will be used as baseline information. Conducting a participatory assessment exercise at the (second) stakeholder workshop and/or expert assessments, qualitative-quantitative approaches could be feasible to get from qualitative SIP narrative descriptions to quantitative modelling and analysis (via Likert-scale estimations, pairwise comparison between SIPs, etc.). EU windows of opportunity for SI and priority areas in Europe for future SI implementation can be identified based on these results.

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6 Appendix

6.1 Glossary

Term	*Definition / Explanation*
Conceptual-scenario Framework	Provides the theoretical foundation for the research subject (of Sustainable Intensification), which should be addressed by the research work; Ensures the theoretical embedding into the academic debate; Defines notions and concepts and the relationship between them; Formulates research hypotheses. The systematic representation of SI consisting of 4 different SIPs, being different future alternatives serves as scenario framework.
Scenario	Scenarios present a technique for the investigation of possible future situations and conditions. They can take on different forms of stories (fictional or realistic), models (quantitative or qualitative), images (visual or narrative), or visions (positive or negative). For the purpose of the VITAL project, scenarios should represent different (normative, visionary) alternative approaches to Sustainable Intensification (SI). They are represented by the SI pathways (SIPs).
Analytical Framework	Translates the conceptual framework into an operational empirical research approach; Defines the research design (workflow within the project between the work packages and tasks); Specifies the project work outlined in the proposal, including operational steps
Indicator Framework	Defines the set of (impact) indicators, which cover the various sustainability aspects and impact fields, which are relevant for SI and the different geographical scales (farm level, landscape/regional level, European level); Spatial and temporal coverage as well as available and accessible data sources are specified; It might also define indicator targets and thresholds
Sustainable Intensification	Sustainable intensification refers to simultaneously increasing or maintaining the output of agricultural production per unit of land while decreasing the pressures to the ecosystem and society or increasing beneficial outputs to them.
Sustainable Intensification Pathways (SIP)	A Sustainable Intensification Pathway (SIP) is understood as a number of concepts and measures, which contribute to the general idea of SI. Four different SIPs are distinguished and reflect the variety of theoretical and conceptual understandings within the literature and the local case study examples.
SI Concept	Collection of various SI measures to achieve improvement toward SI, integrative part of an SIP

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Term	*Definition / Explanation*
SI Measure	Specific practice or management mechanism implemented to achieve improvement toward SI; forms part of one or more broader SI concept(s), integrative part of an SIP
Agronomic development (SIP I)	Encompasses SI concepts and measures that make better use of the available production side on the farm e.g. targeting soil treatments, seeds and covers and implying technological improvements
Resource efficiency (SIP II)	Encompasses SI concepts and measures that use available resources on the farm in a more efficient manner and additionally make use of production residues
Land Use allocation (SIP III)	Encompasses SI concepts and measures that imply a more purposeful planning of land use on a regional scale
Regional integration (SIP IV)	Encompasses SI concepts and measures that improve formal and informal regional cooperation and exchange of inputs and knowledge and an improved interface of producer and consumer needs
Land system	A land system classification classifies combinations of land cover composition, livestock system, and land-use intensity.
Socio-ecological systems (SES)	System that integrates as well bio-physical properties such as soils and climate as well as socio-economic characteristics such as institutions, markets and population.
Environmentally and socially beneficial outcomes (ESBOs)	Includes a wide scope of environmentally and socially valuable outputs and encompasses the concepts of ecosystem services, public goods, environmental externalities, social and cultural outcomes (Maréchal et al., 2016)

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6.2 SI Pathways, Concepts, References

6.2.1 SIP I "Agronomic Development"

Concepts: Adaption of production site; Good agricultural practice, Soil-carbon Management, conservation agriculture

Measures	Subcomponents	References
Data-based farming & side-adapted technology	Precision farming	Buckwell et al. (2014), Gadanakis et al. (2015), Godfray et al. (2010), Petersen and Snapp (2015), Mueller et al. (2012), Smith (2013)
	Spatial targeting of fertilizers	Loos et al. (2014)
	Scale-appropriate machinery	Mottaleb et al. (2016)
Intercropping	Crop rotation, mixed cropping	Kassam et al. (2011), Petersen and Snapp (2015)
	Agroforestry	Godfray et al. (2010), Petersen and Snapp (2015)
Zero or reduced tillage	Zero/reduced tillage, conservation tillage	Godfray et al. (2010), Kassam et al. (2011), Pretty and Bharucha (2014), Mueller et al. (2012)
	Limiting or reducing soil compaction	Kassam et al. (2011)
Adapted soil cover & animal husbandry	Legumes	Kassam et al. (2011), Petersen and Snapp (2015), Pretty and Bharucha (2014)
	Mulches and cover crops	Godfray et al. (2010), Kassam et al. (2011), Petersen and Snapp (2015)
	Herbivore diversity	(Muir et al., 2015)
Conventional breeding	Breeding and using well adapted high-yielding varieties, high-quality seeds and drought resistant crops	Kassam et al. (2011), Pretty and Bharucha (2014)
Genetically modified crops (GMO)	Development of new varieties or breeds of crops, high-yielding hybrids	Baulcombe et al. (2009), Foresight (2011), Godfray and Garnett (2014), Petersen and Snapp (2015), Mueller et al. (2012)
Spatial solutions	Terracing	Petersen and Snapp (2015)
	Greenhouses	Petersen and Snapp (2015)

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6.2.2 SIP II: "Resource Use Efficiency"

Concepts: Soil-carbon management; Integrated pest management; Knowledge management; Circular economy		
Measures	Subcomponents	References
Fertilizer use efficiency		Petersen and Snapp (2015), Teja Tscharntke et al. (2012)
Irrigation efficiency		Harris (1996), Kassam et al. (2011)
Irrigation with marginal water	Recycling water on farm, closed-loop water (re-)use	Petersen and Snapp (2015), Pretty and Bharucha (2014)
Reduction of pesticides	Biological control, pest monitoring against economic thresholds, habitat manipulation	Gadanakis et al. (2015), Harris (1996), Petersen and Snapp (2015), Pretty and Bharucha (2014), Ruttan (1994), Smith (2013)
	Reducing external inputs with the potential to damage the environment or create harmful health effects	Petersen and Snapp (2015), Pretty and Bharucha (2014)
Crop residue and manure use	Integrated management and reduction of waste in production process	Godfray et al. (2010), Barnes and Poole (2012)
	(Green) manure and compost	Petersen and Snapp (2015)
	Closed nutrient cycle	Petersen and Snapp (2015), Pretty and Bharucha (2014)
Process monitoring	Structuring knowledge processes	Navarro et al. (2016), Wani et al. (2015)
Adaptive income structure	Diversified income structure including payments for conservation activities	Raised in regional stakeholder workshop

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6.2.3 SIP III "Land Use Allocation"

Concepts: Land sharing; (agro)biodiversity; zoning; producer-consumer interface

Measures	Subcomponents	References
Spatial targeting	Determine set-aside areas/ Natural improvement areas	Foresight (2011), Franks (2014)
	Implement rigorous schemes of forest protection/restoration alongside SI	Phalan et al. (2011)
Crop-livestock integration	Integrating crop and livestock production across the landscape	Petersen and Snapp (2015)
	Maintaining and enhancing the diversity of crop genetic resources	Baulcombe et al. (2009), Caron et al. (2014), Pretty and Bharucha (2014)
Land use planning	Optimal land use distribution according to soil function	Godfray and Garnett (2014), Coyle et al. (2016)
Infrastructure development	Improving path and water networks	von Haaren (2012)

6.2.4 SIP IV "Regional Integration"

Concepts: Circular economy; Regional governance; Food transparency and traceability; Producer-consumer interface

Measures	Subcomponents	References
Regional cooperation and exchange	Redistribution of inputs e.g. nitrogen fertilizer from regions with over-supply to regions with undersupply	Mueller et al. (2012), Smith (2013)
	Regional networks, ecological networks, farmer-to-farmer learning	Franks (2014), Pretty and Bharucha (2014)
	Formalized schemes for exchange of acreage	
	Renewable energy networks	
	Exchange of inputs (water, residues, …)	
Diffusion of innovation	Agricultural extension services	Baulcombe et al. (2009), Kassam et al. (2011)
	Promotion of engineering technologies that improve water use efficiency	Franks (2014)
	Collaboration with (inter)national	Baulcombe et al. (2009),

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	research centres of soil science and agronomy, site-specific research	Foresight (2011), Kassam et al. (2011), Keating et al. (2010)
	Breed crops that are more “intensive” in their nutritional value	Godfray and Garnett (2014)
Regional value creation	Short value chains and orientation towards the consumer	Levidow (2015)
	(Private) sustainability certification schemes	Buckwell et al. (2014)
	Food labels	
Landscape administration	Establishing realistic minimum environmental flows of environmental goods and services	Baulcombe et al. (2009), Foresight (2011)
	Multifunctional landscape management	Mueller et al. (2012)
Institutional development	Supportive policies	Barnes (2016), Bunting et al. (2015),
	Institutional innovations	Schut et al. (2016),
	Access to credit and investment possibilities	Williams (2015), Ndiritu et al. (2014)

6.3 Presentation for and Results of Stakeholder Validation

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FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Paulinenaue, 17.11.2016

zalf agrathaer

EU-research project VITAL

- **VITAL** - Possibilities for sustainable intensification of agricultural production by changing land use in an innovative and locally adapted way
- Joint research initiative JPI FACCE SURPLUS project
- **Duration** : 2016-2019
- **Partners:** VU Amsterdam (NL), UP Valencia (ES), INRA Avignon (FR), ZALF & Agrathaer (DE)
- **Case study regions :** Kromme Rijn, NL (conflicts of different demands on land use), Valencia, ES (irrigation-intensive viticulture), Vaucluse, FR (intensification and set-aside) Rhinluch, DE (locally adapted land use)
- Connecting water management, nature conservation and land use is an important **issue** in all regions
- Spatial, social science and environmental economics analyses at farm, regional, landscape and European scale
- **Project team ZALF:** Dr. Ingo Zasada, Meike Weltin & Dr. Annette Piorr
- **Project team agrathaer GmbH:** Anita Beblek & Katharina Schmidt

FACCE SURPLUS
SUSTAINABLE AND RESILIENT AGRICULTURE FOR FOOD AND NON-FOOD SYSTEMS

Paulinenaue 17.11.2016

zalf agrathaer

Objectives of the meeting

- **Gain insights into the regional situation** which is facing conflicts between ecologically and economically viable land use respecting the specific site requirements
- **Develop a common understanding** of sustainable intensification that is relevant for and applicable to the regional situation
- **Identify existing and possible future innovations and strategies** at regional and farm level which enable (sustainably intensified) land use adapted to specific site requirements
- **Develop an approach to transfer knowledge** between land use in practice and scientific research (knowledge requirements, areas of interest, transfer possibilities)

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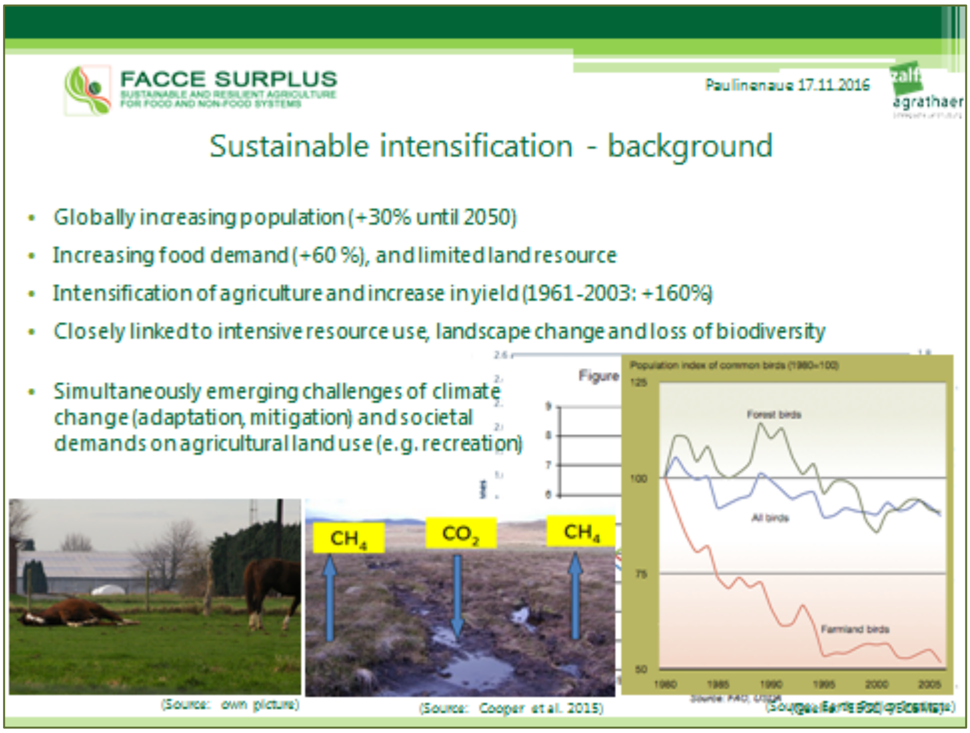

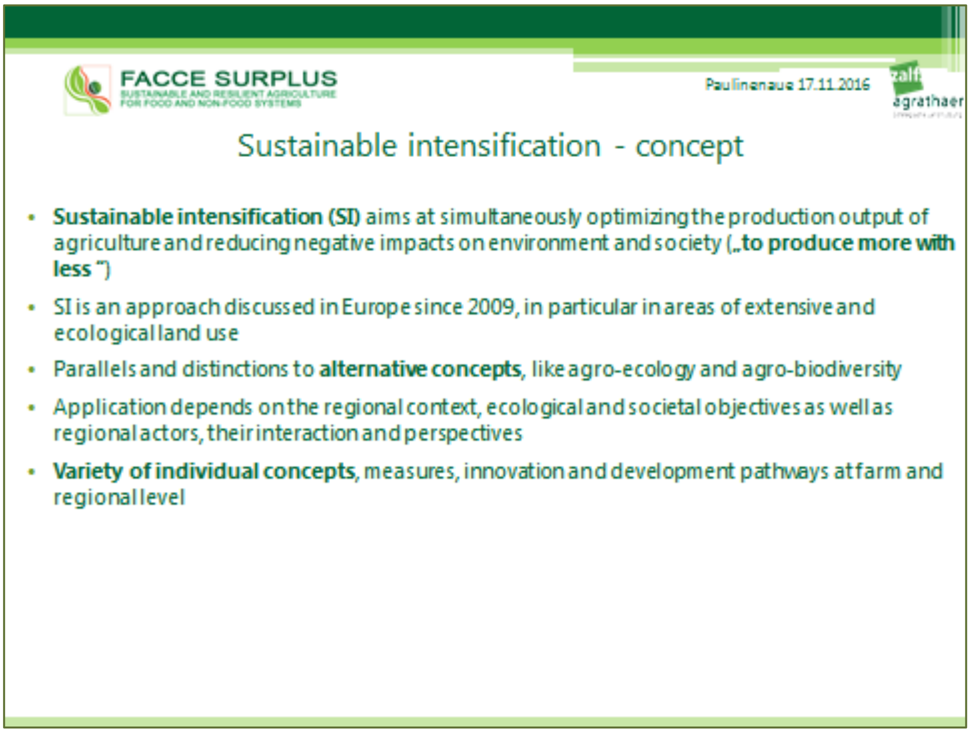

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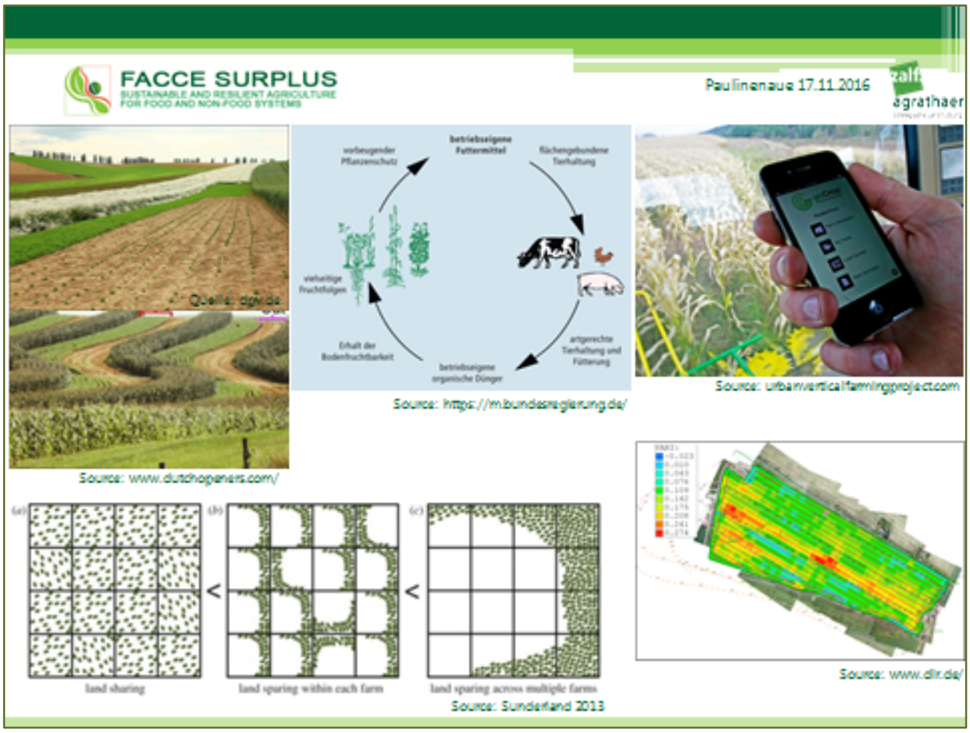

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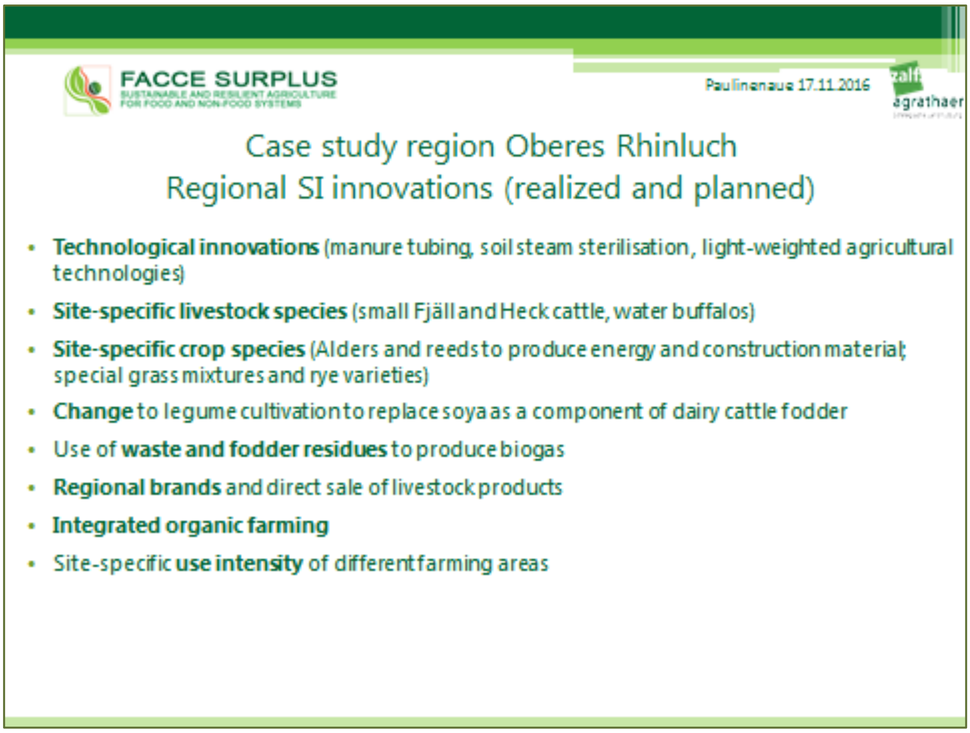

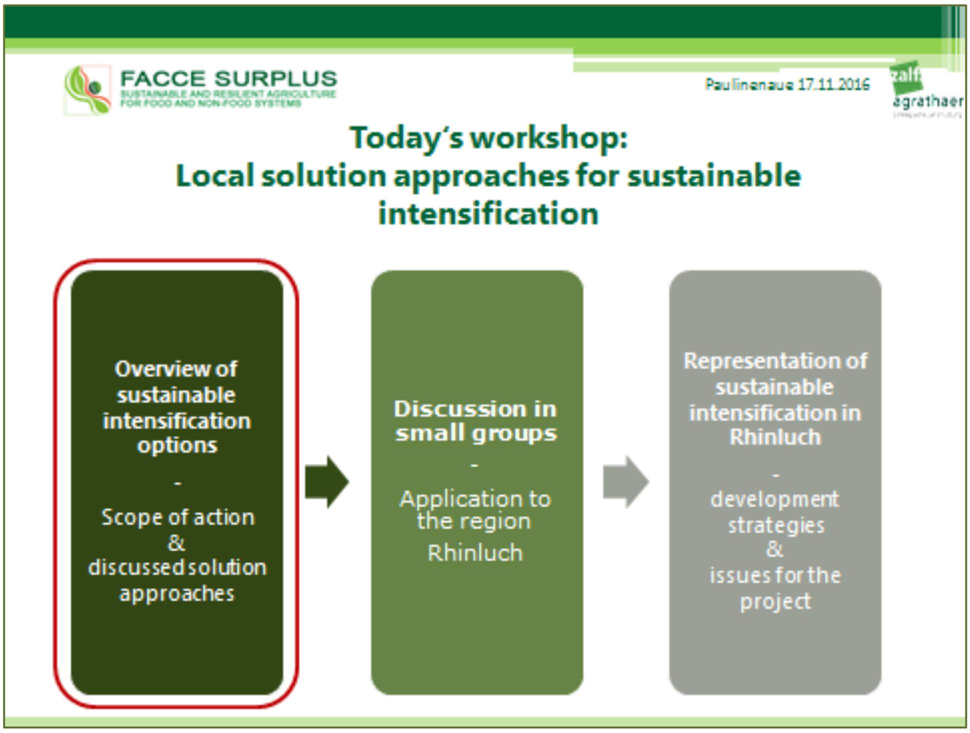

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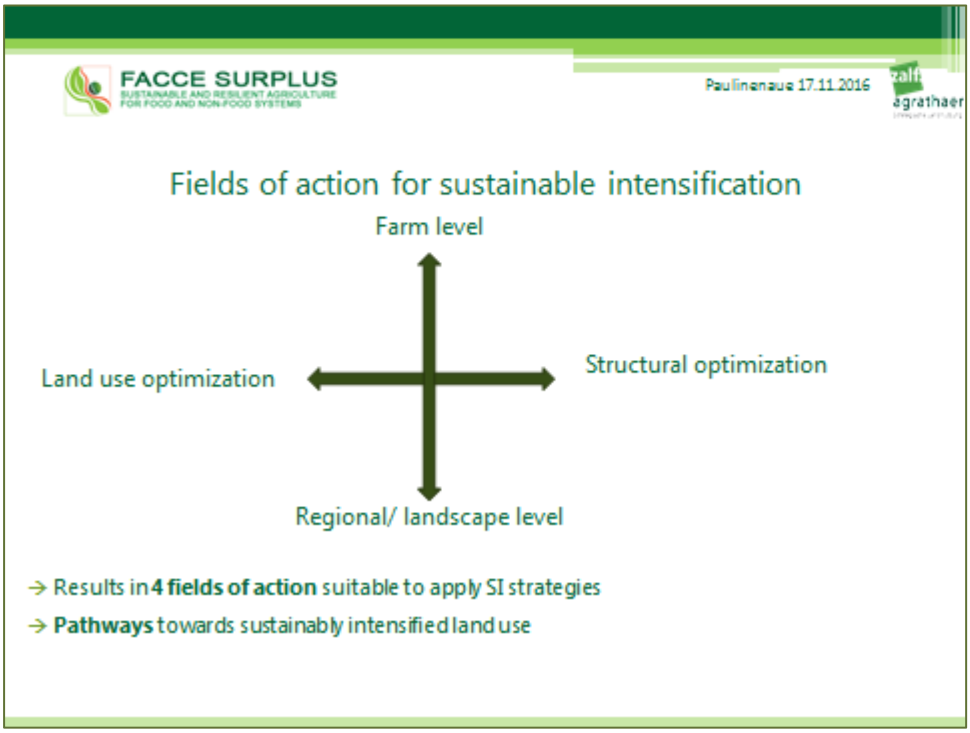

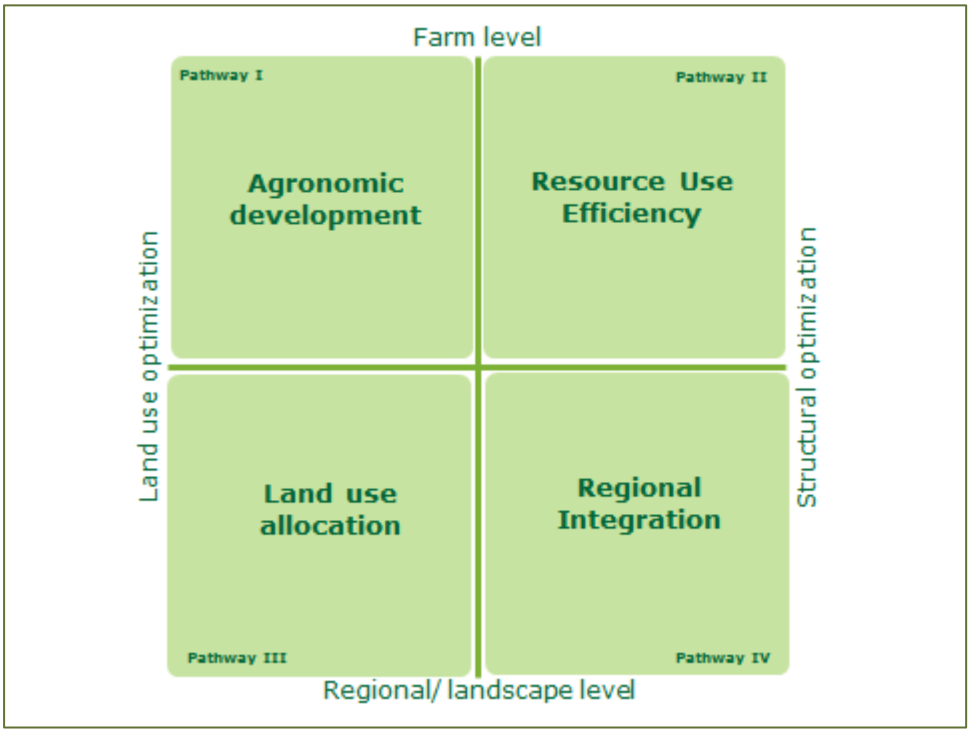

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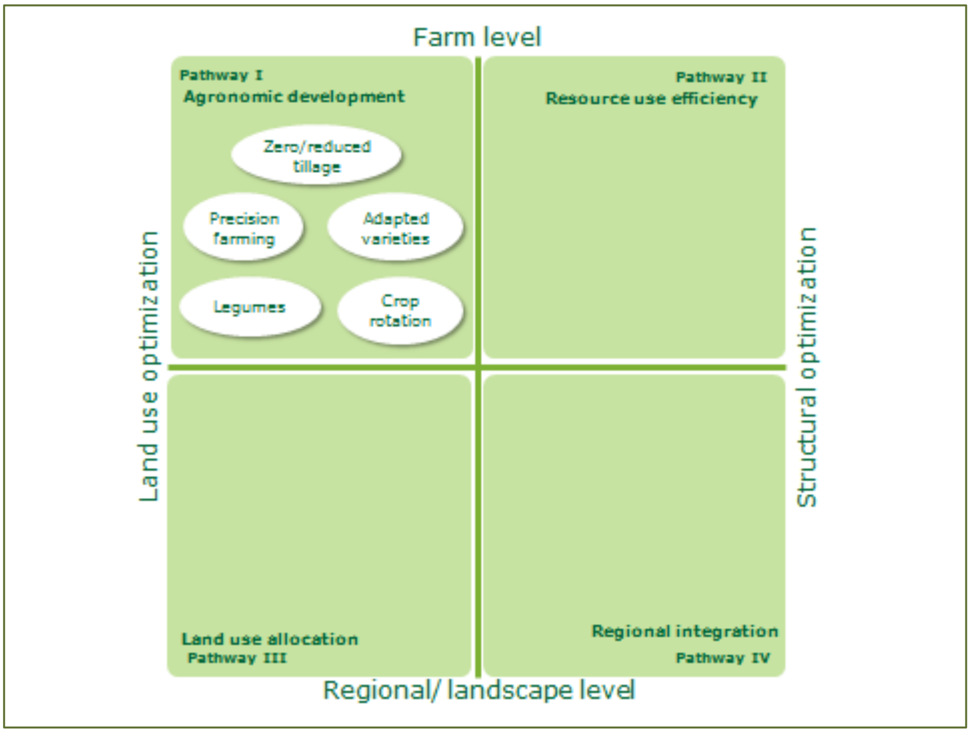

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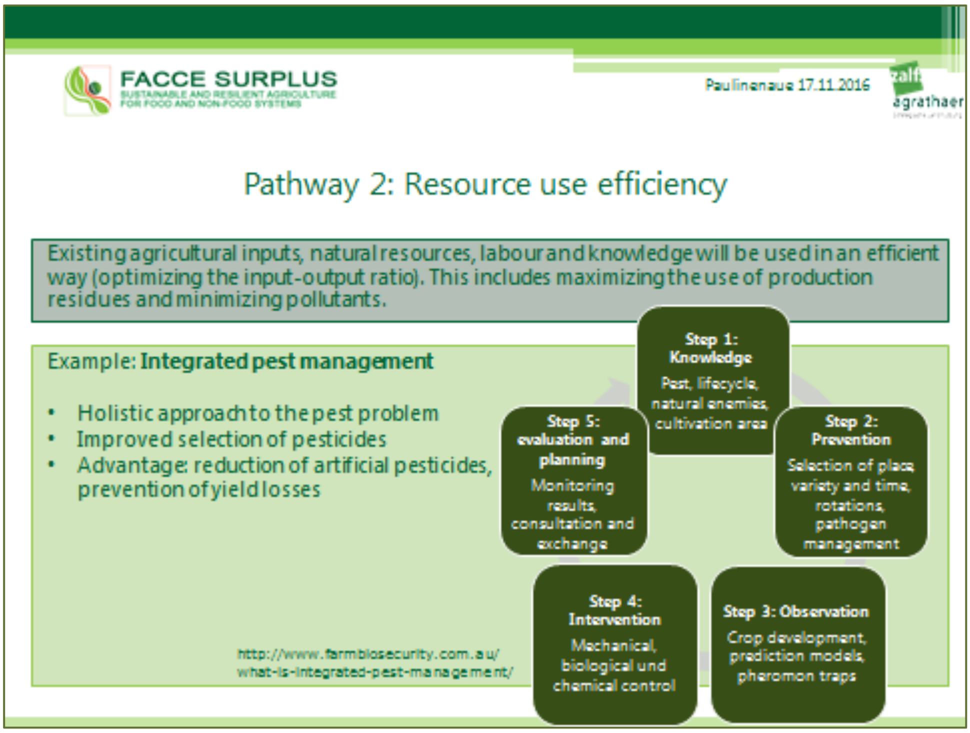

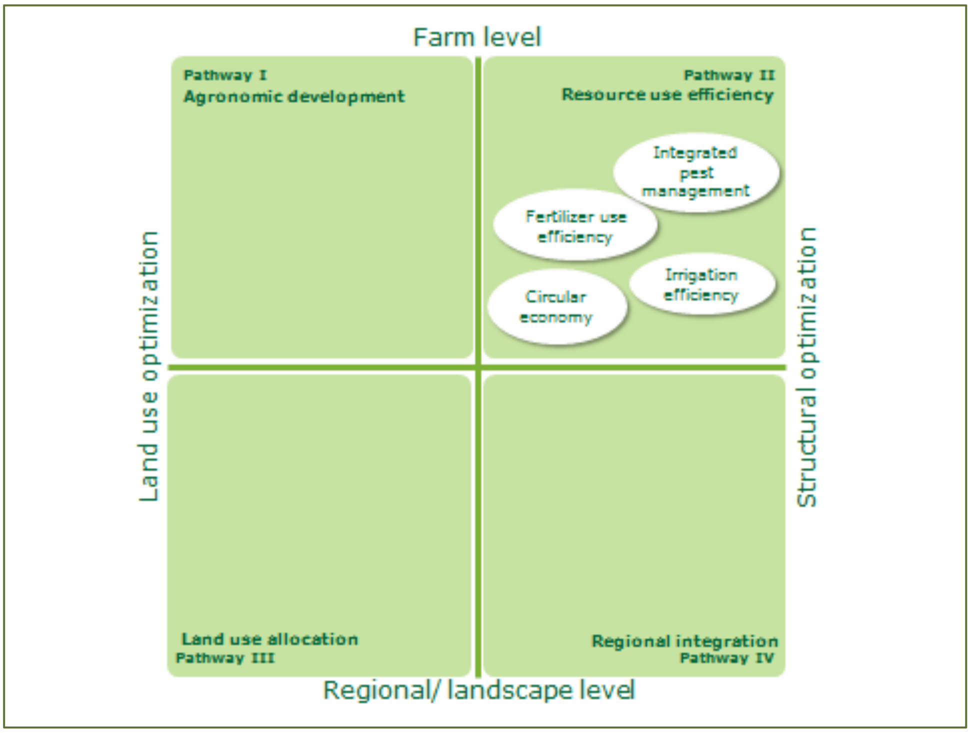

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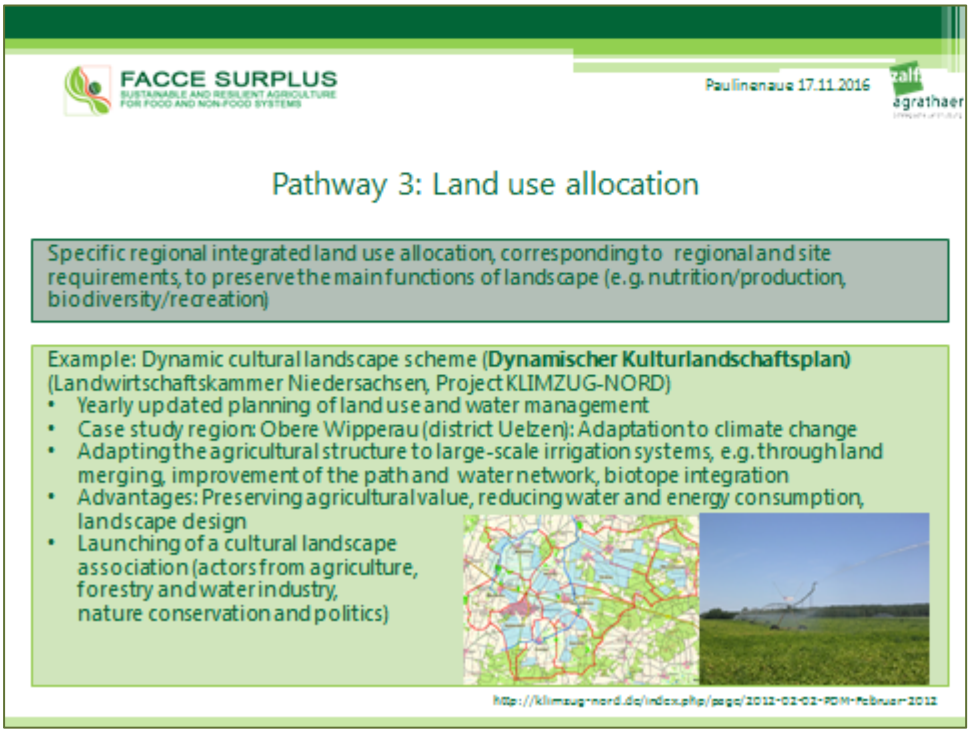

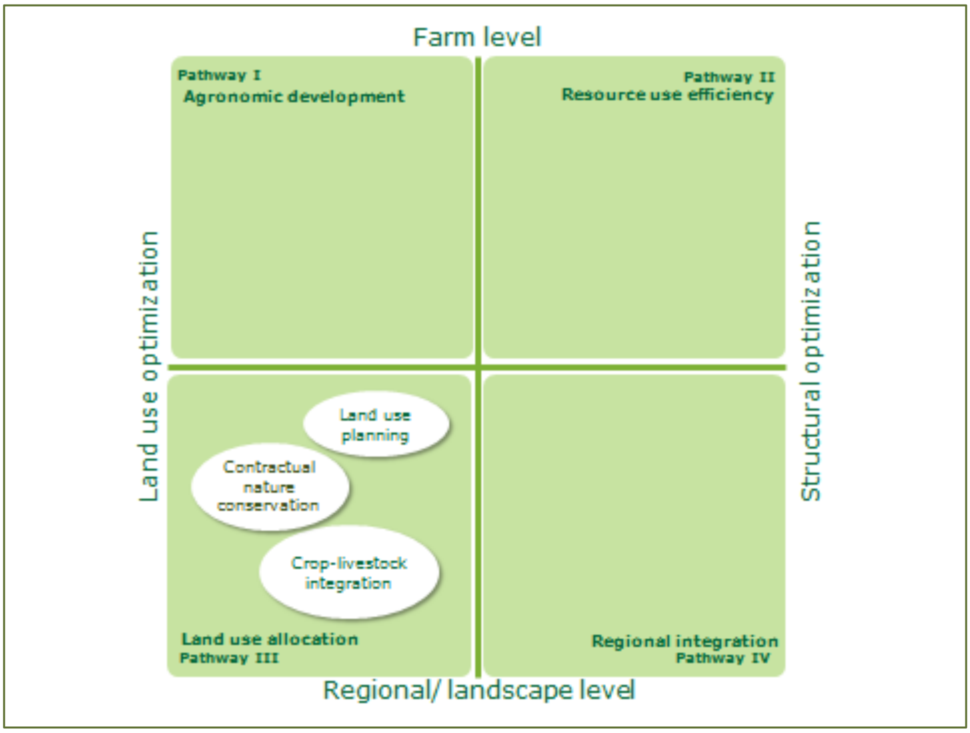

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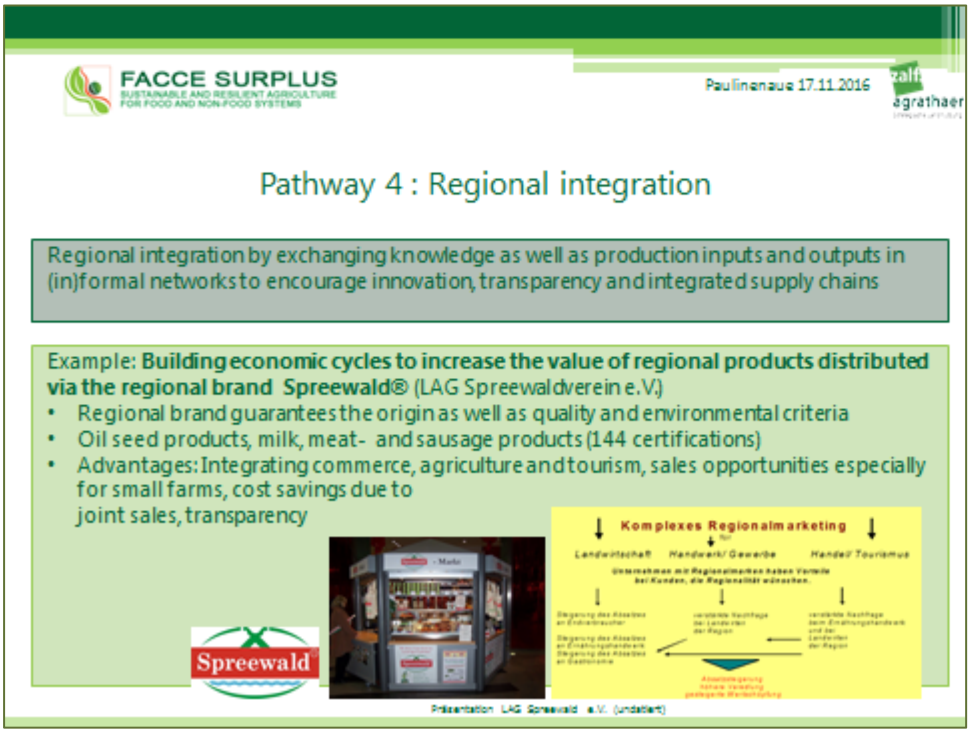

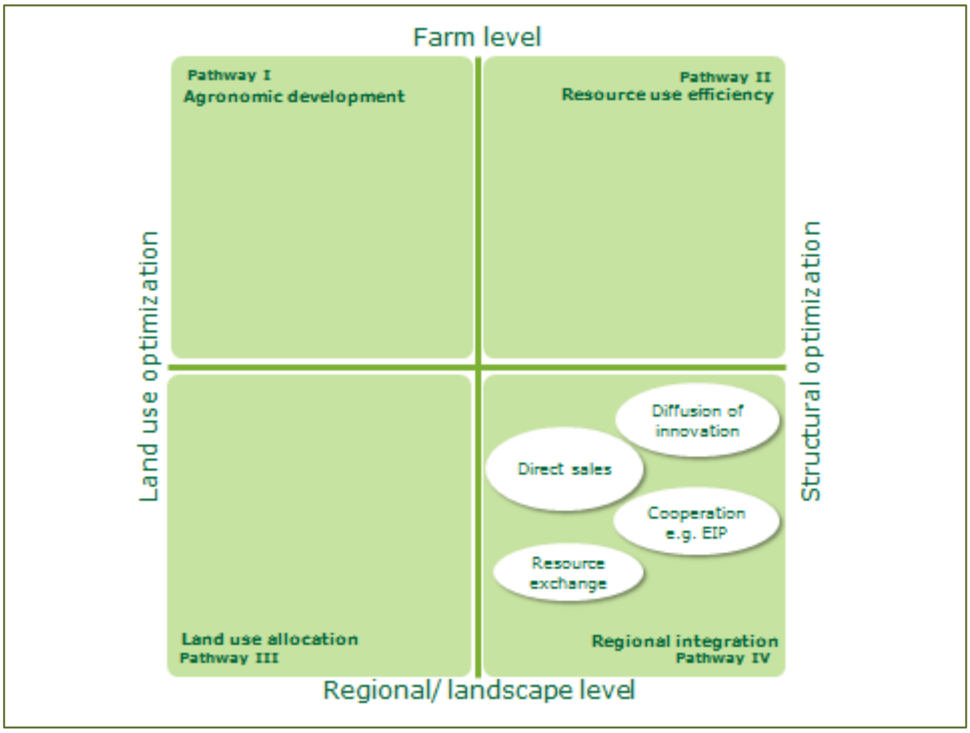

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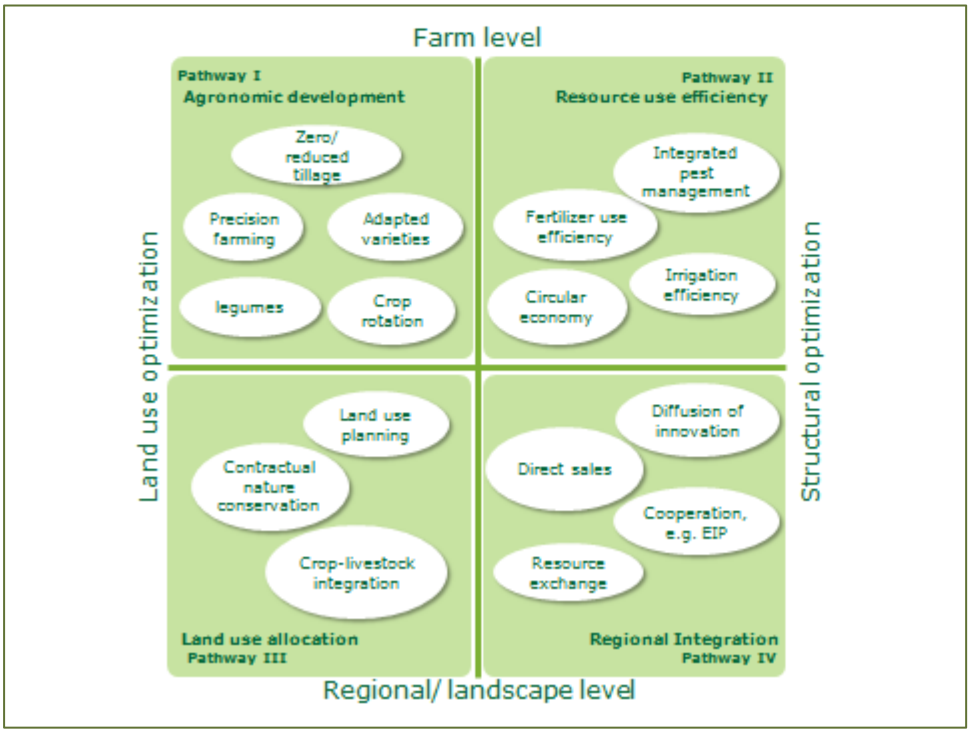

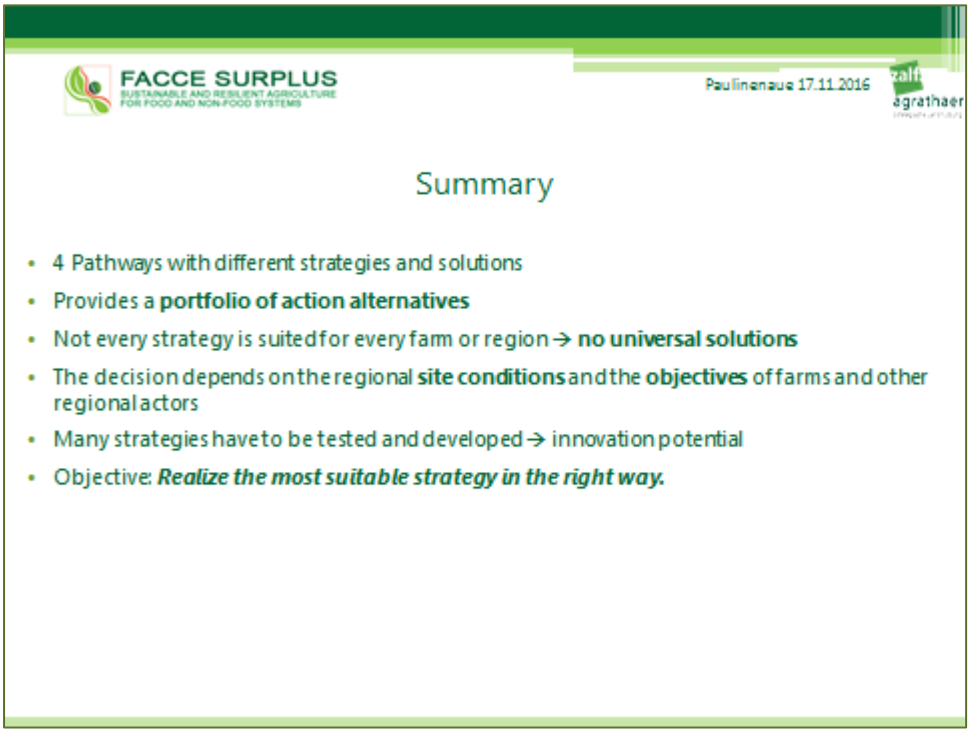

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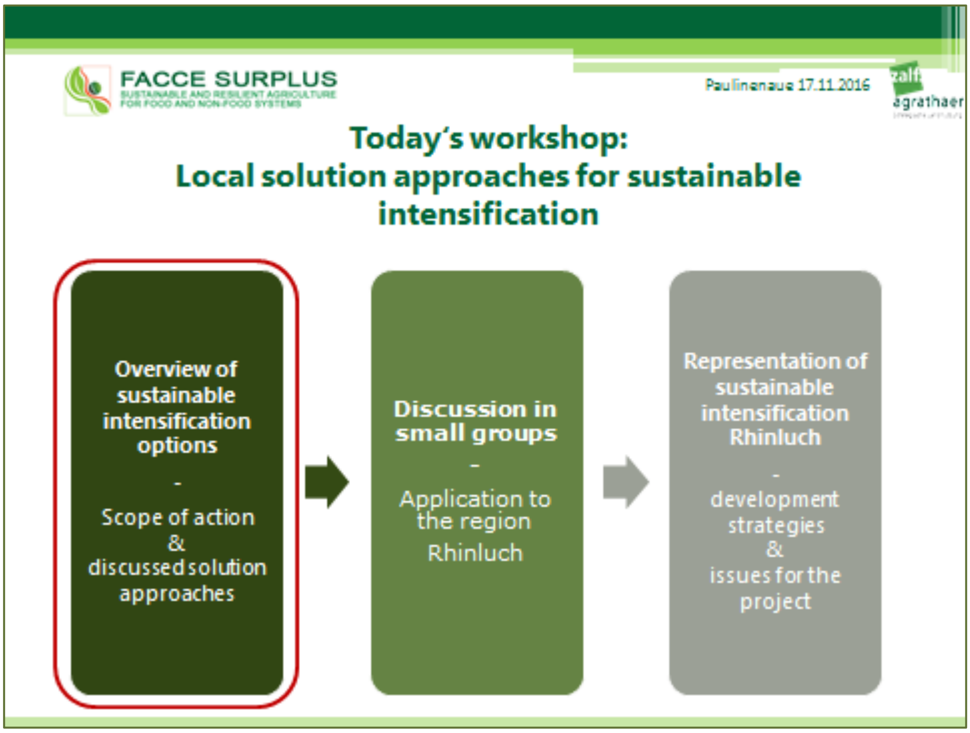

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6.4 SIP exemplar of Rhinluch Region (Germany)

6.4.1 SIP I "Agronomic Development" in Rhinluch Region

Currently applied measures	N[1] 14	P[2] 5	Suggested future measures	N 8	P 6
Spatial solutions	3	0	**Spatial solutions**	1	0
- Assigning extensive and intensive production areas	x2		- Small-scale plot structure (to increase attractiveness)		
- Preferred areas					
Adapted soil cover & animal husbandry	10	2	**Adapted soil cover & animal density**	4	0
- Targeted use of animal welfare			- Paludi cultures		
- Minimum number of animals			- Pasture land for bioenergy		
- Adapted animal stock			- Select animals according to location		
- Free-range husbandry		1	- Economic viable use of pasture		
- Legumes					
- Mulches					
- Use according to economic viability					
- Use according to conservation contracts and directives	x2	1			
- Side-adapted breeds					
Good agricultural practice	1	3	**Data-based farming and side-adapted technology**	3	6
			- Biogas technology		1
			- New economically viable cultivation methods		1
			- Side-adapted technology		4

[1] Frequency of measures mentioned

[2] Points assigned to measures: each participant could assign a maximum of three points to measures for which (s)he sees the most need for action and support

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6.4.2 SIP II "Resource Use Efficiency" in Rhinluch Region

Currently applied measures	N[1] 6	P[2] 1	Suggested future measures	N 4	P 0
Adaptive income planning - Product innovation - Direct sale - Niche products - Offer standard as well as special crops - Diversified income structure	5	1 1	**Adaptive income planning** - Achieve permanent competitiveness	1	0
Reduction of pesticides - Monitoring of pesticide application	1	0	**Fertilizer use efficiency** - Emissions-adapted use of fertilizers	1	0
			Process monitoring - Long-term monitoring and evaluation	1	0
			Crop residue and manure use - use residues from cattle husbandry for bioenergy	1	0

[1] Frequency of measures mentioned

[2] Points assigned to measures: each participant could assign a maximum of three points to measures for which (s)he sees the most need for action and support

6.4.3 SIP III "Land Use Allocation" in Rhinluch Region

Currently applied measures	N[1] 14	P[2] 7	Suggested future measures	N 10	P 7.5
Infrastructure development - Regulation of water bodies and drainage system - Checking water resources	4 x3	4.5 4.5	**Infrastructure development** - Inclusive water concept - Optimization of water regulation	2	3 2 1
Spatial targeting - Conservation contracts - Temporal increase of	4	0	**Spatial targeting** - Large-scale conservation concepts	3	1

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protection zones - Declared nature protection areas and planned increase			- Landscape planning in large scales - Adapting property rights structure		1
Land use planning	**6**	**2.5**	**Land use planning**	**4**	**1.5**
- Adapting use to spatial potentials		1	- Flexibility of mowing dates		1.5
- Assigning extensive and intensive production areas			- Alder forests		
- Use according to economic viability			- In the long-run animal husbandry should dominate, dairy cattle	x2	
- Use according to conservation contracts and directives	x2				
- Species-rich pasture		1.5			
			Other	**1**	**2**
			- Long-term planning		2

[1] Frequency of measures mentioned

[2] Points assigned to measures: each participant could assign a maximum of three points to measures for which (s)he sees the most need for action and support

6.4.4 SIP 4 "Regional Integration" in Rhinluch Region

Currently applied measures	N[1] 14	P[2] 4	Suggested future measures	N 22	P 13.5
Landscape administration	**6**	**1**	**Landscape administration**	**6**	**6.5**
- Regional water administration	x3		- Simplify legal framework conditions	x2	3
- Water administration across regions		0.5	- Inclusive water concept, managed by supervisory body	x2	2.5
- Payments for landscape conservation activities		0.5	- Establish central agencies for all regional questions		1
			- Clear decision-making		

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			structures		
Regional value creation	**4**	**2**	**Regional value creation**	**6**	**1**
- Tourism		1	- Regional development for products and sale		
- Value creation from inside the region		1	- Regional direct sale		
- Regional direct sale	x2		- Tourism	x3	1
			- Transparent food labels		
Regional cooperation and exchange	**4**	**1**	**Regional cooperation and exchange**	**7**	**2.5**
Education and knowledge transmission initiatives, raising awareness for local situation		1	- Horizontal planning of programmes and resorts		
- Networking of direct sellers and local gastronomy (did not succeed)	x2		- Sensitise tourists for regional agriculture and nature conservation topics		
			- Cooperation with neighbours		
			- Cooperation to decide on water tables		
			- Networks		
			- Generate trust among stakeholders and enable communication		2.5
			- Lobby for higher willingness to pay among consumers		
			Innovation diffusion	**1**	**1**
			- Research for new cultivation methods		1
			Other	**1**	**3.5**
			- Long-term planning		3.5

[1] Frequency of measures mentioned

[2] Points assigned to measures: each participant could assign a maximum of three points to measures for which (s)he sees the most need for action and support

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6.5 Conceptual scenario framework

The preliminary version of the conceptual-scenario framework before adaption through stakeholders and the inclusion of the results from the structured literature review is presented here to demonstrate its evolution.

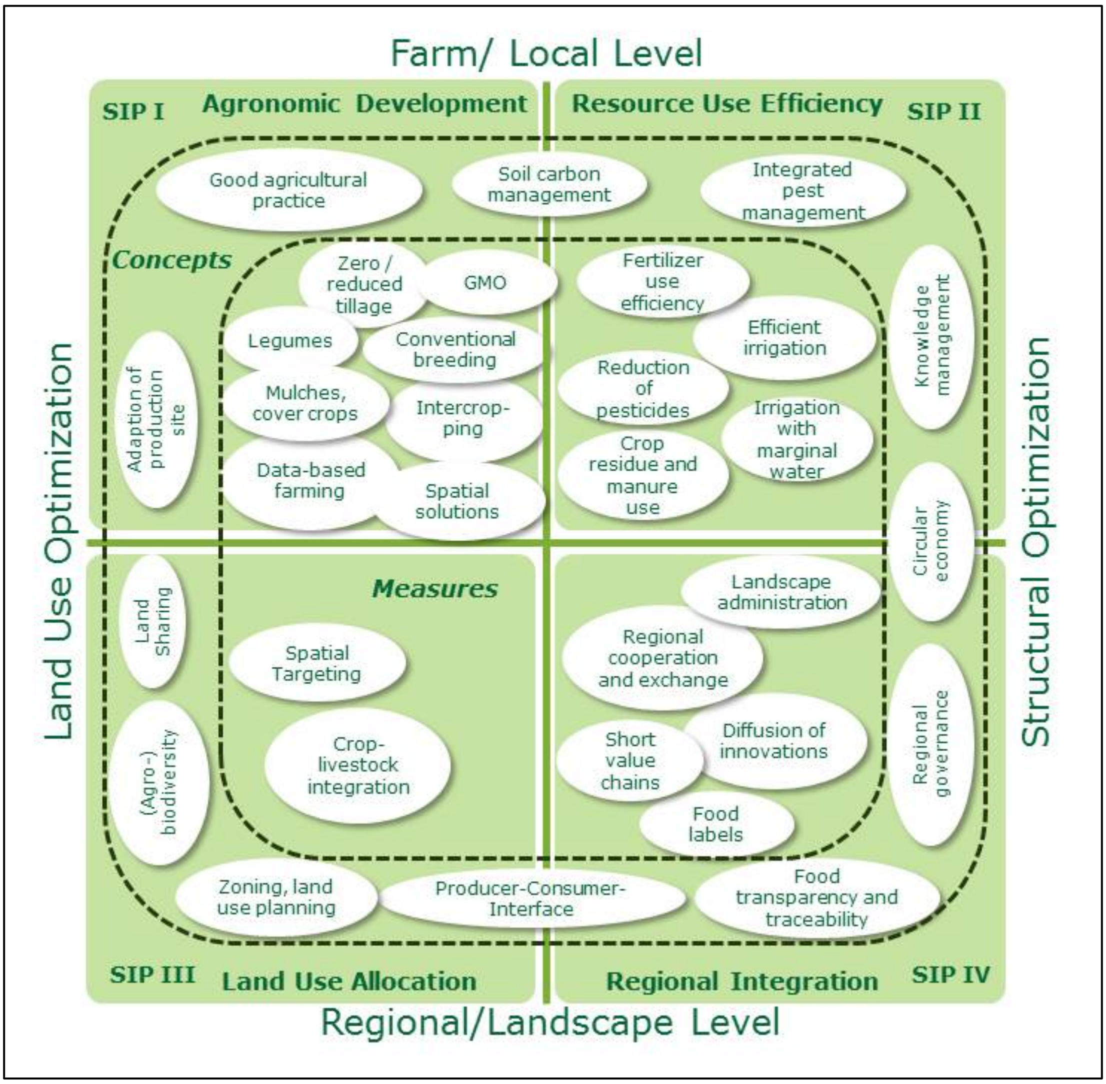

Figure 10: Preliminary version of the conceptual-scenario framework. Sets of concepts and measures, discussed in the literature, which can be subsumed to SIPs, depending on the spatial scale and whether they deal with land use or structural optimisation issues.

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