Review of existing standards and criteria for evaluation of action learning education and applied research

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Foreword

The currently used system for evaluation of the quality of education and research in agriculture are based on absolvents in the case of education and in the case of research on academic merits, such as the number publications in high impact journals. This performance measurement method provide little incentives for interactive innovation and practice-oriented research, nor does it stimulate action learning practices in education. The evaluation of agricultural research outputs should more focus on societal impact and usefulness, and education should be evaluated on a wider criteria scale. This report is a first step in the development of an assessment framework for evaluating the social impact and usefulness of interactive and practice-oriented research, and the transformative qualities of action-oriented education in the agrifood and the forestry sector. Given the urgency for confronting sustainability challenges, there is an urgent need for academic institutions to engage in new ways. An assessment framework for research and education could support universities in their ambition to develop strategies for accelerating social change toward sustainability.

Key messages

- NextFood project aims to close the gap between university education and agriculture and forestry practice by applying cyclical learning approaches, action research and education, and knowledge co-creation
- We provide review on development and different approaches to action research and education which summarizes recent trends in this field. This requires a holistic approach to education with regard to learning contents, teaching methods, cultural and social dimensions of the learning environment.

- We propose two-steps procedures for evaluation of teaching process which should be considered while preparing the higher education curricula or other curses on the topic of Sustainable Agriculture or related. The assessment framework for education developed within the NextFood project will be further developed based on current state of knowledge.

1 Introduction

At the beginning of the 21st century, human society is at a stage of rapid population growth, breakthrough technological innovations, global change, but also enormous exploitation or damaging of natural resources. After World War II, in the need to feed people in the first place, the industrialization of agriculture took place in terms of the so-called green revolutions in European countries. This also involved significant investment in applied research and the development of national and international research and education institutions and initiatives to address food security issues. With the depth and intensity of research, the specialization of the research sectors took place, the applied research actively drew the theoretical knowledge, and quickly put it into practice with the support of state policies. The culminating industrial revolution brought unprecedented quantity and a range of intensification inputs, new techniques and technologies, often associated with the concentration and specialization of production, to the agricultural primary production and food industry. Applied research, increasingly deeper, but more narrowly focused, has lost a holistic view in many cases. In practice then, a one-sided technocratic approach and accelerated application of untested methods have more often led to agroecosystem damage and, even, to its devastation. The industrialization of agriculture also had a negative impact on the social sphere. In industrialized European countries, tens of percent of working population have left agriculture and gradually also rural areas. In terms of sustainability, the economic sphere has shifted from balance at the expense of the environmental and social spheres. The "Economy first" trend was also reflected in the research institute competition for financial support of the state, which made it easier to evaluate and decide on support through a positivist approach. Such an approach supports results that are demonstrated by quantifiable and repeatable measurement methods, facilitates the cost-benefit analysis of funded research programs, but neglects their environmental and social externalities, both concurrent and future. Profitability preference is the biggest motivator, but also an obstacle to the evaluation of the research impact.

Given the complex global challenges (climate change, environmental sustainability, food safety), the agricultural and food research creates not only new knowledge but it is increasingly trying to address social challenges. By the end of the 20th century, a demand for evaluation standards that better perceive agriculture as a complex system for which the positivist approach is inadequate and unsatisfactory in

terms of sustainability, has occurred. Evaluators are beginning to lean towards constructivist logic. Constructivist evaluation provides a more comprehensive understanding of relationships in complex agricultural systems. Constructivism supports active interaction of a research or educational subject with the environment and society. Participatory as well as transdisciplinary research with close interaction between researchers and farmers or food producers, consultants, students and their teachers and, as appropriate, other partners is an appropriate approach to tackling complex sustainability issues. The transition from positivism to constructivism also changed the evaluation from a predominantly traditional ex post into a combined evaluation conducted both during the research and after its application. The development of the evaluation of agricultural applied research demonstrates the understanding of its function as a tool for knowledge production and above all as a tool for change. Evaluation standards must therefore be adapted and developed so that the impact of applied agricultural research can be measured as effectively as possible not only in agricultural practice but also in society as a whole. New quality of cooperation between researchers, producers, consumers and politicians is necessary. Improving communication and understanding between researchers and professionals will make it easier to transfer research and will accelerate innovation processes in competitive and sustainable agriculture.

As a result of globalization changes in society and in the context of the fact that contemporary human beings are subject to ever higher demands, when they have to cope with many opportunities, but also with obstacles and threats, there is also pressure to change the educational paradigm. Contemporary tendencies in education induced by these changes aim at the concept of autonomous intercultural education, developing the individual's personal and social qualities and their self-realization, using cooperative strategies in which different forms of active cooperation and interaction of all subjects in teaching are applied. Aspects supporting cooperation, interdisciplinary skills and problem-solving abilities should be incorporated into everyday teaching practices. They should use active learning methodologies including multimedia approaches, problem-based learning, discussion forums, mapping of roles and concepts. Effective learning strategies will improve students' understanding of complex situations and their individual and collective abilities and motivation for responsible behaviour.

The transition from linear education with insufficient feedback and overlap into practice to participatory-oriented education is urgent. It is desirable to use systemic approaches in which farmers and other stakeholders are considered as important actors and co-creators of knowledge, and, thus, support the transition to innovative and knowledge-based systems, where they engage in learning processes and, even, in common addressing of specific problems of agricultural practice. The graduates of tertiary education in the field of agro-food systems, which are becoming more and more complex, will require not only expertise but also the ability to apply it in practice. Their success in practice will lie in the right level and proportion of knowledge, skills, abilities and competencies. The practical usefulness of the graduate but also of the other participants in the process will depend not only on their scientific level but also on the ability to use knowledge in favour of environmental, economic and social sustainability. This requires internal motivation of both teachers and students, as well as engagement and involvement of other stakeholders. Preparing students to work for a more sustainable future requires a holistic approach to education with regard to learning content, teaching methods, and socio-cultural dimensions of the learning environment. The results of the participants' work could be the basis for the evaluation of teaching and, finally, for the design and revision of academic programs. Practical example of this approach is shown by Edvin Østergaards (2018) in Table 1 "from-to".

FROM	TO
Lecture hall	… a diversity of learning arenas
„Vorlesung" (Lecture)	… „nachlesung" and peer learning
Syllabus	… supporting literature/a variety of learning sources
Textbook	… a diversity of teaching aids
Written exam	… a variety of assessment methods
Lecturer	… learning facilitator

Table 1 Practical example "from - to".

This list is a good way of operationalizing a shift from a conventional linear education system to a transformative and participatory learning model.

Outlined modernization trends of education are based on humanistic ideas and support the importance of active student activity, constructivist approach, open, cooperative and problem-based teaching with a close connection to practice. Improving the quality of education is essential for the sustainable development of society.

2 Methods

Literature review format uses quite rigid methods for result obtaining. Typically, scientific literature database search is conducted using relevant keywords to obtain list of literature which can be further exploited. In addition, a method of conducting literature review is using a co-citation approach (e.g. Janssens et Gwinn, 2015). Janssens & Gwinn (2015) acknowledge that while keyword-based searching for eligible studies provides fair results, it lacks efficiency because scientist must still review thousands of publications in order to find relevant articles.

For the purposes of this study we used standard scientific literature databases search of peer-reviewed journal articles. Specifically, a combination of keywords, research fields restriction and subsequent personal filter focused on relevance of particular results. In specific cases like the evaluating of university curricula, white papers, curricula publications and related university websites were also used as a basis for literature search. The detailed approach of obtaining literature slightly varies, nevertheless, from chapter to chapter, since the authors needed to reflect specific concerns in the respective topics of interest. Therefore, for the detailed methodology of obtaining results, we refer to individual chapters of this study.

3 Impact assessment of agricultural applied research

3.1 Introduction

This section reviews the literature on the impact assessment of agricultural applied research through evaluationst. The goal is to synthesize literature on agricultural applied research evaluations in order to understand the theoretical

background and standards that shape the evaluation process. To accomplish this, the theoretical backgrounds of agricultural applied research evaluation standards must first be uncovered by examining the historical context in which they are situated. Such context allows us then to trace the theoretical evolution from *positivist* to *constructivist* based evaluation models like program theory. The timing of evaluations is also addressed from a theoretical perspective. Following the theoretical framework of agricultural applied research is a discussion of what those evaluation standards look like in practice, citing several linear and non-linear program theory models as references. The chapter then concludes with a discussion about obstacles and priorities that shape evaluation standards.

3.2 Methods for Finding and Reviewing Literature

The reviewed literature was compiled through a structured database keyword search followed by a supplemental unstructured search using both databases & previously cited literature. The initial database search was conducted through Lund University's LUBSearch, a shared search engine with over 130 databases (See Table 1 in Appendix for full list). The initial structured database search included eight different keyword search combinations relevant to composing a literature review for applied research evaluation standards. All keywords were searched with an additional "agriculture" keyword in attempt to avoid an abundance of irrelevant articles, except three denoted with asterisk marks (*). These three searches yielded little to no articles with the addition of an "agricultural" keyword, so it was omitted. A summary of this initial structured keyword search is listed below in Table 2.

KEYWORDS	TOTAL HITS	RELEVANT HITS	FULL TEXT
All keywords were searched with "agriculture" except with those marked *	**(Our of first 100)**	**(Abstracts)**	**(Full text)**
Applied research + evaluation	5,524	18	2
Action research + evaluation	1,514	14	5
Evaluation standard + research/education*	44,063	5	0
Evaluation framework + research/education*	26,358	5	0
Research impact + evaluation	635	3	0
Research evaluation + theory *	183,037	10	3
Research evaluation + guidelines	n/a		
Research impact + theoretical framework	n/a		

Table 2 Structured Keyword Search Results.

According to the figures from Table 2, the initial keyword search was not very successful in finding relevant literature to review. In fact, the last two keyword combinations yielded no relevant articles, although these were admittedly combined with the additional "agriculture" tag, which easy could have skewed search results. Furthermore, while the number of total hits ranged from the several hundreds to several hundred thousands, only 55 articles were deemed "relevant hits" or worthy of pulling the abstracts from. Of these "relevant hits," only 10 articles had subject matter useful enough to read through the "full text." It should be noted that "full text" articles were subsequently incorporated (i.e. cited) in this review.

Janssens & Gwinn (2015) acknowledge that while keyword-based searching for eligible studies is a gold standard, it is inefficient because a trained expert must still screen thousands of publications in order to find only a handful of relevant articles. Accordingly, a supplementary method of finding relevant literature was needed. This was accomplished largely through cited literature within the 10 "full text" articles as well as additional searches on LUBSearch related to specific trends or findings as reading developed. This supplementary unstructured search was crucial to "filling in the gaps" of knowledge lacking from the initial structured keyword search. Of particular use were works from agricultural researcher and evaluator Boru Douthwaite, who was

discovered in one of the "full text" articles (Douthwaite *et al.*, 2003). Douthwaite previously served as the Impact Director of the Consultative Group for International Agricultural Research (now known just as CGIAR), a multinational organization headquartered in France that works toward food security and sustainability. via various projects throughout the world. As a result, much of the subsequent reviewed literature takes examples Douthwaite's publications, which largely draw from experience with from CGIAR-led projects.

3.3 Uncover the theoretical background of evaluation standards

To uncover the theoretical background of agricultural applied research evaluation standards, it is important to first understand *what* an evaluation standard is and *why* they exist before delving into *how* they are structured theoretically and *when* to use them. This chapter will address how contemporary agricultural applied research evaluations came to be via historical and theoretical context. It is predominately a chronicling of the evolution of evaluation theory from predominantly *positivist* thinking to the more *constructivist*-based logic, which now serves as the basis for most program theory evaluations used today. The chapter concludes with a discussion about the timing of evaluations (i.e. to conduct during or after research), which is necessary context for the examples of evaluation models given in the next chapter.

3.4 Historical context

The Organization for Economic Cooperation and Development (OECD) defines evaluation as "a policy tool which is used to steer, manage and improve the activities of and investments in public sector research organisations." (OECD Innovation Policy Platform, 2011). As such, the evaluation of agricultural activities serves to transform insights from applied research into policies that impact societies of stakeholders, from farmers to researchers to policy makers. The need for the evaluation of agricultural applied research first emerged in the mid 20th century because of two scarce resources: food and money. While agricultural products are inherently scarce resources, funding for research projects drastically waned with the post World War II education boom (Horton, 1998). One consequence was that the technologies developed via new research improved the mundane or necessary daily tasks in life, including producing food providing clean drinking water, etc. Successful agricultural technologies resulted in the

Green Revolution, a global phenomenon in the 1950s and 1960s that saw increased research, development, and transfer of agricultural technologies, particularly in developing nations (Horton, 1998). By the 1970s, large, multi-national research initiatives aimed at resolving issues of food security were established, like the CGIAR.

This education boom also saw an explosion of expertise in academic fields — gone were the days of scarce numbers of specialists in academia. Increased competent and available researchers translated to increased research activities that now had to compete for funding. Early European examples on agricultural research activities inspired from The Green Revolution are difficult to find as both policy and education systems varied from country to country and were often published only in the national language. Thus, I will borrow early an example from the U.S. instead.

To better cope with increased research activities, the U.S. Department of Agriculture adopted a Planning Programming Budget (PPB) approach to research evaluations in the 1960s that focused exclusively on quantitative indicators to measure improvement to agricultural conditions like production efficiency (Fedkiw & Hjort, 1967). More qualitative factors like research impact on local communities was not taken into consideration at this time. Consequently, early-stage agricultural research impact assessment during the Green Revolution era was favored *positivism*, a theory which favors results that can be proven through quantifiable and repeatable methods of measurement. This *positivist* approach to early agriculture research was adapted from other natural science disciplines, such as medicine, which used (and still use) *positivism* to "discover general laws about relations between phenomena, particularly cause and effect" (Alderson, 1998).

3.5 Positivism to Constructivism

While a *positivist* approach to evaluation standards help to illustrate cause and effect relationships such as the cost-benefit analysis of funded research programs, it does not account for hidden or tacit social benefits that often result as unforeseen consequences of agricultural technologies. An example of these unforeseen consequences is the Zimbabwe Bush Pump 'B' Type, which was designed to provide access to water via a simple hand pump solution. However, anthropologists Marianne de Leat and Annemarie Mol (2000) note that there are social impacts of the pump as a

community builder, health promoter and, even, nation-building apparatus worthy of being featured on its own postal stamp. (Morgan, 2009).

Clearly, in the case of agricultural technologies and innovation, there is a need to account for more than just numeric indicators of success or failure, which has resulted in favoring a different theoretical approach to agricultural applied research evaluation in more recent years called *constructivism*. According to Douthwaite *et al.* (2003), *constructivism* is built on a principle of active learning processes that legitimize knowledge through performativity. *Constructivist*-based evaluation standards aim to understand the effectiveness of research not only in terms of cost-benefit analysis but also social impact.

While relevant arguments exist for *positivist*-approaches to measuring research impact (Alston *et al.*, 1995), there is a growing endorsement within 21st century literature for *constructivist*-based theory (e.g. Douthwaite *et al.*, 2003; Hansen & Borum, 1999; Chouinard *et al.* 2017; Douthwaite & Hoffecker, 2017). This is largely attributed to socially-oriented programs, becoming increasingly understood as complex interventions within complex systems (Paz-Ybarnegaray & Douthwaite, 2017). The nature of research has evolved in such a way that multiple stakeholders are involved, often across nations, institutes, and disciplines, each with their own priorities and values regarding the impact they feel is important for research to achieve. While traditional *positivist* evaluation standards may be relevant in other research disciplines, Chouinard *et. al* (2017) argue that the process of agricultural research impact assessment is a complex sociopolitical process in which quantitative predictive certainty is not sufficient. Therefore, contemporary agricultural research impact assessment should be based on a type of *constructivist*-theory that allows for adaptive, situational flexibility when measuring impact.

3.6 Program Theory

Under the general *constructivist* theory for evaluation has emerged a popular evaluation theory model: program theory evaluation (PTE). PTE refers to a "variety of ways of developing a causal model linking programme inputs and activities to a chain of intended observed outcomes and then using this model to guide the evaluation" (Rogers, 2008). Essentially, PTE allows an impact pathway to guide the evaluation. PTE goes by several different names across disciplines, like theory of change (Weiss,

2011) and theory driven evaluation (Chen, 1990); however, it is most commonly recognized and referred to as impact pathway evaluation (IPE) within agricultural research (Douthwaite *et al.*, 2003). According to Rogers (2008), PTE attempts to build logic models that can be used in the evaluation process. These logic models are usually linear models, but there are a few non-linear examples that attempt to account for agricultural innovations systems as complex adaptive systems (Paz-Ybarnegaray & Douthwaite, 2017). Examples of both linear and non-linear PTE will give explored in a later section.

3.7 Ex Ante v. Ex Post

Although not explicitly mentioned in the literature reviewed, timing was essential to the theoretical construction of evaluation. Timing, in this case, refers to *when* research impact was assessed, either during research as an *ex ante* evaluation or some unspecified time after research concluded as an *ex post* evaluation. *Ex post* evaluations have traditionally been the favored evaluation time frame, largely in that they allowed for conclusive measurements of research projects' actual cost and benefit streams (Horton, 1998). Even today, *ex post* evaluations dominates over its *ex ante* counterpart (Weisshunn *et al.*, 2018). However, there is a growing argument for *ex ante* evaluation because of its direct influence on designing research and potential for predictive cost-benefits, which mitigate unnecessary costs (Horton, 1998; Hansen & Borum, 1999; Weisshunn, *et al.*, 2018). There are also a few research impact evaluation models that combine *ex ante* and *ex post* evaluation time frames to keep research cost efficient and better address issues of "attribution gap," or how much impact directly results from research rather than external factors. These *ex ante* and *ex* post combination models will be discussed further in the following section.

The evolution of applied agricultural research evaluation from *positivist* to *constructivist*-based theoretical framework indicates a need for adaptable evaluation standards. In this regard, the theoretical backgrounds of agricultural applied research evaluations serve more as fluid structural guidelines than rigid rules. Thus, specific research context, like socio-cultural and political considerations, must also be accounted for when developing an evaluation standard.

3.8 Evaluation standards for action research (focus on social relevance concept)

Given the complex nature of agricultural research, there are no straightforward evaluation standards in place. Instead, there are several popular methods of evaluation based on the general principles of program theory evaluation (PTE). Notable examples include the GTZ model, Impact Pathway Evaluation, and Complexity-Aware models. While the relevance and applicability of these methods depend on the nature and intended purpose of research, they were chosen because they exemplify program theory used in both linear (GTZ & Impact Pathway Evaluation) and nonlinear (Complexity-Aware models) logic models of evaluation standards.

3.9 GTZ Evaluation

An early example *constructivist*-based PTE is the GTZ model, named after the German technical development organization *Deutsche Gesellschaft für Technische Zusammenarbiet GmbH* (GTZ). In order to account for complex social processes inherent in complex social systems, the GTZ model splits evaluation and impact assessment into two parts. The first stage is an internal evaluation early on in a research project, which previous GTZ experiences showed was better value for money since internal evaluation was found to be more critical (Douthwaite *et al.*, 2003). Furthermore, internal evaluation helped researchers navigate complex social systems via a "learn by doing" approach (Douthwaite *et al.*, 2003).

The second stage of GTZ is *ex post* evaluation conducted some years after a research project has concluded. The purpose of this second evaluation is to bridge the "attribution gap" or the gap between direct benefits and developmental outcomes of research, as shown in Figure 1 below.

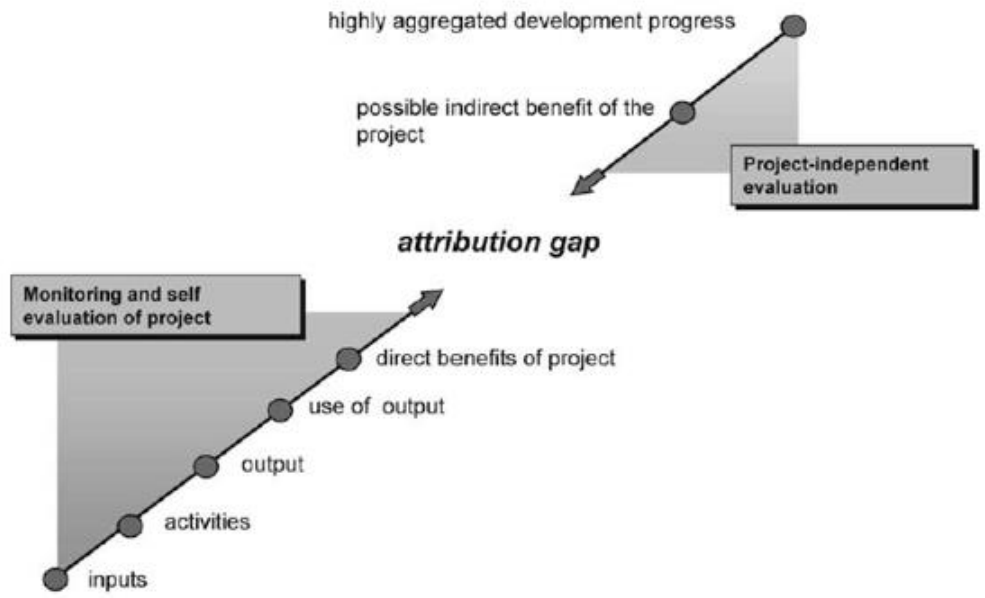

Figure 1 GTZ impact Model (Douthwaite et al., 2003).

According to Horton (1998) "with the passage of time, agronomic, economic, and social conditions often change dramatically, making it difficult to distinguish the changes due to research from those due to other factors." Thus, GTZ's combination of *ex ante* and *ex post* evaluations helped steer research down an impact pathway from early on in the project, rather than merely assessing what had happened after the fact.

3.10 Impact Pathway Evaluation

Impact Pathway Evaluation (IPE) is a *constructivist*-based, two-stage monitoring, evaluation, and impact assessment system developed for the CGIAR. Directly inspired by the GTZ evaluation model, IPE aims to be "the hypothetical bridge between project outcomes and eventual impact" via a two-step *ex ante* and *ex post* evaluation (Douthwaite *et al.*, 2003). The critical difference between GTZ and IPE is the *ex ante* evaluation, wherein the latter allows the impact pathway to guide self-monitoring and evaluation. A related version of IPE is Participatory Impact Pathway Analysis (PIPA), which was also developed for CGIAR funded programs in developing nations. PIPA utilizes project stakeholders to jointly "describe the project's theories of action, develop logic models, and use them for project planning and evaluation" (Alvarez *et al*., 2010).

3.11 Complexity Aware Models

While GTZ, IPE, and PIPA are all examples of linear logical models developed using PTE, there is criticism about the "pipeline" trickle down that such linear models enforce. Douthwaite & Hoffecker (2017) argue that this approach diffuses innovation in a way that does not necessarily give end users of agricultural research technologies a direct say in the research and innovation process. Complexity-aware models attempt to account for all stakeholder interests by using a "causal loop" system rather than linear "if/then" formulation when developing PTE. These "causal loop" systems (usually in the form of a diagram) help depict the dynamics of learning and adaptive change *during* the research process rather than after the fact. An example of a complexity-aware evaluation model is Outcome Evidencing, an *ex ante* ten-step rapid evaluation approach based on the development and revisiting of theories of change as shown in Figure 2 below. Outcome Evidencing is most useful as a central component of program monitoring, evaluation, and learning systems, meaning it is repeated throughout the research process.

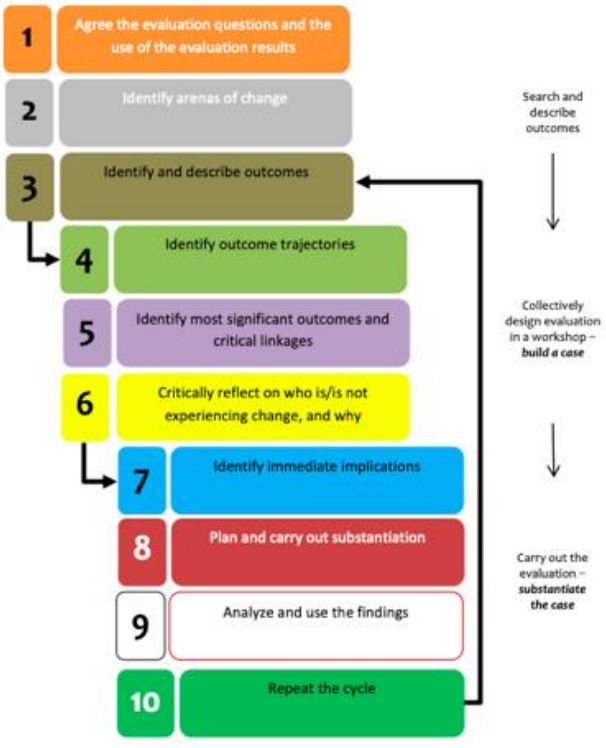

Figure 2 Outcome Evidencing Process (Douthwaite & Paz-Ybarnegaray, 2017).

3.12 Discussion: Shaping & Prioritizing Standards

Linear and non-linear program theory examples like GTZ, IPE, and Complexity Aware models help provide frameworks for evaluation; however there is no explicit set of standards for evaluating agricultural research impact assessment. In fact, the aforementioned models were developed for specific agricultural projects, each with their own unique context (research location, involved actors and stakeholders, budget, predicted outcomes, etc.). While previous models might serve as a source of inspiration, contextual consideration is key in many cases. Chouinard *et al*. (2017) even argue that the challenges evaluators face in practice are so specific to a program's complex sociopolitical and cultural context they cannot be "solved" via the simple application of a "correct" theory.

There is a degree of adaptability in agricultural research impact assessment that, perhaps, does not exist in other disciplines such as medicine. This makes sense considering the nature of precision that certain natural science disciplines require. For example, in medical evaluation, theory functions as a tool to provide evaluators with predictive certainty (Chouinard *et al*., 2017). The risk of poor or imprecise evaluation standards affects lives in a very direct manner (i.e. life or death). On the other hand, agricultural impact is much less direct and functions within a complex system that is often hard to directly measure and even more difficult to standardize.

Despite context-specific obstacles to agricultural research impact assessment evaluation, there does exist a governing body for assessing impact within EU projects, the European Commission Regulatory Scrutiny Board (RSB), which replaced the Impact Assessment Board. The RSB acts the mediator between researchers and policy makers, reviewing impact assessment reports to determine if new EU legislation is necessary (European Commission, 2018).

The RSB acknowledges in their 2017 Annual Report that a level of heterogeneity exists among evaluations, all focusing on various areas, including decision making, organizational learning, transparency and accountability, and efficient resource allocation. The report also states that the RSB main areas of concern with evaluation standards today were design and methodology, as well as the validity of conclusions (European Commission, 2017). The Board also called for future evaluations to deliver more clear assessments of both results, and, more importantly, impacts. Accordingly, using evaluation theory models that tackle "attribution gaps" like

GTZ & IPE or involve a rapid, self-monitoring loop system like Complexity Aware models may better facilitate identification of research impacts in complex agricultural systems.

Despite the obvious need for evaluations that account for multiple types of impact within complex agricultural systems, a majority of evaluations still focus on or prioritize economic impact. According to another recent literature review on agricultural research impact assessment consisting of 171 papers published between 2008 and 2016, the majority (56%) of reports still focused on economic impact (Weisshuhn *et al.*, 2018). In this respect, profit remains both the biggest motivator and obstacle in research impact evaluation. Douthwaite *et al.* (2003) claim that the importance given to economic impact in agricultural research is the product of prevailing *positivist*-centric structuring of evaluation criteria

> "As a result of the Green Revolution and the dominance of positive trained scientists…evaluation has focused on the economic impact assessment of technologies, largely to assist in resource allocation decision and to show accountability to donors" (pg. 248).

Economic impact remains important in evaluation because it serves as a justification to all stakeholders, regardless of their own interests, that agricultural research is an investment (Horton, 1998). Unlike social impact, the quantitative nature of measuring economic impact is universal, meaning the produced statistics can be interpreted by all stakeholders, regardless of their own interests or professional disciplines. As a result, other forms of impact like social or environmental are prioritized below— if at all— economic impact during agricultural research evaluation.

3.13 Conclusion: evaluation standards

This chapter reviewed literature compiled from a structured keyword search through an academic database LUBSearch on agricultural applied research evaluation standards. The theoretical background of such evaluation standards was uncovered by looking into the historical context that gave rise to contemporary agricultural applied research, namely the explosion of growth in education in the mid 20th century and, subsequent, Green Revolution in agricultural research, technology, and development. Increased education and research activities resulted in the need for economic

accountability and the prioritization cost-efficient research under *positivist*-based evaluation models.

The turn of the 20th century, however, saw a demand for evaluation standards that were better adapted to the notion of agriculture as a complex system, catalyzing a shift from *positivist* to more *constructivist* logic. *Constructivism* remains the underlying theoretical foundation for most program theory evaluation used today. The shift from *positivism* to *constructivism* also changed the timing of when evaluations were conducted from a predominantly *ex post* tradition to more focus on combined *ex ante* and *ex post* evaluations performed both during and after research.

The predominating *constructivist*-logic program theory evaluation helps account for necessary adaptability, both through linear models like the GTZ model and Impact Pathway Evaluation and non-linear models like Complexity Aware models. All models use both *ex ante* evaluations in order to guide and self-monitor program during the research process. This allows actual research impact to be more accurately identified in *ex post* evaluations, as well as keep projects cost-efficient.

The evolution of agricultural applied research evaluation shows a broadening of perspectives about research's role and function as an instrument of knowledge production and, more importantly, an instrument of change. While *constructivist*-based evaluation produces a more comprehensive understanding in complex agricultural systems, the adaptability it demands means that there is no purely universal approach. Thus, evaluation standards must be adapted and developed with considerations for the context of specific research projects in order to most effectively measure the impact of agricultural applied research.

4 Indicators on social impact

Due to the complex global challenges in sustaining food production and achieving nutritious diets (climate change, environmental sustainability, food security), agricultural and food research not only generates knowledge but increasingly tries to come up with solutions to societal challenges. As boundaries between traditional academic disciplines are crossed, and research engages with more stakeholders, there is a need for development of how research societal impact is assessed. In this chapter, we will provide an overview of different initiatives to develop frameworks and indicators used for assessing societal impact of research. These different frameworks

differ in the theoretical underpinning, scope of the assessment, as well as in the level of participation of stakeholders in the evaluation process. The aim is to give a description of the importance and role of such frameworks and indicators and give examples of indicators usable for evaluating societal use in science in the agrifood and forestry sector. We start by describing search methods and the concept of societal impact of research. Thereafter, we dive into the existing frameworks for evaluating societal impact, and discuss benefits and drawbacks of such evaluation. Finally, we surface with a list of indicators suitable as template for the Nextfood project, and conclude our findings.

4.1 Methods for Finding and Reviewing Literature

A citation-based search method was used (Cecile J. W. J. *et al.*, 2015). This proved to be an accurate way of finding relevant literature. By following a literature review made by Lutz Bornmann (2013), both backwards in time and forward through citation search, the most valuable contributions to this chapter was found.

4.2 The concept of societal impact of research

The concept of societal impact of research has many names; knowledge transfer, usefulness, public values, third stream activities, societal benefits and societal relevance, just to name a few. The concept of societal impact is mainly concerned with the social, cultural, environmental and economic return of publicly funded research (Donovan 2011, EC 2010). The definitions of these four return aspects are conceived very broadly and are not easily separated from each other. In particular, economic return overlaps with the other forms of return. (Bornmann, 2013).

4.3 The historical development of evaluating societal impact

The development of evaluation approaches in the past connects closely with how society has viewed science and the utility of it. After the second world war, the main focus was on basic research and the predominant belief was that investments in science would inevitably be of good use to society. After the oil crisis in the 1970s, high unemployment and weak economy of national states compelled policymakers to raise the demands that public money invested in research and educational institutes,

should bring positive benefits to society. While this was happening in most countries of the developed world, the course of events in the U.S. is well described as the creation of the market university (Popp B. E., 2012).

The expectation from policymakers grew from believing that science would inherently be good for society to the conviction that research results need to be converted into new or improved products or services to benefit society. Underlying this, was the shift in view on science from so called Mode 1, governed by academics and theory-building, to Mode 2, which focus on collaboration and transdisciplinary research on real world problems (cf Gibbons *et al*. 1994, Erno-Kjolhede & Hansson, 2011, table 4).

This shift in view conceived the idea of assessing not only scientific but also societal impact, and it sparked a development of assessment frameworks. Donovan (2007) divides the development of approaches to evaluating societal impact into three stages. The first step was almost solely economic impact that could be calculated and quantified. The second step aimed at covering both economic and social impacts (Donovan, 2008). For example, a study on Swedish university colleges and their effects on local and regional environment (Palsson *et al*., 2009). The third phase emphasized case studies with a range of both quantitative and qualitative indicators to provide a rich picture of societal impact of research (Bornmann, 2013).

4.4 Evaluating societal impact using indicators

There are several initiatives on national level to develop frameworks for evaluation of social impact, and the European Commission has invested in development projects with this purpose (Bornmann, 2013).

4.4.1 The Dutch initiative

One such framework is the Dutch framework for societal impact assessment. The main areas evaluated in the Dutch framework are a) the expectation that the research will contribute to socio-economic developments (relevance), b) the interaction with users of the results and c) the actual use of the results (SEP, 2016).

Spaapen *et al.* (2007) developed the so-called Research Embedment and Performance Profile (REPP), where a number of indicators relating to a research unit can be depicted in a graphic profile for that unit. The five domains of indicators in this model are: a) science and certified knowledge b) education and training c) innovation and professionals d) public policy and societal issues and e) collaboration and visibility. This profile is combined with the qualitative analysis of a) the mission and the group's research profile b) the stakeholders related to the group or program and c) feedback and implications on strategies.

The specific character of this approach is the construction of a profile of a research group or program in relation to its context by choosing relevant indicators for each of the five domains. "A relevant set of indicators is then chosen for each of the distinguished domains, giving insight into the extent to which embedding and performance have evolved in each domain." (Spaapen *et al.*, 2007). An abundant set of interaction and impact indicators and indications is available. They include co-publications, divided research staffs, cooperation with the professional sector and the business world, contract research, professional publications, scientific articles, staff mobility, advisory positions and membership in policy platforms, involvement in special programs, publications in referred journals and patents. (Spaapen, Dijstelbloem *et al.* 2007).

4.4.2 The UK initiative

Another national example is the United Kingdom, were research has been comprehensively evaluated since the 1980s through the Research Assessment Exercise (RAE). Building on the RAE, the current framework is the 2014 Research Excellence Framework (REF, 2011). The REF uses both quantitative measures and case studies supported by indicators, to allow for assessment of social, cultural and economic impact. In a process of expert review, main panels and multiple subpanels with external experts from both science and professional life are responsible for carrying out the assessment. (REF, 2011).

4.4.3 Initiatives funded by the European Commission

The ERiC project, financed by the European Commission, focuses on developing methods for societal impact assessment in the agricultural and the pharmaceutical sector (ERiC, 2010). One of the main results that came out of this project is that "productive interaction" is necessary to achieve a societal impact: "There must be some interaction between a research group and societal stakeholders" (ERiC, 2010).

SIAMPI is an international project, funded under the European Commission's Seventh Framework Program that studied the interaction process between researchers and stakeholders. In this project, productive interactions are understood as "an exchange between researchers and stakeholders in which knowledge is produced and valued that is both scientifically robust and socially relevant" (Spaapen and van Drooge, 2011). The exchange can be in the form of a research publication, an exhibition or other dissemination activities. This interaction is considered to be productive when as a consequence stakeholders actually make use of the research results, i.e. the new knowledge produced in the research initiates a behavioral change among a group of stakeholders. (Spaapen and van Drooge, 2011). In the SIAMPI project, three kinds of productive interactions are distinguished, which tell us how researchers communicate with their environment:

- *Direct interactions:* 'personal' interactions involving direct contacts between humans, interactions that revolve around face-to-face encounters, or through phone, email or video conferencing.
- *Indirect interactions:* contacts that are established through some kind of material 'carrier', for example, texts, or artefacts such as exhibitions, models or films.
- *Financial interactions:* when potential stakeholders engage in an economic exchange with researchers, for example, a research contract, a financial contribution, or a contribution 'in kind' to a research program.

Indicators for these three categories were also suggested. For the first category of direct personal interactions, indicators are often qualitative, face-to-face communication with different stakeholders, that taken together make up the picture of a research group's activities to connect to stakeholders. Some quantitative indicators of

direct interactions are the number of researchers holding dual posts, the number of memberships of advisory committees and the number of presentations for lay audiences. For the second category, quantitative indicators were tested through internet searches. For the third category, quantitative indicators of financial interactions are often the easiest to collect; contracts, licenses, project grants, sharing of facilities, personal sponsorships, travel vouchers and PhD funding by industry.

4.4.4 The French initiative

The ASIRPA approach (socioeconomic analysis of public agricultural research impacts) is a standardized case study approach developed at the French National Institute of Agricultural Research (INRA) (Joly *et al.*, 2015). Similar to the SIAMPI described above, the ASIRPA approach focuses on the interactions between different stakeholders involved in the research process. The approach builds on theoretical underpinnings that focus on the innovation process, generation of impact in the long-term and the participation of stakeholders in the assessment of impacts. By describing the translational process in a number of case studies, where knowledge was made actionable by using it for developing new products, processes and services, Matt *et al.* (2017) identified four different ideal-types of impact pathways. Each of these ideal-types can be described on the basis of how knowledge is translated, the specific research and adoption networks, research outputs and impact. It is concluded that the co-production and involvement of stakeholders is essential for impact for some types of research projects, but not always. To measure impact in case studies, the ASIRPA approach developed a system with rating scales 1 to 5 for five dimensions of societal impact (economic, political, health, environmental, social). These scales has been tested on a number of research cases and were considered to be trustworthy and allowing of self-evaluation, which would limit the cost for assessment compared to a review by an expert-panel (Colinet *et al.*, 2018).

4.4.5 The Swedish initiative

A thorough evaluation of quality and impact of research at the Swedish University of Agricultural Sciences (SLU) was completed in the fall of 2018. The SLU 2018 evaluation model builds on the Dutch system (SEP 2016); the British system REF and the earlier evaluation of SLU made in 2009 (von Bothmer *et al.*, 2009), thus using

case study models with adequately staffed focus groups with people from both the scientific community and external stakeholders. The SLU 2018 model has been further refined in dialogue with the SLU vice chancellor office. The scientific quality was evaluated together with scientific environment, leadership and strategy for scientific development. The societal impact was evaluated using three criteria:

- *Activities and Outputs* - Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?
- *Outcomes* - Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realized in terms of societal impact.
- *Impact Strategy* - Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The preliminary results point to the notion that while the SLU performs well in the first two categories, less attention has been paid to the third category. Especially the task of creating incentives for researchers to work with impact activities, could use some more focus. (SLU, 2019).

4.5 Discussion on social impact

Societal impact of research is complex and context-dependent, and it is often hard to distinguish cause and effects from other factors, especially since it often becomes apparent only after a certain time span; it is no immediate or short-term result. A study of the Swedish agricultural sector between 1944 -1987 estimates the time frame from resources put into research input until economic impact in practical use is 16-18 years (Renborg, 2010). As much as we would like to think that things have improved since then, a more recent study in the health area of cardiovascular research, estimates "an average time-lag between research funding and impacts on health provision of around 17 years" (Buxton, 2011). This time lapse makes social impact difficult to grasp and adequately measure (ERiC, 2010). Buxton (2011) suggests that early indications of

likely impact should be valuable for research funders; Martin (2000) warns that premature impact evaluation can lead to more research with short-terms benefits. Spaapen and van Drooge (2011) point to that different stakeholders have various interests and expectations of research, and, therefore, will use and appreciate it diversely (Spaapen and van Drooge 2011). These differences provides a challenge to measuring social impact homogeneously. Pedrini *et al.* (2018) suggest that for evaluation of health research multi-stakeholder groups should be engaged in the different steps of the research process, involving them in setting the research agenda, supervision of research programs and in the review process.

Also, it is important to determine not only the impact per se but also the conditions, context and efforts of an institution to achieve impact. Impact assessment should focus on the aims and goals of the specific research and teaching institution, and its cultural and national context. If institutes are to be compared, they must be alike in these aspects. (Bornmann, 2013). One example of this is the recently conducted evaluation of the Swedish University of Agricultural Sciences (SLU, 2019). An important variable was the impact strategy of the evaluated institution. The evaluated units were expected to have strategic goals for societal impact, and were assessed upon how realistic their strategy was and whether the incentives and measures were sufficient for implementing the strategy.

Because of the complex and sometimes diffused and long-term features of societal impact, some authors argue that process characteristics could serve as better indicators of expected impacts than evaluating the impacts themself (de Jong *et al.*, 2014; Spaapen and van Drooge, 2011). De Jong *et al.* (2014) focused on the productive interactions in ICT research and concluded that the characteristics of the process can be used as a substitute for the expected impact. "When assessing societal impacts, emphasis should be on contributions of research to societal impact instead of attributing societal impact of specific research, and efforts instead of results." (Jong *et al.*, 2014, p 100). Huxham and Vangen 2005, page 4) defines collaboration as any situation in which people are working across organizational boundaries towards some positive end. When it comes to universities and research institutes, collaboration is any activity performed together with other stakeholders where the purpose is to make research results useful to the society. The quality of the collaboration can be assessed by measuring the productive interactions, as described by Spaapen and van Drooge (2011). Collaboration

can also be described in more formal terms where the transaction (of knowledge) is in focus: e.g. alliances, partnerships, networks, projects and joint ventures.

Participatory or transdisciplinary research is a form of collaboration with close interactions between researchers and stakeholders. It is an often used approach to solve complex sustainability challenges where the intention is to yield more socially robust and sustainable results. It has been shown that the competencies of observation, reflection, visioning are important for the capability of working transdisciplinary. Together with dialogue and participation these skills are an integral part of the Nextfood model (https://www.nextfood-project.eu/about-2/). Transdisciplinary research hybridizes academic disciplines and institutions, is context-specific and oriented to solve real-world problems. The effects of participatory research are assumed to indirectly contribute to transformational societal change. The link between participation and effects on society is not clear, instead it is influenced by a complex web of relations, culture and political agendas (Hansson and Polk, 2018). The characteristics of the quality of the research process, such as practitioner motivation and perceived importance of the project, breadth of perspectives as well as in-depth exchanges of expertise and knowledge between stakeholders are crucial to produce relevant, credible and legitimate research results (Hansson and Polk, 2018). Belcher *et al*. (2016) put forward a framework for assessing research quality of transdisciplinary research, focusing on assessment of relevance, credibility, legitimacy and effectiveness of research projects.

In conclusion, due to the difficulties to attribute impact to specific research activities, we should strive to assess the collaboration that can lead to a societal impact, rather than only measuring the actual effects of research. Indicators to measure collaboration should include the productive interactions but also quality measures (resource efficiency, trust, innovation) and the volume of collaboration activities. Example of indicators to measure collaboration are:

- Strategic (long-term) partnerships
- Collaboration in education
- Mobility between academia and business
- Collaboration in research projects
- Creativity and innovation
- Openness, trust and mutual respect in relations

- Number of stakeholder groups that collaborate in research and education
- Competence centers involving different stakeholders
- Direct, indirect and financial indicators as suggested by (Spaapen and van Drooge (2011)

By taking this stand, a research assessment framework allows for diversity in the strategic choices and stimulates the development of the specific resources available at the different organisations. In addition, a research assessment framework should consist of a diverse set of indicators in order to cover the width of different types of collaboration activities as well as the local strategies developed at each research institute.

Future generations of professionals in the agrifood and forestry system should not only know about sustainability but must also be able to take responsible action for sustainability. Individuals who are tightly tied together in a network create the opportunity for collective action. Increasing individual and collective social capital by investing in social networks of external relations could, therefore, be an important factor for increasing the capacity for collective action towards a more sustainable food system. Several authors have put forward the idea that a social network is not enough for harvesting the advantages of social capital. The content of the internal relations is also important. Motivation to contribute, the sum of competencies and resources within the network, and hierarchy all shape the possibility for the generation of social capital within the network (Adler and Kwon, 2002, for a review).

A problem that is frequently brought up in discussions of evaluation framework is that it is time and resource consuming to gather all the data needed for the different indicators. It is costly but also difficult to find peer-reviewers who can invest enough time to do the work. There is no accepted and standardized framework for evaluating societal impact of research, which has resulted in the use of the case studies approach. While case studies are an evaluation method that can give a wide and deep perspective, performing a case study takes a lot of time and resources, and, inevitably, brings an element of subjectivity. Bornman and Marx (2014) suggested that practitioners addressing the publication of assessment reports (summaries of the research in a field in a non-academic style) could serve as an indicator of societal impact.

4.6 Conclusions (applied research)

In this chapter, we have outlined the concept and history of evaluating societal impact of research. The development has gone from measuring economic impact to measuring a wide range of aspects using both quantitative and qualitative indicators to the use of case studies. We have briefly described some contemporary initiatives used for evaluation of research societal impact and based on the literature reviewed we have discussed the basis for developing a NextFood tool for evaluation of societal impact.

Because of the transdisciplinary characteristics of the research projects dealing with challenges related to sustainable food and forestry production, the NextFood approach cannot solely rely on relevance, credibility, and legitimacy, traits that traditionally are used in research quality assessment. Instead it must be able to capture the qualities of the researcher-stakeholder collaborative process, which is in line with the findings of Hansson and Polk (2018). The concept of "productive interactions" with its three categories of indicators, in combination with indicators for quality and volume of collaboration, seems promising because it will overcome the problems of time-lag and attribution and should, therefore, be further developed for NextFood purposes. Hence, it is the quality and the magnitude of collaboration as an activity and as a phenomenon that should be evaluated.

A NextFood tool for evaluation of education and research must be reliable but also simple enough to be of good use for the community and cannot be relying on resource-demanding case studies. Scales for self-evaluation like the one developed by Colinet *et al*. (2018) or research summaries targeting practitioners like the research assessment reports brought forward by Bornman and Marx (2014) should be further investigated for the purpose of NextFood.

5 Evaluation of societal impact of education

5.1 Uncover the theoretical background of evaluation standards

The definition of "theoretical background" for this section must be contextualized first with a historical background on the shaping of universal higher education evaluations in Europe as a consequence of the EU's formation. What follows is the structural outcomes of the Bologna Process, most notably the European Association for Quality Assurance in Higher Education (ENQA) along with a

discussion about “guidelines” as functioning theoretical framework for higher education evaluation standards.

5.2 Historical Context

The option of mobility within Europe for higher education is important for a bevy of reasons. A wide body of literature supports that studying abroad helps enhance intercultural competence and personal development (Maharaja, 2018) that has long-term career impact and professional applicability (Franklin, 2010). In fact, some studies even suggest that study abroad experience can serve as a substitute of sorts for lack of professional experience among certain employers (Petzold, 2017). Accordingly, mobility programs have become increasingly important in European education models.

In particular, the formation of the EU in the 1990s saw an increase in mobility among individuals in academia, albeit students, teachers, researchers, etc. However, old pre-EU education systems of accreditation, qualifications, and degrees still existed. Thus, the Bologna Process was enacted in 1999 as an intergovernmental initiative aimed to establish some kind of standardization and transferability of education qualifications among countries, making Europe a world leader in higher education. Although its goals and areas of focus within higher education have evolved over the years, the Bologna Process at its core ensures feasible mobility of students and staff within the EU via a common degree system, European system of credits, quality assurance, and the development of Europe as an alluring knowledge region (European Commission/EACEA/Eurydice, 2018).

5.3 Guidelines as Evaluation Theoretical Framework

A direct outcome of the Bologna Process was the European Higher Education Area (EHEA), which specified a geographic area of comparable or compatible education systems. Today the area extends to 48 countries, highlighted in Figure 3 below.

Figure 3 EHEA Countries as of 2018 highlighted in blue (European Higher Education Area, 2018).

Although the EHEA now includes non-European countries, those within Europe are governed by a few organizations that specialize in various aspects of higher education. Relevant to this literature review is the European Association for Quality Assurance in Higher Education (ENQA), an umbrella organization that represents its members at the European level and internationally, especially in political decision making processes and in co-operations with stakeholder organization (ENQA, 2018). Developed under the ENQA are The Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG).

A 2016 ENQA report acknowledged that impact analysis for quality assurance on higher education was an underdeveloped process that lacked theoretical backing. Thus, there is no apparent theoretical framework for evaluation standards within European higher education. Rather, these governing bodies rely on a system of guidelines that "explain why the standard is important and describe how standards might be implemented" (ESG, 2015). An example of the relationship between standard and guideline is given below in Figure 4.

1.9 On-going monitoring and periodic review of programmes

Standard:
Institutions should monitor and periodically review their programmes to ensure that they achieve the objectives set for them and respond to the needs of students and society. These reviews should lead to continuous improvement of the programme. Any action planned or taken as a result should be communicated to all those concerned.

Guidelines:
Regular monitoring, review and revision of study programmes aim to ensure that the provision remains appropriate and to create a supportive and effective learning environment for students.

They include the evaluation of:

- The content of the programme in the light of the latest research in the given discipline thus ensuring that the programme is up to date;
- The changing needs of society;
- The students' workload, progression and completion;
- The effectiveness of procedures for assessment of students;
- The student expectations, needs and satisfaction in relation to the programme;
- The learning environment and support services and their fitness for purpose for the programme.

Programmes are reviewed and revised regularly involving students and other stakeholders. The information collected is analysed and the programme is adapted to ensure that it is up-to-date. Revised programme specifications are published.

Figure 4 ESG for Ongoing Monitoring and Periodic Review of Programmes (ESG, 2015).

Although this example is not reflective of all evaluation standards in European higher education, it helps shed light onto the relationship between standards and guidelines in creating an evaluation framework. Standards indicate the overarching goal or aim within a program, like ensuring ongoing monitoring and periodic reviews. Guidelines support these standards by giving explicit examples or outlines of processes that need to happen in order for standards to be met properly. In this sense, guidelines accomplish a similar task as theoretical framework for evaluations because they provide good practice or examples in relevant areas for consideration for those involved in assessing quality assurance in education.

Standard and guidelines policies like the ESG were born out of a need to establish common ground among the various educational institutions and systems in place in Europe around the formation of the EU. In creating a system that could be easily recognized and transferred among EU nations, the theoretical framework needed to be flexible and adaptable, hence the use of guidelines in lieu of more conventional theory. However, much like theory, these guidelines are ultimately used to support and facilitate the aims laid out by evaluation standards.

6 Evaluation standards for education (focus on social relevance concept)

Having established an understanding of guidelines as "theoretical framework" for evaluation, this section will focus on standards in European higher education evaluations. This will be accomplished by looking at the purpose and aims of the ESG that has been set by the ENQA, followed by an overview of the structuring of quality assurance standards. The section concludes with a discussion about the Erasmus Plus Programme as a point of comparison to shed light on the overall goals of European higher education through evaluation.

The Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG).

The ESG was developed by the ENQA (governing body) to ensure quality assurance in European higher education within the areas defined by the EHEA (see Figure 3). According to the most recent report from 2015, the ESG is based off of four principles for quality assurance in the EHEA:

1. Higher education institutions have primary responsibility for the quality of their provision and its assurance
2. Quality assurance responds to the diversity of higher education systems, institutions, programmes and students
3. Quality assurance supports the development of a quality culture
4. Quality assurance takes into account the needs and expectations of students, all other stakeholders and society.

While governing bodies can, indeed, provides standards and guidelines for higher education institutions, it is ultimately the institutions' own responsibility to ensure that said standards are met. A recent ENQA report (2016) on quality assurance impact suggests that this "bottom-up" approach to quality assurance makes the leadership (i.e. implementation) of standards and guidelines flow both ways, as demonstrated in Figures 5 and 6.

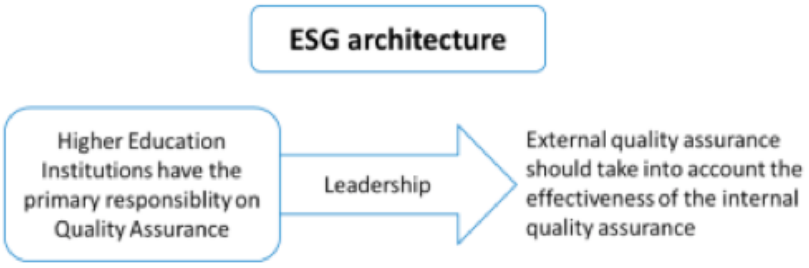

Figure 5 ESG architecture (ENQA, 2016).

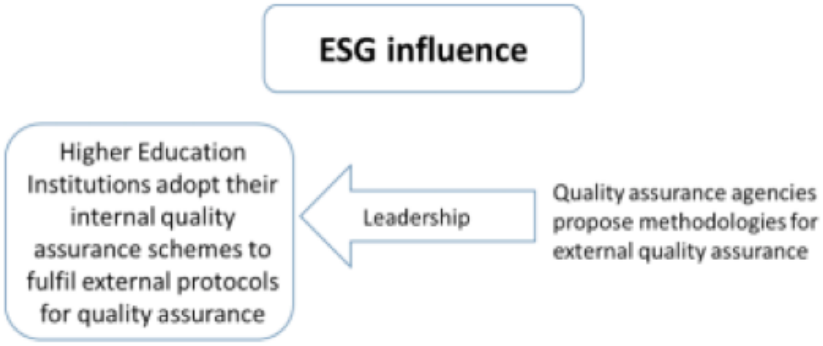

Figure 6 ESG influence (ENQA, 2016).

Figures 5 and 6 demonstrate that quality assurance is managed and executed through three interlinked parts: internal quality assurance, external quality assurance, and quality assurance agencies. Internal quality assurance evaluation standards are largely relevant for education at a program, university, or intuitional level. They oversee the following standards: policy for quality assurance; design and approval of programmes; student-centered learning, teaching, and assessment; student admission, progression, recognition and certification; teaching staff; learning resources and student support; information management; public information; ongoing monitoring and periodic review of programmes; cyclical external quality assurance (ESG, 2015). External quality assurance standards focus more on methodology and implementation. They are relevant at an institutional level or, even, within networks of institutions. External quality assurance standards include: consideration of internal quality assurance; designing methodologies fit for purpose; implementing processes; peer-review experts; criteria for outcomes; reporting; complaints and appeals (ESG, 2015).

While seemingly vague, ESG framework is set up in a way that allows the implementation of such standards and guidelines to be flexible. They acknowledge that the context of evaluation varies among education institutions and is influenced by a

myriad of cultural, social, political, and geographic factors: “Framework must be applicable in an array of higher education contexts. This makes a single monolithic approach to quality and quality assurance in higher education inappropriate” (ESG, 2015).

6.1 Erasmus Plus & OECD

An interesting point of comparison that helps elucidate the values and goals of European higher education in general is the Erasmus Plus Programme, which is governed by the European Commission. It was actually established in 1987, just the “Erasmus Programme,” a decade before the Bologna Process as a way for European students to study, train, volunteer, and gain experience abroad. The rebranded Erasmus Plus Programme was launched in 2014 with a 14.7 billion euro budget aimed at using student mobility to contribute to the Europe 2020 strategy for job growth (European Commission, 2018). As previously discussed, there is wide support for the positive effects of studying abroad, both in personal and professional development (Maharaja, 2018; Franklin, 2010; Petzold, 2017). Thus, facilitating education mobility via quality assurance within and, even, beyond Europe affords students the opportunity to develop these aforementioned skills. The overall goal of programs like Erasmus Plus, agencies like ENQA, and commitments like the Bologna Process is to bolster higher education in Europe with smart, sustainable, and inclusive growth (European Commission, 2018). A more skilled and educated population also ultimately translates to better employment opportunities. Therefore, in some regards, quality assurance in education helps improve other sectors by producing a tasked labor force.

Another interesting point of comparison comes from the Organisation for Economic Co-operation and Development (OECD)’s annual Education at a Glance Report in 2018. While the document largely relays statistical information to paint a picture about *who* is involved in higher education (students, educators, interest groups, and financiers), there is a section addressing the social outcomes of education. Many of these social outcomes address issues of sustainability and environmental awareness, thus catering well to the goals of the NextFood project. The report acknowledges that while awareness of environmental issues provided by educational institutions had statistically increased, this was no uniform or mandatory curriculum, especially across countries and in lower education levels (OECD, 2018). This translates to mixed

attitudes toward personal responsibility for looking after the environment. For example, less than 30% of adults reported being actionable about signing petitions or donating money to environmental group. However, a larger percent (45 %) of adults did report being actionable about reducing personal energy usage. From this, it can be suggested that higher education platforms currently create *awareness* of prevalent issues, such as sustainability, but fall short of making individuals *actionable* about those issues.

6.2 Assessing the potential of higher education as change agent

It is well documented that education has value and benefit in achieving sustainable development, healthy and prospering societies and human well-being. According to Nelson Mandela, "Education is the most powerful weapon which you can use to change the world." The Sustainable Development Goals decided by the United Nations include a goal centered on learners gaining the necessary knowledge and skills to promote sustainable development (UNESCO, 2015). Better education is also a key to a better life for each individual. It leads to lower rates of unemployment and crime and is also associated with better health, and with more involvement in society.

Traditional forms of education has increasingly been criticized for being authoritarian, to bring competitive and individualistic behavior in students and primarily emphasize on rote learning. "The traditional educational system focuses entirely on intellectual and ignores experiential learning, teaches students how to succeed on standardized tests and not much more, has an authoritarian nature, and leads students to only extrinsically value education and not intrinsically value learning." (Bondelli, 2013). This is contrasted by a new direction of quality education that was set out by the World Education Forum (2015) that emphasized a holistic approach with cognitive, socio-emotional and behavioural learning outcomes as described by Østergaard 2018 (table 1).

There are many complex problems in the agrifood system waiting to be solved, and higher education in agricultural and forestry universities should be a part of the solution. If we want universities to have an immediate impact on the society there must be a closer integration of research and teaching. This can be done by letting students work in collaborative projects that confront real problems. In this way, research and education can be transformed into service to the world.

European universities have effectively integrated transdisciplinary case studies on regional, urban, and organizational sustainable transitions into research and the curriculum. (Posch and Steiner, 2006). ”The integration of teaching and research is becoming a key issue in higher education – not only in order to differentiate the character of universities from other teaching and learning institutions, but also in order to find new ways to create the kind of knowledge needed in a world characterized by a turbulent environment and increasing change in daily life. Bringing research into teaching, or vice versa, can help to focus on issues relevant for society, such as sustainability.” (Posch and Steiner, 2006).

Universities should increase their impact in the society by providing students with more opportunities to actively apply new knowledge and skills to real-world problems. Stephens *et al*. (2008) argue that institutes for higher education could serve as agents for change in advancing more sustainable practices, and identifies five mechanisms in which a university can act as a change agent:

- Higher education can model sustainable practices for society; this view is based on the premise that sustainable behavior should start with oneself and by promoting sustainable practices in the campus environment, learning related to how society can maximize sustainable behavior is accomplished.
- Higher education teaches students the skills of integration, synthesis, and systems-thinking and how to cope with complex problems that are required to confront sustainability challenges.
- Higher education can conduct use-inspired, real-world problem-based research that is targeted to addressing the urgent sustainability challenges facing society.
- Higher education can promote and enhance engagement between individuals and institutions both within and outside higher education to resituate universities as transdisciplinary agents, highly integrated with and interwoven into other societal institutions.

According to Becker (2001) the definition of social impact assessment is “*the process of identifying the future consequences of a current or proposed actions, which are related to individuals, organizations and social macro-systems*.” Social sustainability includes the issues surrounding healthy and resilient societies like inclusive communities, democracy, integrity, human rights, equality, ethics and respect

for people. It also includes organizational sustainability like healthy and safe workplaces and socially sustainable leadership. As McGhee and Grant (2016) suggest, sustainability is about flourishing or thriving. It means assuring human rights for all humans at all levels and assuring socially just procedures and outcomes. But what role has higher education in transforming the society toward sustainability? By investigating seven universities world-wide, Ferrer-Balas (2008) found these key characteristics for a transformation towards sustainability:

- Transformative education to prepare students capable of addressing complex sustainability challenges. Rather than being a one-way process of learning, it must be more interactive and learner-centric with a strong emphasis on critical thinking ability.
- A strong emphasis on effectively conducting inter and transdisciplinary research and science
- Societal problem-solving orientation in education and research through an interaction with different stakeholders in the society. As a result, students must be able to deal with the complexities of real problems and the uncertainties associated with the future
- Networks that can tap into varied expertise around the campus to efficiently and meaningfully share resources
- Leadership and vision that promotes needed change accompanied by proper assignment of responsibility and rewards, who are committed to a long-term transformation of the university and are willing to be responsive to society's changing needs.

The investigated universities took a transdisciplinary approach in their curriculum, addressing a wide spectrum of global challenges. Transdisciplinarity is needed when dealing with complex, real world problems that usually can't be addressed adequately by a single discipline or profession. "In the upcoming postindustrial age, however, there is a direct societal need for professionals who can master changes, crises, and catastrophes in human-environment systems. This, in turn, requires individuals who have broad, non-specialized, natural science education that they can apply flexibly and link to emerging problems." (Scholz *et al*., 2006)

Transdisciplinarity creates synergies between different disciplines that results in new insights and knowledge and the creation of something new. Students learn from professors, and also from the practitioners on the front line of sustainability challenges in the society.

Given the urgency for confronting sustainability challenges that have serious negative effects on the food system, there is an urgent need for academic institutions to engage in new ways. The literature presented above, argue that academic institutions, through all of their activities, including teaching, research and broader societal engagement have a unique role in societal change. An assessment framework for research and education should consider the opportunities and challenges for higher education as change agents. Such a framework can support universities in their ambition to develop strategies for accelerating social change toward sustainability.

7 Methods

The literature review was conducted through searching Web of Science for publications assessment and evaluation of societal impact of education, especially those that presented a framework with indicators.

7.1 Evaluating societal impact using indicators

Many higher education institutes increasingly see quality evaluation of education as an important tool for building and shaping attractive and successful education of students. Both to satisfy the claim that students actually have a certain set of knowledge and skills after the education, and the more general notion of quality as a measure and an activity to continuously improve the education itself and the student learning outcome. Varouchas *et al.* (2018) emphasize a flexible notion of quality in education, where "*quality policies should be tailor-made to institution's goals and objectives, mission and stakeholders affected*" (p 1129). This means that while lists of suggested indicators can be used as templates, there must be a significant adaptation of quality measures to fit the specific education.

While there are quality indicators for many aspects of education, we will focus on the indicators aimed at describing societal value of education, such as collaboration, interdisciplinarity, problem-solving capabilities, and practical skills needed in work

life. These indicators are destined to be multidimensional variables. Varouchas *et al.* (2018) found that in most cases, indicators were quantitative such as number of students getting a job right after their studies, salary niveau and assessments of a professor by the students. It is argued that quality aspects that promote collaboration, interdisciplinarity and problem-solving skills should be integrated in the daily practices of the education. This relates to the intrinsic motivation of the education owner and requires engagement and involvement of various stakeholders. Quality assessment should contain a focus on the impact of education, not only a focus on content delivery. (Varouchas *et al.*, 2018).

7.1.1 Examples on frameworks for evaluating education

Several frameworks on education quality have been proposed previously. For example, Varouchas *et al.* (2018) presented a list of 20 quality factors in three main dimensions: content, process and engagement. Identified six critical success factors of higher education institutes and Đonlagić and Fazlić (2015) measured the quality of education from the students' point of view using the service quality model. However, these frameworks are limited in scope regarding the vast transformative changes required in education.

Examples form the area of entrepreneurship

Some insight in the assessment of societal impact of education can be drawn from the growing number of programs educating entrepreneurs at business schools. There has been a growing interest for entrepreneurship at universities, both as a subject for teaching and as an area for research, because of its expected socioeconomic benefits. Fayolle *et al.* (2006) looked into the effectiveness of such education programs and developed an evaluation framework based on the theory of planned behavior. The central factor of the theory of planned behavior is the individual's intention to perform a given behavior (in this case the expression of entrepreneurial behavior). It is supposed that the intention of a given behavior is the result of:

a) the attitude toward the behavior
b) subjective norms
c) perceived behavioral control (Ajzen, 1991).

Fayolle *et al*. (2006) suggested that an education program can be assessed based on its impact on participants' attitudes and intentions regarding entrepreneurial behavior, where the independent variables are the characteristics of the education program that one wishes to assess or compare, such as the:

1) institutional setting, like institutional culture and structure,
2) audience, i.e. the background of the students
3) type of program, i.e. the learning goals of the program
4) objectives of the education program
5) contents in the education program
6) teaching approaches and methods, e.g. the degree of experiential learning

The study, Entrepreneurship Competence: an overview of existing concepts, policies and initiatives (OvEnt), funded in 2015 by EU Joint Research Center –IPTS, traced a broad state of the art on the topic of entrepreneurship competence, identifying and comparing different theoretical approaches from both academic and non-academic environments (Komarkova, *et al.,* 2015). The EntreComp framework emphasises the idea that entrepreneurial competencies and skills are resources for growing innovation, creativity and self-determination. The aim of the framework is to establish a bridge between education environments and workplaces and to foster entrepreneurial learning in a coherent and effective way. Built upon a wide baseline analysis (review and case studies), EntreComp defines entrepreneurship as a transversal competence. This applies to all spheres of life; from nurturing personal development, to actively participating in society, to (re)entering the job market as an employee or as a self-employed person and also to starting up ventures (cultural, social or commercial), (Bacigalupo *et al*., 2016).

This framework responds to a view of entrepreneurship oriented from social and economic values and includes intrapreneurship, social entrepreneurship, green entrepreneurship and digital entrepreneurship. The EntreComp Framework is built around 3 areas of competence. Namely, 'Ideas and opportunities', 'Resources' and 'Into action'. Each area includes 5 competences, which are the building blocks of entrepreneurship as a competence. The framework develops the 15 competences alongside an 8-level progression model. It also provides a comprehensive list of 442 learning outcomes, which offers inspiration and insight for those designing interventions from different educational contexts and domains of application. (Bacigalupo *et al*., 2016).

Entrecomp has a formative purpose, together with the description of each competence, several descriptors and suggestions are provided to learners. This enables their active role in mastering such skills.

Examples form the area of education for sustainable development

Additional insights comes from initiatives trying to estimate the long-term effects of education programs for sustainability. O'Flaherty and Liddy (2018) studied the impact of intentional development education interventions by reviewing studies assessing the impact of Education for Sustainable Development and Global Citizenship Education. They had a wide definition for impact: *"a change in knowledge, skills, attitudes, ethics, actions arising, including both hard and soft measurement outputs, from exams and knowledge tests through to ethical/values measures."* Many studies in their review reported a statistically significant outcome for a number of learning goals including: increased awareness of global issues, more developed conceptualizations of global citizenship and increased understanding of environmental interdependence and global responsibility. A number of interventions that reported significant or positive impact utilized active learning methodologies including multi-media approaches, problem-based learning, discussion forums, role-play and concept mapping.

Wiek *et al.* (2011) looked at different concepts of Education for Sustainable Development and identified key competencies that students are expected to learn. Those included among others system's thinking, interpersonal competence and being able to anticipate a future scenario. Their work could form the basis for designing and revising academic programs as well as teaching and learning evaluations. To prepare students to become change agents for a more sustainable future, they need to be able to think and act critically and holistically in collaboration with others. Lambrechts *et al.* (2018) identified four main typologies among university students in their attitudes to sustainability; "moderate problem-solvers", "pessimistic non-believers", "optimistic realists" and "convinced individualists". The authors called for a diversity of approaches to prepare students to deal with complex sustainability challenges, oriented towards self-regulated learning and the development of critical and interpretational competencies.

Ofei-Manu (2018) developed a sustainability learning performing framework that pinpoints key educational and learning characteristics that lead to effective

achievement of education for sustainable development. The learning process in the framework consists of progressive pedagogics and cooperative learning relationships and the educational contents consists of sustainability competencies and a framework for understanding and world-view. A summary of what was identified for each part of the framework is shown in Table 3. This is can be linked to the discussion on skills and competencies which are developed by NextFood project. The core of the progressive pedagogics is an inquiry-based transformative learning where the student is an active participant in the co-creation of knowledge. Sustainability competencies is comprised of knowledge, skills and values, supported by constructivism as the main theory. The world-view is the lens through which learners interpret and make meaning of sustainability-related actions, which includes a holistic world-view, systems thinking, interdisciplinarity, cultural relativism, and pattern recognition. The sustainability learning performance framework provide a reference for assessment/evaluation of the important elemental characteristics that are closely linked to sustainability learning outcomes. The wider scope of coverage of this framework "can be a vital resource for education and development researchers and practitioners in their attempts to develop indicators and other assessment frameworks to measure progress across the various educational initiatives at global, national and local levels." (Ofei-Manu, 2018, pp 1183).

LEARNING PROCESSES	
Progressive pedagogics	· Critical reflection & practice and problem solving · Action/experience oriented student-centered learning · Knowledge production through iterative interaction · Cyclical process of collective inquiry · Life-long learning
Cooperative learning relationships	Inclusion and internal network structure for interaction Group processing in establishing and managing systems of knowledge and making sense of information Participation Power sharing, shared ownership/commonality Clear definition and purpose of roles Accountability of individuals /groups Positive interdependence and building of trust Opportunities for reflexive moments and discussion Situatedness Social skills
EDUCATIONAL CONTENT	
Sustainability competencies	Environment: Climate change, biodiversity, resilience and socio-ecosystems

	Society: Disaster risk reduction, sustainable development, global citizenship Economy: Sustainable production and consumption, green economy Culture: Indigenous knowledge, cultural and religious understanding
Sustainability skills	Inclusion and internal network structure for interaction Group processing in establishing and managing systems of knowledge and making sense of information Participation Power sharing, shared ownership/commonality Clear definition and purpose of roles Accountability of individuals /groups Positive interdependence and building of trust Opportunities for reflexive moments and discussion Situatedness Social skills
Sustainability values	Respect, care and empathy, charity, compassion Social and economic justice, human and global security Citizenship, empowerment, stewardship, motivation Commitment, cooperation Self-determination, self-reliance
World - view	Holism and integration System perspective or whole systems thinking Interdisciplinarity and cross-boundary approaches Cultural relativism and social constructivism

Table 3 Summary of the identified characteristics related to each element of the Sustainability Learning Performance Framework, adapted from Ofei-Manu et al. (2018).

From all above mentioned concepts, it is clear that there is not one fit for all. They acknowledge that the context of evaluation varies among education institutions and countries and is influenced by a myriad of cultural, social, political, and geographic factors: "Framework must be applicable in an array of higher education contexts. This makes a single monolithic approach to quality and quality assurance in higher education inappropriate" (ESG Report, 2015, pg. 8)

An example of indicators of the quality of education are listed below. This - by definition incomplete - list can serve as a source for development of the tool for evaluation of the quality of education and it can be further used for evaluation of the impact of the new curricula on students' understanding and competence. Suggested method how to measure and interpret them are given in the appendix 1.

1. **Qualification of academics for the education of students**
    a. Were those academics properly educated themselves in the action learning method?

b. Did the academics used the mobility programme to visit the institution where action learning method is applied?

2. Publication activity reflecting action learning method

a. Scientific publications of the academics reflecting action learning method

3. Individual consultation with students

a. Hours of consultations used by students excluding consultations of bachelor and master thesis.

4. Availability of study online material

a. Complex e-learning background for the course

5. Quality of the lessons

a. Peer-review quality assessment (internal or external) in order to reveal if the academics are motivated to keep the lessons content wise up to date.

b. Quantitative assessment of the lessons quality

6. Rule breaking

a. Breaking of the rules when writing a test (e.g. cribbing)

b. Originality of the final students thesis

7. Attitude of students to their study programme

a. Length of the study

8. Outcomes of the education

a. Need for the next qualification

b. Success in the examination to pass to the next university education level

c. The employment rate in the related sector (as declared in the curriculum)

d. Total employment rate

e. Successful rate

f. Correlation coefficient indicating the relationship of the student results in the most important courses of the study programme (e.g. profile courses) and their performance at the final evaluation of the study programme (e.g. state examination)

g. Quality of the final thesis

i. Qualitative: peer-review; guarantor of the study programme nominate 3 best final thesis and they also randomly choose 3 other final thesis all to be send to one independent reviewer. Indicator here will be average performance of nominated and randomly selected thesis, respectively including variance of their quality

9. Internationality of the study programme

a. Students taking the opportunity for the study exchange abroad

b. Visiting foreign students

10. Cooperation with the practice

a. Lessons being taught by the practitioner

To further increase this set of indicators we decided to distribute the questionnaire among the institutions which are already using action learning approach in their curricula (Appendix 2).

8 Student competences and approaches to their evaluation

8.1 Introduction

Dialogues about sustainable development worldwide lead to the extension of this topic in everyday decision making across disciplines. Professional advancement in education for sustainable development in higher education curriculum is, therefore, more than needed (Ryan , 2013). For students (the possible future experts), the ideal setting of his/her Knowledge, Skills, Abilities and Competencies must comply with the elements of complexity (Wiek *et al.*, 2011). However, this chapter is focused more on those connected with the topic of sustainable agriculture. The aim of this working paper is to find out current approaches to how student knowledge, competencies and skills can be defined and subsequently evaluated. By other words, the paper contributes to

comprehension of suitable competencies, knowledge and skills needed for effective learning process in agricultural education. The paper is organized as follows: first key definitions are introduced, then an overview of relevant literature and key conceptual departures are defined along with methodology. Finally, conclusions and recommendations are presented.

8.1.1 Defining of the key words

Keywords for this chapter - *Knowledge, Skills, Abilities and Competencies* - sufficiently defined Linder and Baker (2003) like this: "Knowledge is a body of information, supported by professionally acceptable theory and research that students use to perform effectively and successfully in a given setting. Skill is a present, observable competence to perform a learned psychomotor act. Effective performance of skills requires application of related knowledge and facilitates acquisition of new knowledge acquisition. Ability is a present competence to perform an observable behavior or a behavior that results in observable outcomes. Collectively, knowledge, skills, and abilities are referred to as competencies." Competencies are behavioral proportions. They can recognize effective performance from ineffective performance Maxine, 1997).

8.2 Conceptual framework

A fundamental goal in any kind of education process is to pass on some set of important competencies. In agricultural education, numerous studies have been conducted to look at specific student competencies within specific contexts. The purposes of these which influenced this chapter are stated below. Other types of studies which frames this chapter are about options in evaluation of competencies. For deeper understanding of defining competencies in general, studies from other science disciplines are presented.

Boothroyd and Pham (2000) determined key workforce competencies desired by agricultural and natural resources leaders to inform the design creators of courses in agricultural education departments about the findings and suggestions. Martin Mulder (2017) introduced *A Five-Component Future Competence Model*, which is influenced by competencies on two dimensions, the vertical dimension of disciplinary and interdisciplinary competence and self-management and career competence, and the horizontal dimension of personal-professional competence and social professional

competence. The competence domains can be specified for all actors in all economic sectors, such as in agriculture, food and the environment. Morgan *et al.* (2013) presented competencies needed by agricultural communication graduates as perceived by agricultural communication faculty. With the implementation of hard and soft skills in agricultural programs, agricultural teachers have the ability and opportunity to drastically impact student attainment. Free (2017) thus, investigated the perceptions of secondary Alabama agricultural teachers on the attainment of students' soft skills. A competencies comparison of agricultural education master´s students at Texas Tech and Texas A&M universities made Lindner and Baker (2003). Purpose of Trexler's *et al.* (2000) study was to develop recommendations for products and systems to educate students about sustainable agri-food systems. This study was conducted in Michigan. The required competencies of successful agricultural science teachers identify Roberts *et al.* (2006) of mixed-methods study. In 2014 Peano, C., P. Migliorini, and F. Sottile introduced a methodology for the sustainability assessment of agri-food systems. They tried to construct and use the multicriteria methodology as a communication and process facilitating tool, sensitive to the Slow Food approach to sustainable agriculture food systems, including its emphasis on local aspects. In a focus group approached study from Harlin *et al.* (2007) was determined the competencies (knowledge, skills, and abilities) required of effective Agricultural Science teachers and suggested ways to be effective prior to entering the teaching profession. Identified Required Competencies for the Agricultural extension and Education Undergraduates shows in their study Movahedi *et al*. (2012). Deegan *et al.* (2019) find out that blended learning multimedia materials as an education tool can be used effectively for the instruction of a diverse range of practical skills in agricultural education. Assessing professional competence, particularly but not only with respect to educational impact, was the objective of Van der Vleuten and Schuwirth (2005). They attempted to achieve a conceptual shift so that instead of thinking about individual assessment methods, they tried to think about assessment programmes. Epstein *et al.* (2002) proposed a definition of professional competence in medical practice, to review current means for assessing it, and to suggest new approaches to assessment. Accreditation Council for Graduate Medical Education (ACGME)'s attempts to ensure graduates meet expected professional standards. Natesan *et al.* (2018) presented challenges in measuring ACGME competencies/sub-competencies and milestones through the training program strategy.

Based on the above-mentioned literature review, a strong interest in evaluating competencies and skills in various discipline but, specifically, in the fields of natural sciences and sustainable development can be emphasized. It is not just about the skills, knowledge and competence of pupils and students but also their teachers at different levels of school. Many authors work with different definitions of competencies and skills, and they often adapt methodology of their own analysis and surveys. This also shows the weaknesses of previous approaches. Because of relative vagueness and ambiguous definitions, the weakness of the country/region/schools (and their fields) results is, in particular, limited comparability. Processed studies can thus be considered as the initial source of inspiration for further reflection on the redeployment of existing or the creation of new curricula in the fields of sustainable development and agro-food education. However, it is clear from current knowledge that a new approach on the part of teachers is necessary for the effective acquisition of new skills and competencies by students in these fields.

8.3 Methodological approaches

The literature review for this chapter is based on information and data gathered from peer-reviewed journal articles, white papers, curricula publications and related university websites. During the information and data collection procedure some of the sources were identified as non-reviewable thanks to the lack of English mutation version. These were mainly the curricula publications and related websites describing the study programmes. The researcher reduced this deficiency by including sufficient amount of additional information from similar study programmes. However, many curricula publications were not fully accessible when this study was conducted.

For purposes described above researcher identified study programmes within the scope of Agroecology, Sustainable agriculture or other related subject matter. As for the literature search, it was conducted in Google Scholar. The following keywords (as well as their combination) were used: “Competencies”, “Knowledge”, “Skills”, “Evaluation of (C/K/S)”, “Agroecology”, “Organic agriculture”, “Sustainable development”, “Agricultural education”. For the curricula publications and information about study programmes relevant experts were approached. They provided web links, documents or contacts for other colleagues on the field of sustainable agriculture topic. To obtain more relevant information and links from other experts, the snowball method was used.

All possible terms/concepts of Knowledge, Skills, Abilities and Competencies[1] related with the investigated topic were identified. These terms/concepts have been contextualized with the principal nature of an European Handbook: Defining, writing and applying learning outcomes (CEDEFOP, 2017). Crucial representative example has been introduced in Results and Discussion section.

At the end the suggestion of student's Knowledge, Skills, Abilities and Competencies evaluation on two different levels is indicated.

8.4 Results and discussion

For the rigorous evaluation of Knowledge, Skills, Abilities and Competencies, it is appropriate to observe (and find out) the impacts of educational intervention not only but also by correctly formulated inputs. By other words: designing backwards and delivering forwards (Soulsby, 2009). This is inter alia the main idea of the Theory of Change as a fundamental instrument tool of every reputable evaluation. The essence of success lies in correctly formulated Knowledge, Skills, Abilities and Competencies. However, considerable inconsistency was found across documents, based on the definition of meaning. Therefore, in their formulation, the basic structure of learning outcomes statements should be considered (see Table 4). Precise formulation of Knowledge, Skills, Abilities and Competencies, then define the direction, scope, breadth and depth that can implemented in teaching process.

THE BASIC STRUCTURE OF LEARNING OUTCOMES STATEMENTS

... should address the learner	... should use an action verb to signal the level of learning expected	... should indicate the object and scope (the depth and breadth) of the expected learning.	... should clarify the occupational and/or social context in which the qualification is relevant.
		EXAMPLES	
The student ...	... is expected to present ...	... in writing the results of the risk analysis	... allowing others to follow the process replicate the results.
The learner	... is expected to distinguish between ...	... the environmental effects ...	... of cooling gases used in refrigeration systems.
Source: Cedefop			

Table 4 The basic structure of learning outcomes statements.

This approach allows setting benchmarks for monitoring the intended progress. At the same time, it reveals the fulfillment of the meaning of each Knowledge, Skills, Abilities and Competencies. Statements can be broken down by parts, for instance like: Who? - How? - By dint of? - (For) What? - see examples in the Table 5.

The curricula in the sections describing the knowledge gained by the graduate suffered from a frequent shortcoming. There was no connection with the "By dint of?" part. Very often this part is replaced by a vague expression “to analyze” (see Example). The specific tool has not been defined.

Who?	=	(Graduates of the Master´s programme are in the position
By dint of?	=	(...to analyze...)
What?	=	(...the contribution of different agricultural systems...)
For what?	=	(...to development and loss of biodiversity and related ecosystem services.)

Table 5 Example.

This information can be often found in the description of specific subjects or courses. For a clear set of the follow-up line (if → then), it is essential not to divulge this information or at least subsequently link it for the purposes of the evaluation.

8.5 Recommendations

A complex matter such as the setting up of a quality learning course should be examined a) immediately after the intervention (output / outcome evaluation); b) upon expiration of a sufficient period of time when the competencies could be manifested (impact evaluation). For example, using these procedures: Firstly, Auto-evaluation made by student after course/study programme completion. Secondly, impacts of the intervention can be measurable in real every-working-day routine, once the student is working within the intended specialization. Both levels of evaluation can contribute to findings how to set up the proper balance of evaluated Competencies within the course/study programme.

All studied concepts should be taken into consideration while preparing the higher education curricula or other courses on the topic of Sustainable Agriculture or related. Some other concepts can be added by the creator of the courses or study programmes. Creator's environment and product chain knowledge of local patterns and global needs can be the key element of success in this process.

From this literature review we can conclude that there is a paucity of literature dealing with assessing the social impact of education. The frameworks from sustainability and entrepreneurial education presented here is promising but need more testing and further refinement in different contexts to prove its validity. In the review, it is recognized that an improvement in the quality of education is important to move the sustainable development agenda forward. This requires a holistic approach to education with regard to learning contents, teaching methods, cultural and social dimensions of the learning environment. The assessment framework for education developed within the NextFood project is an integral part of an international education initiative that aims to support the necessary change towards education for transformative learning for sustainable agrifood and forestry systems.

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[1] or ”being competent in…” or ”be able to…”

8.6 Conclusions

In this paper, we aim to gain a greater comprehension of theoretical background of evaluation standards in applied science as well as education activities in the field of agriculture, sustainable food and forestry production.

Drawing on reviewing relevant literature the chapter concentrated on four main elements. First we focused on impact assessment of agricultural applied research through evaluations within a European context. In this term we seek to contribute to a better understanding of evaluation standards that shape the evaluation process and its practical implications (what those evaluation standards look like in practice). Applying evolutionary perspective on agricultural research, we identified evaluation turn from positivist to constructivist-based theoretical framework and via the reference to the literature we defined barriers and weaknesses of both approaches. Overall, increased agricultural applied research demand evaluation standard which will see the agriculture as a complex system. Therefore, there is a shift from positivist to more constructivist logic. Thus, evaluation standards must be adapted and developed with considerations

for the context of specific research projects in order to most effectively measure the impact of agricultural applied research.

Second, the paper contributes to the ongoing debate indicators used for assessing societal impact of research. We provide an initial outline and comparison of different initiatives developing frameworks for societal impact assessment. In more detail, we focused on the Dutch, UK, French and Swedish initiative as well as initiatives funded by the European Commission. The common denominator of the most of frameworks is an emphasis on some kind of interactions with users of the results. By other words, it is necessary to have interaction between a research group and societal stakeholders. The concept of "productive interactions" (ERiC 2010) in combination with indicators for quality and volume of collaboration should be further developed for NextFood purposes. Hence, it is the quality and the magnitude of collaboration as an activity and as a phenomenon that should be evaluated. A conceptual model for evaluating societal impact of research and education incorporating needed change is shown in Table 6.

General approach **Positivistic** **Ex-post evaluation**	→	General approach **Constructivistic** **Ex-ante evaluation**

Research **Strictly within disciplines** **One-way dissemination of results** **Assessed by cost-benefit analysis**	→	**Research** Transdisciplinary Integrating research and teaching Assessed by productive interactions with the society
Education **Curriculum: collection of different parts/disciplines** **Teaching: lectures and written exams** **Content delivery is assessed**	→	**Education** Holistic and transformative curriculum Teaching: diversity of learning arenas and assessment methods Achievement of transformative learning and education for sustainable development is assessed
Institutional setting **Knowledge production and teaching within isolated disciplines**	→	**Institutional setting** Acting as an agent of change toward sustainability

Table 6 A conceptual model for evaluating societal impact of research and education, showing the needed change from a single-disciplinary to a transdisciplinary mode of assessment.

Third, regarding the theoretical background of evaluation standards for education, we focused on outcome of the Bologna Process and background on the shaping of distinctly "European" higher education evaluations. Importantly, our study revealed several frameworks on education quality evaluations. The context of evaluation varies among education institutions and countries and is influenced by a myriad of cultural, social, political, and geographic factors. Therefore, we provided an initial outline of indicators for the measuring the quality of education. It will serve as a source for development of the tool for evaluation of the quality of education.

Finally, the paper contributes to a greater comprehension of student competencies, knowledge and skills needed for effective learning process in agricultural education and approaches to their evaluation. By other words we focused on current approaches how student knowledge, competencies and skills can be defined and subsequently evaluated. Drawing of Theory of Change we emphasized that precise formulation of Knowledge, Skills, Abilities and Competencies is needed. We proposed two-steps procedures for evaluation of teaching process which should be considered while preparing the higher education curricula or other curses on the topic of Sustainable Agriculture or related. The assessment framework for education developed

within the NextFood project will be further developed based on current state of knowledge.

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ANNEX

Appendix

Appendix 1: List of LUBSearch Databases

EBSCOhost	European Views of the Americas: 1493 to 1750 (EBSCOhost)	Political Science Complete, PSC (EBSCOhost)
ACM Digital Library	Gale Virtual Reference Library, GVRL (ebooks)	Project Gutenberg eBook library (ebooks)
AGIC Plus Text	GreenFILE (EBSCOhost)	Project MUSE (ebooks)
AMED- The Allied and Complementary Medicine Database (EBSCOhost)	HeinOnline	Project MUSE (journals)
American Chemical Society (ACS)	Henry Stewart Talks - Biomedical & Life Sciences Collection	PsycARTICLES (EBSCOhost)
American Institute of Physics (AIP)	Human Rights Studies Online	PsycBOOKS (EBSCOhost) (ebooks)
American Mathematical Society (AMS)	Humanities International Complete, HIC (EBSCOhost)	PsycINFO (EBSCOhost)
American Physcological Asssociation (APA)	ICE Virtual Library	Pub Med
Art & Architecture Source (tidigare Art Source) (EBSCOhost)	Idunn.no	Regional Business News (EBSCOhost)
Arts & Humanities Citation Index (AHCI)	IEEE - The Institute of Electrical and Electronics Engineers	RILM Abstracts of Music Literature (EBSCOhost)
arXiv.org e-Print archive	IEEE / IET Electronic Library (IEL) - IEEE Xplore	Rock's Backpages
ASCE Library (Civil Engineering Database) (CEDB)	Index to Foreign Legal Periodicals (HeinOnline)	Royal Society of Chemistry (ebooks)
ATLA Religion Database with ATLASerials (EBSCOhost)	IOP journals	Sage Knowledge (ebooks)
Avery Index to Architectural Periodicals (EBSCOhost)	JSTOR	Sage Research Methods (SRM)
Bentham Science (eBooks)	Kanopy	SAGE Video (Communication and Media Studies)
Bibliography of Asian Studies (BAS)	Kluwer Law Online	Science Citation Index Expanded (SCIE)
BioMed Central	Knovel Library (ebooks)	Science Online
BioOne Complete	Lecture Notes in Computer Science (SpringerLink)	ScienceDirect (ebooks)
Birkhäuser Building Types	LexisLibrary Banking Law	ScienceDirect Freedom Collection
BrillOnline Discovery	LGBT Life with Full Text (EBSCOhost)	Scopus
Britannica Academic	LISTA: Library, Information Science & Technology Abstracts with Full Text (EBSCOhost)	Short Story Index (EBSCOhost)
British History Online	Literary Reference Center, LRC (EBSCOhost)	Social Sciences Citation Index (SSCI)
Building Types Online	Lovisa - Lunds universitets gemensamma bibliotekskatalog	Social Theory
Business Source Complete, BSC (EBSCOhost)	LUBsearch	SocINDEX with Full Text (EBSCOhost)
CAB eBooks (ebooks)	Lund Universitets Publikationer (LUP)	SPIE (ebooks)
Cambridge Books Online (ebooks)	MathSciNet	SPIE Digital Library
Cambridge Journals	MEDLINE (EBSCOhost)	Springer eBook Collections (ebooks)
CHEMnetBASE - CRC Press (ebooks)	MLA International Bibliography (EBSCOhost)	SpringerLink, e-tidskrifter
CINAHL Complete (EBSCOhost)	New Testament Abstracts Online	SpringerProtocols
Cities and Buildings Database	OECD iLibrary (Organisation for Economic Co-operation and Development)	Sustainable Organization Library (SOL)
Cochrane Library Online	Old Testament Abstracts Online	SwePub
Cogprints	Open Suny Textbooks	Taylor & Francis etidskrifter
Communication Source (EBSCOhost)	OvidSP platform	Teacher Reference Center, TRC (EBSCOhost)
Counseling and Psychotherapy Transcripts, Client Narratives, and Reference Works (Vol 1)	Oxford Art Online (fd Grove Art Online)	Thieme E-Book Library (ebooks)
Criminal Justice Abstracts with Full Text (EBSCOhost)	Oxford Bibliographies Online	Urban Studies Abstracts (EBSCOhost)
Dawsonera (ebooks)	Oxford Competition Law (OCL)	Very Short Introductions (Arts and Humanities)
The Digital Library of Classic Protestant Texts	Oxford Handbooks Online (ebooks)	Walter de Gruyter (ebooks)
DOAJ - the Directory of Open Access Journals	Oxford International Commercial Law	Walter De Gruyter etidskrifter
East View	Oxford journals	Web of Science
Ebook Central (ebooks)	Oxford Music Online (fd Grove Music Online)	Web of Science Core Collection
eBooks on EBSCOhost (ebooks)	Oxford Reference Online (ebooks)	Wiley-Blackwell e-tidskrifter
EBSCOhost (database platform)	Oxford Scholarly Authorities on International Law (OSAIL)	World Scientific Publishing (ebooks)
EconLit (EBSCOhost)	Oxford Scholarship Online (ebooks)	
Emerald (ebooks and journals)	Palgrave Connect (ebooks) (nu på SpringerLink)	
ERIC - Education Resource Information Center (EBSCOhost)	Persée - portail de revues scientifiques en sciences humaines et sociales	
Euclid Prime	Philosopher's Index (EBSCOhost)	

Appendix 2: Questionnaire for stakeholders already actively using action learning approach in their curricula

1. Which tools to assess the feedback from education of students do you use at your institutions (e.g. a questionnaire, outcome mapping, interview etc.)?

2. Which information do you aim to reveal using this method (be as specific as possible)?

3. In what parameters your approach of feedback recruitment fails (consider the content not the pitfalls of your means as e.g. lack of questionnaire return)?

4. Which type of information would you expect from ideally functioning methods for evaluation of education?