E-Learning as Tool to Feed the World

Aafke Schaap

Abstract Malnutrition is still a major issue in the developing world. Education and sustainable agriculture can be seen as key links in overcoming malnutrition. Both can be combined in e-learning technologies, a popular method in developing countries. Implementation of e-learning could provide great contribution in improving education for sustainable agriculture in developing countries. E-learning has conditions that contribute to the implementation and success of e-learning. The aim of this chapter is to assess if the Food and Agriculture Organization of the United Nations (FAO) addresses e-learning conditions adhering to scientific findings in their 'E-agriculture Strategy Guide—Piloted in Asia-Pacific Countries'. This research tries to answer the following question: *Does the FAO address e-learning conditions according to scientific findings in their 'E-agriculture Strategy Guide'? If so, which conditions are addressed*? This will be assessed by a literature review which provides a theoretical framework. Within this framework, the selected FAO document is reviewed. The results demonstrate that the FAO takes all conditions into account, except two. The focus of the FAO in their 'E-agriculture Strategy Guide' is course content, system (and internet) quality and equality in education. Interpretation of the results show that the FAO focusses on e-learning conditions of a technical nature, or those that are close to other goals of the United Nations. This research provides a preparatory analysis for evaluation of e-learning strategies implemented by the FAO.

Keywords Distance learning · Climate literacy · E-learning conditions
Strategy assessment · Food and Agriculture Organization (FAO)
Sustainable agriculture · Developing countries

Assessment of e-learning conditions addressed in the 'E-agriculture Strategy Guide' of the FAO for distance learning in sustainable agricultural development in developing countries.

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Introduction

Global action is needed to combat hunger and malnutrition; the number one cause for health issues worldwide (World Food Program 2017). Especially in developing countries this "continues to be a major health burden" (Müller and Krawinkel 2005, p. 1). "Although undernourishment has been on the decline in both relative and absolute terms, nearly 800 million people are still affected by chronic hunger today" (Van Der Meijl et al. 2017, p. 7). This chapter focusses on distance learning in order to contribute to fight against hunger and malnutrition. Distance learning includes e-learning technologies. Sustainable development could provide a contribution in combatting hunger by improving sustainable agriculture. The conditions of e-learning implementation are discussed, which are critical for successful implementation. The discussed statement for this chapter is whether the 'E-agriculture Strategy Guide' of the Food and Agriculture Organization (FAO) addresses necessary e-learning conditions found and proved in scientific literature. More specifically, this chapter attempts to answer the stated question: *Does the FAO address e-learning conditions according to scientific findings in their 'E-agriculture Strategy Guide'? If so, which conditions are addressed*?

The stated research question combines two key links in fighting hunger and improving sustainable development: sustainable agriculture (Farming First 2009) and education (Gartner 2010). Agriculture should be sustainably practised in the next decade "to sustainably produce more food from less land through more efficient use of natural resources and with minimal impact on the environment in order to meet growing population demands" (Hobbs et al. 2008, p. 1). Education (for adults) contributes to technological and social development and empowers the poor, which makes investments in education indispensable for developing regions (Duveskog 2013).

These two key links, sustainable agriculture and education, can be combined in e-learning technologies. E-learning is a solution for filling the knowledge gap between theory and practice by establishing a connection between these (Cooper and Spencer-Dawe 2006). This education method is suitable for the development of sustainable agriculture as "it has the capacity to enhance learning and expand access to education and training in agriculture and natural resource management at the global, regional and local levels" (Atkinson and Rao 2006, p. 155). Promising results of e-learning can already be seen in healthcare education (Cooper and Spencer-Dawe 2006) and in developing countries (Sife et al. 2007). E-learning has multiple advantages: great information access and communication via ICT, increasing teamwork and partnership, and great cost-benefit by teaching large numbers of students. E-learning can also easily incorporate pedagogical improvements, using graphic design, simulations and virtual experiences (Sife et al. 2007; Welsh et al. 2003).

Although e-learning is a widely accepted method, it still faces some challenges. Examples of these challenges are lack of technical support, lack of interaction and lacking ICT skills (Sife et al. 2007). To tackle these challenges it is necessary to clarify the conditions for e-learning implementation.

E-learning education for sustainable (agricultural) development is implemented by The Food and Agriculture Organization (FAO). "The Food and Agriculture Organization of the United Nations (FAO) (2000) asserts that "information and knowledge play a key role in ensuring food security and sustainable development"" (Munyua et al. 2009, p. 4.). The FAO has their own e-learning platform and e-learning policy, which focusses on managing and supporting sustainable use of natural resources (FAO and International Telecommunication Union 2016).

'The E-agriculture Community of Expertise' is a part of the e-learning platform (Food and Agriculture Organization of the United Nations, E-learning centre 2017a). This is a "global initiative to enhance sustainable agricultural development and food security by improving the use of information, communication, and associated technologies in the sector" (Mangstl and Division 2008, p. 5). The term e-agriculture is globally understood as the interaction between ICT and agriculture.

The 'E-agriculture Strategy Guide—Piloted in Asia-Pacific Countries' of the FAO and International Telecommunication Union (2016) is selected for assessment done in this research. This document is suited for this assessment because it is an important document for e-agriculture development: it leads in the development of new ICTs in agriculture and it is one of the newest guides provided by the FAO and International Telecommunication Union (2016).

The short term impact of this research is that it clarifies which conditions and to what extend the FAO addresses scientifically proved e-learning conditions in their 'E-agriculture Strategy Guide'. This research is important because previous research has shown that the lack of appropriate ICT policies hinders further development of ICTs in agriculture (Munyua et al. 2009). This research tries to clarify what conditions are necessary for appropriate e-learning implementation and their related policies. Follow up research could provide an overview of to what extend the FAO has an effective 'E-agriculture Strategy Guide'. On the long term, the impact of this research should be that e-agriculture development brings us a step closer to the development of sustainable agriculture and thereby closer to the eradication of malnutrition.

This chapter is structured as follows; the used definitions will be discussed, followed by the methodology and theoretical framework. After the theoretical framework, the results will be presented, followed by the discussion and conclusion.

Defining Concepts

The following paragraphs will describe some of the common definitions with regards to the subject of this chapter.

Conditions
In this research conditions are seen as the circumstances or factors which affect e-learning. This influence can be either negative or positive. The conditions are built up from associated factors. A factor is the concept, which is given direction by the condition. Conditions can contribute to successful e-learning, which can be seen as the development of an interactive education system, which serves its goal (Zhang et al. 2004; Andersson and Grönlund 2009).

E-learning
Welsh et al. (2003) describe e-learning as follows: "E-learning can be defined as the use of computer network technology, primarily over an intranet or through the internet, to deliver information and instruction to individuals" (Welsh et al. 2003, p. 246). Where Pagram and Pagram (2006) state:

> "E-learning is a much used and misused term. Kurtus (2004) states that e-learning is a catch —all term that covers a wide range of instructional material that can be delivered on a CD-ROM, over the Local Area Network (LAN), or on the Internet. It includes Computer-Based Training (CBT), Web-Based Training (WBT), Electronic Performance Support Systems (EPSS), distance or online learning and online tutorials." (p. 2.)

All these methods will be taken into account in this research since it is not clear which e-learning method is most commonly used by the FAO in developing countries or in (sustainable) agriculture.

Methodology

This research is carried out by a literature review followed by an assessment of the 'E-agriculture Strategy Guide' of the FAO. A literature review will be used to design a theoretical framework which can be applied on the selected FAO document. This review provides a clear overview of the scientific findings and ideas of e-learning conditions. The assessment will answer the stated research question. This method is due to time and financial constraints the most achievable method. Used methodologies in previous and similar research are mainly based on literature reviews (Atkinson and Rao 2006; Munyua et al. 2009; Raab et al. 2002; Sife et al. 2007), some in combination with quantitative analyses. Other authors based their research on participatory methods, interviews or reviews in combination with desk reviews (Behrman et al. 2004; Mangstl and Division 2008; Pretty 1995; Zhang et al. 2004) and the Delphi Method (Bhuasiri et al. 2012). E-learning conditions are rarely researched, this makes a literature review a suitable method to use.

Firstly, the general ideas about e-learning will be collected. These will be shortly described in the introduction and background section. Subsequently the specific ideas about e-learning conditions will be collected. This shall be done by literature research. The articles used in this research were found using Scopus and Google Scholar. Fourteen articles have been selected; all are peer-reviewed articles. These articles have been reviewed. They researched and described factors and conditions regarding e-learning technologies and implementations for e-learning conditions. For the theoretical framework nine articles were selected. This selection is based on the interface with e-learning conditions, not the adaptation process to e-learning. Selection criteria that were taken into account are based on e-learning in combination with one of the following concepts: conditions, factors, education, ICTs, criteria and success. Therefore it was important to take the definition of e-learning conditions, as described in the section 'defining concepts', into account. Originating from these selection criteria nine articles have been selected and reviewed for the theoretical framework.

The selected articles did not provide theories, however they did provide multiple frameworks with conditions, factors or criteria which data is collected by several methods, as described above. Conditions, factors and criteria are used, because they can be brought back to e-learning conditions.

The created theoretical framework in this research is based on the factors and conditions mentioned by Bhuasiri et al. (2012). This article was chosen as basis for the framework because this overview was the most extended and general overview of conditions found in the literature. Furthermore it is the most referenced article found in the used compass.

The other selected articles have been reviewed and the factors, conditions or criteria are compared to the conditions mentioned by Bhuasiri et al. (2012). Matching conditions are added to the framework and categorized under the corresponding conditions of Bhuasiri et al. (2012). Only the conditions which are supported by Bhuasiri et al. (2012) and one or more articles are used in the final framework to improve the reliability of the framework.

To answer the research question a policy or strategy assessment is needed. The assessment will be based on the created theoretical framework. The FAO 'E-agriculture Strategy Guide' will be analysed by the appearance of conditions formulated in the theoretical framework. The results section will describe which conditions met the conditions formulated in the theoretical framework and how these are formulated in the FAO document. This research translates scientifically proven e-learning conditions and how they are addressed in practice in a strategy guide. These results will answer the formulated research question.

Theoretical Framework

The theoretical frame based on the findings of Bhuasiri et al. (2012), identifies the success factors of e-learning in developing countries "that influence the success of e-learning systems" (Bhuasiri et al. 2012, p. 843). These factors are retrieved "from

the literature and compares the relative importance among two stakeholder groups in developing countries, ICT experts and faculty" (Bhuasiri et al. 2012, p. 834). These elements are divided into six dimensions and the related factors. The most important dimension is seen as *learners' characteristics* for ICT developers, where *infrastructure and system quality* were the most important from a faculty perspective (Bhuasiri et al. 2012). The implementation of these success factors should lead to a better learning system in developing countries. The findings of Bhuasiri et al. (2012) are presented in Table 1. Notable is that Bhuasiri et al. (2012) give a broad variety of clear defined factors. It seems a sufficient overview of success factors in developing countries in e-learning implementation. Both technical, motivational, pedagogical as quality aspects are taken into account.

The other selected articles, which are used in the theoretical framework, are shortly summarized before using their findings: Firstly, Sun et al. (2008) investigate the critical factors of e-learning: "results revealed that learner computer anxiety, instructor attitude toward e-learning, e-learning course flexibility, e-learning course quality, perceived usefulness, perceived ease of use, and diversity in assessments are the critical factors affecting learners' perceived satisfaction" (p. 1183). Secondly, Johnson et al. (2008) show that factors related to course performance, course satisfaction and course instrumentality are useful for the creation of successful e-learning environments. Thirdly, Zhang et al. (2010) shows that: "some factors of perceived innovative attributes, such as cost, quality, agility, schedule control, certification of degree, personal demands and so on" (p. 1428), have an influence on the e-learning conditions. Fourthly, Rajesh (2003) finds that ICTs related problems are focussed around: socio-political factors, human and administrative factors, economic factors and technical factors. Furthermore, the paper of Sife et al. (2007) "discusses new learning and training technologies considering their pedagogical, cost and technical implication" (p. 57). Also, Valsamidis et al. (2011) designed a framework with conditions "for applying e-learning to agriculture. It may be applied to three different stages of educational process: (i) platform development, (ii) courses development and delivery, (iii) platform and courses evaluation" (p. 373). Followed by Blass and Davis (2003), they propose a set of criteria to consider when designing an e-learning environment. These criteria focus of whether and how the implementation of e-learning should take place. Finally, Lim et al. (2007) researched both the determinant of effective online training and the variables affect learning performance and transfer performance.

Table 1 shows which authors' criteria, factors and conditions found agree with the stated dimensions and factors of Bhuasiri et al. (2012).

All factors (and thereby the related conditions) are supported by a wide range of authors. For this reason all conditions determined by Bhuasiri et al. (2012) are used in the final theoretical framework. Table 2 shows the related condition of each factor. The conditions defined in table 2 are inspired by the conditions of Bhuasiri et al. (2012).

Table 1 Represented factors and conditions found in the literature, summarized on the basis of Bhuasiri et al. (2012)

Dimensions [by Bhuasiri et al. (2012)]	Factor [by Bhuasiri et al. (2012)]	Reviewed literature
Learners' characteristics	Computer self-efficacy	Blass and Davis (2003), Lim et al. (2007), Sife et al. (2007), Valsamidis et al. (2011)
	Internet self-efficacy	Blass and Davis (2003), Sife et al. (2007), Valsamidis et al. (2011)
	Attitude toward e-learning	Blass and Davis (2003), Lim et al. (2007), Sife et al. (2007), Sun et al. (2008), Valsamidis et al. (2011)
Instructors' characteristics	Timely response	Blass and David (2003), Valsamidis et al. (2011)
	Self-efficacy	Blass and Davis (2003), Sife et al. (2007), Valsamidis et al. (2011)
	Technology control	Blass and Davis (2003), Lim et al. (2007), Sife et al. (2007) Sun et al. (2008), Valsamidis et al. (2011)
	Focus on interaction	Blass and Davis (2003), Lim et al. (2007), Rajesh (2003), Valsamidis et al. (2011), Zhang et al. (2010)
	Attitude toward student	Blass and Davis (2003), Lim et al. (2007), Rajesh (2003), Valsamidis et al. (2011), Zhang et al. (2010)
	Interaction fairness	Blass and Davis (2003), Rajesh (2003), Valsamidis et al. (2011)
Institution and service quality	Computer training	Blass and Davis (2003), Rajesh (2003), Sife et al. (2007)
	Program flexibility	Blass and Davis (2003), Rajesh (2003), Zhang et al. (2010)
Infrastructure and system quality	Internet quality	Blass and Davis (2003), Lim et al. (2007), Rajesh (2003), Sife et al. (2007)
	Reliability	Blass and Davis (2003), Rajesh (2003), Sife et al. (2007)
	Ease of use	Blass and Davis (2003), Lim et al. (2007), Rajesh (2003), Sun et al. (2008), Valsamidis et al. (2011), Zhang et al. (2010)
	System functionality	Blass and Davis (2003), Johnson et al. (2008), Lim et al. (2007), Rajesh (2003), Sife et al. (2007), Valsamidis et al. (2011), Zhang et al. (2010)
	System interactivity	Blass and Davis (2003), Johnson et al. (2008), Rajesh (2003), Valsamidis et al. (2011), Zhang et al. (2010)
	System response	Blass and Davis (2003), Sife et al. (2007)

(continued)

Table 1 (continued)

Dimensions [by Bhuasiri et al. (2012)]	Factor [by Bhuasiri et al. (2012)]	Reviewed literature
Course and information quality	Course quality	Blass and Davis (2003), Johnson et al. (2008), Lim et al. (2007), Sun et al. (2008), Valsamidis et al. (2011), Zhang et al. (2010)
	Relevant content	Blass and Davis (2003), Johnson et al. (2008), Lim et al. (2007), Rajesh (2003), Valsamidis et al. (2011), Zhang et al. (2010)
	Course flexibility	Johnson et al. (2008), Sun et al. (2008), Zhang et al. (2010)
Extrinsic motivation	Perceived usefulness	Johnson et al. (2008), Sife et al. (2007), Sun et al. (2008), Valsamidis et al. (2011), Zhang et al. (2010)
	Clear direction	Johnson et al. (2008), Sife et al. (2007), Valsamidis et al. (2011), Zhang et al. (2010)

Table 2 Theoretical framework of e-learning conditions derived from the literature, dimensions and factors by Bhuasiri et al. (2012). Formulated conditions are inspired by Bhuasiri et al. (2012) and multiple other authors used in the framework

Dimension [by Bhuasiri et al. (2012)]	No.	Factor [by Bhuasiri et al. (2012)]	Condition [inspired by Bhuasiri et al. (2012)]
Learners' characteristics	1.	Computer self-efficacy	Learner is able to use the computer to complete certain task
	2.	Internet self-efficacy	Learner is able to use internet to complete certain task
	3.	Attitude toward e-learning	Learner has a positive impression of e-learning
Instructors' characteristics	4.	Timely response	Instructor responds in a certain time span to question of learner
	5.	Self-efficacy	Instructor is able to successfully perform certain tasks
	6.	Technology control	Instructor can control instructional presentation
	7.	Focus on interaction	There is exchange (educational and social) between instructors and learners and among learners
	8.	Attitude toward student	Instructors provide various forms and methods to contact the students
	9.	Interaction fairness	Learner is feeling equally treated throughout the online learning environment

(continued)

Table 2 (continued)

Dimension [by Bhuasiri et al. (2012)]	No.	Factor [by Bhuasiri et al. (2012)]	Condition [inspired by Bhuasiri et al. (2012)]
Institution and service quality	10.	Computer training	Occurrence of specialized instruction and practice for computer skills
	11.	Program flexibility	E-learning course is flexible to serve learners' needs
Infrastructure and system quality	12.	Internet quality	There is access to internet and the quality is sufficient
	13.	Reliability	Information is accurate, dependent and consistent
	14.	Ease of use	The system is usable without need too much effort
	15.	System functionality	The e-learning system is functional for the purpose of instructions and assessments
	16.	System interactivity	The system is interactive
	17.	System response	The system responds in certain time between user action and feedback received from system
Course and information quality	18.	Course quality	The quality of writing, images, video or flash meets accepted standards
	19.	Relevant content	The provided material (information, course, content and services) meets certain standards
	20.	Course flexibility	The course is flexible to adapt in working, learning and commuting hours
Extrinsic motivation	21.	Perceived usefulness	The e-learning course is enhancing learners learning performance
	22.	Clear direction	E-learning system is free of confusion of ambiguity

Results

The results are derived from the theoretical framework applied on the 'E-agriculture Strategy Guide'. The 'E-agriculture Strategy Guide' is assessed according to the conditions described in the theoretical framework.

As stated in the introduction the assessed report is the 'E-agriculture Strategy Guide—Piloted in Asia-Pacific Countries' of the Food and Agriculture Organization. This report gives a broad overview of the implementation of e-learning strategies in developing countries. It describes in detail the implementation phases of ICTs in agriculture and gives a starting point for implementation. Therefore this document is perfectly suited for this line of research, because conditions can be derived from the detailed information given about the implementation phase of e-agriculture. Only two parts of this documents describe the

implementation phase of e-agriculture 'Part 1: Establishing a National E-agriculture Vision' and 'Part 2: Developing a National E-agriculture Action Plan' (FAO and International Telecommunication Union 2016). Part 3 of the strategy guide describes monitoring and evaluation, which is not relevant for this research.

The 'E-agriculture Strategy Guide' notes that in general economic growth is important for reducing malnutrition as long as it is inclusive. Investing in agriculture is a great opportunity for farmers and: "In fact, agriculture is around four times more effective at raising incomes among the poor than other sectors" (FAO and International Telecommunication Union 2016, p. 4).

The results derived from the FAO document will be presented in accordance with the conditions presented in the theoretical framework. Tables 3, 4, 5, 6, 7 and 8 shows the conditions and the related findings, followed by the corresponding page number in the 'E-agriculture Strategy Guide'.

The conditions found in the 'E-agriculture Strategy Guide' are presented and described in tables 3, 4, 5, 6, 7 and 8. Goals and challenges have been added to the results presented in the table, because goals and challenges may be related to the associated condition. As can be derived from tables 3, 4, 5, 6, 7 and 8, most conditions are supported in the 'E-agriculture Strategy Guide'. Although, not all conditions are clarified or represented that often. Only the factors 'attitude towards student' (Table 4, 8.) and 'clear direction' (Table 7, 22.) and their related conditions are not represented in the 'E-agriculture Strategy Guide'.

Interpretation of the results shows that the 'E-agriculture Strategy Guide' focusses mainly on: well-designed e-learning course, access and capability of the course and equity in the extension of the e-agriculture courses. These conditions are addressed most specifically (see mainly tables 6 and 7). It cannot be said that some conditions are marked as more important than others by the FAO; the number of support in the FAO document of a certain condition cannot be seen as weight. The only conclusion which can be drawn is that the FAO mentions some conditions more often than others. This suggests that these conditions are taken more often into account. A possible explanation of f.i. the related condition of the factor 'equity' is mentioned more often, could be other goals of the FAO; such as empowering women (Food and Agriculture Organization of the United Nations, Millennium Development Goal 3: Promote gender equality and empower women 2017b).

Another explanation for the FAO's focus and the found conditions (well-designed e-learning course, access and capability of the course) can be that the FAO focusses mainly on infrastructural conditions. Without taking these conditions in account, the whole e-agriculture project would not exist. Follow-up research or an evaluation of the e-agriculture project, could possibly give more insights about the social/pedagogical conditions addressed by the FAO.

A possible explanation for the missing conditions is that:

> "components are not required to be defined in detail at this stage. It may also unnecessarily constrain the way in which these components can be realized physically. The implementation plan will determine the detailed requirements and design of these components. Other e-agriculture components will likely be identified during this step, for example components such as policy, standards and information protection. They should be noted as they are

Table 3 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Learners' characteristics'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Learners' characteristics	1.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37); – Digital literacy and capability of farmers to harness ICTs (53); – Digital literacy and human capacity development (71); – Enable farmers to electronically access appropriate agricultural services directly without the need for an extension agent (83); – Smartphone and desktop applications (6); – E-agriculture skills and competencies that agricultural—workers require (91); – Not taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106).
	2.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37); – Digital literacy and capability of farmers to harness ICTs (53); – Equity and accessibility of information services (53); – Digital literacy and human capacity development (71); – Enable farmers to electronically access appropriate agricultural services directly without the need for an extension agent (83); – E-agriculture skills and competencies that agricultural workers require (91); – taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106).
	3.	– Mass media outlets may be the only means by which the general public is informed and influenced about it, so these outlets are particularly important if a high public profile is sought (37); – Communications with other key groups should be designed according to their level of interest, expertise and support (37).

identified, and considered when analysing that specific component" (FAO and International Telecommunication Union 2016, p. 85).

Bhuasiri et al. (2012) describe two dimensions as the most important: learners' characteristics (Table 3) and infrastructure and system quality (Table 6). This includes the following factors and related conditions: computer self-efficacy, internet self-efficacy, attitude towards e-learning, internet quality, reliability, ease of use, system functionality, system interactivity and system response. As can be seen in Tables 3, 4, 5, 6, 7 and 8. The results in this research correspond with Bhuasiri

Table 4 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Instructors' characteristics'.

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Instructors' characteristics	4.	– Timeliness of services (76).
	5.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37).
	6.	– Digital literacy and human capacity development (71); – Smartphone and desktop applications (85); – Not taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106).
	7.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37); – Interaction with experts (76).
	8.	x
	9.	– Awareness of gender aspects and the changing role of women and youth in ensuring food security and using ICTs (29); – Women and young farmers to ensure representation of women and youth (32); – Equity and accessibility of information services (53); – Marginalization of women with respect to ICT use in agriculture (106).

et al. (2012) findings. An explanation can be that in e-agriculture application, both faculty and ICT developers are concerned.

The e-agriculture strategy document mainly discusses the phases of managing teams and stakeholder engagement, and infrastructural issues. The found conditions cannot be seen as practically feasible and are mainly a recommendation for further practice and the decision making process.

Discussion

The results of this research has some weaknesses. The first weakness is the high level of interpretation in the way in which results are obtained. Everybody could possibly connect the conditions of the theoretical framework and the results of the 'E-agriculture Strategy Guide' assessment differently. This level of interpretation would be less if the results were derived from a statistical method. This research in combination with a survey among e-agriculture users would provide less interpretable results. Although this seems a better method, the aim of this research is to

Table 5 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union, 2016) for the associated conditions of the dimension 'Institution and Service quality'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Institution and service quality	10.	– Group forums and workshops wherever practical to facilitate participation by a larger group of stakeholders (42); – Digital literacy and capability of farmers to harness ICTs (53); – Digital literacy and human capacity development (71); – Enable farmers to electronically access appropriate agricultural services directly without the need for an extension agent (83); – E-agriculture skills and competencies that agricultural workers require (91); – Education and training (development, integration or changes to existing curricula) required to develop an e-agriculture-ready workforce (91); – Education and training (literacy and digital literacy) (91); – Not taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106).
	11.	– Mass media outlets may be the only means by which the general public is informed and influenced about it, so these outlets are particularly important if a high public profile is sought (37); – with other key groups should be designed according to their level of interest, expertise and support (37); – Access to agricultural information (75); – Accessibility to information and services (76); – Not taking an inclusive approach with ICTs—attention to differently abled, semiliterate/illiterate users (106); – Content that is no longer required is maintained rather than deleted, and referred to as potential future directions for e-agriculture (115).

map the conditions mentioned by the FAO, taking a survey into account would give an evaluation of the project.

Furthermore the aim of the 'E-agriculture Strategy Guide' is broader than the conditions derived from the theoretical framework. The FAO focuses on control of e-agriculture development and the best methods to implemented several phases of the process. The conditions presented in the theoretical framework are focused on a more practical and pedagogical implementation of e-learning.

The theoretical framework sums up scientifically proven conditions of e-learning. Although they are proven, it may be that some conditions are different in other situations. Whether content is relevant or not depends on the case.

Table 6 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Infrastructure and System Quality'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Infrastructure and system quality	12.	– Current ICTs and e-agriculture environment (26); – Mobile network operators (MNOs)/telecommunication service providers (TSPs) with e-agriculture services (32); – Mobile network operators/TSPs (33); – Equity and accessibility of information services (53); – Improve the profitability of agricultural products and services through efficient logistics, universal and connected ICT infrastructure, better market access (55); – Availability, incident, access and service-level management (81); – Mobile, fixed and satellite networks (84); – Internet (84); – Inadequate penetration of ICT network (e.g. broadband, sensing networks, IT solutions) (106); – Poor ICT and e-agriculture infrastructure (106).
	13.	– Increase the availability, accuracy and speed of information relating to agriculture sector to the stakeholders (55); – Security standards, network and Interoperability standards, and cloud security standards. For example, ITU-T X Series and Y Series recommendations (87); – All e-agriculture services providing agronomic information services are being information to farmers adhere to the AGROVOC provided by several actors (including the standard (88); – Weather station information, production information and demand, historical data about land quality, land ownership, and content relating to agricultural practices (89).
	14.	– Communications with other key groups should be designed according to their level of interest, expertise and support (37); – Accessibility and inclusivity problems due to the diffusion of inappropriate ICT (106).
	15.	– Accessibility and inclusivity problems due to the diffusion of inappropriate ICT (106); – Equity and accessibility of information services (53); – Increase the availability, accuracy and speed of information relating to agriculture sector to the stakeholders (55).
	16.	– Interaction with experts (76); – Interactive voice response systems (IVRS) (84); – Platform-level interconnectivity, and Inter-Cloud interoperability. Financial services interoperability. For example, ITU-T X Series and Y Series recommendations (87); – Accessibility and inclusivity problems due to the diffusion of inappropriate ICT (106).
	17.	– Timeliness of services (76); – Accessibility and inclusivity problems due to the diffusion of inappropriate ICT (106);

Table 7 Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Course and Information Quality'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Course and Information quality	18.	– Academia (agricultural universities) (32); – Increase the availability, accuracy and speed of information relating to agriculture sector to the stakeholders (55); – Capture and sharing of agricultural information among agricultural services' providers (71); – Facilitate free and open sharing of information and knowledge generated by public institutions (72); – Applications platforms e.g., Content Management Systems (85); – Although not a government standard, GSMA' mAgri's Guidelines for creating agricultural VAS content56 are a relevant example; and Direct2Farm content management guidelines (87).
	19.	– Academia (agricultural universities) (32); – Increase the availability, accuracy and speed of information relating to agriculture sector to the stakeholders (55); – FAO's Agricultural Information Management Standards (AIMS) (55); – Clearly defines the content sources and standards (70); – Capture and sharing of agricultural information among agricultural services' providers (71); – Facilitate free and open sharing of information and knowledge generated by public institutions (72); – Applications platforms e.g., Content Management Systems (85); – Open access to data and big data analysis (85); – Agricultural knowledge resources (85); – There are also challenges of data collection through sensors and integration of this information into existing databases and application platforms (85); – Supports standards, technology and good practices for open access and open data in the agricultural domain, geospatial and sensor data, metadata standards, such as Meaningful Bibliographic Metadata (M2B), data set compatibility for cross-platform sharing, and open access date (87); – Weather station information, production information and demand, historical data about land quality, landownership, and content relating to agricultural practices (89).
	20.	– Facilitate free and open sharing of information and knowledge generated by public institutions (72); – Applications platforms e.g., Content Management Systems (85); – Content that is no longer required is maintained rather than deleted, and referred to as potential future directions for e-agriculture (115).

Table 8. Results of assessment of the 'E-agriculture Strategy Guide' (FAO and International Telecommunication Union 2016) for the associated conditions of the dimension 'Extrinsic Motivation'

Dimensions (Bhuasiri et al. 2012)	No.	Appearance in 'E-agriculture strategy guide' as:
Extrinsic motivation	21.	– Weather alerts, good agricultural practices, and market price information personalized alerts and suggested actions based on weather, timing, crop and land quality. M-learning platforms; SMS, MMS, mobile applications (apps); Voice messages, video messages, and disaster warning systems agriculture portal (89).
	22.	x

The result of this research cannot be compared with results of other studies, because the subject is focussed specifically on the assessment of the FAO report. Although, the results of this report focus on infrastructural/technical conditions, where most research concerning e-learning conditions is focussed on social/pedagogical conditions. This makes it hard to place this research in a broader context. Research focussing on the implementation of e-learning and the related conditions should provide a more inclusive framework for as well technical and pedagogical conditions.

Even though this study shows some weaknesses, it gives a sufficient overview of important e-learning conditions addressed by the FAO.

Conclusion

This research used a theoretical framework of e-learning conditions to distinguish the addressed conditions in the FAO's 'E-agriculture Strategy Guide'. The results can be a contribution to further development and evaluation of e-learning technologies. The stated research question: '*Does the FAO address e-learning conditions according to scientific findings in their 'E-agriculture Strategy Guide'? If so, which conditions are addressed*?' is answered by an assessment of the 'E-agriculture Strategy Guide—Piloted in Asia-Pacific Countries'. The analysis shows that all found conditions (computer self-efficacy, internet self-efficacy, attitude toward e-learning, timely response, self-efficacy, technology control, focus on interaction, interaction fairness, computer training, program flexibility, internet quality, reliability, ease of use, system functionality, system interactivity, and system response) are addressed in the 'E-agriculture Strategy Guide', except two conditions (attitude towards students, and clear direction). This means that the FAO addresses conditions according to scientific findings. The focus of this document is on the conditions: quality of the course, internet access and capabilities of the system, and the equality of interaction (empowering women and the rural poor). An explanation for the focus of the FAO on certain conditions could be other goals of

the FAO and the importance of infrastructure for setting up an e-learning system. Although the FAO focusses mainly on more technical conditions, scientific literature discusses many pedagogical and social conditions for e-learning. The main arguable comment on this assessment is the high level of interpretation. This research gives only a direction for further conclusions towards e-agriculture implementation and the conditions the FAO should focus on. This study shows that the FAO takes scientifically proved e-learning conditions into account in the 'E-Agriculture Strategy Guide' in regard with developing sustainable agriculture education in developing countries.

References

Andersson, A., & Grönlund, Ä. (2009). A conceptual framework for E-learning in developing countries: A critical review of research challenges. *Electronic Journal of Information Systems in Developing Countries, 38*(8), 1–16.

Atkinson, A. D., & Rao, S. (2006). Can e-learning support agricultural development in developing countries. *World Agroforestry into the Future, chapter 19,* 155–162.

Behrman, J. R., Alderman, H., & Hoddinott, J. (2004). Hunger and malnutrition. *Copenhagen Consensus—Challenges and Opportunities,* 1–58.

Bhuasiri, W., Xaymoungkhoun, O., Zo, H., Jeung, J., & Ciganek, A. P. (2012). Critical success factors for e-learning in developing countries: A comparative analysis between ICT experts and faculty. *Computers & Education, 58*(2), 843–855. doi:10.1016/j.compedu.2011.10.010.

Blass, E., & Davis, A. (2003). Building on solid foundations: Establishing criteria for e-learning development. *Journal of Further and Higher Education, 27*(3), 227–245. doi:10.1080/0309877032000098662.

Cooper, H., & Spencer-Dawe, E. (2006). Involving service users in interprofessional education narrowing the gap between theory and practice. *Journal of Interprofessional Care, 20*(6), 603–617.

Duveskog, D. (2013). Farmer Field Schools as a transformative learning space in the rural African setting. *Diss. (sammanfattning/summary) Uppsala : Sveriges lantbruksuniv., Acta Universitatis agriculturae Sueciae*, *2013*(47), 1652–6880.

FAO and International Telecommunication Union. (2016). *E-Agriculture Strategy Guide Piloted in Asia-Pacific countries*. From: http://www.fao.org/3/a-i5564e.pdf

Farming First. (2009). *Principles*. Farming First—A global coalition for sustainable agriculture development. Retrieved at April 28, 2017, from Farming First: https://farmingfirst.org/principles/.

Food and Agriculture Organization of the United Nations. (2017a). *E-learning centre*. Retrieved at April 28, 2017, from Food and Agriculture Organization of the United Nations: http://www.fao.org/elearning/#/elc/en/home.

Food and Agriculture Organization of the United Nations. (2017b). *Millennium Development Goal 3: Promote gender equality and empower women*. Retrieved at April 28, 2017, from Sustainable Development Goals: http://www.fao.org/sustainable-development-goals/mdg/goal-3/en/.

Gartner, D. (2010, July 30). *Achieving the Millennium Development Goals: Education is the Key Missing Link*. Retrieved at April 28, 2017, from Brookings: https://www.brookings.edu/opinions/achieving-the-millennium-development-goals-education-is-the-key-missing-link/.

Hobbs, P. R., Sayre, K., & Gupta, R. (2008). The role of conservation agriculture in sustainable agriculture. *Philosophical Transactions of the Royal Society*, (July 2007), 543–555. http://doi.org/10.1098/rstb.2007.2169.

Johnson, R. D., Hornik, S., & Salas, E. (2008). An empirical examination of factors contributing to the creation of successful e-learning environments, *66*, 356–369. doi: http://doi.org/10.1016/j.ijhcs.2007.11.003.

Lim, H., Lee, S., & Nam, K. (2007). Validating E-learning factors affecting training effectiveness, *27*, 22–35. doi: http://doi.org/10.1016/j.ijinfomgt.2006.08.002.

Mangstl, A., & Division, C. B. (2008). Emerging issues, priorities and commitments in e-agriculture. *Agricultural Information Worldwide, 1*(1), 5–6.

Müller, O., & Krawinkel, M. (2005). Malnutrition and health in developing countries, *Canadian Medical Association Journal, 173*(3), 2000–2003.

Munyua, H., Adera, E., & Jensen, M. (2009). Emerging ICTs and their potential in revitalizing small-scale agriculture in Africa. *Agricultural Information Worldwide, 2*(1), 3–9.

Pagram, P., & Pagram, J. (2006). Issues in e-learning: A Thai case study. *Electronic Journal of Information Systems in Developing Countries, 26*(6), 1–8.

Pretty, J. N. (1995). Participatory learning for sustainable agriculture. *World Development, 23*(8), 1247–1263.

Raab, R. T., Ellis, W. W., & Abdon, B. R. (2002). Multisectoral partnerships in e-learning a potential force for improved human capital development in the Asia Pacific. *Internet and Higher Education, 4*(3–4), 217–229.

Rajesh, M. (2003). A study of the problems associated with ICT adaptability in Developing Countries in the context of Distance Education. *Turkish Online Journal of Distance Education, 4*(2), 1–10.

Sun, P., Tsai, R. J., Finger, G., & Chen, Y. (2008). What drives a successful e-Learning? *An Empirical Investigation of the Critical Factors Influencing Learner Satisfaction, 50*(4), 1183–1202. doi:10.1016/j.compedu.2006.11.007.

Sife, A., Lwoga, E., & Sanga, C. (2007). New technologies for teaching and learning: Challenges for higher learning institutions in developing countries. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, *3*(2), 57–67.

Valsamidis, S., Kazanidis, I., Petasakis, I., & Karakos, A. (2011). A framework for E-learning in agricultural education. In *Proceedings of the International Conference on Information and Communication Technologies for Sustainable Agri-Production and Environment (HAICTA 2011)*, 373–384.

Van Der Meijl, H., Ruben, R., & Reinhard, S. (2017). Towards an inclusive and sustainable economy. *Wageningen: Wageningen University & Research*, 1–44.

Welsh, E. T., Wanberg, C. R., Brown, K. G., & Simmering, M. J. (2003). E-learning: Emerging uses, empirical results and future directions. *International Journal of Training and Development, 7*(4), 245–258.

World Food Program (2017). *Zero Hunger*. Retrieved at April 28, 2017, from World Food Program: http://www1.wfp.org/zero-hunger.

Zhang, D., Zhao, J. L., Zhou, L., & Nunamaker, J. F. J. (2004). Can e-learning replace classroom learning? *Communications of the ACM, 47*(5), 74–79.

Zhang, L., Wen, H., Li, D., Fu, Z., & Cui, S. (2010). E-learning adoption intention and its key influence factors based on innovation adoption theory. *Mathematical and Computer Modelling, 51*(11–12), 1428–1432. doi:10.1016/j.mcm.2009.11.013.