An adaptive learning approach to train smart farmers in Thailand, Bhutan and Nepal

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ABSTRACT
In this paper, we describe past approaches used to teach Farmers in Asia, and propose an adaptive learning approach appropriate to teach Asian farmers the basics of Digital Agriculture (overview, components, data processing and decision models), Smart Farming (objectives, cultivation farming, livestock farming, smart monitoring, smart controlling), Standardization (food safety and standards/norms) and Agro business (business modelling, sales and marketing).

CCS Concepts
• **Applied Computing → Computers in other domains →** Agriculture • **Applied Computing → Education →** Interactive learning environments **• Hardware→ Communication hardware, interfaces and storage →** sensors and actuators, sensor application and deployment

Keywords
Smart Farming ; learning approach

1. INTRODUCTION
The purpose of this paper is to present an overview of possible learning approaches and their relevance in the context of smart farming in Asia. The first paragraphs provide an overview of the lessons learnt from past experience. Then the paper provides more details with regards to the situation and the profile of the farmers targeted. Paragraph 5 provides more details regarding the pedagogical approach proposed

2. PREVIOUS EXPERIENCES
Training of farming communities in Asia has evolved over the years. Different approaches have been tested. One of the first approach consisted in "organized seminar with classroom lectures or field demonstrations or both that required registration of participants. Training was provided by research units of agricultural institutes or by major agrochemical companies." [1]

This approach, often referred to as the "Training and Visit (T&V) Extension Program or The Massive Guidance (BIMAS) Program", took place from the mid- 1960s until the end of the1980s. It has been replaced by Farmer Field School (FFS) Programs, during the 1990s. [2]

The Farmer Field School (FFS) is a learning process based on groups discussions, where 3 to 5 farmers from the same area and having similar productions exchange on their findings. The group discussions are moderated by a "facilitator". As Barlett describes, "during the FFS, farmers carried out experiential learning activities that helped them understand the ecology of their rice fields. These activities involve simple experiments, regular field observations and group analysis. The knowledge gained from these activities enables participants to make their own locally specific decisions about crop management practices." FFS educational methods are "experiential, participatory, and learner Centered" [3] As such, the FFS program "encouraged and stimulated farmers to make their own decisions." [2]

3. REFLECTION ON THOSE APPROACHES AND REX
In many cases, researchers observed that farmers used media and community sharing to reinforce their competences. As Feder summarized, "this is confirmed by survey data showing that farmers cite other farmers as their main source of information regarding agricultural practices [4] [5] However, the data indicate that on technical matters entailing greater complexity or high cost, farmers have a preference for first-hand, or specialized sources of information such as extension experts" [6] [7] [8]

To this purpose, innovation platforms can be used to bring different actors together to exchange information, compare and benchmark, and also negotiate collective or coordinated action. [9]

Another point to take into account is underlined by Luther, who insist that the training of trainers should not be overlooked, as is a key element for a successful training program. Indeed, according to him, "without an adequate Training of Trainers (ToT) program, the subsequent FFS program will fall far short of its potential." [10] The value added of a trainee becoming a trainer is underlined by many authors [11] [12] [13] [14] [15] [16] According to Prell et al., "acquiring new knowledge is a complex process which is mediated through establishing mutual ties with knowledge experts, even though challenges may still exist with respect to an actor's ability to receive knowledge" [15]. To offset lacking capabilities on knowledge gains, actors tend to pursue others with more knowledgeable expertise than themselves [13], who mostly come from external links such as government institutions [12]. Hence, for successful knowledge transfer, we also expect that farmers with more ties to extension officials will accrue advantages from reciprocal knowledge exchange with experts (see, e.g., [11] [14], which will translate into better learning outcomes. [15] [16]

The original scope (reducing pesticide usage) is also pointed out as too narrow. To cover this issue, a way of improvement is proposed by Walter, who insists that "ICT and data management can provide novel ways into a profitable, socially accepted agriculture that benefits the environment (e.g., soil, water, climate), species diversity, and farmers in developing and developed countries." [17]

As a conclusion, we should develop training modules on various elements, from agricultural knowledge to business models.

Reflections on past programs also concluded that FFS program needed improvement to widen their geographical scope of action and to be more cost effective. They should be followed by a new program to maintain farmers' knowledge. Whatever the choice, "strong local research with links to international communities, a national political will and administrative breakthroughs are most likely needed" [2]

The sustainability of the FFS approach is therefore limited. This should be taken into account in our proposition. Based on this statement, Luther proposes five options to improve the training approach:

- "First, improve the flow of information and technology from FFS participants to non-participants.
- Second, work with new partners, such as groups based in the communities and municipalities, in order to increase the number of FFS in various countries.
- Third, develop FFS for farmer promoters who can then organize and train other groups of farmers.
- Fourth, further develop self-financing opportunities in order to cover FFS' cost.
- Fifth, complement the FFS, using mass media methods to reach a greater number of farmers." [10]

From this analysis, we conclude that our training modules have to adjust the technologies taught to the revenue and capability of famers. The structure of the program and the economic/business model linked to smart farming for farmers should also be addressed.

A last point that can be learned from previous experiences is that for a training program to be relevant, the trainees should be sorted in groups with homogeneous backgrounds. Indeed, Hashemi's findings underline that there are "different needs of farmers for future training as a result of differences in age along with other background characteristics" [18]

To propose a relevant and adaptive training program, two steps are therefore required:

1. Understand farmers' profiles and requirements, to build homogeneous groups;
2. Propose an adapted and continuous training program for each of these groups, to train farmers who will then become trainers and insure the sustainability of the diffusion of knowledge.

All of these statements are taken into account in the teaching and learning approach we construct in the following paragraphs. Indeed, our program is dedicated to the training of Asian farmers on specific fields of expertise. It comes after a number of training programs and should therefore be built based on their feedbacks.

4. OVERVIEW OF THE DIVERSITY OF FARMERS' PROFILES AND REQUIREMENTS

4.1 Context and global profiles

Training methodologies need to fit with farmers' profiles. It depends on various criteria, from local context and accessibility (Internet access…) to farmers' profiles and current knowledge in the use of technologies.

To define the most relevant training approach, a first step was therefore to include in the survey a part on farming practices and training experiences. The objective is to know farmers' experiences relevant to smart farming and/or training. Three criteria have been used:

- Trainer and trainee experience of farmers
- Understanding, skills and experience on smart farming technologies
- Farmers' preferences on training channel

This survey has been filled by a total of 349 respondents (110 in Chiang Mai (Thailand), 140 in Khon Kaen (Thailand), 50 in Bhutan, 49 in Nepal).

Regarding Farmers profiles, the survey underlined the following elements

- 82,5% of respondents are over 40 years old, including 27,8% over 60.
- 63,8% of respondents are undergraduate.
- 37,8% have language problems
- 71% of respondents earn less than 2000€ per year from doing farming, mainly correlated with the size of the farms (56,2% are smaller than 50 acres). This situation differs in Khon Kaen, where the size of the farms is more diversified.
- 60,5% of Farmers are working alone in their farms. The nature of farming (individual, joint family, cooperative or corporate farming) varies slightly depending on countries (see Figure 1 Nature of farming).
- 25,2% of respondents have Internet access in their farm, and less than half of those no do want to change this situation, preferring to stay without Internet access. This situation differs in Bhutan, where Internet is more widespread (see Figure 2 Access to Internet)

These first elements on farmers' profiles impact the choice of the most adapted training method. Indeed, without Internet access, MOOCS are irrelevant for instance. No Internet access also means no possibility to consult a web based platform with a computer. Nevertheless, farmers have a phone, in most of the cases smartphone. They have an Internet connection on their smartphone, hence a mobile platform such as New Spectrum is suggested. The same issue arises with language problems. When farmers cannot read, they need oral and practical training. Written training material (paper or online) will have difficulties to be understood by farmer if their reading capabilities are limited. Therefore, special attention must be put on the interface. It needs to be user friendly, and easily understood by farmers with limited reading capabilities.

4.2 Specific elements regarding previous and desired training methodologies

The pedagogical approach usually differs depending on the level of expertise of the attendants. In our case, only 51,9% of respondents have previously joined a training relevant to farming practices and/or technology. This situation is country dependent: less than one fourth of Bhutanese farmers have been trained whereas nearly 75% of farmers in Chiang Mai have been trained (see Figure 1). The disparity is less obvious regarding the percentage of farmers, that have acted as a trainer for other farmers.

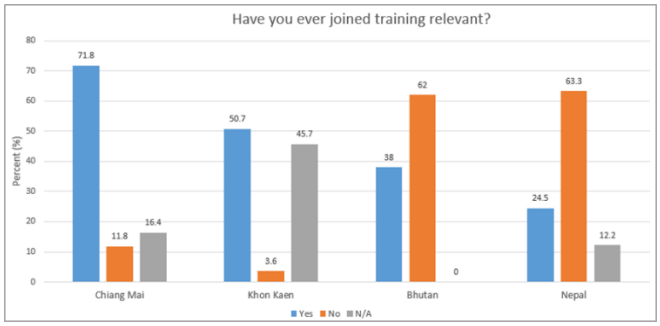

Figure 1. Diversity of past experience regarding the training of Farmers

The methodologies previously selected by the farmers for their training are varied. Out of the 349 respondents, we count:

- 47 reading books
- 58 followed a course with a teacher (including only 2 in Bhutan)
- 12 used MOOCS
- 67 learned with pairs (community learning)

When asked about the prefers method, respondents' choices are mainly community learning and classical training, with a teacher. Then follows an online platform and reading materials.

A last element to take into account is the experience and willingness of respondents to act as a trainer. Indeed, for community learning to be applicable, we need to train first a small group of farmers, that will then act as a trainer for other groups. Some have already acted as such.

For the training to be relevant, we need to create groups of farmers with similar profiles. The training methodologies and contents will be adapted to fit the needs of the groups, depending on the level and expectations of group members.

4.3 Definition of groups

Based on the survey, three target groups are foreseen, with an additional "group 0" composed of farmers that do cannot be included in our project:

- Group 0 – digitally illiterate farmers, who do not want to change their practice
- Group 1 – mostly digitally illiterate farmers, but they are willing and able to learn
- Group 2 – having some expertise in agricultural and/or ICT and/or business management domain (academics also are part of this group)
- Group 3 – experts in agricultural and/or ICT and/or business management domain

Group 0 is not included, as farmers' profiles make the training of these farmers irrelevant for our program.

Group 1 is the less advanced farmers. They do not have Internet access, and sometime also have difficulties to write and read. As long as they are willing to learn, farmers can be included in this group (100 farmers). Due to the diversity of profiles, two sub groups are foreseen. Group 1A with the less advanced in terms of digital literacy, Group 1B with those, who have some basic understanding.

Group 2 is made from practitioners, farmers with their own farms. They are more advanced, may already have some technology. They also are entrepreneurs, which means that they are able to change their practices. (121 farmers).

Group 3 is made from government representatives, junior technical assistant, academic staff or administrative. (36 academics and technical assistants + 16 admin).

Based on these elements, we can conclude that both the content and the pedagogical approach need to be aligned with farmers' profiles and requirements. The content designed for our program will have various levels available, to better fit with farmers' skills regarding agriculture, but also digital literacy, marketing and technology usage.

The skill set for this project is divided in four subjects:

1. Digital agriculture (overview, components, data processing and decision models)
2. Smart Farming (objectives, cultivation farming, livestock farming, smart monitoring, smart controlling)
3. Standardization (food safety and standards/norms)
4. Agro business (business modelling, sales and marketing)

Erreur ! Source du renvoi introuvable. illustrate the need to adjust the content to farmers groups.

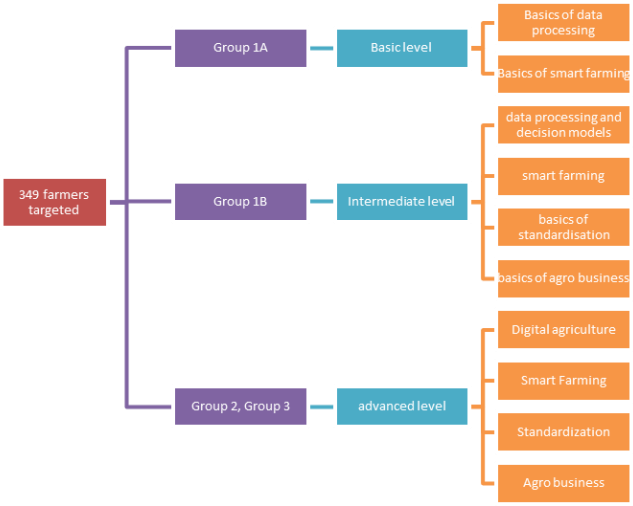

Figure 2. Adaptation of the content to the targeted groups

The pedagogical approach also needs to be adapted to the heterogeneity and diversity of profiles. The choice of the pedagogical approach is developed in the following paragraph.

5. PROPOSED APPROACH

Because of clustering target audience, the learning materials and the learning approaches should be different but compliant with the needs and constraints of specific groups. Based on the surveys and earlier experiences we identified the following learning approaches:

5.1 Courses / classroom sessions

This classical form of training involves the training of a group by a teacher, who explains in details theoretical elements. It generally occurs regularly. At the end of the teachings, students are supposed to achieve a given level of understanding.

5.2 Online training

Online training is the most general form of the advanced and technologically up-to-date form of distance learning. It may consist of filmed lectures, text/videos, hypermedia, descriptions of best practices, potentially they may use chatbots and/or wiki motors combined with social media features. Any of the target groups can use, as any member of any groups can contribute, too. Online learning can be implemented in several ways, depending on the training purposes: formal, informal or non-formal training. Another selection criterion is whether the content is licensed, free (OER) or the provider asks for tuition fee. Different types of video include documentary (describing events), institutional (promoting a project or organization), instructional (developed by researchers with limited input from farmers), farmer-learning (made with farmers), and participatory (made by farmers).

5.3 Blended learning

Blended learning is on-line learning combined with regular or occasional F2F meetings, consultation. Blended learning gives very good opportunity for optimizing the trainees' resources, learning space and at the same time capitalizing on the trainers' personal educational capacity. However, the online training does not exclude the interactivity, it is restricted in the virtual space. If the interactions are automated, then it loses the personal communication surplus, which is still a valuable ingredient of teaching and learning. If it is not automated, then it needs enormous teacher-trainer resources. The blended learning fits to all forms of training, amongst them the to the non-formal one. From the project's point of view the most appropriate choice. The ratio between the online content and Face to Face consultation can be fine-tuned according to the target group features, the content type, place and time.

5.4 MOOCS

It is difficult giving an exact definition of MOOCS (Massively Open Online Courses). It is somewhere in the middle of Gartner's hype curse. There are many forms exist, originally leading universities (e.g. MIT) made the educational content open, then some more content became available free. In most cases MOOCS providers offer degree programs, hence MOOCS fit to the criteria of online learning with the focus on formal training. As in the beginning MOOCS was popular, many courses were developed and bring to the market aiming corporate and non-formal training.

5.5 Community learning

"Community learning's approach builds on the foundation of collaborative learning where students learn best from one another by working together to answer questions and solve problems. Each course is developed in consultation with subject area experts and includes experience and age appropriate lessons integrated around a unique theme." (http://www.commlearning.com/about-community-learning/). This form seems to be appropriate to Group 1, and it may work well. The disadvantage from the project's perspective is that difficult to maintain and sustain, also the content is hardly portable.

5.6 Workshops

Workshop can be anything where the participants actively discuss one topic. The aim of the workshop can be equally knowledge transfer or collaboration for coming out with some solution, does not matter the workshop has technical or awareness raising taste. The F2F element of blended learning also can be organized and implemented in a form of workshop, it fits very well to the non-formal training, in our case Group 2 and Group 3 will make the best use of it.

5.7 Peer learning

Experts (Group 2 & 3) prefer peer learning methods, as they change experiences, best practices, or reasons failures among each other's. From the project's perspective it has low priority.

5.8 Learning by doing

This type of learning is very much connected to the everyday practical work. Novel trainees work under the guidance of an experienced co-worker and learn what cannot be learnt from books. Theoretically knowledge conversion goes on, internalizing explicit knowledge, also learning by doing is a proper vehicle establishing hard and soft skills.

Depending on the profiles of farmers one or a combination of these approaches is possible. The choice of the appropriate teaching methodology is made based on the relevance to the target group. It needs to be

- accessible offline for those who do not have Internet access,
- user friendly, with colours and audio to allow those with allow digital literacy level to use it
- differentiated depending on the group and its level of experience.

Group 1 will benefit more from community learning, mentorship, and basic training courses. Training on a field (technology / business models…) where there have little to no expertise may be difficult. Therefore, the choice of the pedagogical approach is of the outmost importance. According to the survey, community learning and basic teaching are the two most cited approached desired by farmers. They also fit better in their context (low internet access/digital illiteracy). They will be taught by their peers, most advanced farmers from group 2.

Group 2 and 3 will be trained thanks to the pilots/excellence centers, as well as advanced teachings and e-learning on an online platform to be designed during the project. They are to be involved in the design of the training material. Indeed, the content of the teaching material should be co-constructed to combine the knowledge of experienced farmers with the knowledge of academics and ICT experts.

The long-term validation and qualification is an element that also needs to be addressed, as only 12% of the 349 respondents do not want to get an agricultural certificate. The training approach needs to be adaptive and responsible. To better fit with the diversity of profiles of farmers, we propose to proceed by steps, as illustrated by Figure 3.

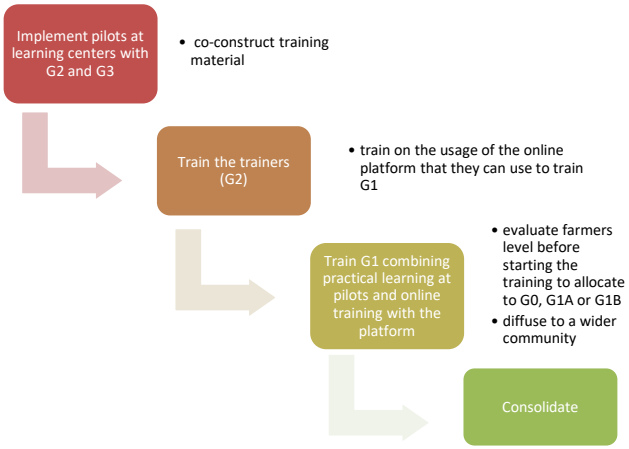

Figure 3. Four steps for our approach.

The four steps of our approach are as follow :

Step 1: Implement training facilities and events around the pilots in dedicated learning centers

Step 2: Train the trainers (group 2 and group 3)

Step 3: Train the rest of the farmers (group 1)

Step 4: Consolidate the various training tracks and transfer knowledge

Four pilots are to be set up: one in Bhutan, one in Nepal, and two in Thailand (Chiang Mai CMU and Khon Kaen KKU). Each of them will host a learning center, which will focus on specific areas:

1. Organic 1 (Rice production in Thailand - CMU)

2. Organic 2 (Beef housing system in Thailand - KKU)
3. Quality (off season vegetable production in Bhutan)
4. Work and health conditions (usage of chemicals and improvement of working conditions in Nepal)

The teaching and learning activities will be scheduled and organized in each of the learning centers. The content will be co-constructed by project members and G2/G3 members. Each partner will focus on its area of expertise.

Each Asian partner has identified these first groups to train during the first half of 2020.

Then G1A and G1B will be trained with a blended learning approach, i.e. a mix of theoretical teachings and practical training on the pilots' sites. The development of an online platform is also planned to accompany G0, G1A and G1B farmers, under the guidance of G2 and G3. The ratio between the online content and face to face consultation can be fine-tuned according to the target group features, the content type, place and time.

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