A comparative analysis of Senegalese farm schools: unveiling effective practices for agroecology training.

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Abstract

This paper assesses the value of agroecological farm schools by analysing 4 Senegalese cases. Pedagogical quality is measured by: (1) feedback from former learners, (2) acquisition of fundamental knowledge, (3) professionalisation. Beyond globally positive opinions about training, our results show that farm schools display distinct performances. Developing a systemic perspective is not an easy task, but having trainers with more advanced agroecological expertise is an asset. Effective training builds on active pedagogy. Post-training business establishment is facilitated when farm schools create networks in agroecology and/or offer a consequent starter kit. Farm schools could thus contribute to agroecological transitions.

Keywords:

Farm schools, agroecology, knowledge acquisition, business establishment, Senegal

SDG keyword list:

SDG 4: Quality education, SDG 12: Responsible consumption and production

1. Introduction

Agriculture faces many challenges, such as providing food and other ecosystem services of suitable quality and quantity, while also enabling farmers and food-chain actors to gain their living, and reducing negative effects on the air, water and land (Garnett et al., 2013; Rockström et al., 2017). New incentives and policies for ensuring food security and protection of ecosystems will be required to meet the increasing food demand without compromising public health and the environment (Gordon et al., 2017; Tilman et al., 2002). In this context, an accelerated expansion of agroecology can be observed, built on the premise that this paradigm appears promising to face those global challenges. The implementation of agroecological practices has been shown to be environmentally beneficial (Boeraeve et al., 2020; Garbach et al., 2017; Wezel et al., 2014) while also showing a strong economic potential (van der Ploeg et al., 2019).

Although promising, a great deal of studies have documented many factors that needed to be unlocked for a transition towards agroecology to take place (*see* IPES-FOOD 2018, 2016; which summarises important

knowledge in this respect). Amongst these factors, scientific and education locks-ins are obviously of importance (Sutherland et al., 2012; Vanloqueren & Baret, 2009). Particularly, system thinking, the acknowledgment of complexity and interdisciplinarity may appear quite challenging in terms of education (De Graeuwe et al., 2020; Fernández González et al., 2021). A variety of lock-in mechanisms are also at play in this matter since personal knowledge and beliefs have a strong influence. Such ideational path dependencies can be qualified as 'cognitive' lock-ins and have been demonstrated to hamper the adoption of agroecology-related thinking (Louah et al., 2017). Developing an effective and efficient educational programme on agroecology thus requires analysing the values and perceptions of students (Francis et al., 2008).

Agroecology programmes have increasingly been proposed in many parts of the world (e.g., Belgium, Germany, United States and Senegal). More than a hundred colleges and universities have launched such programmes. Different pedagogical approaches are developed from degree programmes to student farms (David & Bell, 2018, p. 612). Nicot et al. (2018) and Wezel et al. (2018) highlighted that agroecology training programmes in Europe are numerous, concentrated in certain countries, and diverse. This diversity is further amplified by the fact that NGOs and the private sector have also launched their own training programmes. They propose shorter- or longer-period training in agroecology. Their training is often informal (i.e., not recognised by public authorities) and not part of a formal curriculum. Those programmes are mainly of two types: farmer-to-farmer training or farm school.

> *Farmer-to-farmer training (F2F)* refers to "knowledge exchange approaches which value farmer[s'] knowledge, experience and observation" (Kansanga et al., 2021, p. 108). Farmers train other farmers. Farmers can also experiment with new processes together: usually, one farmer dedicates a piece of land to test the agricultural practice chosen with the other farmers. The group can be informally or formally structured.
>
> *Farm schools* refer to structures that are geared towards training farmers in agroecological farming practices (Wezel et al., 2018). However, training in farm schools mixes direct practical experience with theoretical lectures (as could be observed from field enquiries in both Belgian and Senegalese farm schools).

It is worth mentioning that a rapid look over the scientific literature shows many articles covering farmer-to-farmer training (Chowdhury et al., 2011; Holt-Giménez, 2006; Kansanga et al., 2021; Kpienbaareh et al., 2020; Mariyono et al., 2013; Rosset, 2009), but only a few dealing with farm school type of structures (Laforge & Levkoe, 2018; Schnyder, 2022). This pedagogical structure is widely used in the Global South, particularly in development cooperation. It is an interesting object of analysis, particularly since many NGOs are financing this model[1] and it appears that others are considering it. For non-farmers and/or people from urban backgrounds, it is a real opportunity to acquire knowledge and practical competencies in agroecology.

Bearing all these aspects in mind, the aim of this paper is to assess the pedagogical interest of farm schools with respect to learning agroecology and its related challenges: system thinking, the acknowledgement of complexity and interdisciplinarity. To reach this goal, the training offered by different farm schools in

[1] For example, the Belgian NGO 'Humundi' (previously called 'SOS Faim') is financing the farm school SAIN in Benin; GIZ (German International Cooperation Agency) is financing Ourokale farm school in Senegal (since 2022) and the foundation Biovision is financing the 'Agroecology Centre in Tanzania' through their NGO partner Sustainable Agriculture Tanzania (SAT)

Senegal was studied by measuring their quality and, more widely, their potential contribution to agroecology transition.

Senegal is a relevant country for analysis; the central government has formally promoted some principles of agroecology in their policy discourse (Bottazzi & Boillat, 2021). Agroecological transition is one of the five major initiatives of the Priority Action Plan of the second phase of the 'Plan Emergent' (2019-2024)[2]. However, this does not preclude that many of the widespread obstacles faced by (small) farmers are also present in Senegal, including difficult access to land, credit (Wood et al., 2004) and water (Eeswaran et al., 2022) or the lack of quality tools, etc. (Maertens, 2009; Voss, 2022). This notwithstanding, in 2015 the FAO chose this nation as a pilot country for agroecology in Africa (Boillat et al., 2022; Leippert et al., 2020). Many international NGOs are working in Senegal. Bottazzi and Boillat (2021) and Laske and Michel (2022) showed a high level of dynamism in the Senegalese agroecological advocacy coalition (supported by some NGOs). This may explain the significant amount of farm schools present on the territory. Substantial investments (such as purchases of land, well water installation and building construction) have been made to create and support those structures within the country.

The rest of the paper is structured as follows. The next section exposes the theoretical background together with the methodological setting behind our analysis of Senegalese farm schools and of their respective merits. Section 3 presents the main results which are then further discussed in Section 4. Section 5 concludes the paper.

2. Materials and methods

2.1 Defining and characterizing a farm school

In Senegal, people involved in agroecology training centres commonly refer to the French term 'ferme-école' to qualify their structure. It was thus important to acknowledge this identity within the research process. However, a difficulty arose when translating the term in English to enable a comparison with other existing studies: should the term be translated as 'school farm' or 'farm school'? The answer is not straightforward as, glancing over the literature (Almeida et al., 2017; Blair et al., 2023; Darolt et al., 2021; Laforge & Levkoe, 2018; Leis et al., 2011; Monaghan et al., 2017; Parr et al., 2007; Schnyder, 2022; Wezel et al., 2018), it appears that the terms related to training structures in agroecology are not used in a homogeneous way and capture distinct realities. Still, these structures do share a common characteristic which is a pedagogy that builds on experiential learning. This feature falls within the analytical scope of our study and aligns with the characteristics of the surveyed structures in Senegal. Nevertheless, it remains necessary to briefly expose the terms and classifications used in the literature to better situate our analysis .

The term that appears best suited to grasp the type of training provided in Senegalese 'ferme-écoles' while also keeping close to the words used in French is ***farm school***. In our perspective, they refer to training farms within which agroecology is taught (see also Moore, 2017; Wezel et al., 2018). In this kind of structure, future farmers study and practice agroecology. Within farm schools, the pedagogy builds on (in-farm) experiential learning and on-the-ground practices thus dominate the theoretical hours. The main goal of such farms is to train learners to become professionals in the agricultural world. Farm schools can take the form of private companies, NGOs or other forms of citizens' associations.

[2] https://www.cirad.fr/espace-presse/communiques-de-presse/2020/agroecologie-senegal-politiques-publiques

This classification in our study does not include those ***farm schools*** typically found in South Africa. They can be described as rural schools providing primary education for the children of a district, often situated on a farm, and owned by the farm itself (Christie & Gaganakis, 1989; Pillay, 2022). The term farm school is also used to describe the ideal learning environment for teenagers in Montessori educational thinking (Gambrill, 2015). These are also excluded from our scope.

The term ***farm schools*** has been preferred to the term ***school farms*** which does not specifically target professional training but rather the education of students – from kindergarten to high schools- as shown in a recent literature review (Blair et al., 2023). School farms engage students through direct experiences of agriculture production (Garvie, 1957; Konoshima, 1995; Twenter & Edwards, 2017). This creates opportunities for students to make new connections and acquire new skills using food system frameworks and related pedagogies (Blair et al., 2023).

In a similar vein, the terms ***student farm, teaching farm*** or ***university farm*** are used interchangeably to specifically designate those farms where the learners are students from colleges or universities. Student farms give learners the opportunity to gain hands-on experience outside of their classrooms. The training proposed by a given student farm is only open to students enrolled in the related college or university.

Finally, a ***pedagogical farm*** or ***educational farm*** is a structure that promotes environment education with the objective to introduce visitors to the rural economy, contribute to local development, and promote respect for nature.

It was decided to analyse farm schools rather than student farms because we were interested in professional training rather than university training. This also is why pedagogical farms and school farms were excluded from our scope. We also wanted to study a unique structure, where theoretical and practical lessons are given in a single location. Finally, our objective was also to study long-term training with a minimum duration of 6 months.

2.2 Assessing the quality of training

Each farm school displays its own features and structure. Analysing existing farm schools in agroecology is key to understanding their quality and which characteristics of farm schools give the most significant results. By significant results and high quality, we mean training which:

(1) **obtains positive feedback from former learners**
Emotion has a particularly strong influence on attention. It facilitates encoding and helps retrieve information efficiently, with great resilience over time (Tyng et al., 2017). Many studies report that learners' cognitive processes are influenced by emotions, including learning and memory (Phelps, 2004). Learners' emotions involve complex interactions of subjective feelings that are particularly activated by external stimuli (Tyng et al., 2017). The subjective approach allows us to assess subjective feelings and subjective training experiences. Subjective opinions, feedback and feelings of former learners about the training are thus indicators to apprehend the pedagogical framework set up by a given farm school to promote the acquisition of knowledge and long-term memorisation.

(2) allows learners to acquire fundamental knowledge
Fundamental knowledge is the basis for understanding and acquiring more complex knowledge (Meyer & Land, 2003). The goal of farm schools is to prepare for professionalisation. A good pedagogical transmission is achieved when former learners have acquired fundamental knowledge in agroecology and management. Evaluation of fundamental knowledge focuses on key bases, such as understanding of agroecology, knowledge of agroecology's practices and of key notions of

management: profit, amortisation, savings, and turnover. The acquisition of key notions of management is an important element to ensure the sustainability of a business and professionalisation.

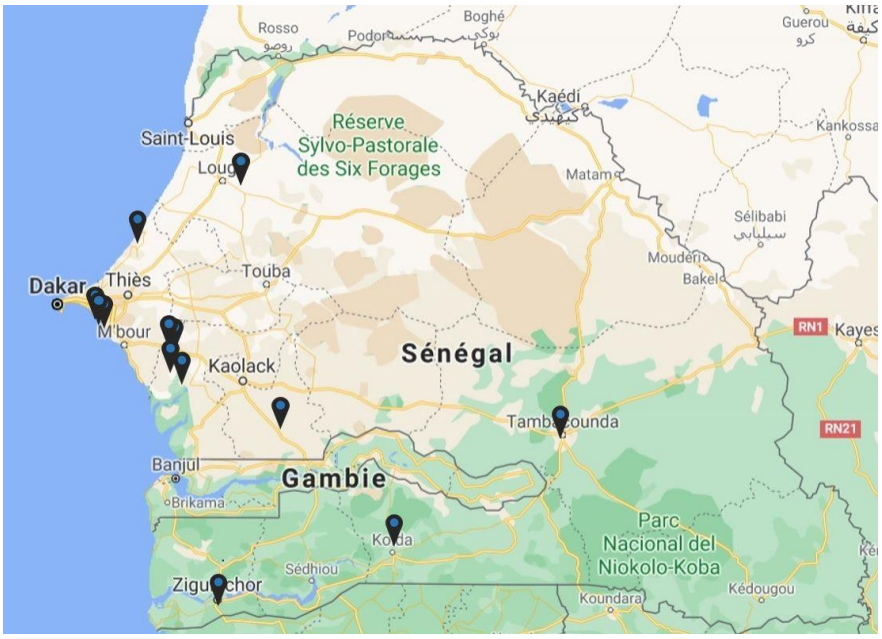
(3) **promote professionalisation**
The main goal of an agroecology-oriented farm school is to train learners to become professionals in the agricultural sector and implement practices that are aligned with core agroecological principles. Professionalisation describes degrees of specialisation related to the development of new knowledge, skills and soft skills (Lilleker & Negrine, 2002). Quality training supports socio-insertion after obtaining a diploma. In our case, this means that a significant number of former learners build their own business and set it up in accordance with agroecology principles; or find a job in this sector. While not all former learners have the possibility to build their own business; finding an agroecology-related job is a way to contribute to transition.

2.3 Research methodology

The first step of this study was to identify farm schools teaching agroecology in Senegal, as no official list of farm schools existed. This took place in January 2021. Given that few actors in farm schools know each other, it was necessary to use several sampling techniques. During our research field trip of 7 months in Senegal, we investigated many internet databases and met with international NGOs (e.g., SOS Faim, Eclosio and Sol), universities (e.g., UCAD), schools of agriculture (e.g., ENSA) as well as local people working in connection with this sector. Performing this task proved quite time-consuming but it enabled us to identify 23 farm schools in Senegal. One farm 'EP Ferme Ecole M'Lomp' also called 'Di Kandong' (located in Oussouye Department, Casamance Region) was no longer in operation and was thus removed from the list. Of the remaining 22 farm schools, six existed only at the planning stage or were under construction (in a conceptual way or literally).

The second step was to visit all 16 Senegalese farm schools active in agroecology with the aim of better understanding the realities of this pedagogical sector. Due to logistics issues (agenda, transport or other difficulties in reaching the farm school), three farms could not be visited. *Figure 1* shows where the 13 visited farm schools are located.

Figure 1: Locations of the farm schools visited (n=13)



Source: Author's construction based on Google Maps plan

An exploratory interview was conducted with a person in charge of each farm school to discuss its legal structure and the specificities of the training provided. Those visits allowed us to create a first contact with each potential future partnership. We also visited some classrooms and attended practical lessons.

Following those visits, 4 farm schools were selected for in-depth study based on three criteria: (1) at least one cohort had already graduated; (2) long-term training, superior or equal to 6 months; (3) significant years of training experience (older than 8 years), either through the farm school itself or through its pedagogical partner(s). These criteria were deemed necessary to pursue our main research objective: to study the respective quality of farm schools and their potential contribution to agroecology transition. This objective requires analysis of training programmes with similar – to some extent – features to ensure comparability. The most important criterion (1) also is the most discriminating as it reduces the sample from 13 to 7. Within the remaining sample of 'mature-enough' training programmes, the choice was made to assess the respective quality of different farm schools that can arguably be considered to belong to the 'same' broad category (i.e., through meeting the other two criteria). Although some information may have been lost in only working with this subset of the 13 identified

cases, we are confident that the remaining heterogeneity within this subset (see below) still provides enough insightful elements to distinguish potentially good practices regarding agroecological training within farms.

Table 1 presents the main characteristics of the selected farm schools.

Table 1: Description of the selected farm schools based on interviews and observations

Legend: ***** Certificate of completion of intermediate studies
x means that the characteristic is present
white box means that the characteristic is not present
? means the information is not known

We can summarise the 4 farm schools following some of the main features that distinguish them (*see* information in blue in the previous table). Farm school A can be qualified as spiritual because its agroecology programme includes spiritual development. Farm school B is the only one which is formalised. Graduates receive the farm school's diploma and are prepared to take the national test of professional aptitude. Farm school C asks the highest ordinary monthly fee although they do not incur more costs than others. It can then be characterised as being driven by economic profitability. We speak about *ordinary* fee to account for NGOs or donors sometimes supporting a learner or a cohort. Finally, farm school D has a strong partnership with a college or university and peasant network of agricultural producers.

Table 1 also highlighted another important variable, *starter kit*. Two farm schools (A and C) grant a starter kit to graduates. The aim of this starter kit is to facilitate business building. It is unconditionally allocated. This kit can either be of a financial or material nature (seeds, plants, animals, etc.).

	Farm schools			
	A	**B**	**C**	**D**
Legal form	Non-profit association	NGO	Non-profit association	NGO
Partnership with universities or colleges				x
Partnership with peasant network				x
Partnership with local authorities			x	
Spiritual dimension	x			
Ordinary training duration	< 1 year	2 years	< 1 year	2 years
Number of cohorts graduated	8	1	8	1
Good expertise level of all trainers[3]	x			x
Lectures	Participative	Ex cathedra	?	Active
Access to data of former learners		x		x
Admission criteria	Read and write + motivations interview	Bfem*		Bfem*
Ordinary monthly fee (CFA)	< 25 000	< 25 000	> 50 000	0
Diploma	School	National level	School	School
Starter kit	x		x	

Analysing the quality of each type of farm required a survey of former learners who have completed the course. To reach this goal, databases of the former trainees were needed. In practice, we received former learner lists from two farm schools. Two farm schools (A and C) did not have a formal list of their former

[3] All trainers have a university background or have at least 5 years professional experience in agroecology.

cohorts. It was thus necessary to recreate a complete database for all the graduate cohorts based on the cell phone numbers received from farm school personnel. It was not an easy task in the Senegalese context.

Our hypothesis is that programmes change slightly over time, but the 'identity' of a farm school and the main characteristics of the training are quite stable. Studying the current curriculum provided insights on the form of training former learners received and what kind of life they had while at the farm school. This knowledge would facilitate interviews with graduates. Therefore, observation and explanatory interviews were a crucial first step.

Three surveyors were hired to facilitate the survey with former learners. Besides the geographical range to be covered, we wanted the interview to take place in the native local language of interviewees to avoid a potential language bias. We organised one-day training with all three surveyors to explain each question and describe how each answer must be filled. Surveyors could contact us with any queries during the interviews. The surveys were undertaken during the first two weeks of July 2021. Despite transportation-related difficulties and the low availability of the interviewees, 54 former learners were reached (*see Table 2*). Most of the surveys were face-to-face and only a few took place by phone. In Senegalese farm schools, a large majority of learners are men. This disparity is reflected in the number of women interviewed in the sample (*Table 2*).

Table 2: Sample distribution (n=54)

	Farm school			
	A	**B**	**C**	**D**
Former learners interviewed	8	13	25	8
including women interviewed	*1*	*4*	*4*	*2*

2.4 Design of the survey

The survey questionnaire was based on elements gathered through direct study of the farm schools, and mixed open-ended with closed-ended questions. Open-ended questions encourage more truthful answers from respondents, such as sharing experiences. It gives respondents a voice during a standardised interview (Singer & Couper, 2017). Alternating open-ended and closed-ended questions is an ideal compromise: the interview gives the respondent enough freedom to express him/herself with a minimum of supervision. This semi-open approach is relevant regardless of the mode of administration: face-to-face or by phone. The survey was composed of 3 sections.

The survey started with a 'feedback' section seeking to assess former learners' perceptions of the training. It contained 2 open-ended questions on their general opinion of the training and potential improvements. This section also included a Likert-type inventory of 9 statements: each important pedagogical characteristic of the training was apprehended with at least 1 and up to 3 statements (*Table 3*). From the aggregation of those statements, a lesson satisfaction index was computed (*see* weights in *Table 3*). 4 additional statements were included to assess other features of training (2 statements about dictation, one about course materials and one about the density of knowledge). Former learners evaluated all statements on a three-point scale (2=agree, 1=neutral, and 0=disagree).

Table 3: Pedagogical characteristics and lesson satisfaction index

Statements	Characteristics	Weight in lesson satisfaction index
I am satisfied with the level of training received.	**Content**	30%
During the training, I learned many agroecological practices.		
At the end of the training, I did not feel the need to do more training to improve myself.		
The duration of practical training suited me.	**Distribution**	20%
I think the distribution of length between practice and theory was adequate.		
During theoretical training, the teachers allowed me to participate actively (asked my opinion, allowed me to ask questions...).	**Participation**	20%
At the end of the training, I felt ready to go to work.	**Self-confidence**	20%
The training allowed me to increase my self-confidence.		
I feel that training's time was appropriate.	**Duration**	10%

The second part of the survey was dedicated to evaluating individuals' knowledge of agroecology and management. This evaluation was based on three open-ended questions.

- One question evaluated the understanding of agroecology, which required interdisciplinary and complex comprehension. Answers had been noted by four different scores on a scale of 10. Score *0*, former learner was not able to explain. Score *2*, the explanation received was basic. Score *7*, the explanation given was more complex. Score *10*, former learners had a complex and systemic comprehension of agroecology.
- Another open-ended question evaluated the practices of agroecology learned during the training and which can be implemented in the field. Graduates were asked to specify as many as possible.
- The last of these questions evaluated the level of acquisition of 4 key concepts of management. Answers for each key concept were noted as three different scores on a scale of 10. Score *0*, the former learner did not acquire this notion. Score *5*, he/she partially acquired it; e.g., it was possible for the former learner to explain the notion, but the example given was incorrect. Score *10*, a high acquisition was observed.

Finally, a 'professionalisation' section was included to evaluate post-training impact. This section also contained background questions to describe former learners. This included general questions such as age, ethnicity, and level of study, but also specific questions on experience and potential former training in agriculture. When a graduate had started a business in agriculture, a multicriteria grid was filled to assess the extent of their agroecological transition (*Table 4*). This grid draws on Wezel et al. (2014) and was adapted to the Senegalese context. Each criterion was evaluated on a scale ranging from *0* to *6*, with a possible middle score of *3* (when sub-criteria are exclusive). Taking the criterion 'biological inputs' as an example, a score of *0* means that the former learner resorts to a controlled use of chemical inputs; a score of *3* reflects that he or she does not use any chemical fungicides, pesticides, insecticides and fertilizers; a score of *6* is given when he or she uses natural inputs (compost, manure, biopesticides or livestock night corralling, etc.). When sub-indicators are not exclusive, other levels of score are used (i.e., 2, 3 or 4). This helps to capture different intensities within an indicator. For example, for water management, more weight is attributed to biological techniques (score of *4*); it is supposed to be unavoidable in an optimised agroecology system in the Senegalese context where water is a scarce resource. The rationale is that a biological technique can be implemented at almost no cost while physical techniques require investment. A former

learner not implementing physical techniques may thus reveal a difficulty in overcoming financial obstacles. However, if she or he does not implement biological techniques, it is considered more critical (hence the higher score attributed to this criteria). For crop management, agronomic rotation and an association of more than 2 species are considered equal as they are both essential in an agroecology system. It was then decided to attribute a score of *3* for those two sub-criteria. The target was to obtain a multicriteria indicator which can be summarised on a graph with a (maximum) scale of *6*.

Table 4: Multicriteria agroecology transition

Criteria	Statements	Scores
Biological inputs	Controlled use of chemical inputs	0
	No use of chemical inputs	3
	Use of natural inputs	6
Water management*	Inefficient use of water or no water-saving practices	0
	Physical techniques (drip, rainwater harvesting, gravity system, solar system, etc.)	2
	Biological techniques (zai, mulching, plant association, half-moon system, stone bunds, etc.)	4
Crop management*	Monospecific cultivation on a large plot	0
	Monospecific cultivation on a small plot	0.5
	Association of species (2 max)	1
	Association of species (>2 species)	3
	Implementing an agronomic rotation (from year to year)	3
Agroforestry	No trees in the field area	0
	Tree association (max 2 species)	3
	Tree association (>2 species)	6
Environment management	No practice applied	0
	1 innovative practice to overcome the (natural or anthropic) pressures of the environment	3
	> 1 practice	6
Livestock breeding	Livestock raised totally independently of crops	0
	Livestock integrated with the crop system through at least one aspect (use of manure, pest predation or rotational grazing, etc.)	3
	Livestock integrated on more than one aspect	6
Space management	Space is not optimised	0
	Medium intensification	3
	High intensification	6
Commercialisation strategy*	Marketing strategy with intermediary	0
	Direct sale to consumers	2
	Up the chain (transformation)	4
Minimum wage per month	Less than 60 000 CFA	0
	Superior or equal to 60 000 CFA	6
Discussion group	Is not a member of a knowledge discussion group with peers	0
	Is a member of a knowledge discussion group with peers	6

Legend:* Sub-indicators are not exclusive. If two indicators are true, the former learner will have the sum of the two scores as the total score.

To test the questionnaire, two interviews were undertaken with former learners. We chose one former learner with a low level of school background and one with a higher level. Thanks to their remarks, French language adaptations were made to better match with actual French words used in Senegal. The aim was to increase survey understanding for the 3 surveyors.

2.5 Data analysis of survey results

First, the paper-based material collected on the field was digitised by input to Microsoft Excel spreadsheets by the research team and the 3 surveyors. A final check, comparing answers from the paper questionnaire to the electronic version was performed by the research team to avoid any mistakes.

Analysing survey responses consisted mainly of examining aggregate former learners' feedback, information, or scores by farm school. Statistical analysis was performed using R software v.3.5.3 (R Core Team, 2021).

For the feedback section, open-ended questions were treated following thematic analysis. The first step was to determine the lexical fields mentioned by the respondents, and themes were identified. Then, a binary variable was created for each theme, scoring 1 when the respondent mentioned this theme and 0 otherwise. The last step was to aggregate individual results by farm school. Finally, factorial correspondence analysis was used for the suggested improvements (i.e., at the end of Section 3.1). Factorial correspondence analysis is a useful data science visualisation technique for determining and displaying the relationship between values from one variable with different variables in a geometrical space.

For the fundamental knowledge section, individual scores were aggregated to calculate farm schools' grades. Mean and median scores were calculated for all former learners by farm school and by question. Determining those two parameters was essential because the number of respondents is not equal for each farm school. Four-factor analyses of variance were performed as well as Tukey's and Chi-square tests.

For the professionalisation part, descriptive statics by farm school were mainly used. A one-factor analysis of variance, Tukey's test and some Fisher's exact tests were performed.

3. Results

In this section, we present our results that deal with the performance and quality of each of the 4 farm schools selected. The findings will be classified in 3 sections: (1) feedback about the training, (2) fundamental knowledge long-term acquisition, (3) professionalisation.

3.1 Feedback about the training

As mentioned above, the survey contains two open-ended questions aimed at gaining the general perception of the training. The first question specifically seeks to capture opinions: "What did you think about the training?" Most former learners think that their training was interesting (*Table 5*). The score of farm school D (100%) is worth highlighting. Although it can be argued that such a high score is easier to reach for a smaller sub-sample of 8 individuals, it most likely reflects the fact that trainers in this farm school have high experience. They are either professors in agriculture (at university or college level) or recognised members of a network of peasants. The category 'acquisition of knowledge' also shows that training is perceived by former learners as increasing their knowledge of agroecology. This aspect appears of a lesser importance in farm school A, which is most likely due to its distinguishing spiritual dimension (the latter being more cited than acquisition of knowledge by former learners having been trained in this school).

In farm school B, group experience seems an important dimension (spontaneously mentioned by 38% of respondents) which can thus potentially explain why this school is perceived to be interesting by a large majority of its surveyed former learners (77%). However, the perception about this school also displays two negative features: a deficiency of tools for practical lessons and training which was deemed incomplete (*see* elements in red in *Table 5*).

Farm school C offers some professional opportunities after the training. However, the starter kit promised after graduation was sometimes incomplete (*see* element in red in *Table 5*). The aim of this package is to facilitate the establishment of agricultural businesses. Former learners received the kit, but some essential parts were missing. This may explain the somewhat mixed opinions former learners reported.

Table 5: Elements spontaneously mentioned in former learners' interviews regarding the quality of training

	Farm school			
Indicators	**A**	**B**	**C**	**D**
Interesting	50%	77%	68%	100%
Acquisition of knowledge	25%	77%	72%	75%
Incomplete	0%	15%	4%	0%
Missing tools for practical lessons	0%	15%	0%	0%
Professional opportunity	0%	0%	16%	0%
Starter kit	0%	0%	4%	0%
Spiritual and self-development	50%	0%	0%	0%
Good living conditions	0%	15%	8%	0%
Group experience	25%	38%	8%	25%

(Percentage refers to the percentage of former learners from a given school having mentioned that aspect.)

Legend: *__Red__ negative feedback is presented in red in the table

*__Green__ Positive feedback is presented in green.

The second open-ended question from the questionnaire was aimed at grasping the perceived possibilities for improvements: "What would be 3 potential improvements for future training?" As explained in Section 2.4, identification of themes was rigorous. With the variables created, a factorial analysis of correspondence was run. Its logic is to create new axes based on the answers received for a particular question. To show the quality of the relationship between an axis and a response, an axis and an individual, the cos2 indicator is mobilised. This indicator varies between 0 and 1. The closer this quality indicator is to 1, the stronger the link. The quality of the representations analysed here are higher than 0.7. The first dimension in *Figure 2* shows the opposition between the improvement of tools and improvement of socio-professional integration after training. For farm schools C and D, the need for professional integration after training is an essential suggested improvement while the need for tools during training is already met. This is not the case for farm school B's respondents, who were dissatisfied by the quantity of tools available. The second dimension represents the improvement concerning the density of knowledge learnt during the training which is an essential factor that farm school A should improve. Since the third dimension of the factorial correspondence analysis had an inertia of less than 6%, it was excluded from further analysis.

Figure 2: Map of factorial correspondence analysis of potential improvements

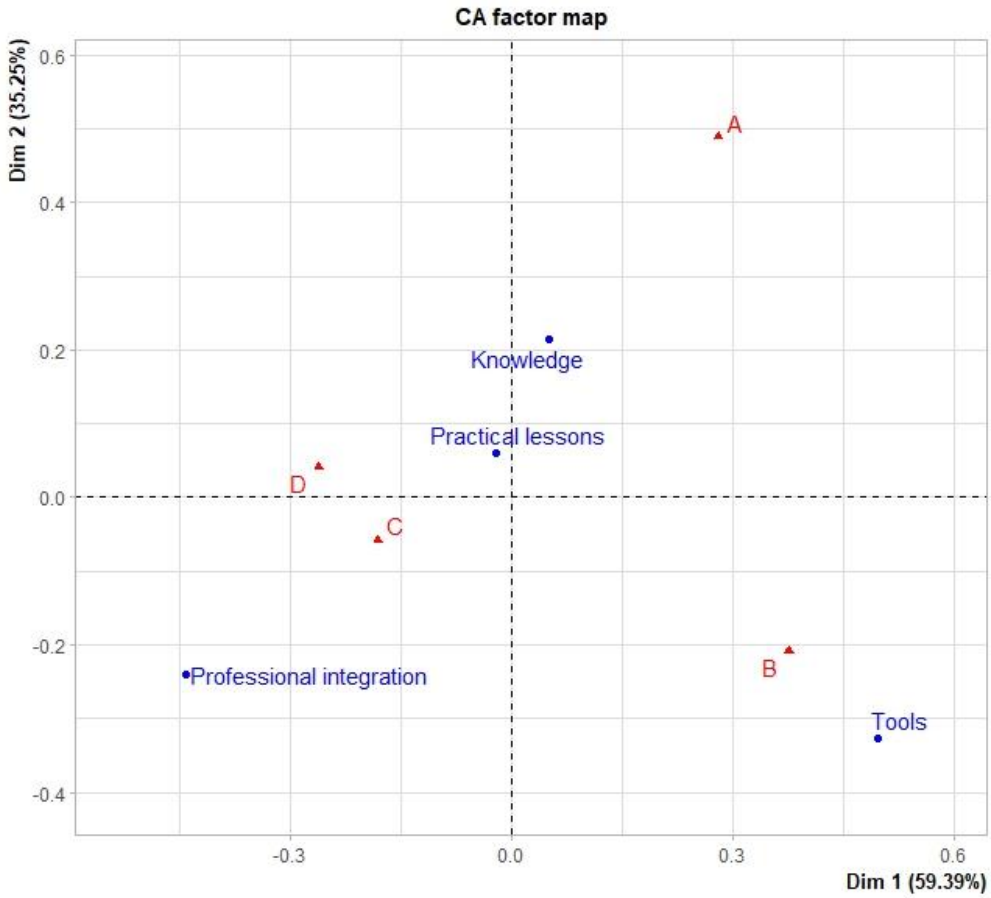
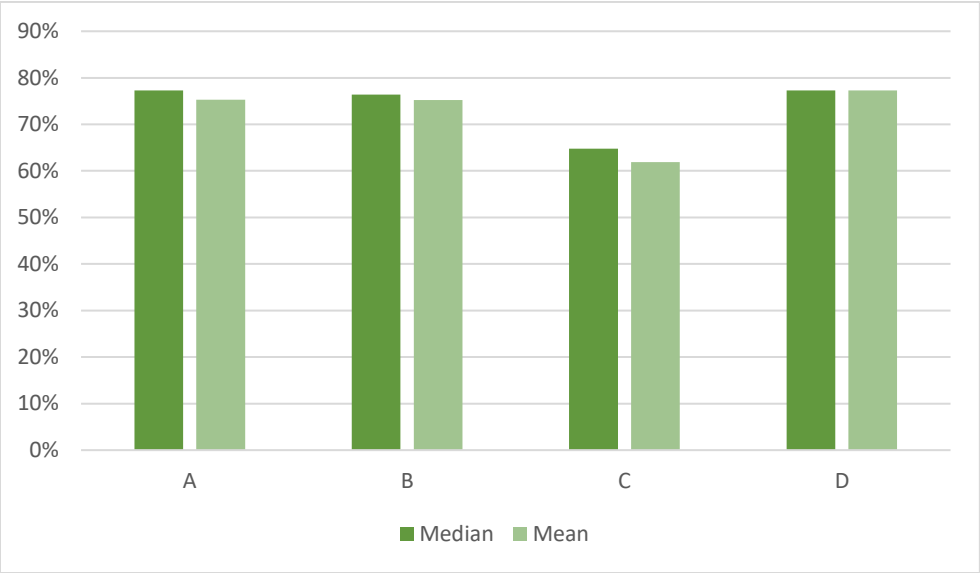


Figure generated using R software

In 3 farm schools B, C and D, a significant majority of former learners wish they had less dictation, (respectively 54%, 64% and 50%). They also wish they had received course materials from the trainers (respectively, 92%, 72% and 88%); photocopied lesson materials were not systematically available, hence many trainers dictated lessons. In farm school A, the numbers for both statements are lower (25% for dictation and 50% for course materials).

Altogether, *Figure 3* shows that farm schools A and D display the highest median lesson satisfaction indexes closely followed by B, C was lowest. The very positive values for this index show that, despite a marked difference between farm school C and the other 3 farm schools, it is likely that each of the farms could borrow respective features from the others to achieve ideal conditions.

Figure 3: Lesson satisfaction indexes based on former learners' interviews



3.2 Long-term acquisition of fundamental knowledge

Farm school D had the highest median result for agroecology comprehension (*Table 6*). In farm schools A and D, 50% of former learners could give a complex and systemic explanation of agroecology (i.e., providing an answer such as "*Agroecology is an ethical lifestyle that allows farmers to coexist with all living beings; healthy agriculture without chemicals and without damaging biodiversity*"). The scores differ in the two other farm schools. For farm school C, only 20% of former learners could get a score of 10. For farm school B, no learners could provide this systemic comprehension. They mostly provided basic definitions, such as "*Organic agriculture that prepares the soil with organic matter and treats insect attacks with chilli and garlic*".

Table 6: Former learners' level of agroecology comprehension expressed in interviews

	Farm school				
Score out of 10	**A**	**B**	**C**	**D**	**Sample**
Mean	6.57	4.54	5.52	7.88	5.67
Median	6	7	7	8.5	7

All schools combined, 15 practices in agroecology were named. Farm schools A and D are ranked first in terms of medians, but the differences are rather small (*Table 7*).

Table 7: Number of agroecological practices mentioned in interviews with former learners

	Farm school				
Practices cited	**A**	**B**	**C**	**D**	**Sample**
Mean	5.1	3.8	4.1	4.9	4.3
Median	5.5	4	4	5	4

According to the four-factor analysis of variance, the scores obtained in agroecology (level of agroecology comprehension and agroecological practices mentioned) cannot be explained by the following variables: (1)

being a farmer before training, (2) individual perception of his/her standard of living, (3) level of education before training. This is quite surprising since, for instance, one could reasonably expect that graduates with previous farming experience would get better scores in agroecology than others who are unfamiliar with agriculture, or that educational and financial capital would positively impact knowledge of agroecology. These features do not reveal statistically significant differences to explain scores. The only significant factor to explain score differences is the variable 'farm school' ($p < 0.05$) which tends to confirm that farm-to-farm differences in terms of the training provided do matter and are thus worth investigating.

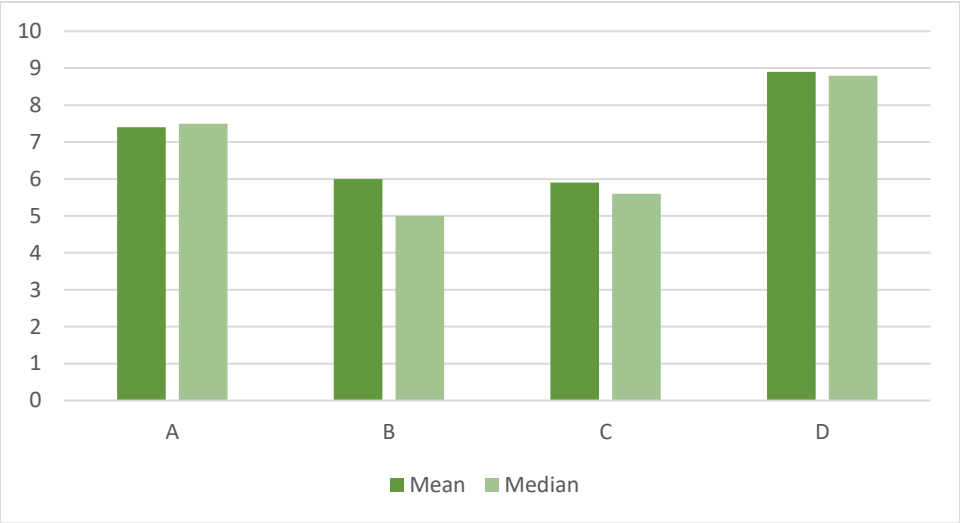
Table 8: Four-factor analysis of variance

ANOVA	Df	Sum of squares	Mean Squares	F	P-value
Being a farmer before training (v1)	1	0.9	0.9	0.3	0.553
Standard of living individual perception (v2)	4	12.1	3	1.2	0.355
Level of education before training (v3)	3	21.4	7.1	2.8	0.074
Farm school (v4)	3	35.7	11.9	4.7	**0.016***
Interaction variables 1*2	4	3.5	0.9	0.3	0.845
Interaction variables 1*3	1	1.1	1.1	0.5	0.513
Interaction variables 1*4	2	10.3	5.2	2	0.165
Interaction variables 2*3	6	35.9	6	2.3	0.165
Interaction variables 3*4	5	34.8	7	2.7	0.058
Residuals	16	40.9	2.6		

Legend: Df: Degrees of freedom; *: p-value <0.05

Management scores differ significantly by farm school ($p < 0.05$). As far as basic knowledge of management is concerned, graduates of farm school D had significantly higher scores (with a mean of 8.9), followed by farm school A (7.4) (*Figure 4*), while farm school D's scores are also significantly different from those of farm schools B (6) and C (5.9) (Tukey's tests, $p<0.05$). The level of education of former learners before training is also significant ($p <0.001$) in relation to the management score. Amortisation is the most difficult notion to acquire for farm schools A, B and C (respectively, 6.25, 5 and 5 on 10 for the third quartile). For each school, that means that 75% of former learners cannot give a correct example.

Figure 4: Management knowledge of former learners (score out of 10) by farm school, based on interviews



For all results in Section 3.2, the effect of the graduation year on scores was verified, and the time lag between graduation and different scores are not dependent. It appears that the time of the survey cannot explain a memory lost and lower scores. No statistical method could confirm that the scores were correlated or explained by this factor. We can thus be confident that the farm-to-farm differences reveal distinct performances regarding the acquisition of knowledge.

3.3 Professionalisation

All agroecology-oriented farm schools proposed courses to train learners to become professional in the agricultural sector and implement practices that are aligned with core agroecological principles. To verify the equivalence between the farm school's intentions and former learners' motivations, an open-ended question was asked: "What were your two main objectives on enrolling in the training?". Spontaneous answers were principally: (1) becoming a professional in agroecology (getting a job or building my own business), and (2) increasing my knowledge of agroecology. In each farm school, 60% or more of the former learners registered with a target objective of working in agroecology (*Table 9*).

Table 9: Motivation to become professional in agroecology, as cited by former learners in interviews

	Farm school				
	A	**B**	**C**	**D**	**Sample**
Cited	5	8	21	5	39
including women interviewed	*1*	*2*	*2*	*1*	*6*
Former learners interviewed	8	13	25	8	54
Percentage former learners who cited	**63%**	**62%**	**84%**	**63%**	**72%**

Farm school D, with its unique cohort that graduated in 2018, has the highest percentage of agricultural businesses established by former learners, followed by farm school C (*Table 10*). The farm school is a significant factor in business establishment results (p <0.01). Farm schools B and D are significantly different from the other farm schools (p<0.05, Tukey's test). It could be expected that owing land, or particularly land with water facilities, before training would facilitate business establishment. However, those variables are not linked to the former learners' businesses. It thus appears from our results that land

possession is independent and does not play a major role in explaining the rate of business establishment in comparison to the farm school where a given learner has been trained.

Table 10: Rate of business establishment by former learners of farm schools, based on interviews

	Farm school				
	A	**B**	**C**	**D**	**Sample**
Number of businesses established	1	1	12	5	19
including women interviewed	*0*	*0*	*3*	*2*	*5*
Number of former learners	8	13	25	8	54
Percentage of establishment	**13%**	**8%**	**48%**	**63%**	**35%**

According to Fisher's exact tests, the rate of business establishment is not dependent on the following variables: (1) being a farmer before training, (2) individual perception of his/her standard of living, (3) level of education before training. However, this same test confirms the dependence between the establishment rate and the farm school variable (p <0.01). This again is an important result since the above-mentioned significance of farm-to-farm differences in terms of knowledge acquisition does translate into distinct performance with respect to the number of businesses started.

Another significant feature explaining the rate of business establishment is the variable 'starter kit' (presented in *Table 1*). Receipt of a starter kit has a positive impact, as shown by Fisher's exact test indicating a dependence between the variables of business established and starter kit (p<0.01). In farm schools (A and C) where starter kits are distributed, many learners reported having launched their business with this help (10 out of 13, as it appears that some former learners who should have got a starter kit did not receive it). *Table 11* describes the help received through the kits.

Table 11: Starter kits received by former farm school learners by category

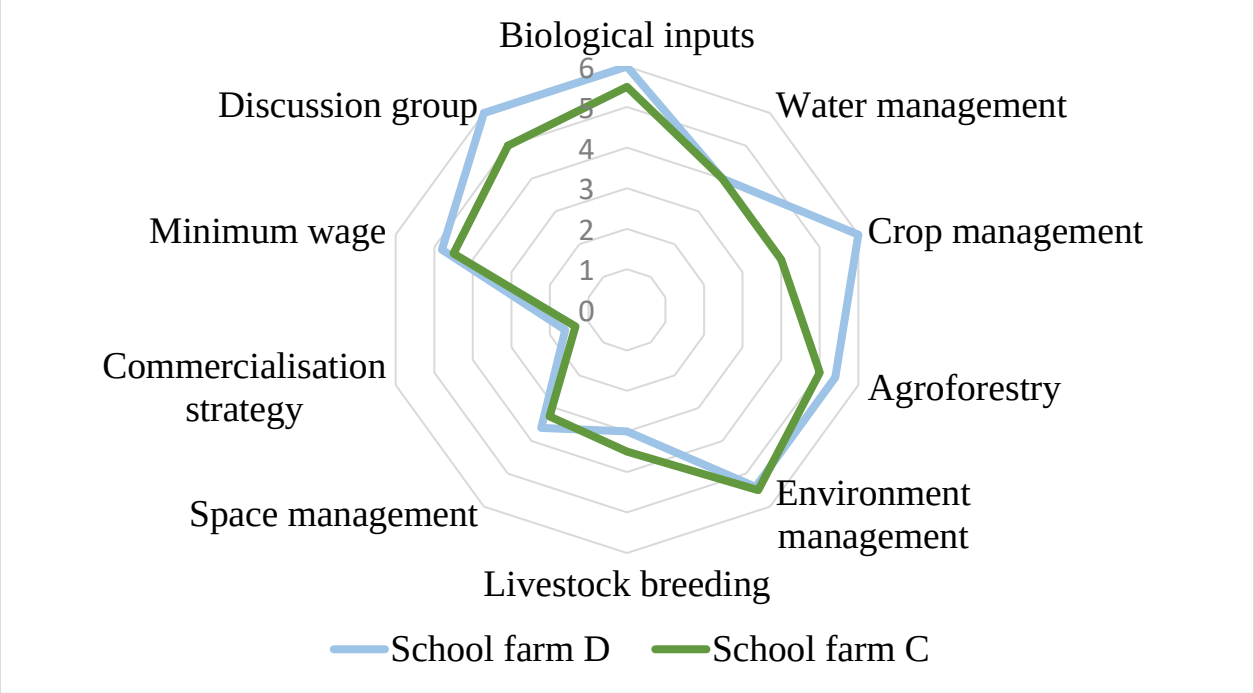
	Starter kits						
Former learners	Monetary	Land	Water well	Fencing	Seeds	Plants	Animals
1	x						
2		x	x		x		
3					x	x	
4					x	x	
5						x	x
6			x	x			
7		x	xx			x	x
8							xx
9			x	¼			
10		x	x			x	

Legend: ¼ - the former learner did not receive all the fencing promised
xx- the former learner specified than they received more than one.

Each business established does not entail the same degree of agroecology. To explore this aspect further, we focused the analysis on those schools that have more than one business established among the former learners surveyed (*Figure 5*). In farm schools C and D, the agroecology-type of commercialisation strategy does not appear well developed. Farm school D stands out for two indicators. First, former learners are more involved in discussion groups. Those groups allow participants to talk about agricultural practices and to

share tips and tricks. Former learners of farm school D are also more advanced in crop management, they all associated more than 2 varieties while rotating crops.

Figure 5: Multicriteria agroecology transition by farm school (mean)



As mentioned earlier, it could not be expected that all learners would start their own business. It thus is also interesting to look at the overall employment rate in agroecology after training. This rate is quite low since, all schools combined, only 4 former learners are employed in agroecology (7%). They mainly come from farm school C (3 former learners), and one is from farm school B. Among them, one is both a business owner and employed: he was hired by a farm school as a trainer and has also built a small business in agroecology.

4. Discussion

Starting from the documented challenges of agroecology education programmes (e.g., David and Bell, 2018; Francis et al., 2011; Schnyder, 2022), the aim of this paper is to assess the quality of the training proposed in different Senegalese farm schools and identify key characteristics that may explain varying performances. The results highlight that farm school D shows especially good performance in this respect. The training received within this farm school obtained high positive feedback from its former learners. More importantly, the analysis shows that this higher 'subjective' performance goes along with a better 'objective' performance regarding the acquisition of fundamental knowledge. Former learners from farm school D display the highest scores for both the level of agroecology comprehension and basic knowledge of management concepts.

Altogether, the proven higher quality of the training provided in farm school D most likely explains why it is also the farm school with the highest rate of post-training business establishment. Although this result should be viewed cautiously given the very small sub-samples involved, it follows from *Figure 5* that this

higher rate of established farmers also appears to be slightly more aligned with agroecology principles than seems to be the case for those having been trained in farm school C.

It must be recalled that this overall good performance of farm school D is valid for its one and only graduated cohort and should thus be verified in future years on a larger and pluri-annual sample. Still, this example suggests that a newcomer can have a real impact on the transition towards agroecology through the training it provides. In the case of farm school D, its above-average performances most likely relate to its partnership with institutions that have significant pedagogical experience (>8 years).

In the following subsections, we first discuss the distinct performances of the 4 studied farm schools (notably through using complementary field observations) and then we overview some of the limitations and suggest potential lines of further research.

4.1 Farm school quality and observations from exploratory visits and interviews

Our exploratory visits aimed to facilitate subsequent data collection but also allowed us to observe pedagogy and didactics. From these observations, it can be argued that the performances of farm school D are likely due to its highly qualified trainers (teachers at university or college or recognised actors from a peasant network) and their specific pedagogy. We attended lessons in which a trainer taught an active learning model and challenged their learners to think. Farm school D also had the most structured training and operated by course module. A trainer was thus present for a long period of time, allowing the learners to be more immersed in the module's topic. All these features could explain the high scores of former learners in knowledge acquisition as well as the higher rate of post-training business establishment.

Farm school A offers advanced technical training. During practical lessons, learners can use tools such as drip irrigation. This equipment is rarely used by farmers in Senegal because it is expensive. The starter kit provided did not allow graduates to duplicate this technology. However, former learners are invited to participate in a more active manner than in farm schools B and C. This participation could explain the relatively good scores of farm school A regarding knowledge acquisition.

Farm school B used more classical lesson structure (dictation, principally ex cathedra lessons, etc.) even though some of their learners have a low level of prior education. This could explain the high difference between mean and median scores for long-term fundamental knowledge acquisition. Moreover, this school is in an agricultural area where many farmers produce food due to the land's suitable qualities. The high food provision means that prices at local markets are some of the lowest in Senegal. This factor can explain the lowest rates of business establishment of this farm school. It is riskier for graduates from this area to build their own business because of low economic margins, and access to land is particularly difficult.

From our observations, farm school C appears very disorganized. Its director is seldom present at the farm school although the educational project is based on his experience. Trainers are former learners who have no degrees (pedagogic nor bioengineering). We went several times to attend lessons to find that they were cancelled that day. Organisational tensions are thus perceptible and seem to be inherent to the structure itself. These elements probably explain the lower scores achieved by former learners of this school in both agroecology and management (i.e., when compared to farm schools A and D). Nevertheless, the starter kits provided by several international NGOs and their partnership with local authorities seem to considerably help former learners in building their own business. Their large starter kit with significant elements appears to remove some obstacles. Coupled to the fact that they attract learners with good motivation (see *Table 9*), these elements explain the higher rate of agricultural business establishment compared to schools A and B.

4.2 Limitations and further research

This study can conclude that a majority of former learners of Senegalese farm schools report satisfaction with the training received. This probably reflects the fact that access to education is difficult in Senegal (Ndiaye, 2006). Beyond the reported general satisfaction, however, the feedback received from the former learners through our survey provided useful insights about each farm school and the quality of the training provided. After a time, former learners remember the most important aspects of the training. To get a sharper image, it could thus be interesting to interview learners just after graduation. Additionally, during interviews, the surveyors realised that some former learners felt grateful to the training centre. Some of them obtained financial support through a sponsor; for others, having received training itself is satisfactory (regardless of the level). A recognition bias can therefore be observed. This is why we insisted that the training could not be 100% perfect and that things could always get better. The open-ended question about potential improvements they would suggest helped to record a more critical view. Together with the statements from the closed-ended question, this provided deeper information about the practices that could be observed during our visit.

Training in farm schools is particularly useful because it helps to unlock educational barriers by bridging the gap between knowledge and action, which is identified as an essential skill for learning agroecology (Østergaard et al., 2010). The insights relative to the long-term acquisition of knowledge give us some clues about the observed differences between farm schools. Results show that developing a systemic and fundamental vision of agroecology is not an easy task, even for long-term training, superior or equal to 6 months. Francis et. (2008) also highlighted this difficulty. We found that 50% or more of former learners in each school did not develop a complex and systemic comprehension of agroecology. The number of agroecology practices cited by former learners are also low. It could be interesting to investigate whether this poor retention is due to the quality of training or to the difficulty of long-term memorisation. It is also possible that some former learners did not mention some agroecological practices upon being asked, because they consider them to be ‘common sense’ practices.

Farm school D has a better business establishment rate even though no starter kit is provided. We can therefore conclude that, although a starter kit is an important element (especially if it is financially or physically important), other factors can also favour business establishment. One hypothesis is that this farm school could have carefully selected trainees to recruit only ‘good’ ones. However, the director of the farm school explained that since it was the first cohort and they had no reputation, every learner who applied had been accepted. Another factor which could help to foster the business establishment rate is that the farm school has a connected network in agroecology which helps learners to find professional opportunities. The positive role of networks for sustaining the agroecological transition of farmers has also been highlighted by Schnyder (2022). Moreover, trainers from the peasant network are dealing daily with agroecology; they are thus considered to inspire the learners.

One complementary result that is worth underlining is that 40% of women and 14% of men (respectively, 2 out of 5 and 2 out of 14) created their own business, even if they reported not necessarily having this objective in mind when they enrolled in the training. Farm schools increased their confidence in their capability to manage a business. Agroecology businesses are an opportunity to generate income and to increase financial independence, especially for women. This echoes the findings of Sylvester and Little (2021), who found that there are multiple benefits to women’s involvement in agroecology, such as increased financial autonomy and better independence in terms of identity. The rate of business establishment is slightly higher for women than for men (45% vs. 33% respectively) among the surveyed former learners. In our sample, women who built businesses are all married and 80% have children (only 27% of men are married and have children). Entering an agroecological business allows women to manage household tasks and childcare. This insight highlights that it is important for farm schools to attract more

women. Seeking gender parity in the training could thus be a relevant objective. Future research on farm schools focusing on women would be a complementary angle to this present study.

In this paper, knowledge acquisition was assessed through appraising the long-term retention of learned elements. Although the level of education of former learners was controlled for and is not significant, it cannot be excluded that some of the knowledge measured had been acquired prior to the training. To this end, short-term appraisal is a complementary way of assessing the quality of training, as was done in De Graeuwe et al. (2020). However, this type of setting requires a two-instance measurement of knowledge – before and after the training – which was not feasible within the realm of this study. Ideally, the quality of training should thus be assessed through multiple surveys to measure both short-term and long-term knowledge acquisition.

A deeper analysis of the obstacles to business establishment would also be a relevant and complementary avenue of research. If former learners receive quality training, agroecology transition will still be hampered if only a limited number of them are eventually able to set up a business and thus apply the fundamental skills and knowledge learnt.

Further research at a larger scale is necessary to quantitatively assess whether reportedly important features that we underline (such as providing a starter kit after graduation) significantly contribute to an eventual increase in business establishment.

Finally, our analysis also shows that farm schools would benefit from working together, through building on their distinct merits. This collaboration could take many shapes, such as writing common course materials, making short pedagogical videos, or online courses to strengthen key fundamental knowledge, organising one-day farm school visits, proposing internships for learners in other farm schools, etc. Although it might be difficult for some farm schools to share their experience, this collaboration could have a legitimate place within the existing network 'DyTAES' (an acronym which, in English, would read 'Dynamics for an Agroecological Transition in Senegal'[5]).

5. Conclusion

Farm schools can be considered as a *transdisciplinary arena* that draw on *experiential learning*, two recognised key aspects when it comes to teaching agroecology (Francis et al., 2011). Training in farm schools a priori seems well-suited because it facilitates reconnecting knowledge and action, which is key for learning agroecology. The objective of this study was thus to assess the quality of farm schools in Senegal and potentially identify good practices to advocate in future similar educational initiatives in agroecology.

A first insight in this respect is that farm-to-farm differences in terms of training matter and lead to distinct performances. A second (and less trivial than it may appear) insight found is that the quality of the farm school training depends on the teaching method itself. From our comparative analysis, effective training meets several criteria. First, quality training involves trainers who are from the peasant 'world' or are professionals who specialise in the topic. Second, training which creates a network in agroecology is favourable to find agroecology careers for learners after graduation. However, such a follow-up plan requires a formal register of learners that is maintained over time. This network should include peasant and agricultural producers and municipalities to facilitate the administrative procedure for building businesses.

[5] This network brings together organisations of producers, consumers, rural women, NGOs, research institutions, civil society networks, a network of local elected officials, businesses, and others.

In parallel, if it is possible, farm schools should find sponsors to offer a starter kit to aid business establishment. Third, training that avoids resorting solely to dictation and provides course materials to support and facilitate participation, leads to better results. The quality of training rests on the active involvement of the learner. In line with a previous analysis, dealing with a 'serious game' about agroecology that underlined the importance of profound enjoyment and concentration (i.e., a good level of 'flow') for efficient learning (De Graeuwe et al., 2020), the present study shows that positively perceived training in subjective terms might also lead to objectively-measured good performance in knowledge acquisition. Active pedagogy is thus confirmed to be a key aspect for agroecology learning.

Beyond the fact that the former learners built their own businesses or were hired in agroecology, a farm school would have a reason to exist if graduates became change makers. By change maker, we mean that they manage to raise social awareness so that they can organise and implement concrete changes towards more sustainability. These changes can be observed in family surroundings, in the community and/or in the professional environment of former learners, and have the potential to help transition at different levels. Further research analysing this additional factor could be interesting to complete this study (see also Laforge and Levkoe (2018) who illuminate a similar research path beyond the sole impact of training on the establishment of businesses). Also, the rate of business establishment for the surveyed women (despite a greater absence of ex-ante motivation) suggests that farm schools should seek gender parity.

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Declaration of interest statement

No potential conflicts of interest were reported by the authors.

Ethics approvals

Ethics Committee for the Humanities and Social Sciences of University of Liège (Belgium) approved the scientific process (Reference: "2022-04").

References

Almeida, C. A. F. de, Reis,Pedro Manuel Nogueira, Batista, Rui Pedro Manita d'Antas Marques, Gomes, Sandra Isabel Correia, & Antunes, Joaquim Gonçalves. (2017). A Pedagogical, Educational and Biological Farm as a New Line of Profitable Business. *International Journal of Contemporary Research and Review*. https://doi.org/10.15520/ijcrr/2017/8/12/383

Blair, S. A., Edwards, G., Yu, K., Jovel, E., Powell, L. J., Renwick, K., & Conklin, A. I. (2023). What Is a School Farm? Results of a Scoping Review. *International Journal of Environmental Research and Public Health*, *20*(7), 5332. https://doi.org/10.3390/ijerph20075332

Boeraeve, F., Dendoncker, N., Cornélis, J.-T., Degrune, F., & Dufrêne, M. (2020). Contribution of agroecological farming systems to the delivery of ecosystem services. *Journal of Environmental Management, 260*. https://doi.org/10.1016/j.jenvman.2019.109576

Boillat, S., Belmin, R., & Bottazzi, P. (2022). The agroecological transition in Senegal : Transnational links and uneven empowerment. *Agriculture and Human Values*, *39*, 281-300. https://doi.org/10.1007/s10460-021-10247-5

Bottazzi, P., & Boillat, S. (2021). Political Agroecology in Senegal : Historicity and Repertoires of Collective Actions of an Emerging Social Movement. *Sustainability, 13*, 6352. https://doi.org/10.3390/su13116352

Chowdhury, A. H., Van Mele, P., & Hauser, M. (2011). Contribution of Farmer-to-Farmer Video to Capital Assets Building : Evidence from Bangladesh. *Journal of Sustainable Agriculture*, *35*(4), 408-435. https://doi.org/10.1080/10440046.2011.562059

Christie, P., & Gaganakis, M. (1989). Farm Schools in South Africa : The Face of Rural Apartheid. *Comparative Education Review*, *33*(1), 77-92. https://doi.org/10.1086/446813

Darolt, M., Anglade, J., Moity-Maïzi, P., Lamine, C., Rengard, F., Iceri, V., Genay, A., & Celis, C. (2021). Teaching, training and learning for the agroecological transition : A French-Brazilian perspective. In *Agroecological transitions, between determinist and open-ended visions.* (Peter Lang Verlag). https://www.peterlang.com/document/1114400

David, C., & Bell, M. M. (2018). New challenges for education in agroecology. *Agroecology and Sustainable Food Systems*, *42*(6), 612-619. https://doi.org/10.1080/21683565.2018.1426670

De Graeuwe, M., Jouan, J., Carof, M., Baccar, R., Bareille, N., Bastian, S., Brogna, D., Burgio, G., Couvreur, S., Cupiał, M., Dumont, B., Jacquot, A.-L., Magagnoli, S., Makulska, J., Maréchal, K., Pérès, G., Ridier, A., Salou, T., Tombarkiewicz, B., … Godinot, O. (2020). Learning Interdisciplinarity and Systems Approaches in Agroecology : Experience with the Serious Game SEGAE. *Sustainability*, *12*, 2-15. https://doi.org/10.3390/su12114351

Eeswaran, R., Nejadhashemi, A. P., Faye, A., Min, D., Prasad, P. V. V., & Ciampitti, I. A. (2022). Current and Future Challenges and Opportunities for Livestock Farming in West Africa : Perspectives from the Case of Senegal. *Agronomy*, *12*, 1818. https://doi.org/10.3390/agronomy12081818

Fernández González, C., Ollivier, G., & Bellon, S. (2021). Transdisciplinarity in agroecology : Practices and perspectives in Europe. *Agroecology and Sustainable Food Systems*, *45*(4), 523-550. https://doi.org/10.1080/21683565.2020.1842285

Francis, C. A., Jordan, N., Porter, P., Breland, T. A., Lieblein, G., Salomonsson, L., Sriskandarajah, N., Wiedenhoeft, M., DeHaan, R., Braden, I., & Langer, V. (2011). Innovative Education in Agroecology : Experiential Learning for a Sustainable Agriculture. *Critical Reviews in Plant Sciences*, *30*(1-2), 226-237. https://doi.org/10.1080/07352689.2011.554497

Francis, C. A., Lieblein, G., Breland, T. A., Salomonsson, L., Geber, U., Sriskandarajah, N., & Langer, V. (2008). Transdisciplinary Research for a Sustainable Agriculture and Food Sector. *Agronomy Journal*, *100*(3), 771. https://doi.org/10.2134/agronj2007.0073

Gambrill, S. J. (2015). *Redesigning & rethinking montessori adolescent education : A hybrid model for the 21st Century* [University of Wollongong]. https://ro.uow.edu.au/theses/4708

Garbach, K., Milder, J. C., DeClerk, F. A. J., de Wite, M. M., Driscoll, L., & Gemmill-Herren, Barbara. (2017). Examining multi-functionality for crop yield and ecosystem services in five systems of agroecological intensification. *International Journal of Agricultural Sustainability*, *15*(1), 11-28.

Garnett, T., Appleby, M. C., Balmford, A., Bateman, I. J., Benton, T. G., Bloomer, P., Burlingame, B., Dawkins, M., Dolan, L., Fraser, D., Herrero, M., Hoffmann, I., Smith, P., Thornton, P. K., Toulmin, C., Vermeulen, S. J., & Godfray, H. C. J. (2013). Sustainable Intensification in Agriculture : Premises and Policies. *Science*, *341*(6141), 33-34. https://doi.org/10.1126/science.1234485

Garvie, R. J. (1957). A school farm. *Childhood Education*, *33*(396-400). https://doi.org/10.1080/00094056.1957.10729638

Gordon, L. J., Bignet, V., Crona, B., Henriksson, P. J. G., Van Holt, T., Jonell, M., Lindahl, T., Troell, M., Barthel, S., Deutsch, L., Folke, C., Haider, L. J., Rockström, J., & Queiroz, C. (2017). Rewiring

food systems to enhance human health and biosphere stewardship. *Environmental Research Letters*, *12*(10), 100201. https://doi.org/10.1088/1748-9326/aa81dc

Holt-Giménez, E. (2006). *Campesino a campesino : Voices from Latin America's farmer to farmer movement for sustainable agriculture*. Food first books.

IPES-FOOD. (2016). *From uniformity to diversity : A paradigm shift from industrial agriculture to diversifed agroecological systems*. http://www.ipes-food.org

IPES-FOOD. (2018). *Breaking away from industrial food and farming systems : Seven case studies of agroecological transition.* http://www.ipes-food.org

Kansanga, M. M., Bezner Kerr, R., Lupafya, E., Dakishoni, L., & Luginaah, I. (2021). Does participatory farmer-to-farmer training improve the adoption of sustainable land management practices? *Land Use Policy*, *108*, 105477. https://doi.org/10.1016/j.landusepol.2021.105477

Konoshima, H. (1995). Participation of school children in agricultural activities at school farms in Shiga prefecture. *Acta Horticulturae*, *391*, 217-222. https://doi.org/10.17660/ActaHortic.1995.391.21

Kpienbaareh, D., Bezner Kerr, R., Luginaah, I., Wang, J., Lupafya, E., Dakishoni, L., & Shumba, L. (2020). Spatial and Ecological Farmer Knowledge and Decision-Making about Ecosystem Services and Biodiversity. *Land*, *9*(10), 356. https://doi.org/10.3390/land9100356

Laforge, J. M. L., & Levkoe, C. Z. (2018). Seeding agroecology through new farmer training in Canada : Knowledge, practice, and relational identities. *Local Environment*, *23*(10), 991-1007. https://doi.org/10.1080/13549839.2018.1515901

Laske, E., & Michel, S. (2022). What contribution of agroecology to job creation in sub-Saharan Africa? The case of horticulture in the Niayes, *Senegal*. *Agroecology and Sustainable Food Systems*, *46*(9), 1360-1385. https://doi.org/10.1080/21683565.2022.2107595

Leippert, F., Darmaun, M., Bernoux, M., & Mpheshea, M. (2020). *The potential of agroecology to build climate-resilient livelihoods and food systems*. FAO and Biovision. https://doi.org/10.4060/cb0438en

Leis, A., Whittington, M. S., Bennett, M., & Kleinhenz, M. (2011). Student Farms at United States Colleges and Universities : Insights Gained from a Survey of the Farm Managers. *NACTA Journal*, *55*(1), 9-17.

Lilleker, D. G., & Negrine, R. (2002). Professionalization : Of What? Since When? By Whom? *Harvard International Journal of Press/Politics*, *7*(4), 98-103. https://doi.org/10.1177/108118002236354

Louah, L., Visser, M., Blaimont, A., & de Cannière, C. (2017). Barriers to the development of temperate agroforestry as an example of agroecological innovation : Mainly a matter of cognitive lock-in? *Land Use Policy*, *67*, 86-97. https://doi.org/10.1016/j.landusepol.2017.05.001

Maertens, M. (2009). Horticulture exports, agro-industrialization, and farm-nonfarm linkages with the smallholder farm sector : Evidence from Senegal. *Agricultural Economics*, *40(2)*, 219-229. https://doi.org/10.1111/j.1574-0862.2009.00371.x

Mariyono, J., Luther, G. C., Bhattarai, M., Ferizal, M., Jaya, R., & Fitriana, N. (2013). Farmer Field Schools on Chili Peppers in Aceh, Indonesia : Activities and Impacts. *Agroecology and Sustainable Food Systems*, *37*(9), 1063-1077. https://doi.org/10.1080/21683565.2013.819827

Meyer, J. H. F., & Land, R. (2003). Threshold Concepts and Troublesome Knowledge : Linkages to ways of thinking and practising within the disciplines. In *Improving Student Learning – Ten Years On* (C.Rust). Oxford Centre for Staff and Learning Development (OCSLD).

Monaghan, K., Swisher, M., Koenig, R. L., & Rodriguez, J. C. (2017). Education for sustainable agriculture : A typology of the role of teaching farms in achieving learning goals and objectives. *Environmental Education Research*, *23*(6), 749-772. https://doi.org/10.1080/13504622.2015.1091877

Moore, S. S. (2017). Organize or die : Farm school pedagogy and the political ecology of the agroecological transition in rural Haiti. *The Journal of Environmental Education*, *48*(4), 248-259. https://doi.org/10.1080/00958964.2017.1336977

Ndiaye, M. (2006). Partnerships In The Education System Of Senegal. *Prospects*, *36*(2), 223-243. https://doi.org/10.1007/s11125-006-0006-3

Nicot, R., Bellon, S., Loconto, A., & Ollivier, G. (2018). The European networks of research, education and training stakeholders in agroecology. *Open Agriculture*, *3*, 537-552. https://doi.org/10.1515/opag-2018-0058

Østergaard, E., Lieblein, G., Breland, T. A., & Francis, C. (2010). Students Learning Agroecology : Phenomenon-Based Education for Responsible Action. *Journal of Agricultural Education and Extension*, *16*(1), 23-37. https://doi.org/10.1080/13892240903533053

Parr, D. M., Trexler, C. J., Khanna, N. R., & Battisti, B. T. (2007). Designing sustainable agriculture education : Academics' suggestions for an undergraduate curriculum at a land grant university. *Agriculture and Human Values*, *24*, 523-533.

Phelps, E. A. (2004). Human emotion and memory : Interactions of the amygdala and hippocampal complex. *Current Opinion in Neurobiology*, *14*, 198-202. https://doi.org/10.1016/j.conb.2004.03.015

Pillay, N. (Éd.). (2022). *Exploring the Challenges and Opportunities of Farm School Infrastructure in Kwa-Zulu Natal, South Africa*. CORP - Competence Center of Urban and Regional Planning = Kompetenzzentrum für Stadtplanung und Regionalentwicklung.

R Core Team. (2021). *R: A Language and Environment for Statistical Computing*. *R Foundation for Statistical Computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Rockström, J., Williams, J., Daily, G., Noble, A., Matthews, N., Gordon, L., Wetterstrand, H., DeClerck, F., Shah, M., Steduto, P., de Fraiture, C., Hatibu, N., Unver, O., Bird, J., Sibanda, L., & Smith, J. (2017). Sustainable intensification of agriculture for human prosperity and global sustainability. *Ambio*, *46*, 4-17. https://doi.org/10.1007/s13280-016-0793-6

Rosset, P. (2009). Agrofuels, Food Sovereignty, and the Contemporary Food Crisis. *Bulletin of Science, Technology & Society*, *29*(3), 189-193. https://doi.org/10.1177/0270467609333733

Schnyder, M. (2022). Examining value-based framing of agroecology by experts in training centers in Belgium, France, and Spain. *Agroecology and Sustainable Food Systems*, *46*(1), 82-107. https://doi.org/10.1080/21683565.2021.1935395

Singer, E., & Couper, M. P. (2017). Some Methodological Uses of Responses to Open Questions and Other Verbatim Comments in Quantitative Surveys. *Methods, Data, Analyses : A Journal for Quantitative Methods and Survey Methodology*, *11*(2), 115-134. https://doi.org/10.12758/MDA.2017.01

Sutherland, L.-A., Burton, R. J. F., Ingram, J., Blackstock, K., Slee, B., & Gotts, N. (2012). Triggering change : Towards a conceptualisation of major change processes in farm decision-making. *Journal of Environmental Management*, *104*, 142-151. https://doi.org/10.1016/j.jenvman.2012.03.013

Sylvester, O., & Little, M. (2021). " *I came all this way to receive training, am I really going to be taught by a woman* ?" Factors that support and hinder women's participation in agroecology in Costa Rica. *Agroecology and Sustainable Food Systems*, *45*(7), 957-980. https://doi.org/10.1080/21683565.2020.1811830

Tilman, D., Cassman, K. G., Matson, P. A., Naylor, R., & Polasky, S. (2002). Agricultural sustainability and intensive production practices. *Nature*, *418*, 671-677. https://doi.org/10.1038/nature01014

Twenter, J. P., & Edwards, M. C. (2017). Facilities in School-Based, Agricultural Education (SBAE) : A Historical Inquiry. *Journal of Agricultural Education*, *58*(3), 275-292. https://doi.org/10.5032/jae.2017.03275

Tyng, C. M., Amin, H. U., Saad, M. N. M., & Malik, A. S. (2017). The Influences of Emotion on Learning and Memory. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.01454

van der Ploeg, J. D., Barjolle, D., Bruil, J., Brunori, G., Costa Madureira, L. M., Dessein, J., Drąg, Z., Fink-Kessler, A., Gasselin, P., Gonzalez de Molina, M., Gorlach, K., Jürgens, K., Kinsella, J., Kirwan, J., Knickel, K., Lucas, V., Marsden, T., Maye, D., Migliorini, P., … Wezel, A. (2019). The economic potential of agroecology : Empirical evidence from Europe. *Journal of Rural Studies*, *71*, 46-61. https://doi.org/10.1016/j.jrurstud.2019.09.003

Vanloqueren, G., & Baret, P. V. (2009). How agricultural research systems shape a technological regime that develops genetic engineering but locks out agroecological innovations. *Research Policy*, *38*(6), 971-983. https://doi.org/10.1016/j.respol.2009.02.008

Voss, R. C. (2022). On- and non-farm adaptation in Senegal : Understanding differentiation and drivers of farmer strategies. *Climate and Development*, *14*(1), 52-66. https://doi.org/10.1080/17565529.2021.1881424

Wezel, A., Casagrande, M., Celette, F., Vian, J.-F., Ferrer, A., & Peigné, J. (2014). Agroecological practices for sustainable agriculture. A review. *Agronomy for Sustainable Development*, *34*, 1-20. https://doi.org/10.1007/s13593-013-0180-7

Wezel, A., Goette, J., Lagneaux, E., Passuello, G., Reisman, E., & Rodier, C. (2018). Agroecology in Europe : Research, Education, Collective Action Networks, and Alternative Food Systems. *Sustainability*, *10*, 1-18. https://doi.org/doi:10.3390/su10041214

Wood, E. C., Tappan, G. G., & Hadj, A. (2004). Understanding the drivers of agricultural land use change in south-central Senegal. *Journal of Arid Environments*, *59*(3), 565-582. https://doi.org/10.1016/j.jaridenv.2004.03.022

Appendices

Tables

Figures