University of Sopron

Alexandre Lamfalussy Faculty of Economics

The role of sustainability transition in strengthening agricultural development resilience to water scarcity in Morocco

Theses of the doctoral (PhD) dissertation

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1. Introduction

2.1. Background of the research and actuality

In Morocco, the sixth-largest African economy by GDP, agriculture is still considered the backbone of the country's economy. Socially, agriculture is still a prominent employer nationally, especially in rural areas where the rural population depends on this activity for their livelihood, which demonstrates the sector's relevance to rural development. However, as the increase in drought frequency affects the sector's viability, its adaptability and sustainability are becoming paramount.

2.2. Objectives

The thesis examines the relevance of the transition to sustainability to enhance agricultural development resiliency regarding water shortages, with the focus on the available strategies, methods, and practices, which could further enrich and inform the current governmental and scientific discourse. To achieve the research objectives, a multi-method approach was applied. Based on the literature review analysis and the in-depth interviews conducted, hypotheses were developed. Using quantitative methods, the dataset generated from the questionnaire results was analyzed, and the hypotheses were tested.

2.3. Hypotheses

The following hypotheses were formulated for this study:

$H1_1$: The extent to which farmers' inclination for sustainable practices adoption is influenced by the degree of the perceived climate change's impact on the farms.

It is evident from the literature analysis and experts' opinions that climate change is a significant factor influencing farmers' decisions to adopt sustainable practices. It is therefore important to explore this relationship. The study examined whether there is an association between the number of consequences of climate change observed and dealt with by farmers and their decision to adopt sustainable practices, with climate change as a key influencing factor. To rephrase, it is an attempt to assess if the level of awareness regarding climate change impacts in their work is associated with their level of inclination toward transitioning to sustainable practices, with climate change as the main driver. Therefore, the sample was examined for this association.

$H2_1$: The extent to which farmers' inclination for sustainable practices adoption is influenced by the number of practices already applied to conserve water on the farms.

The second hypothesis examines whether there is an association between the number of already applied practices for water conservation efficiency purposes and the inclination for sustainable practices adoption, with the improvement of water use efficiency as a key influencing factor. This is to explore the extent of the farmers' existing commitment to water conservation (through the number of applied practices for water conservation), acting as positive

reinforcement and a driver for adopting new, more comprehensive sustainable practices, to improve water use efficiency. This is also based on the potential perception gap between adopters and non-adopters of conservation methods (McCollum et al., 2022).

> *$H3_1$: The extent to which farmers' inclination for sustainable practices adoption is influenced by the support opportunities offered by the government for the farms.*

The third hypothesis aims to examine whether there is an association between the farm previously benefited from government support and the farmer's inclination to adopt sustainable practices, with access to the government's financial support programs as a key influencing factor. The inclusion of this hypothesis stems from the importance given to support as an approach to drive favorable change, deduced from the in-depth interviews conducted and the literature analyzed.

> *$H4_1$: The number of practices already applied to conserve water on the farms is influenced by the level of education attained by the farmers.*

The last hypothesis aims to examine whether there is an association between the number of practices already applied to conserve water on the farms (for water efficiency) and the farmers' level of education. The inclusion of this hypothesis is because education may encourage farmers to adopt a more proactive approach to farm management, which involves seeking and implementing new solutions instead of relying only on traditional methods. Also, educated farmers may have

better access to information and be more inclined to seek out information on new technologies and conservation methods.

2. Research questions and methods

2.4. Research questions

The main research question that the dissertation aims to address is the following: *How can the transition to sustainable agriculture be effectively fostered to enhance agricultural development resilience in Morocco amidst persistent water shortages?* It is translated into four sub-questions:

Sub-question 1: What is Morocco's past and current agricultural development status concerning the sustainability aspects of this sector and water resources?

Based on the literature review, the results of the sub-question helped and provided the basis for the subsequent research sub-questions and contextualized the findings.

Sub-question 2: How do farmers view sustainable agriculture solutions, and what are the perceived challenges associated with this transition? How do farmers cope with and adapt to water shortages?

The second sub-question was predominantly examined through a survey conducted with farmers from the leading agricultural region by size of agricultural area (Marrakesh-Safi region), which covers 38,445 km² and comprises 2,055,977 ha of agricultural land (HCPM, 2025c; MAFRD, 2023).

Sub-question 3: How do institutions view and contribute to Morocco's transition to sustainable agriculture? What are the perceived hindrances to this transition?

The third sub-question was mainly addressed through in-depth interviews with specialists from different organizations, including governmental and state institutions, from the same region where the survey was conducted.

Sub-question 4: Are there any appropriate sustainable strategies, methods, and practices to enhance the resilience of agricultural development facing water shortages in Morocco?

The last sub-question was tackled by combining insights from the previous results of the dissertation's sub-questions. In addition, an extensive literature review analysis was conducted to find, suggest, or build any appropriate sustainable concept, methods, and practices to enhance the resilience of agriculture development facing water shortages in Morocco.

2.5. Methodological approach

A multi-stage empirical procedure has been employed to fully address both the main research question and the sub-questions.

The following Figure 1 provides a methodological overview and a presentation of the dissertation's structure for better clarity.

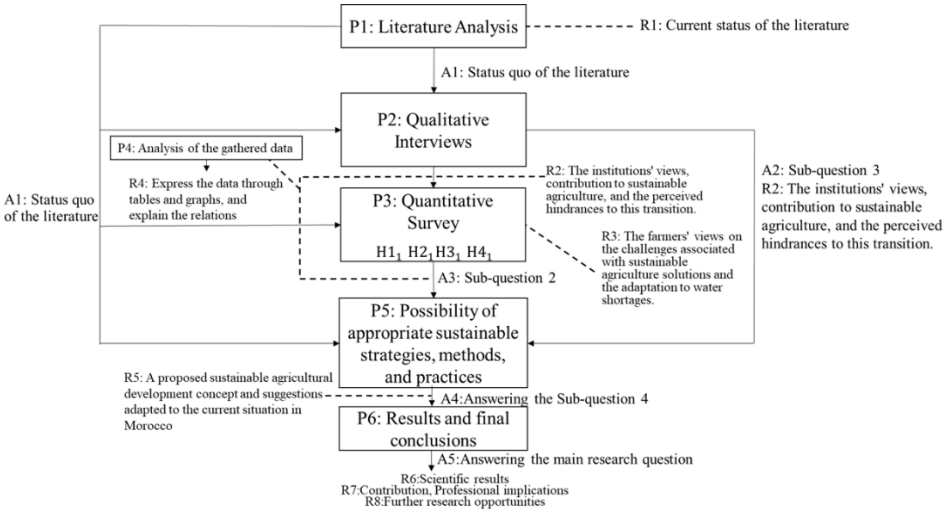

Figure: Thesis' methodology flow chart

Source: author's own research, 2024

Due to the nature of the research study, the research questions, the hypotheses formulated, and the data obtained from the completed questionnaire, the professors consulted, suggested and assisted in the application of the following statistical analysis methods:

Descriptive analysis, applied to summarize and describe the main characteristics of the dataset. This entails the process of organizing, analyzing, and presenting data in a meaningful manner, which is intended to uncover trends, patterns, and characteristics. Combined with graphical analysis, they form the foundation for virtually all quantitative data analysis.

The chi-square test of independence is applied to establish if there is a statistically significant association between two categorical variables.

Goodman and Kruskal's gamma is employed to determine the association between two ordinal variables and evaluate the strength and direction of the relationship.

The data analysis process relied on the following software programs: the data extracted from the conducted questionnaire were analyzed using SPSS software (version 20). For the initial coding of the in-text analysis of the qualitative interviews, it was performed with the assistance of NVivo software (release 1.7.1, October 2022).

3. The results

The main results from the qualitative interviews, incorporating literature analysis, were compactly summarized as follows:

Result 1:

Policy making must incorporate an effective participatory approach, where the government consistently takes into account farmers' experiences in the field. There is a participatory approach included in the agricultural development strategies. However, based on the interviews, it is not effective and does not reach the goals for which it was created, thus creating a gap between the alignment of the government’s goals and the farmers' interests. An effective participatory approach will contribute to the efficiency of the agricultural development projects in reaching their goals.

Result 2:

The agricultural export policy must align with the national interests of supporting the transition to a sustainable agricultural development strategy. Because the government still places importance on water-

consuming crops to the detriment of the available water resources for export interests, since the agriculture sector is considered crucial to support balancing the trade balance of the country.

Result 3:

Assuring food security even if it is considered one of the top priorities and concerns for the government, should not be to the detriment of a long-term adaptation of the agricultural sector and its resiliency to climate variability, drought, and with regard to water resources availability (because food security was a concern, the government fostered the retransition of the agricultural lands to cereal, from the initial plan to support the transition to more resilient crops)(Zarouali, 2025).

Table: Summary of hypotheses assessed

Hypotheses	Relationship	Results
H1	The extent to which farmers' inclination for sustainable practices adoption is influenced by the degree of the perceived climate change's impact on the farms.	Supported
H2	The extent to which farmers' inclination for sustainable practices adoption is influenced by the number of practices already applied to conserve water on the farms.	Supported
H3	The extent to which farmers' inclination for sustainable practices adoption is influenced by the support opportunities offered by the government for the farms.	Not supported
H4	The number of practices already applied to conserve water on the farms is	Supported

	influenced by the level of education attained by the farmers.	

Source: Author's own research and analysis, 2025

The main results from the quantitative survey, incorporating literature analysis and the in-depth interviews' findings, were compactly summarized as follows:

Result 1:

The analysis of the responses demonstrates that the farmers are inclined to cooperate in adopting and transitioning to sustainable agriculture practices if it is intended to help tackle the prevalence of drought challenges and adapt to climate change. Additionally, it can be stated that the prevailing adaptive strategy among farmers facing drought and general water shortages is the increase in water abstraction. At the same time, this trend is unfortunately coupled with less efficient irrigation practices. A critical barrier is the underestimation of the farmers' training, as well as the insufficient consideration of water distribution management and the adoption of more efficient irrigation practices that would enhance their long-term agricultural resilience regarding the issue.

The results appear to be significantly influenced by climate variability and the inadequate distribution of precipitation in the last five years, including a strong positive association between the number of observed climate change consequences dealt with on the farms and how strongly climate change as a factor is influencing the decision to adopt sustainable agriculture practices. Additionally, a moderate positive association was identified between how many of the practices

already applied on the farm for water conservation and the decision to adopt sustainable agriculture practices, with the improvement of water use efficiency as a key influencing factor. As a result, the extent of the farmers' existing commitment to water conservation may be acting as a positive reinforcement, which could be due to a perception gap between adopters and non-adopters of water conservation methods (McCollum et al., 2022).

Result 2:

Out of the mentioned potential challenges to implementing sustainable agriculture practices, which were based on the in-depth interviews conducted and the literature analyzed. Besides the lack of infrastructure and fragmentation of the farm, the costs of the transition constitute the common denominator across the sub-regions where the survey was conducted. Notably, the availability of support, including financial support from the government or other proposed organizations, does not necessarily influence the decision for sustainable agriculture practices adoption.

Additionally, it is safe to assume that the government's financial support programs are not necessarily a decisive factor in the decision to adopt sustainable agricultural practices, nor are they associated with whether the farm previously benefited from any governmental support.

While the data indicate that farmers have a common view that financial resources can instigate change, it appears that there is a lack of trust in the efficacy of subsidies. This may reflect not only poor

access but also signal a plausible lack of trust among farmers in the institutions and subsidy mechanisms, given the previous findings imply a certain degree of common marginalization sentiment and the need for an effective participatory approach. And could explain the disparity between farmers' need for financial resources and their inability or reluctance to access the existing subsidy mechanisms.

Result 3:

Based on the results, there is a moderate positive association between the level of education attained by farmers and the number of practices already applied to conserve water on the farms (for water efficiency). Accordingly, this implies that improving educational attainment and reducing illiteracy among farmers and rural communities will not only be favorable for development but also will likely lead to increased adoption of efficient water conservation methods and practices in the face of water shortages. This entails that farmers will likely seek and implement new solutions instead of relying only on traditional methods, since they may have better access to information and be more inclined to seek out information on new technologies and conservation methods.

4. The new scientific results

The scientific outcomes were organized in the following three parts.

Scientific outcomes 1:

Based on the results from the literature review and the qualitative part of the research, the following findings constitute the first outcomes of the study:

- Policy making must incorporate an effective participatory approach, where the government consistently takes into account farmers' experiences in the field. An effective participatory approach will contribute to the efficiency of the agricultural development projects in reaching their goals and closing the gap between the government’s goals and the farmers' interests.
- The agricultural export policy must align with the national interests of supporting the transition to a sustainable agricultural development strategy.
- Assuring food security, even if it is considered one of the top priorities and concerns for the government, should not be to the detriment of a long-term adaptation of the agricultural sector and its resiliency to climate variability, drought, and with regard to water resources availability.

Scientific outcomes 2:

Based on the previous findings and the quantitative part of the research, the following constitute the second outcomes of the study:

- Drought, as a key issue, is substantiated not only by the reviewed literature and the insights of the interviewees from different relevant organizations, including governmental ones, but also by farmers who are directly confronted with the situation.
- Farmers are inclined to cooperate in adopting and transitioning to sustainable agriculture practices if it is

intended to help tackle the prevalence of drought challenges and adapt to climate change.

- The prevailing adaptive strategy among farmers facing drought and general water shortages is the increase in water abstraction. At the same time, this trend is unfortunately coupled with less efficient irrigation practices. A critical barrier is the underestimation of the farmers' training, as well as the insufficient consideration of water distribution management and the adoption of more efficient irrigation practices that would enhance their long-term agricultural resilience regarding the issue.
- The results appear to be significantly influenced by climate variability and the inadequate distribution of precipitation in the last five years, including a strong positive association between the number of observed climate change consequences dealt with on the farms and how strongly climate change as a factor is influencing the decision to adopt sustainable agriculture practices.
- A moderate positive association was identified between how many of the practices already applied on the farm for water conservation and the decision to adopt sustainable agriculture practices, with the improvement of water use efficiency as a key influencing factor. As a result, the extent of the farmers' existing commitment to water conservation may be acting as a positive reinforcement, which could be due to a perception

gap between adopters and non-adopters of water conservation methods.

- Besides the lack of infrastructure and fragmentation of the farm, the costs of the transition constitute the common denominator challenge to implementing sustainable agriculture practices perceived by farmers.
- The availability of support from the government or other proposed organizations does not necessarily influence the decision to adopt sustainable agriculture practices. Similarly, it is safe to assume that the government's financial support programs are not necessarily a decisive factor in the decision to adopt sustainable agricultural practices, nor are they associated with whether the farm previously benefited from any governmental support.
- While the data indicate that farmers have a common view that financial resources can instigate change, it appears that there is a lack of trust in the efficacy of subsidies. This may reflect not only poor access but also signal a plausible lack of trust among farmers in the institutions and subsidy mechanisms, given the previous findings imply a certain degree of common marginalization sentiment and the need for an effective participatory approach. And could explain the disparity between farmers' need for financial resources and their inability or reluctance to access the existing subsidy mechanisms.

- Improving educational attainment and reducing illiteracy among farmers and rural communities will not only be favorable for development but also will likely lead to increased adoption of efficient water conservation methods and practices in the face of water shortages. This entails that farmers will likely seek and implement new solutions instead of relying only on traditional methods, since they may have better access to information and be more inclined to seek out information on new technologies and conservation methods.

Scientific outcomes 3:

The last part consists of the provided suggestions, which were consolidated under the following four primary areas: Fostering the deployment of drought-resilient crop varieties; improving the effectiveness of the participatory approach and targeted farmer advisory services; improving farmers' education and technology adoption; and ensuring the alignment of food security and the agricultural export policy with the sustainability and adaptation objectives of the agriculture sector.

The research also proposed the following concept, which is an attempt to incorporate the findings into a more concise, practical presentation, with the focus on fostering the adaptability and sustainability of agriculture and strengthening the government-farmer cooperation to increase the sector’s resilience regarding the persistent water shortages.

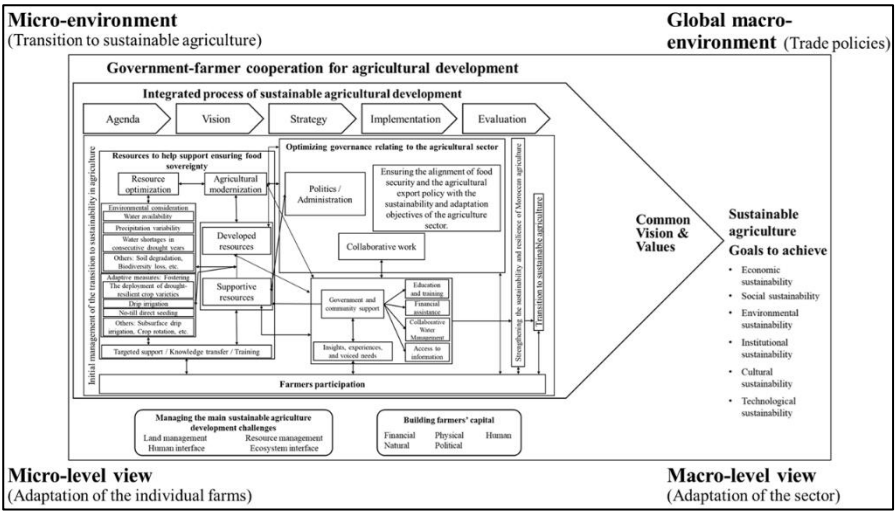

Figure: A balanced sustainable agricultural development concept focused on strengthening the government-farmer cooperation and the sector's resiliency regarding water shortages through fostering the transition to sustainable methods and practices

Source: Please find the large version of the concept with all sources in the dissertation on page 132.

The study also discussed other suggestions relating to sustainable agricultural methods and practices suitable for the Moroccan context; the potential role of cooperatives in fostering the active participation of farmers in extension services and strengthening the government-farmer cooperation; the relevance of the incorporation of more collaboration elements into government-farmer cooperation; and the potential of further cooperation opportunities with Israel to advance the modernization of the sector, agricultural knowledge, and

technology transfer, with the purpose of transitioning to more adapted and sustainable agriculture facing the persistent water shortages.

5. -Conclusions and recommendations.

The results indicate that drought and, particularly, water shortages constitute a major challenge and threat to agricultural development for this decade and the following. Similarly, the drought, as a key issue, is substantiated not only by the reviewed literature and the insights of the interviewees from the in-depth interviews conducted, but also by farmers who are directly confronted with the situation based on the survey findings. The results also indicate that there is a potential distrust and common marginalization sentiment among farmers toward organizations, particularly governmental ones. The illiteracy, low level of education, and low technology adoption also constitute important challenges for the sector's development and its transition to sustainable practices. Additionally, the results imply that improving educational attainment and reducing illiteracy among farmers and rural communities will not only be favorable for development but also will likely lead to increased adoption of efficient water conservation methods and practices in the face of water shortages. It is also evident that more effort needs to be made to consider farmers' experience and voiced needs in both research and decision-making, and improving the effectiveness of the participatory approach and targeted farmer advisory services was suggested to increase the efficiency of the already implemented efforts. Furthermore, the results indicate the need for the alignment of food security policies and the transition to

sustainable agriculture, which could be based on the principles of Sustainable Food and Agriculture (SFA) established by the Food and Agriculture Organization (FAO), and the alignment of the agricultural export policies with the national interests of supporting this transition. The findings also revealed that farmers are inclined to cooperate in adopting and transitioning to sustainable agriculture practices if it is intended to help tackle the prevalence of drought challenges and adapt to climate change. Additionally, it can be stated that the prevailing adaptive strategy among farmers facing drought and general water shortages is the increase in water abstraction. At the same time, this trend is unfortunately coupled with less efficient irrigation practices. Furthermore, a moderate positive association was identified between how many of the practices already applied on the farm for water conservation and the decision to adopt sustainable agriculture practices, with the improvement of water use efficiency as a key influencing factor. As a result, the extent of the farmers' existing commitment to water conservation may be acting as a positive reinforcement, which could be due to a perception gap between adopters and non-adopters of water conservation methods. Moreover, out of the proposed potential challenges to implementing sustainable practices, costs constitute the common denominator in the sub-regions where the survey was conducted, even though the availability of support, including financial support, from the government or other proposed institutions does not necessarily influence the decision to adopt sustainable practices.

To convey the research findings and translate them into a discourse that is relevant to both practice and science, based on the findings, the proposed suggestions cover four main areas: fostering the deployment of drought-resilient crop varieties, improving the effectiveness of the participatory approach and targeted farmer advisory services, improving farmers' education and technology adoption, and ensuring the alignment of food security and the agricultural export policy with the sustainability and adaptation objectives of the agriculture sector. Finally, a proposed concept was presented as a culmination of all findings related to agricultural sustainability, adaptation, and resilience to water shortages, particularly to foster government-farmer cooperation. On the one hand, the concept provides a basis for future research, and on the other hand, it can act as the groundwork for practical implementation in future plans and decision-making.

6. The author's scientific publications related to the topic of the dissertation

Samir Zouhair. (2022) Conference Paper under the title: Agriculture and sustainable development example of Morocco: A brief review of the literature. Published at Spring Wind Conference 2022 in the second proceeding conference volume (XXV. Tavaszi Szél Konferencia – Tanulmánykötet - II. Kötet), the University of Pécs, Hungary. (90-103). ISBN: 978-615-6457-13-4.

Samir Zouhair. (2023) Journal article at E-CONOM Online Scientific Journal (Online tudományos folyóirat), Alexandre Lamfalussy Faculty of Economics, University of Sopron. Title of the paper: Morocco's agriculture and rural development from sustainable development aspects. (153-169). ISSN: 2063-644X. DOI: 10.17836/EC.2023.1.153.

Samir Zouhair. (2023) Conference Paper under the title: Agriculture in Morocco: sustainable development, climate-smart Agriculture, and the potential usefulness of political ecology perspectives. IX. International Winter Conference of P.h.D. Students and Researchers in Economics. Óbuda University, Budapest, Hungary. Publisher: Association of Hungarian PhD and DLA Students – TéKa. (pages 130-138). ISBN: 978-80-974152-6-6.

Samir Zouhair. (2023) Chapter in Book (Study) under the title: Socio-economic Impacts of Sustainable Development on Agriculture in

Morocco. Published at Szemelvények a BGE kutatásaiból II. kötet. (pages 232-242). ISBN: 9786156342768.
DOI: https://doi.org/10.29180/978-615-6342-76-8_30

Samir Zouhair, Pappné Vancsó Judit. (2023) Journal article in the Journal of Economy & Society (Gazdaság & Társadalom), University of Sopron, Volume 16 (34), Issue 4 (2023), under the title of: The challenges facing rural population and the potential of sustainability of rural development in Morocco. ISSN: 08657823 DOI: https://doi.org/10.21637/GT.2023.4.04

Zouhair Samir, Pappné Vancsó Judit. (2025) Journal article in the Journal Földrajzi Közlemények, under the title of: Az aszály hatása a marokkói mezőgazdaságra – Az alkalmazkodás lehetőségei a döntéshozók szándékai és a gazdák tapasztalatai alapján / The impact of drought on Moroccan agriculture – Adaptation options based on policy makers' intentions and farmers' experiences. DOI: https://doi.org /10.32643/f k.149.2.1

DECLARATION ON IDENTITY

I, the undersigned Zouhair Samir, declare that **the printed and electronic versions** of the doctoral dissertation and thesis booklet **are identical in all respects**.

Sopron, 2026, March 19

signature of PhD candidate