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Feasibility Study of a Program to Secure Cereal Production for Food Sovereignty in the Saïss Plain (Morocco): Case of Soft and Durum Wheat

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Abstract

This study assesses the feasibility of a program to secure cereal production in the Saïss plain (Morocco). In a crucial agricultural context, the main objective is to determine the program's technical and financial feasibility. The methodology includes estimating wheat producers' willingness to pay for one cubic meter of water using a logit model, a technical analysis of production and irrigation costs, and a thorough financial analysis. The results indicate strong farmer support, with 100% approval and 92% willingness to contribute financially. Financially, the total investment cost is approximately 650 million dirhams, with positive profitability indicators (IRR of approximately 11%, NPV of 708 million dirhams, payback period of seven years), confirming the project's feasibility. Implementing the program could significantly strengthen food security and economic development in the region.

Keywords: Cereal Sector, Food Security, Security Program, Feasibility Study, Saiss Plain (Morocco).

Introduction

According to FAO, cereals constitute nearly half of the global diet, making food security highly dependent on cereal production, the global market, and stocks. They are essential for both human and animal nutrition. The ability to cultivate locally and build up stocks is vital to protect against fluctuations in the global market. Fluctuations in cereal prices have a direct impact on food access, influencing economic and social stability. Furthermore, cereal production supports the agricultural economy and contributes to food resilience in the face of climate change. FAO's efforts, such as the detailed monitoring of cereal production, supply, and demand by country in the Cereal Supply and Demand Bulletin, reflect the special attention given to these commodities. The cereal sector is one of the main sectors of agricultural production in Morocco. It has significant social importance because cereal farming is practiced by almost all farms to meet the food security needs of the Moroccan population and constitutes a major source of animal feed. [1]. Economically, the cereal sector plays a leading role in the national agricultural sector. Covering an area of 3.57 million hectares and producing an average of 50 million quintals annually, it makes a significant contribution to the Agricultural Gross Domestic Product (AGDP), representing a substantial share estimated at between 10 and 20% [1]. Furthermore, this activity provides income for no fewer than 1.4 million farms in the country, generating a turnover exceeding 15 billion dirhams [1].

The country remains heavily reliant on imports to meet domestic demand for cereals, particularly soft wheat (SW) and durum wheat (DW), which reached a volume of 10 million tons in 2022, due to a combination of factors. Climate challenges, including recurring droughts and unpredictable rainfall fluctuations, have reduced local cereal production. Simultaneously, ongoing geopolitical tensions, such as the Russo-Ukrainian War, have dis-

rupted global cereal markets, creating supply uncertainties and causing price fluctuations. Furthermore, the COVID-19 pandemic has affected logistics and international trade, impacting cereal supply flows. Consequently, Morocco imports 6 billion dirhams worth of cereals annually [2]. Morocco has implemented several initiatives to develop and secure cereal production within the framework of the Green Morocco Plan (PMV) and the "Generation Green" strategy. The PMV aims to modernize Moroccan agriculture by improving yields and promoting crop diversification. It aims to secure cereal production of 7 million tons through the program contract, demonstrating its commitment to strengthening food security. Simultaneously, the "Generation Green" strategy focuses on strengthening social protection for farmers and improving their access to agricultural inputs, thereby contributing to securing cereal production. Within the framework of Generation Green, solidarity agriculture saw the launch of 319 projects over the period 2010-2012, covering 611,000 hectares and benefiting 500,000 farmers for an investment of 10.3 billion dirhams, concerning 19 sectors, notably the cereal sector [2].

It is in this context that the present work is situated, the main objective of which is to study the feasibility of a program to secure cereal production within the framework of food sovereignty through supplementary irrigation from the Mdez dam. The aim is therefore to meet three specific objectives, which are:

- The completion of a technical study of the program.
- The estimate of the average CAP of wheat producers for one m3 of water intended for supplementary irrigation.
- The completion of a financial study of the program.

Methodology

Study Area and Sampling

The study was conducted in the Saïss region, specifically in the prefecture of Meknes and the province of El Hajeb (Morocco). The Saïss plain is an agricultural region of national importance due to its fertile land, suitable for a variety of crops. It comprises approximately 40% of the country's arable land. Cereals, particularly wheat, barley, and legumes, constitute the dominant agricultural activity. These crops play a significant role in national cereal production. In fact, the Saïss plain contributes nearly 30% of Morocco's total wheat production. The choice of the Saïss area was motivated by the priority given by the Regional Directorate of Agriculture of Fès-Meknès to a program aimed at securing cereal production through supplementary irrigation.

Presentation of the Project to Safeguard the Saiss Plain

The program for securing cereal production taken into consideration in this study,This project is essentially based on a structuring initiative aimed at safeguarding the irrigated plain of Saïss. The transfer of water from the M'Dez-Ain Timétrine hydraulic complex to the Saïss plain forms the basis of this project, with an average annual transfer volume of 125 million cubic meters (Mm3) [3]. Along with other actions outlined in a groundwater management contract, this project will contribute to improving the groundwater balance, with the goal of restoring the water table to its previous level. The project aims to promote the adoption of a more water-efficient irrigation system, improve the use of water, and increase the agricultural income of farmers in the project area.

Data Collection and Analysis Methods

To construct the sample, the simple random sampling method was used. Among the 215 cereal farmers involved in the Saïss plain preservation project, a sample of 50 farmers was selected for this study, including 37 in the Meknès prefecture and 13 farmers in the El Hajeb province, which ensured the geographical representativeness of the two areas. The data collected in this study focus on the production conditions of soft and durum wheat during the 2021/2022 growing season, as well as the socio-economic profile of cereal farmers, while also exploring their perception of the program. This information was obtained through surveys conducted using a structured questionnaire. The calculations performed included determining fixed and variable costs, production value, production cost, and profit margin. This data was then used to calculate financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Profitability Index (PI), in order to assess the program's profitability. To analyze the determinants of cereal farmers' willingness to pay using contingent valuation, an econometric model was specified for the analysis. Given that the dependent variable is binary, the use of a logit model seems appropriate in this case. Socio-economic characteristics (age, education level, and income) as well as the auction amount were identified as factors influencing farmers' willingness to pay.

Based on the work carried out by [4], the logit model is formulated as shown in equation 1:

$$logit = log\left(\frac{Pi}{1-Pi}\right) = CAP\,(M, Xj) = \alpha_0 + \alpha_1 M + \Sigma_{j=2}\,\alpha_j X_j + Ui \quad (1)$$

Pi : Probability of agreeing to pay the proposed amount; Proposed amount;M
Xj : Explanatory variables;
α_0 : Constant;
α_1 : and a set of parameters to estimate;α_j
Ui : Error term giving the model a random character;
This is the multiple logit model where the dependent variable is dichotomous and takes the value 1 if the individual agrees to pay the proposed amount and 0 otherwise.

The average willingness to pay (average WTP) is calculated using the truncated mean method, based on the econometric results of our logit model, according to the following expression in equation 2

$$CAP\ moyen = -\frac{1}{\alpha_1}\ln\left(\frac{1+e^{c}}{1+e^{c-\alpha_1 M^{*}}}\right) \quad (2)$$

With :
α_1 : Estimated coefficient relating to the effect of the proposed bid;
c : Sum of the products of the estimated coefficients and the average levels of the significant explanatory variables of the model;
M* : Maximum value of the bids offered.

The analysis compares two water use scenarios to assess their impact on the program's profitability. The first scenario examines the effect of free water on profitability, while the second incorporates the cost of water established by the contingent valuation method to assess its financial impact.

Results and Discussion

Socioeconomic Profile

Unfortunately, all the farmers surveyed were men. Regarding the distribution of farmers by age group, the most represented

age group was 30 to 45, comprising 48% of the sample. As for education level, more than half of the farmers, 56%, were illiterate. Table 1 shows the distribution of respondents by age and education level.

Table 1: Distribution of respondents according to age group and education level

Variables	Percentage
Age group	
- Under 30 years old	4%
- 30 to 45 years old	48%
- 45 to 65 years old	40%
- 65 years and over	15%
Education level	
- Illiterate	56%
- Primary education	32%
- Middle/high school	12%

Source: Author's own research, 2023

Technical Management

The study of agricultural practices on cereal farms in the Sais plain highlights a diversity of methods and decisions made by farmers. They adapt to climatic and economic constraints by mainly using simplified cultivation techniques for soil work, with the number of operations varying according to available resources (54% make two passes, 34% make three, and 10% make four passes, while only 2% opt for direct seeding).The Faiza variety is the most widely used by farmers in the study area (46%). The average seeding rate used by cereal farmers in the study area is 2.06 quintals per hectare.

Fertilization is carried out with base compound fertilizers and nitrogen fertilizers, although the latter are less frequently used due to their cost (88% use base fertilizers, while 58% use nitrogen fertilizers, mainly Ammonium Nitrate), with average quantities of 2 quintals per hectare and 1.2 quintals per hectare, respectively. Chemical weed control is commonly practiced to combat weeds (94% of farmers use it). The average amount of chemical herbicide applied is approximately 0.9 liters per hectare or 150 grams per hectare. Phytosanitary treatments are used to control fungal diseases (90% of farmers use them) with an average application rate of approximately 0.68 liters per hectare. The workforce plays an essential role in these operations, with wages varying according to the tasks (80 to 120 DH per day). Wheat grain yields vary considerably from farm to farm, with average values ranging from 4 to 50 quintals per hectare. Straw production also varies between farmers, with total average production ranging from 10 bales to a maximum of 150 bales per hectare. This variation can be attributed to several factors, including the use of supplemental irrigation by some farmers to improve yields [5].

Table 2 presents the average values of each variable mentioned in the technical management of soft and durum wheat.

Table 2: Average values of agricultural variables for wheat cultivation

Variable	Average value
Sowing rate (qx/ha)	2.06
Average quantity of base fertilizer (quintals/ha)	2.0
Average quantity of nitrogen fertilizers (quintals /ha)	1.22
Average quantity of herbicide (L/ha)	0.92
Average quantity of plant protection products (L/ha)	0.68
Average labor wage (DH/day)	80-120
Wheat grain yield (quintals /ha)	4 to 50
Straw Production (Number of bales per hectare)	10 to 150

Source: Author's own research, 2023

Technical Study of the Program

The program's objective is clearly defined: to produce 500,000 quintals of cereals on an area of 10,000 hectares, with a target yield of 50 quintals per hectare. To achieve this objective, an irrigation plan is in place, including the construction of 100 storage basins with a capacity of 6,000 cubic meters each, pumping stations for every 100 hectares, and the acquisition of 100 center pivots to irrigate the entire area with an allocation of 2,000 m^3 per hectare (DRA Fes-Meknes, Personal Communication).

Investment Needs

The project requires a total investment comprising several components. Firstly, the water supply comes from the M'dez dam as part of the Saiss plain safeguarding project, involving an investment of 50 million dirhams for supplementary cereal irrigation. Regarding the on-site infrastructure, the project includes the construction of 100 water storage basins, each with a capacity of 6,000 cubic meters, at a unit cost of 300,000 dirhams per basin. In addition, the installation of pumping stations is planned, with

an estimated unit cost of 1,200,000 dirhams per station for every 100 hectares. Finally, irrigation will be provided by approximately 100 center pivots, each requiring a total investment of 15 million dirhams. The total cost of the investment amounts to 650 million dirhams, with details presented in Table 3.

Table 3: Total investment cost of the project

Designation	Cost per hectare (DH)	Total cost (DH)
Supplementary work on piping	5,000	50,000,000
Pivot subsidy	44,000	440,000,000
Total state investment	49,000	490,000,000
Acquisition of pivots, storage basin and pumps	16,000	160,000,000
Total investment of wheat producer	16,000	160,000,000
Overall investment	65,000	650,000,000

Source: DRA Fès-Meknès, 2023

Working Capital Requirements

The working capital requirement (WCR) for the security program is primarily attributable to variable costs, encompassing supplies, mechanization, labor, and operating and maintenance expenses. Seeds represent the largest share of supplies, with an average cost of 826 DH per hectare, followed by base fertilizers, which average 691 DH per hectare. Mechanization costs, covering soil preparation through to harvest, amount to approximately 1196 DH per hectare. Mechanization has reduced reliance on manual labor. The total labor cost for one hectare of wheat, from soil preparation to harvest, is 352.42 DH/ha. Regarding operating and maintenance costs, energy expenditure related to the operation of pivots amounts to 1830 DH/hectare, while maintenance and repair costs for pivots total 660 DH per hectare. Specific costs are detailed in dirhams in Table 4:

Table 4: Variable costs of the project

Designation	Cost DH/hectare
Seed supply	826
Base fertilizer + topdressing fertilizer	1245
Herbicides and fungicides	708
Transportation costs	25.26
Workforce	352
Mechanization (soil preparation, sowing, fertilization, treatment and harvesting)	1196.33
Energy cost	1830
Maintenance and repair	660
Total cost	6842.59

Source: Author's own research, 2023

Products of the Operation

The project plans to produce two categories of products: wheat grains and wheat straw.

Table 5 shows the prices associated with each type of product, as well as the quantities that will be produced.

Table 5: Farm output

Product	Yield per hectare	Unit price DH
Grains	50 quitals	372
Straw	150 bucks	21

Source: Author's own research, 2023

Analysis of the Willingness to Pay (WTP) and its Determinants

Contingent Scenario: A contingent scenario was presented to farmers in which they had to answer "yes" or "no" to the question of whether they were willing to support a program aimed at securing cereal production by paying a random amount from among six options ranging from 0.25 DH to 2 DH per cubic meter of water.

Analysis of Responses: Of the 50 farmers in the sample, 56% agreed to pay the proposed amounts. The distribution of responses varied depending on the amount, showing a decrease in the acceptance rate as the amount increased. Most refusals were due to genuine financial inability.

Willingness to Pay According to Socioeconomic Variables: Subsequently, the analysis focused on how Willingness to pay varies according to certain socioeconomic variables, such as age, education level and income. Depending on age, it has been

found that the maximum amount granted increases with age up to 65 years, then decreases. Education level showed a positive correlation with CAP, indicating that more educated individuals were willing to pay higher amounts. Furthermore, farmers with higher incomes were more willing to pay larger amounts.

Determining Willingness to Pay: We used a logit model to analyze the determinants of willingness to pay (WTP). The results in Table 6 show that the significant variables were the proposed amount, income, and education level. More specifically, the proposed amount was negatively correlated with WTP, education level was positively correlated, and income had a positive impact on willingness to pay.

Average CAP Estimate: The average Willingness to Pay (WTP) is calculated using the econometric results of the previous logit model estimation and simply applying the exponential function. The estimated average WTP is 1 DH, as shown in Tables 6 and 7.

Table 6: Results of the estimation using the logit model

Variable	Coefficient	Std.Error	z	Prob
Constant	-2.549586	2,234806	-1.140854	0.2539
Amount offered	-2.362997**	1,171169	-2.017640	0.0436
Income	1,597295***	0.606596	2,633209	0.0085
Age	0.770373	0.721659	1.067502	0.2857
Education level	1,964806***	0.671810	2.924648	0.0034

The asterisks *** and ** indicate the significance of the parameters at the 1% and 5% levels respectively.
Source: Author's own research, 2023

Table 7: Calculation of the average CAP

coefficient	Value
c	3.2786
Mi Coefficient	-2.362997
Maximum amount	2
CAP average	0.97 DH

Source: Author's own research, 2023

Financial Analysis of the Program

In this study, two scenarios were examined to assess the feasibility of the development project in question, using a discount rate of 8% and based on a 25-year time horizon for the project's cash flows. In the first scenario, the project was analyzed without considering the costs associated with water use. The results revealed a positive Net Present Value (NPV), an Internal Rate of Return (IRR) of 14%, and a Profitability Index (PI) of 2.41. These values clearly indicate that the project generates significant returns, even though the payback period is slightly extended, reaching six years. In summary, this first scenario demonstrates that the project is profitable, despite a relatively long payback period. In the second scenario, annual water usage costs, estimated at 20 million dirhams using the contingent valuation method, were taken into account. The results remain positive, with a positive NPV, an IRR of 11%, and a return on investment (ROI) of 2.09. However, it is important to note that the return on invested capital takes slightly longer, occurring in the seventh year. Despite this slight extension of the capital payback period, the project remains economically attractive, offering satisfactory returns. Ultimately, these two scenarios highlight the robustness of this program, even when considering water usage costs in the second scenario, demonstrating its long-term viability.

Conclusion

In conclusion, this research examined the feasibility of an innovative program focused on securing cereal production in the Saïss plain, with an emphasis on wheat. The methodology employed involved a technical analysis of the costs associated with production and additional irrigation using center pivots, an estimation of wheat producers' willingness to pay for one cubic meter of water using a logit model, and a thorough financial analysis. The study's findings highlighted significant challenges related to vulnerability to climatic conditions, underscoring the need for more effective approaches, including the use of supplemental irrigation to mitigate the impact of rainfall variations. Willingness to pay analysis revealed strong farmer support, with 100% approval of the initiative and 92% prepared to contribute financially. Financially, the project's feasibility study presented promising indicators, with a total investment cost estimated at 650 million dirhams. Financial projections, including an internal rate of return of 11%, a net present value of 708 million dirhams, and a seven-year payback period, suggest that implementing the program to secure cereal production is feasible. The practical implications of this program in the Saïss Plain are numerous. It would contribute to improving the region's food sovereignty by ensuring more stable and resilient cereal production in the face of climate variations. Furthermore, the program would bring substantial economic benefits, such as the preservation of the Saïss Plain and the creation of jobs in the agricultural sector, potentially stimulating the country's economic growth. Finally, the program could have a positive impact on reducing food insecurity in the region. However, it is crucial to note that the implementation of this program will require effective coordination among the various stakeholders involved, including farmers, local authorities, and financial partners.

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