Profitability analysis of onion production in Morocco

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Abstract. This study aims to analyze the profitability of onion production in Fes Meknes Region in Morocco and to visualize sensitivity of this production on an increase in production costs or a decrease in yield due to climate change. The data used were collected from 80 randomly selected producers. Different analysis methods were used in the analysis of data: budgetary analysis, cost-benefit analysis and correlation analysis. The budgetary analysis results show that onion production is profitable and the profitability is sensitive to a decrease in production or an increase in costs. By comparison, the analysis shows that the repercussions of the onion production shock are more detrimental than an increase in production costs. So, the farmers are supposed to adopt farming practices that boost the productivity and reduce his sensitivity. Correlation analysis reveals a positive and significant relationship between net agricultural income, the type of irrigation and the level of education of the farmers. These variables must be taken into account to improve the level of agricultural profitability.

Keywords: profitability, onion, budgetary analysis, cost-benefit analysis, correlation analysis, net income, Morocco.

1   Introduction

The onion production is one of the main market gardening crops in Morocco with an area ranging from 25 000 to 30 000 hectares. The onion total production ranges from 700 000 to 900 000 tons/year, it generates significant income for famers and contributes significantly to the national economy through its export to different countries. This generates important export incomes, promotes international trade, diversifies of agricultural income sources and strengthens the country's trade balance. Furthermore, the onion is a staple food for Moroccans, it ensures a regular and stable supply in the local market, thereby contributing to the country food safety. Moreover, onion cultivation contributes to socio-economic development through job creation, improvement of farmers' living conditions, development of agricultural infrastructure and the stimulation of the local economy. Fez-Meknes region dominates regarding onion crop, the most well-known varieties of onions are the 'Red of Doukkala' and the 'Yellow of Valence', they require an adequate irrigation to promote bulb growth.

In order to develop farms, the profitability of agricultural activity is essential. Similarly, Corselius et al. [9] justified the need for agricultural profitability and emphasized that it helps farmers to respond to increasing levels of demand and to support an adequate standard of living while ensuring the annual investments to improve resources productivity.

This research demonstrates the role of onion producers in the agricultural development of Morocco. The question then is how onion farming contribute to the economic consolidation of producers. Based on the various challenges related to agricultural farms, this study analyzed the economic performance (profitability) of onion farms in the region of Fez-Meknes and the principal variables that influence it.

The profitability is the capacity of a farm to generate a profit margin. It provides a potential level of performance that is measured by the difference between selling prices and production costs. Bouquiaux et Al. [4] define the profitability as the ability of the farm to generate a profit from invested capital [4]. However, it's important to note that profitability indicators such as Value-Added (VA) and Gross Margin (GM) don't guarantee that farmers cover their expenses and make a profit. Therefore, the Net Income (NI) has been considered to assess the level of profit in agricultural activity [Cochet H et Al. 2015 8, Gietman B et Al. 2006 11]. These indicators were estimated for farmers using drip irrigation and those using surface irrigation.

The main objective of this study is to analyze the profitability of agricultural farms in order to understand the role of onion farms in agricultural development. In order to achieve our objective, we proceeded to estimate the total income, intermediate consumption, total variable costs, total fixed costs, total costs, gross margin, value added, and net income.

In Morocco, profitability of onion cultivation is a matter of great concern to farmers and policy makers. It allows selection of the most suitable varieties, implements the best cultivation techniques to maximize profit, estimates production costs which will enable farmers to plan their expenses more accurately, and assess the economic viability of the cultivation by

estimating potential income based on projected market prices. In addition, the profitability analysis takes into account risks, such as price fluctuations and climate change.

The first gap identified in our research is the scarcity of previous studies on our topic in the selected working area, which required additional efforts to bridge the lack of relevant and reliable studies. The second gap is, at the beginning of our surveys, we encountered difficulties to obtain information from farmers who showed a certain level of distrust in their responses, we understood that the presence of paper questionnaires made them uncomfortable. Therefore, we limited ourselves to use a small notepad. As we progressed with our surveys, it become easier to obtain information by developing our way of asking questions.

2   Methods:

2.1 Data collection

We conducted a literature review to identify basic information and necessary tools to accomplish our work. Then we did an exploratory survey which helped us in selecting the sample of farms to be surveyed. After that, a pre-survey was conducted to test and refine the data collection tools. After these preliminary investigations, we proceeded the surveys using the final version of the questionnaire.

The questionnaire contains several sections, which are presented as follows:

Farm identification	Presentation of the farm: location, level of education of the farmer, age of the farmer, presence or absence of permanent labor …
Water resources	Different data to estimate the quantity and cost of pumped water
Variable costs	Different data related to the variable costs associated to onion production (inputs, labor, irrigation, transportation…)
Fixed costs	Different fixed costs at the surveyed farms (Depreciation, insurance, financial expenses, ...)
Products	Yield and selling price

After the survey phase, we entered the collected information into Excel spreadsheets for both quantitative and qualitative data to create our own database.

- Sample size calculation [5]:

$$n=z^2 *p(1-p)/m^2$$

n: sample size

z: confidence level according to the standard normal distribution

⇒ for a confidence level of 95% z=1.96,

⇒ for a confidence level of 99% z=2.575

p: the estimated proportion of the population with the characteristic (when unknown, we used p=0.5 which corresponds to the worst-case scenario that means the highest dispersion).

m: margin error

For our case, we have chosen to calculate a proportion with a confidence level of 95% and a margin error of 7%.

$$n=(1.96)^2 *(0.5)(1-0.5)/(0.15)^2 =42.68$$

To be representative, the sample size must be more than 43. For this purpose, we chose to conduct surveys for 80 farms. In addition, for data collection, we used the simple random sampling method recommended by MAGAIN [5,19] it's considered as the most reliable method for our case as it's based on the principle that all onion farms have an equal probability (non-zero probability) of being included in the sample.

2.2 Presentation of the study area:

The agricultural sector is one of the promising sectors in the Fez-Meknes region. According to the regional agricultural plan, the Utilized Agricultural Area (UAA) in the region accounts for 15% of Morocco's total UAA with a wide variety of crop production. The total of onion production ranges from 700 000 to 900 000 tons/ year. Given the importance of this crop, the scarcity of work on our theme in this area and the remarkable number of farms that grow onions, we chose to work on onion cultivation in the Fez-Meknes region. The surveys were conducted for the 2022 agricultural campaign.

2.3 Methods of data analysis:

The method used for our work is budgetary analysis by calculating the Gross Product, Gross Margin and Net Farm Income [13].

The Gross Product or Total Income (TI), the Gross Margin (GM), the Net Income (NI) and the Total Cost (TC) are calculated using the respective formulas from (1) to (5). The profitability and productivity indicators were normalized by hectares in order to facilitate the comparison between different categories of farmers.

$$TI = \Sigma \ (P_i {*} Q_i) \tag{1}$$
$$MB = \Sigma \ (Pi{*}Qi) - \Sigma \ Xi \ Pxi = TI - TVC \tag{2}$$
$$NI = T \ I - TC = \Sigma \ (Pi{*}Qi) - (TVC + TFC) \tag{3}$$
$$CT = TFC + TVC \tag{4}$$

TI	Total Income	TFC	Total Fixed Cost
Pi	the selling price of the agricultural product i	Xi	Input matrix
Qi	the total quantity produced of the agricultural product i	Pxi	Input price matrix
TC	Total Cost	NI	Net Income
TVC	Total Variable Cost	Σ	Summation Sign

The indicators described by the equations (1) to (4) are complemented by the Value Added (VA) which is the difference between the Total Income (TI) and Intermediate Consumption (IC) and serves to remunerate the various actors involved in the production process: government, manual labor, microcredit institutions... [8]. The VA is defined by the following equation:

$$VA = TI - IC \tag{5}$$

In parallel to these approaches, the correlation between the different variables was calculated.

Finally, we conducted clustering using minimum variance method, also known as Ward method [23] in order to form hierarchical groups of onion producers. This method is called cluster analysis in agricultural economy. Then, the two categories formed are farmers using drip irrigation and those using surface irrigation. Therefore, the public interventions to improve the factors influencing net income for the two categories would not be the same.

The software used to achieve our work are SPSS and Microsoft Excel.

3   Results:

In this section, we have presented: socio-economic characteristic of onion producers, the correlation between Net Income and the variables that determine it and his sensibility to production shock and the increase in production costs.

The descriptive statistics show that the surveyed farms are located within the jurisdiction of the Provincial Department of Agriculture of Meknes (PDA), more specifically, they are located in rural municipalities: Boufekrane, Oued jdida, Mhaya, Majjate, Sidi Slimane Moul Lkifane (El Haj Kaddour), Ait Ouallal and the operational area of Provincial Department of Agriculture of El Hajeb more specifically : Ait naamane, Sbaa aiyoun, Ain taoujdate, Ait Boubidmane, Bitit, Laqsir, Ait yaazem, Jahjouh et Ras ijerri.

The average land area allocated to onion farming is 13.73 Ha. We have divided the surveyed farms into three categories based on their Utilized Agricultural Area: small (UAA ≤5 ha), medium (UAA from 5 to 10 ha) and large (UAA≥ 10 ha).
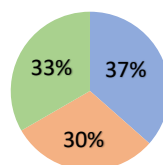

Figure 1: Distribution of the sample by farm size

The figure below presents the distribution of surveyed farmers by age, the average age is around 46 years with a minimum of 24 year and a maximum of 66 years. This indicates that farmers are still physically strong and have important experience in carrying out agricultural work.
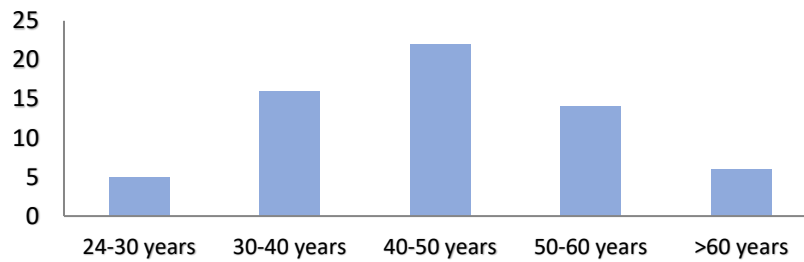

Figure 2: Distribution of surveyed farmers by age

The level of education is an indicator which allows to understand the extent of the illiteracy problem among the farmers. The figure bellow presents distribution of surveyed farmers by level of education.
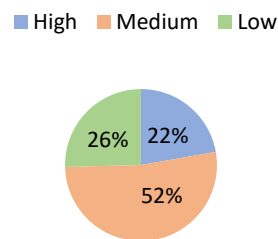

Figure 3: Distribution of surveyed farmers by level of education

Despite the difficulties involved in surface irrigation system, 36% of farmers continue to use it. They would like to replace it with drip irrigation system, but several constraints prevent them:

- Financing problem
- Lack of follow-up on subsidy procedure
- land status (the agreement of all co-heirs)

The results of correlation analysis are presented as follows:

Table 1: correlation coefficient matrix between the Net Income and its determinants

	Net Income	Gross Product	Production Cost	Age	Irrigation type	Level of education	Superficie
Net Income	1,000						
Gross Product	0,937	1,000					
Production Cost	0,491	0,765	1,000				
Age	-0,340	-0,406	-0,384	1,000			
Irrigation type	0,574	0,680	0,636	-0,617	1,000		
Level of education	0,484	0,522	0,409	-0,225	0,396	1,000	
Superficie	0,188	0,338	0,496	-0,105	0,230	-0,304	1,000

After the presentation of onion farmers' socioeconomic characteristic and the correlation analysis, now we will proceed with a detailed analysis of onion production profitability.

Table 2: Analysis of the average profitability of onion cultivation.

Irrigation type UAA	Drip irrigation			Surface irrigation		
	Small	Medium	Large	Small	Medium	Large
Production (kg/ha)	54500,0	59000,0	68500,0	36923,1	42222,2	45000,0
Selling Price (dh/kg)	1,3	1,3	1,4	1,4	1,5	1,4
Total Income (dh/ha)	72600,0	74600,0	95350,0	53192,3	63055,6	63000,0
Labor cost (dh/ha)	12024,0	14543,0	17058,8	12110,4	15346,7	17100,0
Intermediate inputs consumption (dh/ha)	34990,5	32210,0	38589,3	25251,9	30478,9	30500,0
Total Cost (dh/ha)	47014,5	46753,0	55648,0	37362,3	45825,6	47600,0
Net Income (dh/ha)	25585,5	27847,0	39702,0	15830,0	17230,0	15400,0
Added Value (dh/ha)	37609,5	42390,0	56760,8	27940,4	32576,7	32500,0

The calculations show that agricultural farms practicing surface irrigation have a very low Net Income. This result seems to be due to the use of large quantities of water, which has raised pumping costs so an increase of production expenses of onion crop.

The Net Income ranged between 77 900DH/ha and 8 450DH/ha with an average of 33209.12 DH/ha. Indeed, the farms with a low Net Income tend to use a very high level of inputs compared to other farms (large quantity of fertilizer, unexplained pesticide use, higher than average labor use...). Following this, the farmer finds himself at the end of the season with a very high expenses and consequently a low Net Income.

It was observed that large farms using surface irrigation system generated important Added Value. This result is explained by the economies of scale aspect and the presence of technically qualified profiles (engineer and technician). In fact, following our investigations, the purchase price of inputs for large farms is lower than that paid by the rest of the farms. In other words, large-scale farmers benefit from discounts offered by suppliers of fertilizers and pesticides, as they purchase large quantities

In addition, we have examined the sensitivity of the profitability of farms to a decrease in agricultural production. By adopting the principles of marginalist analysis, we considered a variation rate of 1% [24]. The analysis results are presented as follows:

Table 3: Profitability analysis in response to production shock

Irrigation type UAA	Drip irrigation			Surface irrigation		
	Small	Medium	Large	Small	Medium	Large
Production (kg/ha)	53955,0	53100,0	67815,0	36553,8	41800,0	44550,0
Selling price (dh/kg)	1,3	1,4	1,4	1,4	1,5	1,4
Total Income (dh/ha)	71874,0	73278,0	94396,5	52660,4	62425,0	62370,0
Labor cost (dh/ha)	12024,0	14543,0	17058,8	12110,4	15346,7	17100,0
Intermediate inputs consumption (dh/ha)	34990,5	32210,0	38589,3	25251,9	30478,9	30500,0
Total cost (dh/ha)	47014,5	46753,0	55648,0	37362,3	45825,6	47600,0
Net Income (dh/ha)	24859,5	26525,0	38748,5	15298,1	16599,4	14770,0
Added Value (dh/ha)	36883,5	41068,0	55807,3	27408,5	31946,1	31870,0
Total Income variation (%)	-1,00%	-1,77%	-1,00%	-1,00%	-1,00%	-1,00%
Net Income variation (%)	-2,84%	-4,75%	-2,40%	-3,36%	-3,66%	-4,09%
Added Value variation (%)	-1,93%	-3,12%	-1,68%	-1,90%	-1,94%	-1,94%

By continuing with the marginalist analysis, we examined the effects of the increase in production costs on profitability. The following table shows profitability sensibility in response to cost increase of 1 % [24].

Table 4: Profitability analysis in response to cost increase

Irrigation type	Drip irrigation			Surface irrigation		
UAA	**Small**	**Medium**	**Large**	**Small**	**Medium**	**Large**
Production (kg/ha)	54500,0	59000,0	68500,0	36923,1	42222,2	45000,0
Selling price (dh/kg)	1,3	1,3	1,4	1,4	1,5	1,4
Total Income (dh/ha)	72600,0	74600,0	95350,0	53192,3	63055,6	63000,0
Labor cost (dh/ha)	12024,0	14543,0	17058,8	12110,4	15346,7	17100,0
Intermediate inputs consumption (dh/ha)	35340,4	32532,1	38975,1	25504,4	30783,7	30805,0
Total cost (dh/ha)	47364,4	47075,1	56033,9	37614,8	46130,3	48384,1
Net Income (dh/ha)	25235,6	27524,9	39316,1	15577,5	16925,2	14616,0
Added Value (dh/ha)	37259,6	42067,9	56374,9	27687,9	32271,9	32195,0
Net Income variation (%)	-1,37%	-1,16%	-0,97%	-1,60%	-1,77%	-5,09%
Added Value variation (%)	-0,93%	-0,76%	-0,68%	-0,90%	-0,94%	-0,94%

4 Discussions:

Onion provides important Income to farmers, although they may not be profitable for all of them. Its profitability is measured by Net Income, which is obtained by the difference between Total Income and total production costs [20]. For producers who use drip irrigation, their low level of efficiency could be constrained by the high cost of production [21], which may be due to the inefficiency in the use of irrigation water. For small farms, the decrease in efficiency is due to the unexplained use of inputs and the lack of technical expertise in the cultivation process.

The results of correlation analysis have highlighted the significant and positive effect of irrigation type and education level on Net Income. Therefore, it is necessary for farmers to choose new and innovative agricultural techniques which increase production productivity and efficiency and convert their irrigation to drip irrigation.

Moreover, the profitability of onion crop has also shown sensitivity to an unexpected decrease in production [15]. It is essential for farmers to have a good understanding of these risks in order to manage the sensitivity of their production to factors that may cause a decrease in profitability [21]. Specifically for production cost, the positive correlation with Net Income highlights the importance of investments in agricultural production activities [20]. Furthermore, since the profitability is sensitive to the level of production cost, it is crucial to control it [2, 7]. This would require certain producers to pay attention to their choices when making decisions regarding investments and fund allocation, to encourage the minority of farmers using surface irrigation to switch to drip irrigation and provide technical support and training to farmers on drip irrigation technique.

The results of our research show that the production of onion in Fez-Meknes region is profitable. If it fulfills all these conditions, onion will maintain its qualification as a food security crop in the Moroccan and African markets.

5 Conclusion:

Onion is among the staple foods in the diet of Moroccans, ensuring a regular and stable supply in the local market, thus contributing to the food security of the country.

Based on the data collection, their analysis, and discussions, we have observed that the cultivation of onion is profitable but highly sensitive to production decrease and cost increase.

To develop onion cultivation in Morocco, it is important to promote research in order to explore alternative methods to enhance and optimize water irrigation efficiency and other production factors, especially in light of climate change and global inflation.

6 Acknowledgement:

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