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Contents

Foreword

Stanojević deals with the complementarity between Serbia's exports of cereals and the import demand of the Middle East and North Africa (MENA) countries. The markets analysis was conducted (including food safety indicators), and two different import-export matching coefficients were applied. The results showed high trade complementarity in terms of corn and wheat with all countries in the region, while for a few of them, it was barley.

The paper analyzes the performance of the Tunisian olive oil exports compared to its main competitors during the last fifteen years, on the European market and four potential markets. The authors *Arfaoui et al*. use the Shift Share Analysis to identify the main sources of change. The results show that the maintenance of a sustainable international competitiveness of Tunisia on the olive oil market depends on its domestic production and that of its European competitors, to which is added recently the Turkish competition, policies and trade agreements that must be negotiated and requires the improvement of its non-price competitiveness.

A focus on the relative importance of the SDGs in the olive oil cooperative sector in Andalusia is analyzed by the authors *Parrilla González and Ortega Alonso*. They use the Qualitative Comparative Analysis (QCA) technique and apply the fuzzy-set approach (fsQCA) to the tenets of the SDGs. The main findings of this study suggest that the sustainable development goals on which the cooperative societies analyzed are focused, in addition to producing olive oil, promote values linked to food security, sustainability, the showcasing of heritage, and gender equality.

Mohammadian and Niknami examine the existing knowledge and need by Damavand gardeners to produce organic apples. The results showed that in the planting stage, most of the respondents had very poor and weak level of knowledge. However, this need decreases with increasing issues such as level of education, use of information resources, level of cultivation and work experience. Finally, based on the Borich model, priority educational issues were identified to bridge the knowledge gap in order to produce organic apples in the planting, growing and harvesting stages.

Bechir et al. try to highlight the territorial development in the governorates of South-East Tunisia on the border with Libya. The objective is to show the existence of a direct relationship between regional disparity and work in informal trade. A survey will be made

with the informal trade actors to analyze their situations and finally an analysis of the state intervention as well as recommendations will be proposed. Paper has shown that regional and local disparity is one of the causes of informal trade in the southeast and confirme that most of the players in the informal trade are unemployed young people.

The topic on interactive innovation in two case study in Spain dealt with by *Lee et al*. Rural innovation is addressed by measuring stakeholder interactions utilizing participatory methodologies to bring in diverse perspectives of stakeholders, who have control over the development and decision-making process. Results reveal that lack of communication among internal stakeholders was the main threat. Recommended action plans included establishing an effective communication strategy, establishing a well-defined terminology to avoid miscommunication among internal stakeholders and considering ethical and cultural differences among stakeholders to avoid mistrust.

Örs et al. deals with the economic impact of the use of robotic milking systems (RMS) adopted by the farmers in Turkey. A simulation model was created that gives possible economic analysis results because of the use of RMS by using the current economic analysis results of dairy farms. While the simulation results show that the use of RMS is a preferable investment that increases profitability for 10-60 head and 121 + head groups; it shows that it will be an investment that negatively affects profitability for the 61-120 head group. A dairy farmer considering an RMS investment can be able to obtain a result specific to his farm if he combines the simulation model with his own economic analysis results.

Makhlouf and Montaigne analyze the new Algerian dairy policy that obliges dairies already registered with the State to offer producers and collectors of raw milk formal and written contracts which must, in practice, help resolve or limit the multiple market failures. The paper shows exhaustively the nature of these formal contracts that bind dairies to their raw milk suppliers by using the tools of the theories of contracts and transaction costs. This review will shed light on contractual practices through a vertical coordination process of a dynamic sector propelled by the various supports and bonuses from the State. These contracts are nonetheless tools for structuring and modernizing the milk sector.

Assessing Serbia's cereals export to the Middle East markets

Nataša Stanojević*

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Abstract

Agriculture, especially cereal production, is one of the few sectors in which Serbia has a significant comparative advantage. Due to the policy of approaching the EU, almost all grain exports are placed in a few EU countries, which are not end-users but are also significant producers and resellers on the world market. This increases the risk of external shocks and reduces earnings from exports, while end importers pay a higher price. This research aims to determine the complementarity between Serbia's exports of cereals and the import demand of the Middle East and North Africa (MENA) countries. For these purposes, the markets analysis was conducted (including food safety indicators), and two different import-export matching coefficients were applied. Serbia's competitiveness in relation to the current suppliers of MENA for each type of cereals was assessed. The results showed high trade complementarity in terms of corn and wheat with all countries in the region, while for a few of them, it was barley. The trade routes for each type of cereal specified in this research are guidelines for engaging the government in export promotion.

Keywords: *Exports, Cereals, Trade complementarity, Serbia, MENA region.*

1. Introduction

During the transition of the 1990s, Serbia lost its competitive position on the international market in many manufacturing sectors. In terms of the technological level of some industries such as electronics and machinery, it returned to the level of several decades before the transition. Although it has also suffered transitional shocks, the agricultural sector has remained one of the pillars of the Serbian economy. Agriculture production is one of the few sectors in which Serbia has a significant comparative advantage in the international market. Agriculture has a higher share in GDP (6.5%) than the World average and almost all European countries (around 3.5%). In terms of exports, agriculture also has a relatively large share. The global share of agricultural exports in total exports is 1.4%, in Europe it is 1.3%. In comparison, in Serbia, it is 2.1% (World Bank Indicators, 2020). The value of total exports of agricultural and food products has a tendency to grow, with oscillations common to this sector.

However, the agricultural potentials of Serbia are not even close to being fully utilised. The abundance of natural resources, such as water, rich fertile land, unused agrarian land, scientific resources in the form of several agricultural institutes which achieve significant results in

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the development of new varieties of seeds and bio-materials, and the application of information technology in agriculture provide an opportunity for significantly higher production and exports.

Due to the accession process to the European Union (EU), the most important export partners for food, as for all other products, are the countries of the EU to whose markets Serbia exports food products mainly duty-free based on the Stabilisation and Association Agreement. The EU is a large enough market for Serbia, and yet there are at least two arguments in favour of recommending the expansion and diversification of the food export market.

The first is a general recommendation for each country to have as many export partners as possible. Although the EU has 28 members, Serbian exports in each sector relate to only a few export markets. In the case of cereals, it is Romania, which accounts for more than 70% of Serbia's corn exports and about 60% of wheat exports. The second is Italy with 10% of exports of these products. This makes production sensitive to changes in demand in these countries, which is especially evident during crises such as the World Financial Crisis in 2008-2009 and the Covid-19 pandemic in 2020.

Another reason for export diversification is a loss of potential income because Romania, Italy, Germany, and Bulgaria, as main export partners for Serbian cereal, are not end-users but also large producers and exporters of cereals on the world market. This circulation of goods increases the procurement costs of the end buyers and reduces the earnings of Serbia. For example, the countries of the Middle East in 2019 imported corn from Serbia at the price of 2.6 $/kg, 3 $ from Germany, and 4-5 $/kg from Italy (author's calculation based on UN Comtrade).

The problem of Serbia's very limited number of export partners in terms of total exports can often be found in scientific papers, although most often without an analysis of potential new export markets or ways to diversify exports. The importance of the markets of the Middle East and North Africa for the total export of Serbia was emphasised in Udovički (2018), and a quantitative assessment of the potential increase was made only in the works of Stanojević, Batić (2009; 2010). To our knowledge, there is no research on the export potential of a group of products from Serbia to the MENA region.

When it comes to the economic aspects of agriculture in Serbia, there is a relatively large number of significant studies in the field of business and management. At the same time, foreign trade in agricultural products and food is largely neglected in scientific papers. Among the most important articles are Đurić *et al.* (2017), whose results show that even though the agricultural sector has a dominant export position, its competitiveness is still at a low level. Similar and detailed results are obtained by Cvijanović *et al.* (2016), who show low competitiveness and diversity of agricultural products with a higher degree of processing and significant achievements in yield and quality of raw materials – cereals, fruits, and medicinal plants. With these results in mind, our research analyses the export of cereals as products whose processing does not require complex technology and is competitive in the world market.

Among the most influential authors on the export of Serbian agriculture are Aničić and Simić (2017), who investigated the adverse effects of very low geographical diversification of exports and the considerable dependence on the economic and political situation in the European Union. To our knowledge, there are no scientific papers that quantitatively (using compatibility coefficients, such as this paper, or developing an empirical model) assess potential export markets for Serbian agricultural products.

Due to numerous economic and geographical characteristics, the Middle East and North Africa (MENA) is identified as a suitable export market for Serbia's exports of food. The limitations of natural conditions in the MENA region, i.e. water scarcity and shortage of arable land, are an insurmountable obstacle to grain production which could meet the region's demand. Given the characteristics of Serbian agricultural production and the food needs of the MENA region, it is apparent at first glance that there is significant trade complementarity, that is, that Serbia has a great potential for exports to the region. Cereals are in the focus of the assessment because this product group shows the

lowest self-sufficiency ratio in the MENA region (Woertz, 2017). At the same time, cereals are the most essential of Serbia's export groups of agricultural products.

However, this perception of complementarity is not enough to detect the most favourable export destinations in the region. Due to the limited production capacities of Serbia, a more detailed assessment is necessary. To recommend correct economic policies, the number of potential markets needs to be reduced to those with the best prospects for exports. So, the main research question is: *Which MENA markets have the greatest complementarity of imports of certain types of cereals with Serbian exports?*

We come to the answer to this question and recommendations for correcting Serbia's economic policies through a three-stage procedure.

First, the MENA markets themselves are explored regarding the relationship between food availability and affordability. By analysing this data, some markets will be excluded.

Second, two different import-export matching coefficients are applied in this study: the coefficient of conformity (CC) and the trade complementarity index (TCI). In this way, the trade compatibility of cereals as a group and certain types of cereals with the largest share in the export of Serbia to each country in the MENA region are investigated.

Third, to create economic policies, it is necessary to combine the results of MENA market analysis, compatibility obtained by applying trade indices, and other economic circumstances affecting trade, such as the most critical competitive suppliers of cereals.

2. Theoretical background: MENA limitation and Serbia's advantages as the backbone of the food trade

Due to numerous economic, political, and geographical characteristics, the MENA region is identified as a suitable market for increasing Serbia's export in general.

- The geographical distance is relatively small and allows for lower transport costs compared to other countries in Africa and Asia; Distance can be a particularly negative factor in the food trade, especially in goods of low degree of processing, because their price per unit of product is low (Ozer, Koksal, 2016).
- Serbia as an economic partner has been present in many markets of the MENA region for several decades since the former Yugoslavia. Traditional trade links can be considered a positive factor in determining future trade routes. Trade ties that existed before are usually much easier to renew and expand than to penetrate new markets.
- The current intensification of the overall economic relations between Serbia and certain countries in the region created stimulating conditions for the identification of these countries as potentially great exporting markets. The inflow of substantial foreign investments from the UAE, Saudi Arabia, and Qatar to Serbia, provided by the Serbian government under extremely favourable conditions, has been growing strongly for several years, indicating significant economic and political convergence.

However, although these are good preconditions, they are not enough to include the focus on these countries as export partners for specific goods in the economic policies of Serbia. For the assessment of export routes to agricultural products, a necessary precondition is import/export compatibility, which is determined in this chapter by statistical description and qualitative assessment of compatibility in trade in cereals.

2.1. *Challenges of food supply in the MENA region*

The stability and sustainability of the MENA region's food supply have occupied the attention of scholars from various fields for decades and the most important international organisations. In contrast, the export potential of Serbian agriculture is very rarely the subject of scientific research. These two groups of studies form the conceptual framework for researching the compatibility of Serbian exports and MENA food imports.

According to the records of the UN Commission on West Asia (ESCWA, 2017), insuf-

Table 1 - Global food security index 2020.

Global rank	*Country*	*Affordability*	*Availability*	*Quality*
13	Qatar	99	64	84
18	Israel	83	74	84
21	UAE	90	64	78
27	Kuwait	88	62	76
30	S. Arabia	86	62	74
46	Oman	78	58	74
50	Bahrain	82	56	57
55	Egypt	58	70	66
59	Morocco	62	64	62
64	Jordan	71	55	54
69	Tunisia	62	58	62
70	Algeria	67	56	53
111	Yemen	45	29	30

Source: The author according to EIU 2020.

ficient food safety is the greatest challenge in the MENA region, with as many as 33 million vulnerable people. This is especially true for countries that do not have significant energy resources. However, even the richest countries in the region occasionally face irregular supplies due to the sanctions on Iran, which is the largest producer of food, especially cereals, which are scarce in the region.

Table 1 shows MENA countries' position on the global food security index list, compiled by the Economist Intelligence Unit (EIU). The index consists of three groups of criteria: affordability, which refers to the fact that the population has the means to buy food; availability, which refers to the market supply that meets demand; and quality, which refers to the nutritional value and health safety of products. Concerning the countries surveyed in this paper, the EIU has no data for Libya.

Any country where the availability is significantly lower than the affordability can be considered as an additional space for Serbia's food exports to this region. As the table shows, these are all Middle Eastern countries except Syria and Yemen, while Egypt and Morocco are the only countries in North Africa where food availability is greater than the ability to buy it.

Natural conditions are a critical limiting factor in developing agriculture in these countries and make the region dependent on food imports. The most important natural-geographical features, such as lack of water, desert climate, and desert land, largely shape the structure and development of economies in the region.

Lack of water is a key obstacle to the development of agriculture, many branches of industry, and the cause of constant and growing insecurity about domestic food supply. In most parts of the region, land cultivation is impossible without abundant irrigation. However, using scarce resources is not feasible because limited amounts of water are often not enough to meet the population's basic needs. Despite their great length and amount of water, the key rivers in the region are not enough to meet the requirements for water and food of the countries through which they flow, much less the entire region. Furthermore, "the region is predicted to become hotter and drier in the future due to climate change" (OECD/FAO, 2018, p. 70). Comparative data for 1972 and 2014 on water availability per capita indicate an alarming reduction in the available amount of water in the Middle East. This amount has been reduced 2 to 20 times depending on the country in just 30 years. Oman and Bahrain have almost no water, but the population of Egypt is also endangered,

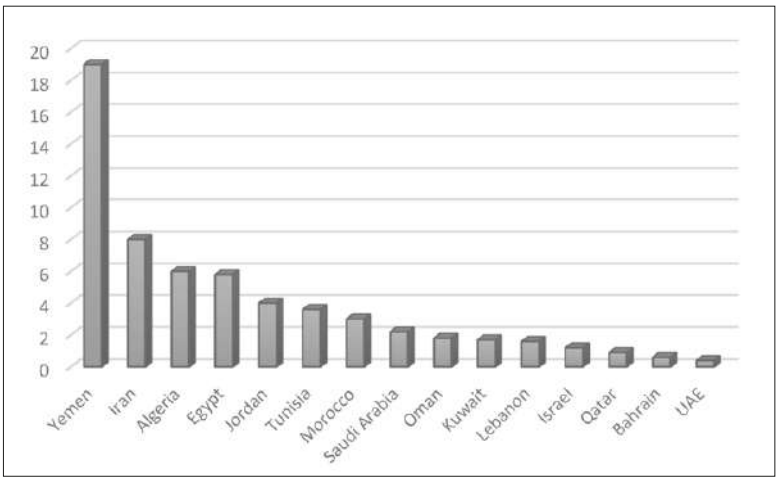

Figure 1 - Imports of cereals by MENA countries (% of total imports).

Source: The author according to the UN Comtrade data.

which, despite the Nile River, has no more than a symbolic amount of clean water per capita (Nin-Pratt *et al.*, 2018, p. 20).

Due to such natural conditions, the countries of the MENA region have much higher food imports (about 13% of total imports) compared to the world average (8% of total exports), as well as a huge trade deficit (World Bank Indicator, 2020). Due to the increasing demand of the rapidly growing population, food imports have been growing further (Hedoui *et al.*, 2019). Regarding the import of cereals, whose potential export from Serbia is the subject of this research, the relationship is even more unfavourable. Over the last 20 years, the share of domestic cereal production has been only 37%, while on average, in the world, this share is around 95% (Harrigan, 2014).

Cereal imports account for 40% to 50% of total food consumption in the region, and it reaches 70% (ESCWA, 2017) in Yemen and Lebanon. At the country level, food imports account for at least 7.2% of UAE merchandise imports and as much as 40% of Yemen's imports. As cereals participate in the total imports of the countries with very different shares, this cannot be observed at the level of the entire region, but the markets must be analysed separately.

Cereal imports are high in the poorest Yemen, with over 19% of merchandise imports and 8% in Iran, Algeria, and Egypt. At the same time, in the rich countries of the Persian Gulf, this share is minimal. The share of cereal imports accounts for less than 2% of total merchandise imports of Qatar, UAE, Bahrain, Kuwait, Lebanon, and Israel (Figure 1).

Differences in imports are not the result of differences in natural conditions but the degree of economic development. It is noticed that the share of grain imports is inversely proportional to the development of the economy. This is quite common because the import of other products dominates in richer countries, with a higher processing degree and higher prices, so that the import of basic food products, despite its huge amounts, represents a smaller part of the import.

Table 2 provides an overview of imports of basic cereal species from the countries of the MENA region, both in terms of value and quantity.

In recent years, MENA countries have been hit hard by global food price rises during and after the global economic crisis (Ianchovichina *et al.*, 2012), which pointed to numerous problems of dependence on imports of vital products (Woerz, 2017; Hedoui *et al.*, 2019). Governments in the

Table 2 - MENA import of the main type of cereals (2020).

Cereal	*HS cod*	*Imported value million US $*	*Quantity 1000 tons*
Wheat	HS 1001	11451	46326
Maize	HS 1005	6952	35416
Barely	HS 1003	2089	6614
Oats	HS 1004	31	78

Source: Author's calculation based on ITC data.

region are trying to tackle the problem of import growth and the price of food imports by changing economic policies in two directions. The first is a new concept of buying fertile land abroad to produce food for domestic consumption (IFPRI, 2012). Hurrigan calls this new approach to food security in the Arab states "macro-food sovereignty" (Hurrigan, 2014). The second approach is more common and involves the return of many governments in the region to earlier policies from the 1970s when there were numerous, mostly unsuccessful attempts to increase domestic food production.

The first strategy is the simplest and most efficient solution to the problem of food supply. Still, the costs of extraterritorial production are not lower than when imported. The initial investments exceed the possibilities of most countries in the region by far. This can be a successful strategy for a very small number of countries.

As for the second strategy, increasing domestic food production instead of imports is possible to some extent, but with additional consumption of water and land. Dependence on the imports of strategic products is always an unfavourable solution. Still, on the other hand, this situation can be observed the other way around: food imports contribute to more efficient water and land management. No country in the region can give up large-scale food imports. The most important goal of managing resources and the economy for each country is to find the optimal balance between water and food needs in terms of volume and the type of food.

As cereals require much more water and land than some other crops, imports of the four main grains: barley, corn, rice, and wheat, enable countries in the region to save significant amounts of water and land needed for population and agricultural production of other, traditional crops. In the example of Egypt, the import of 8.3 million tons of wheat saved 7.5 billion m^3 of irrigation water and 1.3 million ha of land (Lee *et al.*, 2019). These are the necessary resources for intensifying the production of traditional agricultural products, for which there are relatively favourable conditions: olives, dates, cotton, and others.

2.2. *Advantages of Serbia as an exporte of agricultural products*

In contrast to the countries of the MENA region, Serbia has relatively favourable conditions for food production. About 57% of the area of Serbia (5 million hectares) is agricultural land, which allows agricultural production to significantly exceed domestic needs. Arable land covers about 3 million hectares, while the rest are orchards, vineyards, meadows and pastures (Ševarlić, 2015).

Serbia has potential for additional production of high quality and healthy products, both conventional and organic, for the needs of the domestic market and for export (Đurić *et al.*, 2017). Agro-climatic conditions are favourable, with sufficient rainfall for almost all crops even without irrigation, temperate climate and relatively fertile land, as well as a wide range of agricultural products. A significant advantage is that Serbia is one of the leading European producers of cereal seed material, with several reputable development institutes. This enables it to develop different varieties of cereals in accordance with its own conditions and the needs of export markets (Babić *et al.*, 2016).

Serbia is a large producer and exporter of wheat and corn. Corn production in 2020 amounted to 7.3 million tons, and wheat 2.9 million tons (Statistical Office of the Republic of Serbia, 2021). In terms of maize exports quantity, Serbia is the fifth country in the world, behind the USA, Argentina, Ukraine, and Brazil, whose area is several hundred times larger than Serbia (Knoema, 2019). This is a remarkable achievement and is based on very high productivity given the very small territory. In terms of wheat productivity per hectare, Serbia is second behind the EU, with 5.6 t/ha, while corn productivity is in fifth place globally with a production of 6.7 t/ha (Saković, 2019). Corn is in second or third place in the total export of Serbia, in which it participates with about 3%.

Wheat has a significant share in agricultural production, but the share in exports is about 0.3%. At the international level, Serbia is the 8th largest exporter of corn and the 14th largest exporter of wheat globally (Index Mundi,

Table 3 - Serbian exports of cereal (millions of USD $).

	2018		*2019*		*2020*	
	Total	*MENA*	*Total*	*MENA*	*Total*	*MENA*
Corn	252.6	1.8	530.4	3.2	644.6	2.4
Wheat	195.1	0.00	51.2	0.00	89.0	0.00
Soya beans	31.6	1.3	71.9	0.4	108.7	0.01
Barley	14.5	0.02	9.6	0.02	16.2	0.06
Oats	0.3	0	0.5	0	0.3	0

Source: Author's calculation based on ITC data.

2021). In 2020 Serbia exported 3.5-3.6 MT of corn (depending on the source) and 436,000 MT of wheat (Statistical Office of the Republic of Serbia, UN Comtrade, ITC). The value of export of corn and soybeans are on a sharp rise in 2019 and 2020, while exports of other cereals have large oscillations (Table 3).

Despite the outstanding results in the production and export of cereals, a very small part of Serbia's cereal exports is placed on the MENA market. In 2020, the total corn export of Serbia amounted to 644 million USD, of which only 3 million USD was placed on the MENA markets, more precisely in six countries: Iran, UAE, Qatar, Algeria and Morocco (ITC, 2020). Export of other cereals to the region are statistically insignificant (Table 3).

This is a very small share of the region in the total export of Serbia if we keep in mind the geographical proximity of the Middle East, and especially North Africa from Serbia.

3. Data and methods

3.1. *Data set*

The type of research data is secondary, collected from UN Comtrade, based on Harmonised Standard (HS) classification. Besides data used for the main calculation of indices, data from the International Trade Centre (ITC), the Statistic Office of the Republic of Serbia, and Index Mundi, were also used.

Given the pronounced variability of production and even exports of agricultural products, the data were calculated based on a 3-year average depending on weather conditions and conditions. A preliminary review of exports in previous years showed a significant increase in Serbian grain exports over the past three years. Exports of corn have almost doubled, and barley exports have increased significantly, raising total exports of agricultural products. On the other hand, the export of oats and wheat, which participate less in the export of Serbia, has decreased. This is not just an incident but a trend. Therefore, only the latest data are included in the analysis, i.e. the average for 2018, 2019, 2020.

The analysis covers 11 countries in the Middle East and 5 countries in North Africa listed in Table 4. Due to the security situation, Iraq and Syria have no trade records for the recent period.

3.2. *Methods*

Several types of indices are most often used to assess more accurately the export potential of a particular product or group of products to specific markets. Indices have been the standard method for estimating foreign trade for several decades due to their simplicity, but above all, reliability.

The most commonly used is CC – coefficient of conformity, which occurs in research in several forms, ESI – Export Similarity Index, which was first presented by Finger and Kreinin (1979), as a means of measuring the similarity of the exports of any two countries to a third market, ICT – Index of Competitive Threat, RCA – Revealed Comparative Advantage, introduced by Balassa (1965), and the NRCA – Normalized Revealed Comparative Advantage, proposed by Yu *et al.* (2009), TCI – Trade Complementarity Index, introduced by Drysdale (1969), as well as TCI – Trade Complementarity Index by Michaely

(1996), SICT and DICT – Static and Dynamic Index of Competitive Threat, proposed by Jenkins (2008) and many others.

All of them consider the shares of different products in total exports and measure the extent to which two countries are "natural trading partners" in the sense that what one country exports overlap with what the other country imports.

The main idea of the index is to measure the extent to which one country's export pattern matches another country's import pattern more closely than it fits the pattern of world imports (Hoang, 2018). This research employs *the coefficient of conformity* (CC) as one of the most common indicators of import-export complementarity and Drysdale's (1969) Trade Complementarity Index (TCI).

The coefficient of conformity (CC) can be found in literature in several similar forms. A Blázquez-Lidoy *et al.* (2006) version is used in this study, as the most used in literature, especially in the OECD studies. Other indexes are often used only by the organisation that created them or single authors. CC will be used only for a rough assessment of import-export potentials between Serbia and MENA countries in terms of cereals in general.

It is calculated in the following formula:

$$CC=\frac{\sum_p^n XipMjp}{\sqrt{\sum_i^n (Xip)^2 \sum_i^n (Mjp)^2}} \qquad (1)$$

where i stands for an exporter country and j for an importer partner; the subscript p shows different product groups; Xip is the share of exports of product p in the overall export of country i; Mjp is the share of imports of product p in the overall import of country j.

The results of the CC analysis have values between 0 and 1. Value 1 means perfect complementarity between country *i's* export and country *j's* import. By contrast, the values closer to 0 refer to a competitive trade structure. Trade competition is more likely if the exporting structure between two countries is quite similar (Blázquez-Lidoy *et al.*, 2006).

Much more precise and important results are expected from applying Drysdale's (1969) Trade Complementarity Index (TCI) to the trade in cereals, especially each individual type of cereal in the export range of Serbia. The great advantage of this model is that, in addition to the import of one and the export of another country, it includes global average import/export ratio trade in the target product. While the other mentioned coefficients exclude the possibility of assessing the role of the third party (importers and exporters of specific goods), TCI puts bilateral trade in the context of competitiveness in the world market.

The TCI can be presented as follows:

$$TCI_{ab} = \Sigma j^n \left(\frac{Xa^j}{Xa} \times \frac{Mw-Ma}{Mw^j-Ma^j} \times \frac{Mb^j}{Mb}\right) \qquad (2)$$

where X_a is the country a's export of commodity j; X_a is country a's total export; M_w is the world import; M_a is country a's total import; M_w is the world import of commodity j;^jM_a is the country a's import of commodity j; M_b is the country b's import of commodity j. M_b is country b's total import.

The value of TCI greater than 1 indicates the existence of strong complementarity between the export specialisation of a country a and the import specialisation of country b, and conversely, an index of less than 1 shows weak complementarity and low prospects for trade improvement. The TCI value 1 means that the export and import specialisations are similar to the world economy specialisation. Therefore, the existence of comparative advantage cannot explain bilateral trade.

Both indices actually determine the export-import structure of two countries in terms of a selected product group. To assess the compatibility of the economies of Serbia and the MENA countries, the import-export match coefficients CC and TCI were applied to the cereals sector.

4. Results and discussion

The results show that Serbia does not use significant potentials for grain exports to the MENA region. Table 4 highlights all fields that indicate significant import/export compatibility according to the above methodology. Both indices show a high degree of complementarity between Serbia and all Middle Eastern econ-

Table 4 - Compatibility of Serbia and MENA countries in terms of cereal trade.

Country	*CC*	*TCI*
Iran	0.993	5.344
Israel	0.986	0.793
Lebanon	0.990	1.076
S. Arabia	0.971	1.685
UAE	0.976	0.311
Qatar	0.977	0.635
Oman	0.988	1.111
Kuwait	0.987	1.148
Yemen	0.984	12.689
Bahrain	0.990	0.391
Jordan	0.985	2.701
Egypt	0.979	4.131
Algeria	0.981	2.451
Libya	0.976	3.446
Morocco	0.990	2.286
Tunisia	0.995	2.486

Source: Author's calculation.

omies in terms of cereal trade. The CC ranges from 0.97 for Saudi Arabia, which has relatively favourable conditions for exporting cereals, to 0.99 with Iran, Lebanon, Oman, Kuwait, Bahrain, Morocco and Tunisia (Table 4).

The Trade Complementarity Index (TCI) confirms high complementarity because in many but not all countries, it shows amounts far higher than 1. The TCI shows that Serbian grain exports could first increase to Yemen, Iran and all five North African countries (Egypt, Libya, Algeria, Morocco and Tunisia) (Table 4).

The application of the TCI index to the most important individual products in the group of cereals is shown in Table 5. Wheat and corn, as the most important agricultural products in Serbia, have excellent compatibility with the markets of the Middle East. Trade compatibility concerning these two cereal types has a TCI value greater than 1 (shaded fields) in most countries of the region (Table 5).

Table 4 highlights all the fields that, according to the above methodology, indicate import/export compatibility. The greatest complemen-

Table 5 - Trade Complementarity Index (TCI) of Serbia and MENA countries: cereals by types.

Country	*Maize HS 1005*	*Wheat HS 1001*	*Soya beans HS 1201*	*Barley HS 1003*
Iran	82.12	0.00	2.16	4.23
Israel	7.95	2.74	0.22	0.00
Lebanon	10.39	3.26	0.22	0.72
S. Arabia	7.49	0.73	0.12	3.11
UAE	0.69	0.61	0.01	0.34
Qatar	0.61	1.01	0.00	0.55
Oman	2.97	2.88	0.00	1.02
Kuwait	2.34	1.63	0.00	0.23
Yemen	52.13	42.60	0.00	0.25
Bahrain	0.57	1.05	0.00	0.17
Jordan	9.74	4.39	0.00	2.17
Egypt	43.06	18.04	0.00	0.76
Algeria	15.59	10.35	0.00	0.17
Libya	29.49	16.78	0.04	0.22
Morocco	10.17	7.09	0.70	0.37
Tunisia	8.11	4.26	0.21	0.32

Source: Author's calculation.

tarity in terms of corn exports is observed with the markets of Iran, with a TCI of as much as 82, Yemen with 52, Egypt with 43. Still, complementarity is also emphasised with other countries in the region. The only exceptions are the UAE, Qatar and Bahrain.

Potentially the most important export markets of Serbia for wheat are Yemen, Egypt, Libya, Morocco and other countries except Iran, Saudi Arabia and the UAE.

Other cereals that have a certain share in some countries' imports are soybeans and barley. The complementarity of Serbian barley exports is relatively high with Iran, Saudi Arabia, and Jordan imports. Soybeans can be a significant export product only to Iran (Table 5). Due to the small oats production in Serbia, no assessment of TCI has been made for this cereal.

As the export markets require to be defined more precisely, the most important result of the quantitative research is actually the differences between the markets. According to the TCI values, Yemen stands out as a market, with an index of 12.6. Given the long-running civil war, the stagnation of its economy and the inability to pay, Serbia's export strategy should not be aimed at this country. The same is true for Libya, which has shown high complementarity with Serbian exports of all cereals. Still, this country is volatile in terms of security due to deep internal turmoil and conflicts that have been ongoing since the removal of Muammar Gaddafi and the Arab Spring in 2011.

Unlike significant compatibility variations with the countries in the Asian part of the Middle East, compatibility with all five North African markets is very high. At the same time, the realised export to these countries is almost symbolic, as presented in Table 2. The value of corn exports to the Asian part of the Middle East is several times higher than North Africa. This difference is not proportional to the size of the market and the smaller distance of Serbia from North Africa than from the Middle East.

There is obviously high compatibility in food production, especially cereals, between Serbia and the MENA countries. As the data showed, this compatibility is not reflected in the realised exports.

The implications of the survey results show that there is no significant potential to increase exports of any cereals to Yemen, Morocco, UAE and Qatar, as well as Iraq and Syria, which are not even included in the analysis due to the security situation. The application of import/export coefficients shows that Yemen stands out as the most important market. Still, given the long civil war and less affordability to pay for food than its availability, this market is not of interest to Serbia. In addition, in Yemen and Morocco, food affordability is significantly lower than availability (Table 1), which further reduces their importance as export markets. The UAE and Qatar, although they have high purchasing power, are not targeted markets for grain exports from Serbia, as TCI has not shown import/export compatibility for any type of grain.

The results also imply no potential for a significant increase in exports of oats, barley and soya beans to MENA countries. As Serbia's most important agricultural products, wheat and corn have the greatest compatibility with the MENA markets. For soybean exports, Iran is depicted as a potentially significant market, while barley exports have significant compatibility with imports from Iran, Saudi Arabia and Jordan. However, these cereals have low import needs and modest export potential, so policy implications are relevant only for corn and wheat exports to the 12 remaining countries.

For the export of corn, as one of Serbia's most important export products, potentially the most important markets are Iran, then Libya, Israel, Saudi Arabia, Lebanon, Algeria, and Egypt. These countries have a high index of trade compatibility with Serbia. In addition, their key suppliers of corn are countries that are not large producers or are not corn producers at all, but only resellers. Relations with Iran deserve a special place in trade policies. This country is a major consumer of food and a key distributor for other countries in the region. Trade coincidence between Serbia and Iran is very high in corn exports, and Iran is one of the largest importers of corn in the world. Serbia and Iran have recently intensified trade cooperation, but only in one direction. Serbia's imports from Iran multiplied in 2015-2019 (UN Comtrade), while exports re-

mained unchanged. This leaves room for Serbia to negotiate higher exports of corn, whose average value in the previous period was about $ 1.5 million. This would not be to the detriment of Iran, as its largest suppliers of corn are Switzerland, the Netherlands and Singapore, which are in fact trade intermediaries, from which Iran imports $ 200-300 million worth of corn a year.

Algeria, Libya, Lebanon, Israel, Saudi Arabia, and Egypt also do not have particularly favourable supply options. They import corn from large producers such as Argentina, Brazil, USA, with high transport costs, then from Romania, which actually buys 70% of corn from Serbia and their neighbours who are also importers.

The most significant potential increases in exports can be realised to Libya, Algeria, Egypt, and Lebanon when it comes to wheat exports. The trade compatibility index is slightly lower than in the corn trade, but it is still high. These countries import wheat from some of the largest producers, such as Ukraine and Russia, and in the case of Algeria, France. Serbia is not competitive with these exporters in terms of price, nor can it meet a significant part of the needs of these markets with its production volume. However, in Lebanon and three North African countries, there are countries with which Serbia can compete as large suppliers of wheat. These are Romania, which, in addition to its own, resells wheat from Serbia and other Eastern European countries, Canada, the USA and Australia due to high transport costs.

5. Conclusions and policy implications

Based on the assessment of the limitations of natural conditions in the MENA region and the characteristics of Serbian agriculture, the cereals sector stands out as particularly important for both parties. Due to the scarcity of natural resources, especially water and arable land, the production of cereals in the MENA is economically unprofitable, i.e. mostly more expensive than imports. No country in the region can meet the demand of the domestic food market with its own production, which is why food imports have a more significant share in total imports than the world average. Some exceptions are Egypt, Morocco, Tunisia, which have relatively developed agriculture, but even there, the production of key products, especially cereals, has an extremely low level of efficiency.

Although the dependence on the imports of strategic products is generally an unfavourable position of the MENA countries, the import of cereals is more rational for these countries than domestic production. Given that cereals require large areas per unit of product, domestic production is not rational regarding a very scarce area of arable land in the region. Also, cereals require more water than provided by the natural supply of the region. The import of cereals enables the scarce resources to be used more usefully, to intensify the production of traditional agricultural products for which there are favourable conditions and demand on the international market: olives, dates and other products specific to this region.

The import of cereals is of strategic importance for all the countries in the region, while at the same time, this is one of the most important Serbia's export group of agricultural products. High trade compatibility is the best and longest-lasting basis of foreign trade.

It is interesting that Serbia, which has traditionally had excellent trade and friendly relations with MENA countries, simply neglected these trade routes and limited exports to Romania and Italy. In recent years, restoring traditional friendly and economic relations with Arab countries has been a significant part of the Serbian government's foreign policy. Most of the initiatives in the field of investment and trade have received a positive response from these countries, and many projects are being successfully implemented. However, trade in agricultural products, especially cereals as a key comparative advantage of Serbia over MENA countries, has not been the focus of bilateral relations with these countries.

The research confirmed extremely high compatibility between the exports of Serbia of the whole group and certain types of cereals, with the import of the MENA. In most papers of complementarity in agricultural trade, these indices are far lower than those obtained in this study. This is especially true for research on the complementarity of markets in the same geographi-

cal region, as agriculture is largely determined by natural-geographical conditions. Thus, the aforementioned Hoang's (2018) application of TCI in ASEAN countries showed extremely low values, almost close to zero and found that food trade within the region has no potential to increase. Even in articles that have applied import-export coefficients to countries with different natural geographical conditions, such as China and trading partners along the Belt and Road (He *et al.*, 2016), their value is far lower than that obtained for corn trade and wheat between Serbia and MENA countries. It should be added that the coefficients in these papers were not applied to individual products but to entire groups of food products, which multiplies the probability of compatibility.

Specifying export destinations is particularly important for Serbia due to its very limited production and export capacities. Therefore, it was necessary to determine a smaller number of markets in which the placement of cereals would be easiest to increase.

Policy implication derives from the above data on a) MENA markets in terms of affordability, availability and quality of food; b) results of statistical research on import/export compatibility between Serbia and each individual MENA country of each type of cereals that Serbia exports, and c) assessment of whether Serbia is competitive in such targeted markets concerning their current suppliers. The situation with procurement from resellers is mentioned, but due to the abundance of this data, it is not described in detail in the text. These data (based on ITC, 2020) serve as additional information on markets that have proven to be desirable based on the first two criteria.

Based on these three criteria, the results showed that for corn exports, the largest potential markets are Iran, then Libya, Lebanon, Algeria, Egypt, Israel, and Saudi Arabia, while for wheat, it is Libya, Lebanon, Algeria, Egypt. These are markets that have shown a high degree of complementarity with imports and exports from Serbia, significant affordability for food imports and have suppliers that are not substantial competitors to Serbia in terms of exports of certain cereals.

Since they are in most of the same countries, Serbian institutions have additional reasons to put these countries in the focus of economic policies. The results imply that significant adjustments to Serbia's trade policies regarding cereal exports are needed.

Significant potential for increasing exports of corn and wheat to target markets has to be supported by the initiative of:

- chambers of commerce (central and several regional);
- Ministry of Foreign Affairs through embassies in these countries;
- Development Agency of Serbia (RAS) and other state economic entities and diplomatic missions.

Even if they are large companies, producers in this sector alone cannot take significant export initiatives. Namely, the purchase of cereals in Serbia is centralised; no producers independently export these products in raw form. The state has a wide range of mechanisms of influence on both trade and foreign policy relations. The Ministry of Agriculture also cannot play a significant role in increasing exports. Still, together with producers, it should enable an increase in production for export.

Based on the experience in cooperation between Serbia and MENA countries in other segments of the economy, it may be recommended to include Arab partners in joint investment projects to increase the quantity or certain types of food to supply the MENA region.

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The performance of the Tunisian olive oil exports within the new distribution of world demand

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Abstract

The present work aims to analyze the performance of the Tunisian olive oil exports compared to its main competitors (Spain, Italy, Greece, Turkey and Portugal) during the last fifteen years, on the European market and four potential markets: the United States, Canada, Japan and Brazil using the Shift Share Analysis, in order to identify the main sources of change. The period 2011-2015 was a boom period for Tunisia in all studied markets. The gain in Tunisian competitiveness on the new markets (Canada, Japan and Brazil) is related to the growth of their global imports and the competitiveness of Tunisian exports reinforced by the superior quality of Tunisian extra virgin olive oil and the recourse to packaged oil. The results indicate that the maintenance of a sustainable international competitiveness of Tunisia on the olive oil market depends on its domestic production and that of its European competitors, to which is added recently the Turkish competition, policies and trade agreements that must be negotiated and requires the improvement of its non-price competitiveness.

Keywords: *Olive oil, Competitiveness, Exports, Shift share, Tunisia.*

1. Introduction

Olive oil represents an economic activity of considerable importance for Tunisia, in addition to its great cultural, social and environmental significance. During the period "2016-2020", Tunisia produced 206 thousand tons of olive oil, of which 180 000 tons were exported. The olive oil sector contributed for 8% to the value of the total agricultural production and for 36.6% to the value of food exports in 2021 (NOAT[1], 2021). Olive oil export receipts covered the import expenses of seed oils and generated a surplus that contributed to the reduction of the chronic deficit of the trade balance.

At the international level, Tunisia is ranked the second world producer of olive oil after the European Union and the fourth exporter, behind Spain, Italy and Greece.They contribute, together, to over 75% of production and have a comparative advantage in the production and export of olive oil (Kashiwagi *et al.*, 2020; Klonaris and Agiangkatzoglou, 2018). Tunisia contribute with 10% of the world production and 20% of total exports. The main export market is the European Union being since the seventies the tra-

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ditional market for Tunisia (60% of total export sales). However, consumer awareness with respect to Tunisian olive oil in the EU is low. This owes in part to the fact that most of the olive oil is exported in bulk and to the practice of European importers to mix Tunisian olive oil with other olive oils without being obliged to declare its Tunisian origin (Weber *et al.*, 2019).

In recent years, Tunisian exporters have to some extent succeeded – but continue to struggle – to diversify markets (Asia, US and Canada) and to increase the share of bottled and branded products. However, since 2012, Tunisian exports faced several difficulties due on one hand to the strong fluctuation of prices in world markets and on the other hand, the increase of national production costs exceeding international market prices (NOAT, 2021). According to the (IOC, 2021a), the world production has increased by 27% passing from 2564 to 3266 thousand tons from 2017-2020 while world consumption has increase only by 6%. Consequently, this tendency has generated a drop in prices on several markets with high levels of world stock, notably European union (EU) markets, where the price of extra virgin olive oil was 33% lower than the five last years. Indeed, in Tunisia, the reference prices of olive oil have fallen significantly in response to the considerable decrease in export prices (7.08%) (ONH, 2020).

This crisis situation in international markets has directly impacted the Tunisian market where production increased at 142% in the last successive campaigns compared to 2013 (IOC, 2021b). However, exports has frozen to the EU at a level 127 thousand tonnes (57,000 tons under the preferential quota allowed by the free trade agreement with EU (ALECA agreement) and about 70,000 tonnes under bilateral regime called TPA regime for temporary exports to Italy), generating an export potential of around 93,000 tonnes that Tunisia must to sell for non-EU destinations.

On the national level, Tunisia suffers from a lack of innovation, and the high cost of packaging. In addition, the demand on the national market is characterised by a low level of consumption equivalent to 44 thousand tonnes (about 3.8 kg by capita). This consumption could not help to absorb part of the non-exportable surplus (about 88 thousand tonnes in 2020) due to the competitive prices of seeds oil subsided since 1970 by government to encourage exportation of olive oil.

Although production and exports have increased substantially, the Tunisian olive oil sector faces many challenges, including (i) high volatility of olive oil exports; (iii) dependence on the EU market; and (iv) a large share of bulk exports in total olive oil exports which makes export opportunities in new markets limited.

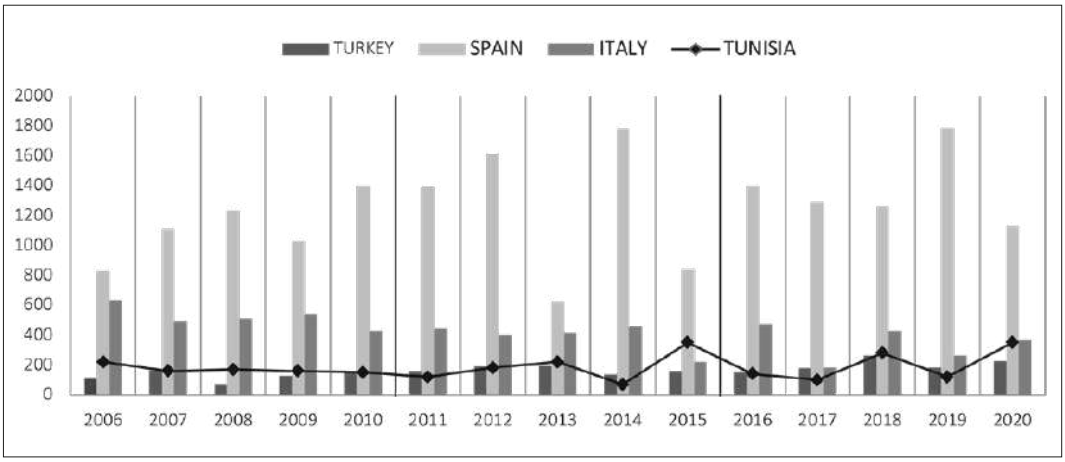
Under this context, the main research questions of this study are as follow:

- Is Tunisia facing the end of the golden era for exports to EU market?
- Does the EU market still constitute a promising market in case the Tunisian production of olive oil increases?
- Does the market share of Tunisian exports on the European market and non-European imports markets follow the evolution of Tunisian production or the evolution of European demand?
- Are Tunisian exports dependent on other factors: qualitative, marketing or others such as the volume produced by European competitors, mainly Spain, Italy, Greece and Portugal?

The objective of this study is to analyse the competitiveness of the Tunisian olive oil and more precisely the evolution of its market share on different world markets, especially the EU market, the traditional importer of olive oil in Tunisia, and four other potential markets (United States, Japan, Canada, and Brazil). Competitiveness is analysed through a shift share method applied for the main destination countries. This approach is uses to assess the export performance of Tunisia compared to its main competitive Mediterranean countries. Export performance will be explained by the evolution factors of the market share during three periods (2006-2010, 2011, and 2016-2020) of each country's exports relative to the total quantity of imports of each target market.

This paper is structured as follows: Section 1 presents the evolution of international and national olive oil exports according to the changes

Figure 1 - Evolution of the world olive oil production by country (thousand tons) (2006-2020)



Source: Own elaboration from IOC, 2021b.

in the world market. Section 2 develops the literature review of competitiveness focusing in the method used in the present study. In section 3 the methodology of the study is explained. Sections 4 and 5 present results and discussion separated and finally, section 6 proposes policy implications and some future recommendations to help decision of olive oil operators.

2. Evolution of international olive oil market and positioning of Tunisia

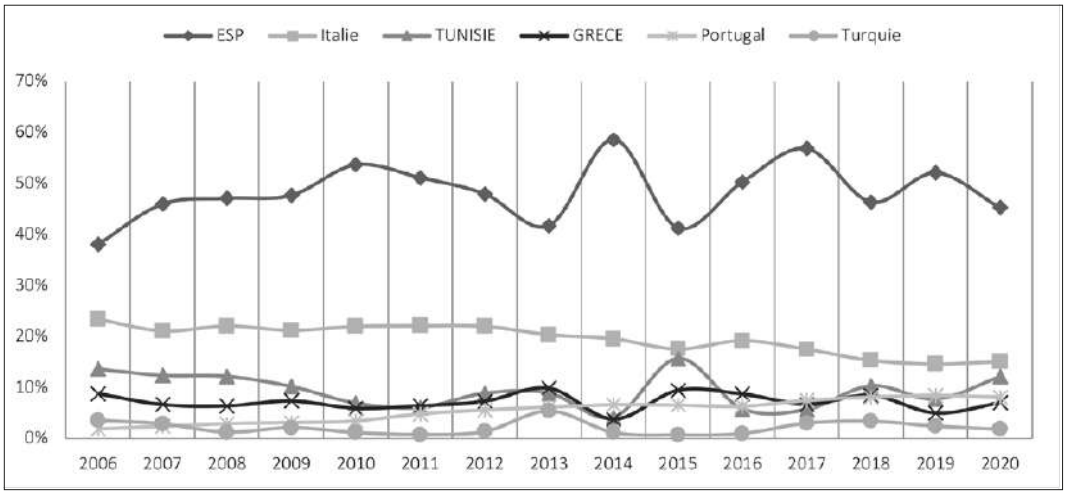
The world olive oil market is traditionally characterized by a concentration of production and demand within the countries of the Mediterranean basin, mainly the countries of the European Union (EU). Spain and Italy cover together 79% of the world's production and 60% of total exports between 2006 and 2020. In second place, some Mediterranean producers hold significant shares of global production including Greece (11%), Tunisia (6%), and Turkey (5%). Since 2006, olive oil sector has known a period of expansion of world production (from 2495.5 thousand tons to 3321 thousand tons). However, after this period of high production growth a strong instability was observed since 2013 mainly for Spain, Italy (Figure 1).

Thus, world production was characterized by the frequency of fluctuations having a significant impact on the instability of the world market in terms of quantity and price, which have altered the profitability and competitiveness of south Mediterranean countries (Karray, 2012). Both leading producers and exporters of olive oil in the world, Italy and Spain in 2015, saw their production drop by 35% from 463 to 300 and by 53% from 1781 to 841 thousand tons respectively, due to the *Xylella fastidiosa* bacterium which had decimated thousands of olive trees in both countries. Over the past three campaigns, world production has resumed its growth rate, notably in Spain, Italy and Tunisia (Figure 1) but a significant imbalance in the world market continues to occur, leading to high volatility in world prices.

At the same time, these fluctuations were accompanied by the emergence of new producers such as China, the United States and Australia, which have already increased their production, with the establishment of intensive and super-intensive agricultural systems. This change had also a significant impact on the instability of the global market.

Since, 2016-2020, the Mediterranean producing countries tacked a more active export policy to expand this product and diversify exports outside their traditional markets following the new dynamics of supply and demand in American and Asiatic markets. Italy and Spain remain the first two suppliers of the international market despite the decline of their exports in 2015. In

Figure 2 - Evolution of olive oil exports shares by country (%), 2006-2020.



Source: Own elaboration from IOC, 2021b.

the same way, Tunisia recorded its highest average of exports during the five last years (220 thousand tons compared to 110 thousand tons between 2006-2010, thanks to its record production registered in 2015, 2017 and 2019 (340 thousand tons).

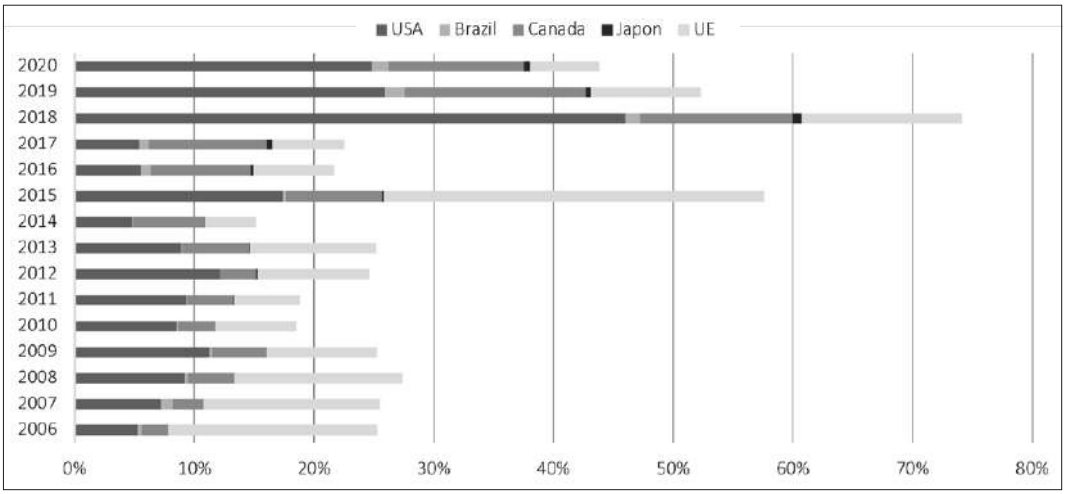
Despite the COVID-19 pandemic during the campaign 2019-2020, Tunisia has exported 365 thousand tons of olive oil with a total value of about 2.23 billion dinars (which contribute to about 4,25% of the state budget for 2020), to 54 countries (NOAT, 2021). For this campaign, Tunisia has occupied the first rank of the world's olive oil exporting countries in volume, outside the European Union. The main destinations of Tunisia's olive oil are the European and American markets, and more recently the Asian one. In spite of its respectable share in EU imports (75% of non-European imports), Tunisia did not maintain its market share in its traditional markets passing from 18% in 2006 to 6% in 2020 in EU, except for the year 2015 when the Italian and Spanish production recorded a significant decrease (Figure 3). At the same time, Tunisia has successfully diversified its markets for the export of olive oil by turning to other destinations such as the United States of America (USA) where Tunisian exports have increased from 5% in 2006 to 25% in 2020 and Canada passing from 2% to 11% for the same period, to which are added Brazil and Japan which have become major destinations in recent years with imports from Tunisia respectively 1 484 and 307 thousand tons in 2020 (Trade Map, 2021).

Moreover, the expansion of free trade and the emergence of new exporting countries such as Turkey, Syria, Portugal and recently some Latin American countries has placed Tunisia in front of new challenges to maintain its competitiveness on the world olive market.

In recent years, coinciding with the economic crisis, the sector has been going through a period of uncertainty that gives rise to great concern. Prices have fluctuated sharply, with a downward trend since 2010, and operating margins have been reduced, putting many farms in a situation that threatens their survival. This situation has revealed inefficiencies and structural problems that were latent in the sector, as well as the growing of competitiveness on European markets due to the market liberalization and the latest reform of the Common Agricultural Policy on 2013 moving from a highly protected sector to open market rules. All these factors have revealed the need to improve the functioning of the Tunisian olive oil commercialization and to promote export's competitiveness and efficiency due to its strategic importance for the national economy and its role in the balance of trade equilibrium.

However, the prevailing issues of the olive oil

Figure 3 - Evolution of the Tunisian share of olive oil exports on the main destinations (%), 2006-2020.



Source: Own elaboration from Trademap database, 2021.

sector in Tunisia remain its low productivity and limited progress achieved in terms of competitiveness, resulting from constraints in generating radical or incremental innovations – especially process-related – and weak financial capacity and low investment especially due to small and scattered farmers (lack of cooperatives), an oligopoly of private exporting operators (c. 40% share of the market) who control exports in parallel with the national olive oil office (ONH).

3. Literature revue: Competitiveness analysis context

Trade competitiveness has been analysed over time in a variety of ways. The simplest approach has been to improve the structural competitiveness of a sector or country through different indices (specialisation, dependence, market share, prices competitiveness, exchange rates…). The simultaneous use of these indicators provides an explanation of the comparative advantage in a market of perfect competition where products are homogeneous (Balassa, 1965; Alonso, 1990). In the case of agricultural products, these assumptions were quite realistic until the nineties and there have been numerous works analysing international agricultural trade. However, agricultural products are increasingly subject to manipulation and transformation – losing their homogeneous and eminently agricultural character – in order to become more differentiated (Thompson, 1981). In recent years, a number of changes have occurred whereby agricultural products are no longer homogeneous; differentiation has been imposed by new consumer demands, agricultural production has become concentrated in a few countries, leading to imperfect competition, and trade in agricultural products has become highly intra-industrial in character Alonso (1990).

The recognition that agricultural products are not perfectly homogeneous leads to import markets diversifying their external sourcing of products with a consequent product differentiation by country of origin. This led to the development of new market trade flow analytical models. In the case of agricultural products, a variety of approaches based on trade flows have been used. For this reason, multi-regional models started to be used, based mainly on simultaneous systems of individual equations that reflect the behaviour of several trade regions and their interrelationships across the world market. There are 3 classes of multi-regional models: 1) non-spatial equilibrium price models, 2) spatial equilibrium price models and 3) market trade flow models. These three models differ in the way that prices or quantities are determined. The first two models allow for the analysis of interrelationships

between countries and consider that the products exchanged are perfectly homogeneous, (which is true even for agricultural products) while the last one do not provide information on trade flows and market shares and focus more on export prices elasticity's and their effect on trade.

Since then, work has been carried out to estimate destination-based export demand equations, market share equations and elasticities of substitution for various agricultural products where the most general assumption has been differentiation by country of origin. Within these models, two different approaches can be distinguished. The first one, which uses share market desegregation in factors for analyzing trade flows without taking in account the role of prices (constant market shares such as shift share approach, Markov models, etc.). The second approaches based on elasticity prices incorporate product differentiation and impose a priori many assumptions and restrictions such us homogeneity, constant elasticity of substitution in the framework of a complete import system (Armington, 1969; Winters, 1984). The findings of the study indicated that EU demand for dates has with regards to constant share applications, this approach seems to be easier to be applied and it has largely been used in numerous agricultural trade studies due to the fact that the statistical information required is very elementary and the analytical possibilities that it offers are quite large. Lakkakula *et al*. (2015) analysed changes in country shares of global rice exports from 1997 to 2008 using a shift-share analytical framework. Their results indicated a growing concentration among a few exporting countries in the global rice market, and the competitiveness effect is often significant. Government policies affecting rice trade and the competitiveness of trading partners are identified as important factors for the shifts in rice trade patterns. To analyse the competitive position of Tunisian date exports to the European Union market, Chebbi and Gil (2002) used is a shift-share competitiveness matrix considering five markets within the EU: France, Italy, the United remained stable over the last years. Tunisia is the main supplier within the EU, France and Italy being the main destination of Tunisian exports. Albisu *et al.* (1987) and Alvarez-Coque, Bautista (1994) for vegetables and citrus foreign trade in Spain can be highlighted.

Several studies were conducted to analyze the competitiveness of olive oil exports. In their study Türkekul *et al.* (2010) used the constant market share analysis to determine the competitiveness of Turkey, Spain, Italy, Greece and Tunisia in the US, Australia, Canada, Brazil and Japan olive oil markets during two periods. Their findings showed that Tunisia was the most competitive country; however, the competitiveness of all the discussed countries decreased during the periods studied. This study concludes that competitiveness in the international market depends on production, organization and trade policies. Mokrani *et al.* (2011) used also Shift share to study the competitiveness of Tunisian olive oil on three markets, European, Canadian and American between 1997 and 2006. In this study, Both Canadian and American markets have been retained as expanding markets while considering Australia, Argentina, Syria and Chile as the main competing countries for Tunisia.

This work proposes to apply the Shift share method thanks to the usefulness of separating and quantifying the contribution of a country's business structure (market and product composition) to business performance, as well as qualifying the contribution of other factors which is the purpose of this paper. The overall growth of imports in each market (market effect), Tunisia's domestic export potential (extra-market effect) and the Tunisian capacity to maintain its share market in relation to its main competitors (residual effect or international competitiveness).

Although the model does not provide a detailed explanation of why exports grew as they did, because prices are not considered, but it is useful for numerically dividing export growth into different components. In particular, the model also helps to identify where to look for explanations of export changes: either to structural and domestic factors or to competitive forces in order to well orient deciders in establish strategic plans. The application of the Shift-Share method chosen will allow the evolution of import flows to be broken down into three periods and five markets based on changes in market shares. Calculations were easy to be held and offer exactitudes because we work with quantities which avoid incertitude due to lack of constant prices and exchange rates effects.

4. Methodology

In order to analyse the competitiveness of Tunisian olive oil by the Shift-Share method, four main olive oil producing/exporting countries are considered: Spain, Italy, Greece, and Turkey adding Portugal in Brazilian market. This approach allows evaluating the performance of Tunisian exportations with those of its main competitors by comparing their behaviours on the different importing markets: European, American, Canadian, Japanese and Brazilian markets during the last fifteen years. This period is divided in this analysis into 3 sub-periods 2006-2010; 2011-2015 and 2016-2020.

The change in export quantities is expressed by the SSA analysis as follows:

$$\Delta Q\ exported\ =\ Eif\ -\ Eid$$
$$=\ Eid * Gy +\ Eid\ (Gextra\_y\ -\ Gy)$$
$$+\ Eid\ (Gi -\ Gextra\_y)$$

Where:

Y: the market considered in each analysis;

Eif: the exportations of olive oil from country i to market y during the period (f: end of period);

Eid: the exportations of olive oil from country i to market y during the period (d: beginning of period);

Gy: the rate of growth of total olive oil imports of market y;

Gextra_y: the growth rate of the total olive oil imports of the extra-y which represents the rest of the market;

Gi: the growth rate of exports from country i to market y;

Y_Effect = EidGy: the effect of the demand of the concerned market on the exports of each country.

Extra_y Effect = Eid (Gextra_y – Gy): the effect of demand from other markets (extra-y) on each country's exports.

Residual Effect = Eid (Gi – Gextra_y): the competitiveness component of each country. The relative values provide a measure of the performance of each exporter.

With:

Eif = (*Ei*2009 + *Ei*2010) /2: the olive oil exportations of country i to market y during the period 2009-2010 at the end of the period (f =2009-10, end of period).

Eid = (*Ei*2006 + *Ei*2007) /2: olive oil exportations from country i to market y during the period 2006-2007 at the beginning of the period (d = 2006-07, beginning of period).

The average annual growth rate is calculated by the following formula, which takes into consideration the variations in quantity during the studied period:

(exp(*S*/10) –1) *100 with:

$$\boldsymbol{S} = (\sum_{i=1}^{5} i * Ln\ Vi) - 3 * \sum_{i=1}^{5} Ln\ Vi$$

With:

Vi: the quantity of olive oil exported by the country studied to the market in question during year i.

The use of the exponential allows to follow the evolution taking into consideration all studied years, contrarily to the average which could hide some peaks.

The data used was collected from the databases and statistics of international and European trade, namely TradeMap, FAOSTAT, the Tunisian National Institute of Statistics (NIS), the Ministry of Agriculture, Hydraulic Resources and Fishing of Tunisia (MAHRFT), and the national customs agencies.

5. Results

5.1. *Competitiveness in European market*

During the first sub-period 2006-2010, Tunisian and Turkish exports to the European market decreased by 71681.5 and 11372.5 tons respectively, offering the first places to Spain and Italy. These results explain the unfavorable position of Tunisia shown by the negative component of the residual effect (Table 1).

During the second period 2011-2015, the increase of Tunisian exports allowed to an improvement in its competitiveness component thanks to the increase of European demand (positive market effect 79056.8) and the decrease of Spanish and Italian exports. This is due mainly to the high Tunisian production in 2015 coupled with a decrease of Spanish and Italian production in 2015 caused by the *Xylella fastidiosa* bacterium (Semeraro *et al*., 2019).

Table 1 - Shift-Share analysis of imports from the European E27 and US markets for the periods 2006-2010; 2011-2015; 2016-2020.

	Export growth		*Market effect*		*Extra market effect*		*Residual effect*	
2006-2010								
	EU	USA	EU	USA	EU	USA	EU	USA
Spain	134074.5	19651	1098792.3	78706.1	-862621.3	-37011.7	4821407.7	555232.6
Italy	16749.5	-4231.5	275954.6	298742.3	-216641.8	-140484.3	491486.2	-241828.5
Turkey	-11372.5	-4547.5	40551.2	28113.1	-31835.3	-13220.3	-609132.1	-221538.9
Greece	-4492.5	-440	223295.8	10252.6	-175301.3	-4821.3	-325186.6	-17465.3
Tunisia	-71681.5	10522.5	-1462842.1	41860.0	-289948.3	-19684.8	-2903937.1	256620.5
2011-2015								
Spain	63644.5	27536	599050.4	83153.4	2290188.7	94375.4	-3092586.1	445974.6
Italy	-4779.0	-17477	138744.5	159394.0	530424.5	180905.1	-876668.9	-942983.2
Turkey	-1417.0	-484.5	2334.0	4207.4	8922.9	1251.5	-34570.3	-111.9
Greece	6523.5	2108.5	99304.5	4559.3	379644.3	5174.5	-23546.9	51900.3
Tunisia	47465.0	1556.5	79056.8	41144.7	302236.7	46697.4	1165492.0	52601.4
2016-2020								
Spain	56293.0	33756	1625196.9	683900.0	-123928.8	-355449.2	173746.2	616652.1
Italy	-23289.0	191324	380178.9	632163.2	-28990.4	-328559.6	-1266869.4	1678487.8
Turkey	-5004.5	8268.5	51663.0	56986.6	-3939.5	-29618.1	90190.0	299768.5
Greece	14343.5	18931.5	285356.3	44794.7	-21759.7	-23281.5	-282237.0	159098.4
Tunisia	15538.0	77257	190122.4	103012.6	-14497.7	-53539.6	-33188.7	1099012.9

Source: Own elaboration based on FAOSTAT data and TradeMap (2021).

This position is counterbalanced during the last five years despite the expansion of European demand (market effect has increased for all countries).

5.2. *Competitiveness in potential markets*

During the last years, Tunisia started to take a good position on new destinations outside the community, mainly the *American* and *Canadian* markets and lately the *Japanese* and *Brazilian* ones.

Concerning the American market, between 2006 and 2015, Tunisia is ranked second after Spain. In fact, despite the increase of its exports to this market by 47467 tons, during the second sub-period, Tunisia maintained the same position (Table 1). The negative competitiveness components of Turkey indicate that this country does not concentrate on the countries whose imports grew relatively fast over the period.

During the last five years, Italy recorded the highest increase in exported quantities (191324 tons) compared to studied countries, which allows it to dominate in competitiveness followed by Tunisia which shows a stagnation of its competitive position in the American market.

Regarding the Canadian market Italy recorded the highest growth in export quantities, between 2006 and 2010, followed by Tunisia (5472 and 540 tons respectively) as well as competitiveness (Table 2).

Similarly, in the Japanese market, the European countries are the best positioned, thanks to the market size effect that shows the Japanese demand in continuous increase until 2015.

During the second period, Tunisia has gained in competitiveness being in first position in Canadian market and fourth in Japanese one, thanks to its record production in 2015 and the decrease in Spanish and Italian production. Tunisia recorded a relative gain of about 1300 tons and a growth rate of 17% in Canada.

Table 2 - Shift-Share analysis of imports from the Canadian and Japanese markets the periods 2006-2010; 2011-2015; 2016-2020.

	Export growth		*Market effect*		*Extra-market effect*		*Residual effect*	
2006-2010								
	Canada	Japan	Canada	Japan	Canada	Japan	Canada	Japan
Spain	161	4372	2411.7	83323.1	-1265.8	-66512.1	5610.5	100427.7
Italy	5472	2173.5	51544.8	120659.2	-27053.1	-96315.4	157241.3	47277.1
Turkey	-2428	567	11290.0	12203.7	-5925.5	-9741.5	-123058.7	19872.2
Greece	-592.5	162	10059.4	2148.5	-5279.7	-1715.0	-5729.4	4210.7
Tunisia	540	3	2585.6	30.4	-1357.0	-24.2	12456.9	89.5
2011-2015								
Spain	507.5	11159	-1354.0	204731.7	4140.1	-162732.5	7994.0	290192.4
Italy	-1605.5	2523	-29652.1	233420.4	90669.0	-185535.9	-159956.1	47458.8
Turkey	-182.5	552.5	-533.1	22129.9	1630.2	-17590.1	-2135.0	-2223.4
Greece	100	384.5	-3446.3	5300.5	10537.8	-4213.1	-2676.5	9443.2
Tunisia	1345	42.5	-1736.2	427	5309.0	-339.4	27270.7	1306.1
2016-2020								
Spain	8544	12153.5	30198.7	220815.5	-22258.8	-140235.4	196230.0	-495406.0
Italy	-2285.5	-35.5	196987.7	142216.0	-145195.1	-90318.5	-132892.0	-70908.6
Turkey	441	1372	2591.8	6469.1	-1910.4	-4108.4	10450.4	27229.5
Greece	-1244	-95	28806.4	5408.7	-21232.5	-3434.9	-54263.7	-6190.5
Tunisia	3293	138.5	34723.8	1160.2	-25594.1	-736.8	69758.9	3540.6

Source: Own elaboration based on FAOSTAT data and TradeMap (2021).

From 2015, Tunisia benefited from the increase in Canadian demand and improved its residual effect, but this is not enough to maintain its first place, Spain has regained its first position, followed by Tunisia. The situation has counterbalanced, from 2015, in favor of Turkey which occupies the first rank followed by Tunisia with respective quotas of about 27229.5 and 3540.6 tons respectively in the Japanese market. Turkey during this period has recorded for the first time in the last fifteen years a positive component of competitiveness, as in the case of the European and American markets.

These finding do not agree with those found by Türkekul *et al*. (2010), who revealed that all the studied countries (the same of the present study) except Tunisia have decreased their competitiveness between 2000 and 2008. When two periods are compared, it is seen that part of a country's export growth is attributable to the general increases in Japanese imports.

For the Brazilian market, Portugal is added to the studied countries, given that it represents the first olive oil supplier to Brazil. During the first period, Tunisian exports have decreased, by 158 tons (Table 3) what explains its negative component of competitiveness from where it occupied the last rank compared to the studied countries. This situation is completely reversed in the following period, where Tunisia ranked first before Portugal, recording the only positive competitiveness component. From 2015, Turkey started to benefit from the expansion of Brazilian demand, and Tunisian exports increased allowing this country to be second after Portugal. In fact, Brazilian imports of olive oil from Tunisia have marked a strong annual growth of 116% in terms of quantity between 2014 and 2018, all in packaged form (or 5% of Tunisian exports of olive oil) which shows that it is a market with high potential for Tunisia.

Table 3 - Shift-Share analysis of imports from the Brazilian market on the periods 2006-2010; 2011-2015; 2016-2020.

	Export growth	*Br-Effect*	*Extra-Br effect*	*Residual effect*
		2006-2010		
Spain	4684.5	97325.0	-89611.5	131038.4
Italy	1549.5	20466.5	-18844.4	35592.2
Turkey	36	305.2	-281.0	---
Greece	200	2681.0	-2468.5	6480.9
Tunisia	-158	3728.7	-3433.2	-6489.6
Portugal	10764	252881.6	-232839.5	304197.1
		2011-2015		
Spain	-5087	-35213.6	81074.5	-228936.5
Italy	-147	-8061.0	18559.3	-24383.2
Turkey	137.5	-3.1	7.2	----
Greece	-25	-782.5	1801.5	-2973.2
Tunisia	56	-59.3	136.6	1013.9
Portugal	1230	-35213.6	179867.5	-82316.2
		2016-2020		
Spain	5308.5	212345.2	-189890.8	110638.3
Italy	676	68595.3	-61341.7	12829.7
Turkey	61	1029.6	-920.8	1317.6
Greece	-93.5	8609.0	-7698.6	-4101.2
Tunisia	998	9190.5	-8218.7	19187.6
Portugal	32273.5	666294.8	-595837.6	779893.2

Source: Own elaboration based on FAOSTAT data and TradeMap (2021).

6. Discussions

The results found regarding the competitiveness of Tunisian exports in European markets indicate that the share Tunisian exports to this market depends on the volatility of Spanish and Italian production. On the other hand, the Tunisian share in non-EU imports decreased from 78% between 2014 and 2016 to 70% between 2017 and 2019. This regression was accompanied by an increase in the shares of Syria, Morocco and Turkey during the same period. This result contrasts with those found by Mokrani *et al.* (2011) during the period (1997-2006) in this market compared to non-European competitors where Tunisia occupied the first rank in terms of competitiveness. In fact, Turkish exporters benefit from several incentives for the access to the European olive oil market, among which the support for the creation of a brand abroad, the promotion of quality signs, the participation in professional fairs abroad and other marketing tools of conception and market studies. Moreover, additional supports are given to Turkish exporters if they are not able to access the European market (Türkekul *et al.*, 2010).

Similarly, on the American market the main competitors of Tunisia are the EU countries and Turkey. Indeed, Spain and Italy have positioned themselves well thanks to the recent American consumers awareness of the benefits of the European olive oil, and to the marketing campaigns carried out by the European leaders on this market. These findings are in contrast with those obtained by Klonaris and Agiangkatzoglou (2018) who concluded that Tunisia has the competitive advantage in the US market. The loss of competitiveness of Tunisia can be explained also by the increased preference of American consumers for extra virgin

olive oil from California over imported oil (Delgado *et al.*, 2013). The position of Tunisia on the American market is not affected by this competition and explains the regression of its performance on the European market. The market size effect is the main contributor to the increase in exports from these countries. However, the magnitude of this contribution varies for each country.

In the Canadian market, the effect of extra-Canadian demand is the main regulator of the competitiveness of studied countries and the Tunisian position explains its regression observed in the European market during the last period. In fact, the evolution of the values of exports of agricultural products between Tunisia and Canada in recent years witnessed a significant increase recording an annual growth rate of about 21.7% and the extra virgin olive oil packaged in containers less than or equal to 1 liter (66%) is the main agricultural product exported to Canada in 2019.

Market size effects, shows the continuous increase in Japanese demand for olive oil The olive oil market has developed from the 2000s in Japan thanks to the confirmed health benefits of olive oil which attract consumers to this product (Mtimet *et al.*, 2011) Japanese olive oil imports have increased sharply since 1996 to reach 67950 tons in 2020. According to TMAHRF (2021) the Asian market in general, and Japanese in particular, opens up new horizons for the Tunisian olive oil exports today. Indeed, Japanese imports from Tunisia scored a strong annual growth of 57% between 2014 and 2018, all of which is in packaged form. In 2019, 94% of these oils were extra virgin olive oil, the rest (6%) were virgin oil.

The results show that Tunisia has focused on promoting its quality competitiveness on these two markets which has improved its export performance compared to European countries. As recommended by Klonaris and Agiangkatzoglou (2018), strategic shift to export high-quality branded virgin olive oil instead of bulk seems necessity, in order the Tunisian virgin olive oil to dominate to the international markets.

The period 2011-2015 can be considered as the period of expansion of Tunisian exports, on all studied markets. This is attributed to its record production in 2015 and the fall of European production because of the bacterium that decimated thousands of olive trees.

The first position of Tunisia on Japanese market shows that Tunisia, during the last years, has followed a strategy of diversification of its destinations of olive oil, obeying the new geographical distribution of the world demand and explains its regression in their traditional markets.

In this context, trade agreements have been successful. Indeed, the customs tariff applied to Japanese imports of olive oil from Tunisia is zero and that to Brazilian imports is 9%. The Turkish competition is again learned on this market, of which Tunisia must face.

The improvement of the Tunisian position on the Canadian, Japanese and Brazilian markets whose imports are 100% virgin olive oil and packaged, confirm that Tunisia should invest more in the differentiation of its product by quality signs under the increased competition and changes in the agri-food market and the new requirements of consumers.

Indeed, this improvement in the quality of olive oil is linked to several factors such as the increase in the crushing capacity, the reduction of its period, the modernization of oil mills through a program of upgrading since 1996. The supervision and awareness of operators providing them with a guide to good practice summarizing the results of several years of scientific research in the field of olive cultivation and the alignment of Tunisian regulations on quality to international standards (Codex Alimentarius, International Olive Oil Council).

Thus, it was found that the hottest areas (Tunisia, Greece) have relatively low values for oleic acid which favors the extra virgin oil.

Regarding quality signs and, in particular, the number of trademarks, quality labels and AOC, Tunisia suffers from a significant competition with EU countries. In Spain and Italy more than 100 commercial brands exist and 24 AOC against less than a dozen brands in Tunisia and a single AOC (oil Teboursouk) obtained in 2018. In terms of packaging capacity, the olive oil sector in Tunisia has a competitive disadvantage compared to other olive oil producing countries (10% in Tunisia against a capacity of 100% in Italy and Spain) and a share of 3% in total world exports.

7. Conclusions

The present study has proposed to deepen the studies that have been devoted to the analysis of the evolution of price competitiveness from the analysis of comparative advantages, export functions and Aids models (Karray, 2012; Mokrani *et al*., 2011; Ameur *et al*., 2006; Boudiche *et al*., 2003) through the interpretation of the most recent data of international trade in olive oil (between 2006 and 2020) and the identification of the determining sources of the competitiveness of Tunisia and its main competitors as well as the real opportunities offered by the various target markets in order to contribute to the implementation of an adequate strategy for a sustainable Tunisian competitiveness.

The findings of Shift-Share approach revealed that Tunisia wasted competitiveness in the European market over the last five years despite the expansion of demand and that its position is inversely proportional to the Spanish and Italian production. This regression was accompanied by the improvement of the position of Tunisia on the other studied markets which shows the Tunisian policy of diversification of its destinations. Indeed, on the American market, Tunisia occupies the second position during all the studied period, always after one of the European competitors. The period 2011-2015, was a golden period for Tunisia occupying the first position on most of the studied markets including the European one. This period was characterized by a record production in 2015 and the fall of production of European competitors.

Despite its excellent campaign 2019-2020, Tunisia has not kept this performance during the last five years. Consequently, the domestic supply is not enough to garnish an advanced position, it is linked mainly to the Spanish and Italian performance.

Indeed, in the EU, the olive sector is organized among all the actors which is effective on the international markets of oil apart from the positive image as producers of olive oil. The sector is also supported by subsidies from the Common Agricultural Policy (CAP) paid through the Common Market Organization (CMO) for olive oil which has allowed a restructuring modernization of the milling and processing industry (Türkekul *et al.*, 2010).

This work has led to the conclusion that, in Tunisia, obtaining a sustained production and quality is the key factor to increase the market share of Tunisia on new markets. In order to reduce the effect of alternation on production, and to bring Tunisia's production level closer to that of the European Union, cultivation activities such as irrigation and mechanization should be improved.

In 2006, the Tunisian Ministry of Agriculture launched a FPPOO[2] to gradually eliminate the present system of selling olive oil in bulk. Tunisia should invest in the packaging of olive oil as, apart from the allocation of this Tunisian product of a specific identity, the export price of packaged oil is twice that in bulk (15.3 Dt / kg against 8.3 Dt in 2021). To achieve this plan, the Tunisian olive oil sector will need to be better organized, given that the production of olives is small-scale and fragmented. In addition, the quality must be improved, and the production process must be modernized, because the methods of harvesting and pressing applied in Tunisia are still traditional and inefficient compared to European standards.

In addition, due to the lack of a brand or a trade name for olive oil, Tunisian olive oil remains relatively unknown in the target markets. In order to improve its competitiveness, Tunisia must capture the growing global demand for olive oil by improving its image as a country producer and exporter of olive oil and work on the quality competitiveness which has shown its effectiveness on the Canadian market, Japan where exports are fully packaged and virgin or extra virgin quality. These countries have been occupying an increasing share in the world consumption of olive oil in the recent years and hold a strong potential for consumption growth in the future (Mili and Bouhaddane, 2021), which made them as potential attractive markets to the Tunisian olive oil. Consequently, to distinguish itself on foreign markets, Tunisia should

[2] Fund for the promotion of packaged olive oil.

focus more on exports of packaged products and brand. Moreover, it is necessary to move towards the sale of olive oil products under AOC designation in order to improve the price and to carry out a detailed study of the prices. Likewise, organic olive oil could be also a force to face competition from European countries and the new olive oil producing countries which are growing more and more. In fact, as concluded by Mili and Bouhaddane (2021), demand will be prompted by the shift in consumption habits towards healthier and more natural products, and to a lesser degree by preference towards more differentiated products such as organic olive oil and oils with indications of origin.The launch of the "Bio Tunisia" label in 2010, the efforts to create AOCs in Tunisia and the respect of increasingly demanding international quality standards as well as the packaging and orientation towards flavored olive oil and its stabilization by aromatic and medicinal plants, could constitute a solution to widen the markets of destination and to offer to Tunisian olive oil an identity which is singular and unique.

Finally, Tunisia should build on its trade agreements with potential new importers around the world and revise its agreements with the European Union, which are proven to be protectionist of community producers. This country an interest to negotiate prices to align at least the export prices of extra virgin olive oil in Spain, or even the prices charged in Italy given the quality of Tunisian olive oil. The decline in prices is due to the fact of the sale to the EU in TPA and over quota. For this the negotiation on the quota is necessary.

Among the challenges that will be facing the Tunisian exporters of olive oil in the upcoming years, is to build the a good image for the olive oil "made in Tunisia" by participating in fairs and international organizations, especially that, apart from the European competition, Turkey started to take advantage, with important growth rates on all the studied markets, after the depreciation of its pound which constitutes a new challenges for Tunisia.

To achieve a complete study, more detailed analysis could be made by category of olive oil on the different markets.

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Sustainable Development Goals in the Andalusian olive oil cooperative sector: heritage, innovation, gender perspective and sustainability

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Abstract

The Sustainable Development Goals (SDGs) represent a commitment to sustainability through innovation, sustainable economic growth and the diversification of economic activities. The social economy and the revaluation of rural heritage play a fundamental role in implementing and progressing towards these goals, especially in agri-food cooperatives. In the case of the Spanish olive oil industry, a substantial percentage of the business in olive oil producing areas revolves around the social economy: 70% of the olive oil produced in Spain is made by cooperatives. For these cooperatives, the implementation of the SDGs offers them a potential tool for sustainable development, diversification and the economic growth of their businesses. This article focuses on analysing the relative importance of the SDGs in the olive oil cooperative sector in Andalusia, using the Qualitative Comparative Analysis (QCA) technique and applying the fuzzy-set approach (fsQCA) to the tenets of the SDGs. Lastly, causal models have been established, the practical implications of which centre on the implementation and development of the SDGs as a means of achieving the sustainable economic growth of these enterprises. The main findings of this study suggest that the sustainable development goals on which the cooperative societies analyzed are focused, in addition to producing olive oil, promote values linked to food security, sustainability, the showcasing of heritage, and gender equality.

***Keywords**: Sustainable Development Goals, Olive oil cooperatives, Social innovation, Heritage, Gender perspective, Sustainability.*

1. Introduction

The Sustainable Development Goals (SDGs), represent one of the most important challenges that governments, companies and consumers must tackle to ensure the preservation and sustainability of our environment. On 25th September 2015, the United Nations General Assembly adopted the agenda "Transforming our world: the 2030 Agenda for Sustainable Development" (2016). A total of 139 countries were signatories to the document, which is organized under the following 17 SDGs: 1) No Poverty, 2) Zero

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Hunger; 3) Health; 4) Education; 5) Gender Equality; 6) Water; 7) Affordable and Clean Energy; 8) Decent Work; 9) Industry, Innovation and Infrastructure; 10) Reduced Inequalities; 11) Sustainable Cities and Communities; 12) Responsible Consumption; 13) Climate Action (climate change); 14) Marine Life; 15) Terrestrial Ecosystems; 16) Peace, Justice and Strong Institutions; 17) Partnerships (United Nations Development Programme, 2016).

In recent years there has been exponential growth in the number of business and management studies contributing to the discussion on the SDGs and their impact on business organizations (Pizzi *et al*., 2020). The SDGs are a call to action for all countries – rich, poor and middle-income – to promote prosperity and protect the planet. They are an acknowledgement that the implementation of strategies to promote economic growth and address social needs such as education, health, social protection and job opportunities is the most feasible way to definitively end poverty, while emphasizing climate change mitigation and environmental protection (Mio *et al*., 2020).

As Verano (2020) explains, building a sustainable future is undoubtedly one of the major challenges facing society in the next 10 years. Sustainability involves meeting current needs without compromising the ability of future generations to meet theirs, ensuring a balance between economic growth, caring for the environment and social well-being. In this regard, the agri-food sector is one of the sectors that can contribute the most to the fulfilment of the SDGs in various areas (Mozas-Moral, 2019).

The strategic importance of the olive oil industry in Spain, and more specifically in Andalusia, poses new challenges that companies in the social economy must face, given its substantial weight at a global level (Mozas-Moral, 2019). Spain is the world's leading producer of olive oil, and at national level social economy companies such as olive oil cooperatives are responsible for 70% of that production (CAE, 2021; CES, 2018). In the case of Andalusia, olive cultivation covers just over a million and a half hectares, and plays a particularly important role in the provinces of Jaén, Cordoba, Granada, Malaga and Seville, which make up the so-called "axis of olive groves". In terms of employment, Andalusian olive groves generate an average of between 15 and 20 million day's wages per year, accounting for around 35% of total agricultural employment in the region (INE, 2020).

In light of the above the objective of the present paper is to analyse the value and relevance that Andalusian cooperatives registered in Designations of Origin and product clubs, assign to the different SDGs, according to the importance for their organizations, and then establish the possible causal relationship among the SDGs that are of greater relative importance and its directly contribution to these cooperatives. To implement this study, a survey was administered to those in charge of the cooperative companies under study, in which they assigned values to the different SDGs, thereby enabling the subsequent application of the fuzzy set Qualitative Comparative Analysis (fsQCA) method. This paper has thus been structured following a classical research sequence. First, a theoretical framework is developed relating to the SDGs and the agri-food sector linked to entities in the social economy; in this case, olive oil cooperatives. Then the method of analysis is established and the results are obtained. Lastly, a discussion is presented with comparisons to other studies and some conclusions are drawn with practical implications when it comes to implementing the SDGs in the olive oil cooperative sector.

2. Theoretical Framework

2.1. *New approaches in Andalusian olive oil cooperatives*

Olive oil cooperatives are organizations that cover the different areas of the territory where they are located, taking a holistic approach that allows them to generate economically sustainable initiatives focused on their continuance (Sánchez-Martínez *et al*., 2020). The incorporation of the SDGs into these entities entails a shift from systems focused almost exclusively on production and distribution, to new paradigms involving environmental, nutritional and ethical objectives (Antonelli *et al*., 2020). These

companies are social entities that can articulate the processes of implementation of the SDGs, so it is especially interesting to develop sustainable policies in the sector through cooperative societies. In this way, it is established as a dependent variable in the fuzzy QCA model proposed in this article, that cooperative societies are entities with greater capacity to implement the Sustainable Development Goals than other types of organizations established in the olive oil sector.

In this respect, social innovation is established as a key factor to achieve this transition, especially through four dimensions: economic, cultural, environmental and technological (Parrilla González and Ortega Alonso, 2021a/b). Andalusia is the Spanish autonomous community with the highest production of olive oil and olives in Spain, accounting for around 82.2% of the national average production of olive oil and 79.2% of table olives. Furthermore, Andalusian production of olive oil represents around 35.4% of total global production, and 19.2% of global table olives production. It also produces 48% of the olive oil at European level (IOC, 2021). These data underline the major strategic importance of addressing the link between the Andalusian olive oil cooperative sector and the SDGs, measuring the impact of the goals set by the UN, and examining the results obtained in this agrifood industry. Based on this, we formulate proposition 1, related to SDG 2 Zero Hunger:

Proposition 1: Olive oil cooperatives offer key solutions for development and are critical to the eradication of hunger and poverty.

Territorial policies have prioritized some of the SDGs, such as that relating to food availability, and have overlooked others such as biodiversity, soil quality, and the conservation of natural resources (McIntyre *et al.*, 2009). In fact, as Ortega Alonso and Parrilla González (2021) point out in their study of the dimensions of social innovation in agricultural cooperatives, the environmental and technological dimensions are still not sufficiently integrated into the olive oil cooperative sector, despite the fact that some of the main challenges it faces in order to comply with the SDGs are environmental and technological. This relates to the results of previous studies, such as that by Campopiano and Bassani (2021) focusing on the Italian context, which incorporate the fields of social entrepreneurship innovation and cooperativism, and examine the effects of social enterprises' investments in product, technology and process innovation on social and environmental outcomes.

The identification and design of what are known as "innovation ecosystems" can support business creation processes in the olive oil industry and improve growth opportunities and entrepreneurship development for young people (Antonelli *et al.*, 2020). In this regard, the olive oil cooperative sector can be a strategic tool for local socioeconomic development, if the companies implement innovative and sustainable strategies that can boost the employment rate, with a special emphasis on young people and women (Seyfettinoglu, 2016). In the specific case of rural women, their inclusion in decision-making bodies and access to productive resources can represent an opportunity in terms of sustainable management of available resources and economic development (Sisto and Furst, 2019).

The European Commission, which has pledged to promote gender equality in the field of innovation, establishes a wide-ranging commitment to equality in all EU policies; moreover, it has a well-established regulatory framework on gender equality, which includes binding directives broadly applied in the entire labour market as part of its gender equality strategy for 2020-2025 (European Union, 2020). This is an extension of the context established in Horizon 2020, in relation to which Pollitzer and Schraudner (2015) identified important roles that can be played by gender in innovation ecosystems, both in terms of knowledge activities and the improved capacity of human capital resources to generate market opportunities, ultimately influencing success. This gender perspective leads us to make the following proposition, related to SDG 5:

Proposition 2: Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world, and both necessary and beneficial in olive oil cooperatives.

2.2. *SDGs for the management of rural heritage in the olive oil cooperative sector*

The existing heritage resources in the rural environment provide a source of key economic activities such as tourism, handicrafts and other outputs linked to the exploitation of specific local resources (Abichou *et al*., 2009). In some territories in the Mediterranean basin, these activities have become a principal source of income in the face of emerging threats such as desertification caused by climate change or deficiencies in industrialization (Rallet, 2001). By recognizing the value of heritage resources, a more balanced development of the territory can be achieved.

Cooperatives act not only as organizations that drive the economic performance of the municipalities where they are located (Rodríguez-Cohard *et al*., 2020), but also as instruments of social cohesion (Mooney, 2004) that take on an important role as entities whose objective is to provide a sufficient quantity of quality food. The recent inclusion of the olive grove among the candidates for possible World Heritage status in 2023, if accepted by UNESCO, should spur the olive oil industry to accelerate the implementation of the SDGs, emphasizing cross-cutting elements such as their cultural, landscape, heritage, historical, ethnographic or aesthetic value.

In this vein, Echevarría (2008) claims that social innovations, when they affect broad sections of the population, lead to a richer cultural, artistic, educational and, ultimately, heritage character. Olive oil mills are gradually assuming the role of reservoirs of ethnographic values and knowledge about the rural territory, becoming attractive places to visit for people who view the rural environment as secondary (Ortega Alonso, 2020). The elements of museumization introduced in these spaces represent tools that give rise to new stimuli based on social responsibility and the conservation of tangible and intangible heritage (Ortega Alonso and Padilla Fernández, 2019). On the technological side, the interaction between digitalization and sustainability opens up great opportunities to shape a greener economy and society (Parrilla González and Ortega Alonso, 2021a), paving the way towards the achievement of the SDGs, although there is still little evidence on the contribution of digital paradigms to sustainability (del Río *et al*., 2020).

The actions undertaken by cooperatives generate collective benefits for rural societies, due to their multiplier effect on the agriculture sector and other related activities (Parrilla González and Ortega Alonso, 2021a/b). Thus, the role assumed by these entities makes them business ecosystems of a social nature (Leick, 2020), spearheading collective action and establishing themselves as pillars supporting the potential development of rural areas (Mozas-Moral and Rodríguez-Cohard, 2000), thus enabling people living in the territories in question to get quality jobs. Based on the above arguments, we formulate the following proposition, related to SDG 8:

Proposition 3: Sustainable economic growth requires societies to create the conditions that allow people to have quality jobs in olive oil cooperatives.

As has been seen in the wine industry, the management of rural heritage by olive oil cooperatives encourages interaction and dialogue between the public, the landscape and the museumized spaces, and takes into account the public's growing interest in sustainability and visitors' prioritization of ecological issues (Montella, 2017). Antonelli *et al.* (2020) place the focus on other relevant factors, such as the cultural acceptance of the food produced in these entities, and the need to work in a context of respect for and conservation of natural heritage and the environment without producing social inequalities.

The growing demand for green or sustainable tourism is therefore a key issue defining the global sustainability of the tourism business to which the management of this heritage is becoming linked (Gössling *et al.*, 2002). It is also linked to the production of healthy, environmentally-friendly food. The cross-cutting nature connecting heritage values with environmental values and health values is another characteristic of the cooperative principles referred to by Alarcón and Álvarez (2020) in their discussion of the merit goods of cooperativism, including those obtained by cooperativists as

a result of democratic decisions to maximize their collective well-being, which are ultimately expressed in non-state public goods. These can help identify the impact of cooperative efforts to improve the quality of life and well-being of their stakeholders (Álvarez, 2017). In light of the above, we put forward proposition 4, related to SDG 3:

Proposition 4: Olive oil cooperatives can help ensure people lead healthy lives and promote their well-being, which is essential for sustainable development.

2.3. *The SDGs and their implementation in the olive oil cooperative sector*

Mozas-Moral *et al*. (2020) refer to various reports that address the SDGs in relation to this sector (PWC, 2015; Barrero-Barrero and Baquero-Valdés, 2020). Said reports highlight the importance of the SDGs as a vital opportunity to do business, promote corporate responsibility and develop initiatives for sustained growth and equality. Especially relevant is the fact that, for this type of company, the social economy plays a notable role when it comes to developing strategies aimed at

Table 1 - SDGs and impact on olive oil cooperatives.

Sustainable Development Goal	*Description*	*Impact on olive oil cooperatives*
SDG 2	*Zero Hunger.* The food and agriculture sector offers key solutions for development, and is central for hunger and poverty eradication	Production of more olive oil as food
SDG 3	*Good Health and Well-Being.* Ensuring healthy lives and promoting well-being for all at all ages is essential to sustainable development	Production of sustainable and healthy foods such as olive oil
SDG 4	*Quality Education.* Obtaining a quality education is the foundation for improving people's lives and sustainable development	Belief in education as the foundation for any change or progress
SDG 5	*Gender Equality.* Gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world	Ensuring olive oil cooperatives in rural areas serve as a vehicle for curbing depopulation and the aging of the population, and closing the gender gap
SDG 7	*Affordable and Clean Energy.* Energy is central to nearly every major challenge and opportunity	Decarbonization and the use of sustainable resources
SDG 8	*Decent Work and Economic Growth.* Sustainable economic growth will require societies to create the conditions that allow people to have quality jobs	Through the creation of job opportunities and personal development
SDG 9	*Industry, Innovation, and Infrastructure.* Investments in infrastructure are crucial to achieving sustainable development	Facilitating an economic structure and activity
SDG 12	*Responsible Consumption and Production.* Responsible consumption and production are essential to ensuring sustainable development	Promotion of more responsible consumption
SDG 13	*Climate Action*. Climate change is a global challenge that affects everyone, everywhere	Special commitment to the fight against climate change
SDG 15	*Life on Land.* Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss	Halting terrestrial biodiversity loss
SDG 17	*Partnerships*. Revitalize the global partnership for sustainable development	Collaboration to achieve truly ambitious goals

Source: Own elaboration based on Mozas-Moral (2019).

the achievement of these goals (TFSSE, 2014). The intrinsic nature of agricultural cooperatives as social economy entities represents an important link to the SDGs (Pacheco *et al.*, 2019) and connects them with the development of proposals and scientific studies relating to the SDGs.

Thus, within the companies committed to the SDGs, social economy entities and companies play a relevant role. This is underscored by various international organizations such as the United Nations Task Force on the Social and Solidarity Economy (UNTFSSE), Social Economy Europe (SEE), Cooperatives Europe and the International Cooperative Alliance.

Mozas-Moral (2019) provide a classification of the most relevant SDGs for the olive oil cooperative sector, showing the importance of some of these goals based on the critical impact they can have on olive oil cooperatives and olive mills. Based on said classification, we have compiled Table 1 below.

3. Methodology

This study focuses on analysing the level of knowledge about and application of the SDGs in the olive oil industry, specifically in cooperatives and olive oil mills in Andalusia. To that end, a survey was first administered to these entities, given their strategic interest as part of one of the main olive oil producing regions in the world. In order to define the population under study, we contacted the Designations of Origin and the cooperatives that are included in diversification and sustainable development initiatives, such as Oleotour Jaén, Sabor Málaga or Olearum. This allowed us to obtain a broad sample of the cooperatives that are committed to sustainable development initiatives, and which had previous knowledge about the incorporation of SDGs. Once the population had been determined, a search was carried out by regions of Andalusia in order to check the selected population and the subject of this study. Subsequently, a structured face-to-face survey was given to the organizational heads of these entities, resulting in responses from 129 of the 168 companies selected (76% response rate). The characteristics of the study are detailed in the following table.

First, the heads of the organizations assigned scores to each of the 17 SDGs based on how important they consider these goals to be for the olive oil industry. After obtaining the scores assigned in the questionnaire, the Qualitative Comparative Analysis (QCA) technique was carried out using the fuzzy-set approach (fsQCA), in order to determine the variables that can be used to establish the current relevance of the SDGs in the olive oil cooperative sector, according to the managers. This will make it possible to prioritize the implementation of actions and initiatives that help to achieve the SDGs, and enhance those actions that are already being developed in the Andalusian mills.

The QCA technique, which is based on Boolean algebra, uses a verbal, conceptual and mathemati-

Table 2 - Technical Data Sheet for the study.

SAMPLE UNIVERSE	Cooperatives belonging to Designations of Origin and recognized initiatives such as Oleotour Jaén, Sabor Málaga or Olearum
GEOGRAPHICAL SCOPE	Andalusia
TIME FRAME	April to June 2021
POPULATION REGISTER	Oleotour Jaén, Olearum and the Network of Mills with Andalusian Designation of Origin
UNIVERSE SIZE	168 olive oil mills
SAMPLING UNIT	Cooperative that produces and/or markets olive oil, with knowledge of the SDGs
RESPONSE RATE	76% (129 organizations)

Source: Own elaboration.

cal language that yields both qualitative and quantitative results, combining the main advantages of the two (Ragin, 1987). The application of this technique enables the systematic analysis of a set of cases to determine causal patterns in terms of relationships of necessity and sufficiency between a set of conditions and an outcome (Schneider and Wagemann, 2010). Fuzzy-set QCA (fsQCA) has become one of the most widely-used QCA variants as it overcomes one of the main drawbacks of the original csQCA; namely, its strictly dichotomous approach (Sehring *et al.*, 2013). The fsQCA technique was developed for small sample or population settings (Ragin, 1987), so it is appropriate for the small sample universe in this study. To implement this technique, we have followed the steps recommended in the literature (Schneider and Wagemann, 2012): the calibration of the condition variables and outcome variables, followed by the analysis of necessity and then sufficiency.

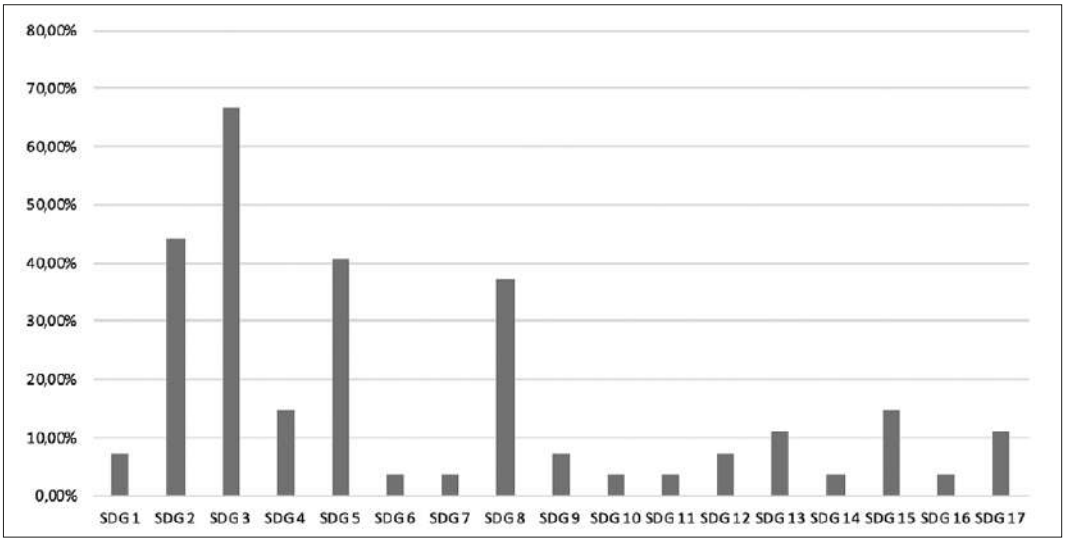
The ultimate output of fsQCA is the identification one or several antecedent combinations that are sufficient for obtaining a specific outcome, such as: X1*~X2*X3 sufficient for an outcome (Y). Using the symbols employed in this technique (X1*~X2*X3→Y), X1, X2 and X3 are antecedents; Y is the outcome; * the union; and ~ the absence or negation, in this case the opposite value to X2 (1 - X2).

4. Results and discussion

The scores assigned to SDGs in the survey given to entities in the sector yield the results shown in Figure 1.

The results indicate that, according to the heads of the entities, there are four SDGs that especially stand out: SDG 2 obtained a score of 44.4%. This corresponds to the *Zero Hunger* goal, which can be explained by the fact that the food and agriculture sector offers key solutions for development, and is central for hunger and poverty eradication. SDG 3, which corresponds to the *Good Health and Well-Being* goal, focused on ensuring healthy lives and promoting well-being for all at all ages as essential to sustainable development, scores 66.70%. As for SDG 5, which scores 40.80%, it corresponds to the goal on *Gender Equality,* which is centred on the fact that gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world. Lastly, SDG 8 scores 37% and corresponds to the goal *Decent Work and Economic Growth*, which is based on the idea that working for sustainable economic growth will require societies to create the conditions that allow people to have quality jobs. Thus, the analysis focuses on the four SDGs that obtain the highest score

Figure 1 - SDGs addressed in olive oil cooperatives.



Source: Own elaboration.

Table 3 - Summary of the four most relevant scores, according to the weight of the SDGs in the olive oil cooperatives.

SDG	*Description*	*% obtained by cooperatives (that focus on this SDG)*
SDG 2	*Zero Hunger:* the food and agriculture sector offers key solutions for development, and is central for hunger and poverty eradication	44.4%
SDG 3	*Good Health and Well-Being:* ensuring healthy lives and promoting the well-being for all at all ages is essential to sustainable development	66.70%
SDG 5	*Gender Equality:* gender equality is not only a fundamental human right, but a necessary foundation for a peaceful, prosperous and sustainable world	40.8%
SDG 8	*Decent Work and Economic Growth:* sustainable economic growth will require societies to create the conditions that allow people to have quality jobs	37%

Source: Own elaboration.

in the questionnaires carried out, as they are the most substantially representative in the sample. The Table 3 below summarizes the scores recorded in the four most relevant SDGs for those in charge of the entities.

Having clarified the degree of importance of the SDGs for olive oil cooperatives, the fsQCA technique is applied along with different variables related to the results of the survey used in this study to obtain the data. These variables, which make up the proposed model, are detailed in Table 4.

In this model, the business format classified as cooperative is configured as the dependent variable and outcome variable, while the rest of the variables are included as condition variables and are related to the SDGs assigned the most weight within the olive oil cooperative sector. Based on this, an fsQCA model can be generated, enabling the identification of causal relationships.

Once the variables have been classified and they have been calibrated according to the premises of Ragin (2008), the proposed model has been built in which the dependent variable acts (cooperative and non-cooperative societies) and the variables to be considered as independent, which in in this case, they are the Sustainable Development Goals listed in table 3. Subsequently, a truth table has been obtained in which the configurations and cases that validate the model appear. Finally, the variables have been calibrated using dichotomous variables in which the values 0 and 1 predominate (Ragin and Rihoux, 2004) and the intermediate solution has been proposed, the result of which can be seen in Table 5.

Table 4 - Variables used for the fsQCA technique.

Outcome variable	*Description*	
Coop	Company type: Cooperative companies	Dichotomous variable
Condition variables	*Description*	
SDG.healthy	Related to SDG 3 *Good Health and Well-Being*	Dichotomous variable
SDG.security	Related to SDG 2 *Zero Hunger*, solutions for development	Dichotomous variable
SDG.sustain	Related to SDG 8 Sustainable Economic growth	Dichotomous variable
SDG.equality	Related to SDG 5 Gender Quality	Dichotomous variable

Source: Own elaboration.

Table 5 - Results of the fsQCA analysis.

	Raw coverage	*Unique coverage*	*Consistency*
~SDG.healthy*SDG.security*SDG.sustain*SDG.equality	0.411765	0.411765	0.583333
SDG.healthy*~SDG.security*~SDG.sustain*SDG.equality	0.352941	0.352941	0.461538
SDG.healthy*~SDG.security*SDG.sustain*~SDG.equality	0.191176	0.020316	0.412500
~SDG.healthy*~SDG.security*~SDG.sustain*SDG.equality	0.120588	0.020588	0.433333
Model coverage		0.864706	
Model consistency		0.74430	

Source: Own elaboration.

In Table 5, the presentation of fsQCA results generally involves explaining the two most relevant causal configurations. The results obtained show that in the intermediate solution of the model the first configuration yields a raw coverage of 41.17%, indicating relationships between the business format of the olive oil cooperative and a focus on fulfilling the SDGs linked to food security (SDG 2), development solutions (SDG 8) and equality (SDG 5) while the negative variable (SDG 3) is not relevant for this model. Therefore, it can be deduced that the SDGs that express a causal relationship with cooperatives are SDGs 2, 5 and 8; that is, the promotion of sustainable development, gender equality and socioeconomic equality, and food security play a relevant role in olive oil cooperatives.

Similarly, the second causal configuration should be highlighted: it again includes the business format of cooperative companies as the variable dependent on the SDGs concerning the promotion of health and well-being (SDG 3) and equality (SDG 5). The results of this causal configuration present a raw coverage of 35.29%. In the case of this second model, the SDGs that express a causal relationship in cooperatives are related to SDGs 3 and 5 while the variables related to food security (SDG2) and development solutions (SDG8) are considered negative variables. Therefore, a causal relationship can be identified with the promotion of health and well-being through olive oil, and gender and socioeconomic equality, as tools to improve the social and labour conditions of the olive oil cooperative sector.

Overall, this model presents a coverage of 86.47%, which denotes the proportion of organizations explained by the variables under study, and overall consistency of 74.43% of cases.

The main point for discussion emerging from the results is that the managers of the olive oil producing cooperatives in the sample corresponding to Andalusian Designations of Origin and product clubs show a clear commitment to the implementation of actions aimed at fulfilling the SDGs in the areas of health and well-being, equality, and the production of quantities of this product as means of ending hunger in the world, as well as actions aimed at revitalizing rural heritage and thus rural areas. It is particularly striking that the rest of the SDGs, the remaining 13, barely register in the values assigned by the study universe. This may be due to the fact that these managers opt for a cross-cutting implementation of the SDGs, as is clear from the previous study by Mozas-Moral *et al.* (2020), or because the initiatives to boost global consumption – with olive oil currently representing 2% of all fats consumed globally (IOC, 2021) – involve promoting the product as a healthy fat, which is at the core of the Mediterranean diet. These promotional efforts are accompanied by support for territorial development, advocacy of the region's cultural, natural and ethnographic heritage identity, and strategies regarding equality policies at the European level.

The results obtained are thus in line with previous studies that have demonstrated the existence of a strong causal relationship between the social economy – represented here by cooperatives – and the SDGs. While it is true that no study to date has related SDGs and cooperativism, Mozas-Moral (2020) also finds that an emphasis on the SDGs serves the social economy and these

agents should promote cooperativism through both wage and gender equality, and a commitment to health and sustainability. Other studies such as that by Sánchez-Martínez *et al*. (2020) present cooperatives as ecosystems of social innovation, which address criteria such as ending hunger or promoting initiatives that stimulate rural development to achieve equality among territories. These studies thus lend support to the results from the model applied here, given that no relevant references have been found on the relationship between olive oil cooperatives and the implementation of the SDGs.

5. Conclusions

This study analyses aspects related to the implementation of the SDGs in the olive oil cooperative sector in Andalusia, applying the different conceptual areas into which this issue is divided, in an effort to identify causal relationships with them. After conducting a literature review of the SDGs, the social economy and the importance of the olive oil sector in Andalusia, a theoretical framework was constructed which covered the key aspects of the implementation of the SDGs in Andalusian cooperatives. The most notable SDGs in that framework were 2, 3, 4, 5, 7, 8, 9, 12, 13, 15 and 17.

The next step in the study was to assign scores and weights to the 17 SDGs, followed by the application of the fsQCA technique and an analysis of its results. The resulting model is both novel and of practical application for companies in the olive oil industry, regarding the implementation and development of the SDGs that have been identified in the causal relationships of the model.

At a practical level, the results obtained in terms of the causal patterns identified by the fsQCA model will enable the design of strategies for the implementation and development of these goals in olive oil cooperatives, taking as a reference those cooperatives that have already incorporated these goals or are in the process of doing so. The design of strategies based around the SDGs provides olive oil mills with higher added value, thus contributing to their individual differentiation and the sustainable growth of the sector. Furthermore, results will contribute to the design of effective strategies, messaging, and actions aimed at the transfer of knowledge and experience of implementing SDGs in this area.

The results of the fsQCA applied in this study underline the strength of the relationship between the social economy – represented here by olive oil cooperatives – and the implementation of the SDGs. Ultimately, this article focuses on the importance of developing strategies to implement the Sustainable Development Goals in cooperative societies, serving as a model for developing policies in this regard. These cooperative olive oil mills, in addition to producing olive oil, promote values linked to food security, sustainability, the showcasing of heritage, and gender equality. These aspects are hugely important in the current economic crisis triggered by the Covid-19 pandemic (Ranjbari *et al*., 2021), in which global economic growth involves setting targets aimed at achieving the SDGs.

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Bridging the knowledge gap of apple growers: Transition from conventional to organic production pattern in Iran

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Abstract

Organic Agriculture (OA) is an ecological, economic and social system that has been in the spotlight to replace and reduce the adverse consequences of conventional agriculture (CA) and achieve sustainable agriculture. The future of OA depends heavily on the knowledge of producers. Accordingly, the current research is based on the Borich model and a survey method using a questionnaire, to examine the existing knowledge and needed by Damavand gardeners to produce organic apples. Thus, using Cochran's formula, a sample of 158 gardeners were selected and interviewed by simple random sampling method. The validity of the assessment tool was obtained through a panel of experts. Also, to evaluate the reliability of the designed items, a pilot study was conducted outside the main sample. The results showed that in the planting stage, most of the respondents had very poor and weak level of knowledge, in the growing stage and the harvest the less than needed average level of knowledge to produce organic apples. The study of gardeners' information-seeking behavior showed that they were initially more inclined to individual resources like other experienced and prominent gardeners, and then to agricultural experts and extension agents. The need to acquire knowledge for organic production increased with the increase in the age of gardeners. However, with increasing issues such as education level, use of information resources, cultivation level and work experience, the need to acquire knowledge decreases. Finally, based on the Borich model, priority educational issues were identified to bridge the knowledge gap in order to produce organic apples in the planting, growing and harvesting stages.

***Keywords**: Organic agriculture, Conventional agriculture, Training needs assessment, Borich model, Organic apple, Iran.*

1. Introduction

The ensuring food security has emerged as one of the serious challenges with increasing population. Thus, in recent decades, more emphasis has been placed on intensive agriculture through the increasing use of chemical inputs, especially fertilizers and chemical pesticides (Palis *et al.*, 2006). Although some success has been achieved, the indiscriminate use of these inputs has led to worrying consequences, including the instability of agricultural systems, the unauthorized chemical residues in food products, and the emergence of a variety of diseases and environmental hazards (Jensen and Blok, 2008; Yazdan-

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Table 1 - World: Organic agricultural land (including in-conversion areas) and regions' shares of the global organic agricultural land 2019.

Region	*Organic agricultural land (hectares)*	*Regions' shares of the global organic agricultural land*
Africa	2030830	2.8%
Asia	5911622	8.2%
Europe	16528677	22.9%
Latin America	8292139	11.5%
Northern America	3647623	5.0%
Oceania	35881053	49.6%
World	72285656	100.0%

Source: IFOAM, 2021.

panah *et al.*, 2015). Because CA is like a double-edged sword, which on the one hand has low cost and high yield and on the other hand has negative effects on humans and the environment (Lumpkin, 2003). In conventional agriculture, more than 300 types of hazardous chemical compounds such as pesticides, herbicides and chemical fertilizers are used to control pests, insects and provide the nutrients needed by the soil. In addition to polluting groundwater, the residues of these substances are absorbed by plants and trees and deposited in fruits and vegetables and transferred to the human body by consumption (Asgari and Hasani Moghaddam, 2011). Accordingly, industrial agriculture has caused the loss of biodiversity and habitats and has provided the conditions for the emergence of various diseases and the spread of viruses. Therefore, the need for sustainable and resilient food systems is very much felt (Luttikholt, 2020). Now, along with ensuring food security, the issue of food safety has become very important. Thus, OA has been introduced as a suitable alternative to CA (European Commission, 2016). OA is a type of agriculture that aims to create integrated, systematic and humane production systems that do not conflict with environmental, social and economic advantages. Different definitions of organic products emphasize the non-use of genetic modifications, toxins, chemical fertilizers, hormones and other chemicals. Because these products are the result of OA process (Basha *et al.*, 2015). Positive effects on the environment and improving the situation of villagers and rural society economically justifies OA and with its proper implementation can provide healthy and sustainable food. Today, the role of OA in achieving sustainable development goals is quite clear (Gabriel and Tscharntke, 2007; Luttikholt, 2020). OA can also help reduce climate change because it reduces greenhouse gases, especially nitrous oxide, by not using nitrogen fertilizers. By creating and consuming organic matter, it stores carbon in biomass and soil. Eliminating the energy required to produce fertilizers and chemical pesticides and using the farm's internal inputs reduces energy consumption by 30-70% per unit area, and as a result, the fuel used for transportation is reduced (IFOAM, 2020). OA is a production system that maintains the health of soil, ecosystems and people. This system emphasizes ecological processes, biodiversity and cycles adapted to local conditions. Thus, the expansion of OA has grown exponentially, especially after the intensification of sensitivities to agriculture climatic and environmental issues. These new ideas include more rational use of natural resources, environmental protection, high-efficiency low-input agricultural approach, food security, land return and sustainable agricultural development through systems such as organic, biological, biodynamic and natural systems with extensive relevant theoretical and applied studies (Regouin, 2003). In parallel with this development, the world organic food market has expanded by an average of 20% per year (Pino *et al.*, 2012). According to the latest global statistics (Table 1), the amount of land under cultivation of organic products in the world is 72.3 million hectares, which includes 1.5% of

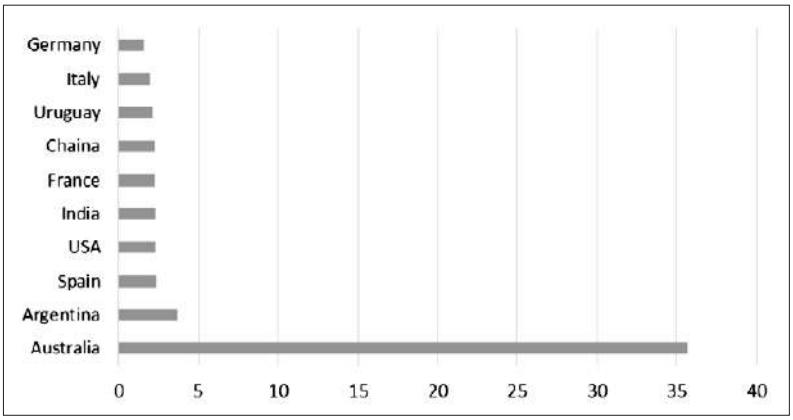

Figure 1 - World: The ten countries with the largest areas of organic agricultural land 2019.

Source: IFOAM, 2021.

the total land in the world. Asia, with an area of 5.9 million hectares, accounts for about 8.2% of the world's organic matter. Australia with 35.7 million hectares, Argentina with 3.7 million hectares and Spain with 2.4 million hectares, respectively, have the highest area under organic crops in the world (Figure 1). The number of producers of organic agricultural products in the world is 3.1 million, of which 1366226 belong to India, 210353 to Uganda and 203602 to Ethiopia (IFOAM, 2021). Despite the high growth of production and demand for organic products, but the share of production of these products is still small compared to conventional methods of agricultural production in the world. Therefore, in many countries, agricultural policies show a strong orientation towards friendship with nature.

In Iran, there is a greater tendency for intensive agriculture and high consumption of chemical inputs to achieve food security and increase production, so that the amount of chemical fertilizer consumption has increased from 2.5 to 3.5 million tons in the last 10 years, i.e., at the level of 12 million hectares, the amount of chemical fertilizer consumption is 1665588 tons with an average of 61 kg and pesticides 1800628 liters with an average of 0.4 liters per hectare (FAO, 2013). These conditions have made Iran rank 67th among 180 countries in terms of environmental performance index (EPI, 2020). Despite the increasing spread of OA in the world, in Iran this trend is slowly increasing. According to the latest global statistics, the amount of agricultural land under cultivation of organic crops is 11,916 hectares, which is about 0.03% of the total land of Iran and about 3879 people are working in this regard (IFOAM, 2021). In Iran, apples are the most important horticultural product, so that it is in the first rank of production (Ministry of Agriculture, 2020); besides, globally, apples are ranked third in terms of acreage after citrus and bananas (Choupannejad *et al.*, 2018). Iran has a special position in the world due to the favorable climatic conditions for the cultivation of apple (Naderi *et al.*, 2020). World apple production is about 90 million tons and that in terms of area under apple cultivation, Iran ranks third and in terms of production (3872000 tons), sixth in the world after China (54447793 tons), Poland (5649323 tons), Italy (4604271 tons), USA (3925828 tons) and Chile (3872000 tons) (FAO, 2020). According to the latest statistics, the Ministry of Agriculture (2020) announced the area under cultivation of Iranian apple orchards in 2020 as 296 thousand hectares with a production of 5.2 million tons and exports of 925 thousand tons. The average apple production in Iran is 16 tons per hectare and in Tehran province is 32 tons per hectare. There are about 12,000 hectares of apple orchards in Tehran province. Furthermore, the average yield of apple production belongs to Damavand city with about 85 tons per hectare. Damavand city with the area under cultivation of 5800 hectares and the production of 230 thousand tons of apples has the first rank in Tehran province. Damavand apple is one of the best and most famous apple brands in Iran. In recent decades, due to the indiscriminate use of pesticides and chemical fertilizers to increase crop production by Damavand gardeners,

Malling apple trees have been damaged, which makes it difficult to control pests and plant diseases, production instability and reduced crop quality, susceptibility to environmental stress, natural resources pollution and endangerment of human health. Organic apples are higher in quality of nutrition and tastier than conventional apples because chemical inputs are not used in its production (Ministry of Agriculture, 2020).

The main role of gardeners in moving towards OA necessitates analysis of farmers' knowledge to move and change the paradigm from a CA model to organic agriculture. However, despite the prediction of increasing the production of organic products in the future, few practical and experimental studies have been conducted on the training needs of gardeners to produce organic products. Despite the advantages of producing and consuming organic produce, it is not possible to make the right decisions without sufficient information (Lind *et al.*, 2003). However, traditional farmers have emphasized the lack of knowledge and information as one of the main constraints to the transition to organic agriculture (Sadeghi *et al.*, 2012). Farmers' decision to produce organic produce can be influenced by several factors. One of the important factors for OA by farmers is their knowledge of the production of these products. Study Gostchi *et al.* (2007) showed that there is a positive and significant relationship between knowledge of OA and the general environmental attitude of farmers. The results of a study conducted in Canada showed that the lack of knowledge and skills required for organic farm management and the lack of marketing opportunities for organic products are the most important reasons for avoiding OA practices. Economic factors also had the greatest effect on the conversion of OA among conventional farmers. Pest control, diseases and insects, uncertainty of economic efficiency, complexity and difficulties of the conversion process were identified as the main obstacles to the use of OA operations (Khaledi *et al.*, 2007). An influencing factor in the acceptance of OA is knowledge and awareness of its advantages (Stobbelaar *et al.*, 2007). While high costs, uncertainty of certification, lack of marketing information, lack of information related to price, high cost of manpower, production problems and information insufficiency were expressed as the main obstacles in the process of producing organic products (Sterrett *et al.*, 2005). In study of Alhafi Alotaibi *et al.* (2021), they found that the sustainability of OA depends on farmers' experience, the quality of information provided, risk management, and compliance with related regulations. Organic farmers and the OA Organization were two important sources of information. Also, adaptive capacities to climate change and certification are the key to production success in organic systems. Findings Hameed and Sawicka (2016) showed that there were significant relationship between farmers' knowledge and variables (education level, age, years of work in agriculture. Ben Abdallah *et al.* (2018) concluded that the need to reinforce the economic performance of organic olive growing production system through political strategies focusing on I) the improvement of the productivity by the implementation of good practices II) the increase of the demand of organic products in the local market, essentially by the improvement of the consumer's purchase capacity and III) the adoption of a strategic plan to explore new markets. Papadopoulos *et al.* (2018) showed that the farmer's decision to implement organic farming is determined by their attitude towards organic farming and to a lesser extent by economic reasons closely related to subsidies. Iofrida *et al.* (2020) stated that a similar level of economic profitability in both scenarios, due to the public subsidies for organic farming, which balanced higher production costs. From a social point of view, some differences have been highlighted: organic farming would be suitable not only to increase incomes but also to improve the occupational health of the people involved. The results of study Alhafi Alotaibi *et al.* (2019) also showed that the development of vocational training programs in order to meet the training needs of agricultural extension agents about OA should be based on the current knowledge of extension agents. The training need in OA indicates a lack of knowledge that can be reduced or eliminated through education (Man *et al.*, 2016). According to the model (Borich, 1980), which is widely used in agricultural extension, the training need is the gap between the

current capability and the ideal situation of the individual in the same context. The premise of the Borich model is that needs assessment audiences can better judge their performance. Needs assessment identifies the gap between what one should know and do and what one knows and does in the current situation, and shows what education should emphasize (McCawley, 2009). In fact, the training need is the gap between the current and desired level of ability of individuals to perform their duties and responsibilities. Given the importance of apples as the first garden product in Iran and the prominent role of Damavand city in providing this important product, it is important to make arrangements for the stability and health of this product while examining the training needs of gardeners in the first and most important step. Because OA is more knowledge-intensive and information-intensive than input-intensive and needs to promote and improve the level of knowledge and even the use of indigenous knowledge. As Vaarst *et al.* (2009) stated OA and its management is very knowledgeable and training and access to it is important. Because the first step in extension and developing OA is to determine and analyze the gap between current knowledge and the knowledge required by gardeners, Due to the fact that special study was not conducted on the analysis of knowledge of gardeners in order to grow organic apples in Iran and the educational needs of gardeners in this regard were not clear to researchers, the present study was conducted. Thus, the current study aims at determining the training needs of gardeners to produce organic apples based on the Borich model.

2. Material and methods

2.1. *Introducing the study region*

Tehran province with an area of about 12981 square kilometers, is located between 34 to 36.5 degrees' north latitude and 50 to 53 degrees' east longitude. This province has 16 cities, 45 towns and 78 villages and limited from north to Mazandaran province, from south to Qom province, from southwest to Markazi province, from west to Alborz province and from east to Semnan province (Figure 2). This province, with 20% of the country's population, occupies 40% of the total consumer market. The average long-term rainfall in this province is 238.6 mm. Damavand city is a mountainous region located in the southern part of the central Alborz mountain range and in the northeastern part of Tehran province. This city is part of Tehran province and its area is about 24645 square kilometers and has an average height of 2300 meters above sea level and its shape is an irregular hexagon. In terms of temperature, the coldest month of January is with an average of 5 to 8 degrees and the warmest month of July is with an average temperature of 25 to 32 degrees Celsius. The average annual number of frost days in this region is 115 days for Abali, 101 days for Damavand and 95 days for Hamand Absard. The prevailing wind in this city blows from the northeast with an angle of about 30 degrees from the north and the average annual rainfall is more than 380 mm. The average annual relative humidity of the region is about 50.2% and its monthly relative humidity fluctuates between 28.7% in July to 74.7% in February. Thus, it has a semi-humid and cold climate. According to the latest divisions of

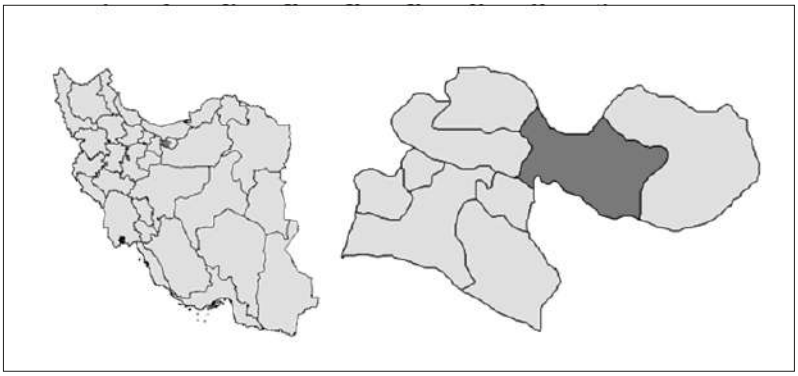

Figure 2 - Area of study (Damavand, Iran).

the country, Damavand city has only two parts, the central and the Rodehen. This is while more than 95% of the area of this city is located in the central part. The central part has three villages: Abarshiveh (with 20 residential villages), Tarroud (with 17 residential villages) and Abaroud (with 30 residential villages); There are a total of 67 villages with a population of more than 20 people and also three urban points of Damavand, Kilan and Absard (OAJT, 2020). According to the results of the present study, in terms of cultivated area, 59% of the studied gardeners had less than 8 hectares, 24.4% between 9-18 hectares, 16% between 19-28 hectares and only 0.6% more than 29 hectares of apple orchards. Among the gardeners studied, 39.2% were privately owned, 27.8% rented, 26.6% shareholders and 6.3% communal.

2.2. *Survey*

The present research is an applied study in terms of purpose, is a non-experimental study in terms of how to control variable, and is a survey in terms of research method, is field study in terms of data collection and is a cross-sectional study in terms of data collection time. The statistical population consists of 3000 gardeners of Damavand city. A sample of 158 individuals was determined using Cochran's formula through simple random sampling method with proportional assignment and table of random numbers (Table 2) and through face-to-face interview. A field study was conducted. Data collection was done in two stages, namely library study and review of research background by searching databases and then in the field stage. In the field stage, a questionnaire was used as the main research tool. The prepared questionnaire was given to a panel of experts and the necessary corrections were made based on the received comments. Accordingly, the face and content validity of the questionnaire was confirmed. In the next stage, the pretest was performed outside the study region to determine the reliability of the research tool. The results of Cronbach's alpha coefficients related to the questionnaire showed good reliability (α = 0.89-0.93).

$$n = \frac{Nt^2S^2}{Nd^2 + t^2 \times S^2} \rightarrow$$

$$\rightarrow n = \frac{(3000)(1.96)^2(0.33)^2}{(3000)(0.05)^2 + (1.96)^2 \times (0.33)^2} = 158$$

N = statistical population
t = Student t value with 95% confidence (significant distance level) and 5% error = 1.96
S = standard deviation of the dependent variable
d = error distance (degree of accuracy) = 0.05
n = Statistical sample size

2.3. *Needs assessment process and data analysis*

Educational needs assessment is an action that identifies the gap between what is and what should be, and shows what education should emphasize. There are several models for assessing educational needs. Among the needs assessment models, Borich's needs assessment model has been widely used in agricultural extension. According to the Borich model, the educational need is the distance between the current competencies and the ideal situation of the individual in the field of the same competencies. The assumption of the Borich model is that people in the needs assessment can better judge their performance. Borich's needs assessment model is based on ranking the difference between the importance of the educational subject and the individual's knowledge in that field (Pezeshki-Rad, 2008).

Table 2 - Statistical population and sample size.

Damavand	*Statistical population*	*Village*	*Statistical population*	*Sample size*
Central region	3000	Abarshiveh	1010	53
		Abaroud	1325	70
		Tarroud	665	35
Total			3000	158

Based on the Borich needs assessment model (Borich, 1980), gardeners were asked to use the Likert scale to determine their current level of knowledge for organic apple production, so that 5 = very high knowledge, 4 = high knowledge, 3 = medium knowledge, 2 = low knowledge and 1 = without knowledge. Gardeners were also asked to determine the importance of each item for organic apple production in the Likert scale based on 5 = very important, 4 = important, 3 = somewhat important, 2 = minor and 1 = insignificant. Then, training needs are determined and prioritized through the following steps and formulas.

Stage 1: Calculate the average amount of knowledge and information and the importance of each item asked from the respondent's point of view

Stage 2: Calculate the training need per item: CAL EN= (Im-Kn) Ig

Where,

CAL EN= Calculated educational need

Im= Importance of the item reported by the respondent

Kn= Perceived knowledge of the item reported by the respondent

Ig= Average importance of the item as rated by all the respondents.

According to these formulas and relationships, if the priority score of each item is higher than 4, it has the highest need for training and is in the training priority group. Items whose priority score is 2 and up or less than 4 have no training priority but need to be reinforced. Items whose priority score is below 2 do not need to be trained (Zarafshani *et al.*, 2011).

The F-test was used to compare between groups. F-test assumptions include the following: Observations are selected from a normal population. The data being compared should have almost the same variance. The collected data should have an interval or ratio scale. Multiple regression is used as a tool to predict the value of a dependent variable from the values of independent multivariable. In multiple regression, the parameters of a linear model are estimated using an objective function and the values of the variables. Regression is closely related to the correlation coefficient. This means that to perform regression, the correlation coefficient must be calculated. If there was a correlation between the studied variables, only then can we use regression to test the research hypotheses. The stronger the correlation between the variables, the more accurate the prediction. The difference between regression and correlation coefficient is that regression seeks prediction, while correlation coefficient examines only the degree of dependence of two variables. Although there are fundamental differences between regression analysis and correlation coefficient, they are used as complementary in data analysis.

3. Results

3.1. *Personal and productive characteristics*

Among the respondents, 98.3% were male and 1.3% female, with a minimum age of 20 and a maximum of 61 years and a mean age of 45 years. In terms of education level, 15.2% were illiterate, 35.4% elementary school, 10.8% middle school, 5.1% high-school diploma, 29.7% bachelor degree and 3.7% master degree. In terms of apple growing history, it was a minimum of one year, a maximum of 20 and an average of 7 years. Given the area under apple orchards, 59% of the subjects were less than 8 hectares, 24.4% were 9-18 hectares, 16% were 19-28 hectares and 0.6% were more than 29 hectares. Given the average annual yield of respondents' apples per hectare, the findings show that 72.9% of them had an average yield of less than 47 tons per hectare. 10.3% had a yield between 48-96 tons, 7.1% had a mean yield between 145-97 tons. 8.5% had a mean yield between 194-146 tons and 0.6% averaged between 243-195 tons per hectare.

3.2. *Current knowledge of gardeners about organic apple production*

The results of the survey of current knowledge of gardeners about the production of organic apples in the planting stage indicate: 23.1%, 41%, 34%, and 1.9% had very poor, poor, moderate and good knowledge, respectively. Also in the growing stage: 5.8%, 38.1%, 48.4% and 7.7% had very poor, poor, moderate and good knowledge, respectively. At the harvest stage: 1.9%, 19.6%, 54.4% and 24.1% had very poor, poor, moderate and good knowledge, respectively (Figure 3).

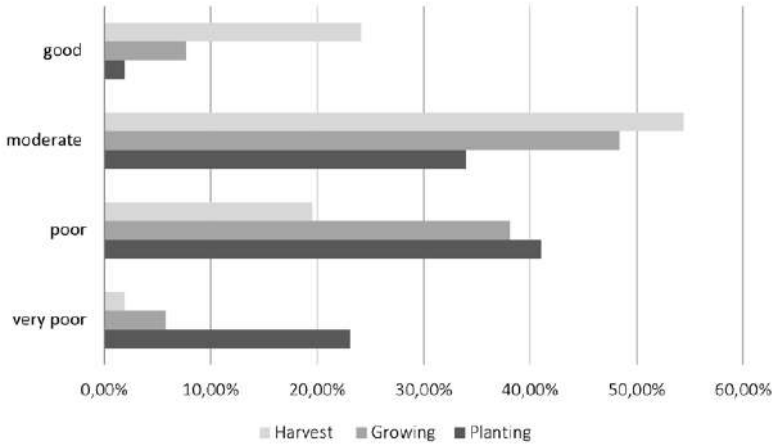

Figure 3 - Current knowledge of gardeners about organic apple production.

3.3. *Tendency to use information sources to produce organic apples*

According to the results of the coefficient of variation, the highest tendency of gardeners to use information resources to produce organic apples include consult experienced and prominent gardeners, consult with extension agents and agricultural experts, participate in training courses, communicate with consulting service centers, participate in certifying institutions (inspectors), visiting organic apple orchards, using training magazines and extension al publications, using training videos and using radio and television training programs (Table 3).

3.4. *Results of prioritizing the training needs of gardeners for organic apple production*

In order to determine the educational needs from the viewpoint of gardeners themselves, the Borich needs assessment model was used using 20 items. For each of the questionnaire questions, gardeners used the Likert scale (1-5) to determine how much knowledge or importance they had in each of the educational subjects measured. How to assess the educational need based on the Borich model was explained in the research methodology. Table 4 shows the prioritization of gardeners' training

Table 3 - Ranking of gardeners' willingness to use information sources to produce organic apples.

Item	*Mean*	*SD*	*Coefficient of variation*	*Priority*
Consult experienced and prominent gardeners	3.72	0.59	0.161	1
Consult with extension agents and agricultural experts	3.94	0.77	0.197	2
Participate in training courses	4.22	0.94	0.225	3
Communicate with consulting service centers	3.97	0.96	0.244	4
Participate in certifying institutions (inspectors)	3.92	0.98	0.252	5
Visiting organic apple orchards	3.85	1.06	0.227	6
Using training magazines and extension al publications	3.89	1.07	0.227	7
Using training videos	3.82	1.18	0.309	8
Using radio and television training programs	2.49	1.15	0.462	9

Evaluation scale: 1 = very low; 2 = low; 3 = moderate; 4 = high; 5 = very high
Source: Authors' survey.

Table 4 - Prioritize the training needs of gardeners for organic apple production.

Stage	*Item*	*Current knowledge mean*	*Importance mean*	*Training need score*	*Priority*
Planting	Knowledge of appropriate non-genetic cultivars of organic apples in the region	1.87	4.13	8.34	1
	Knowledge of characteristics of standard organic apple seedlings	1.93	4.07	7.90	2
	Knowledge of the standard (permitted instructions) of organic apple production	2.26	3.74	5.46	3
	Knowledge of the course and how to convert an ordinary garden to organic	2.44	3.56	4.13	4
	Knowledge of the climatic, soil and water conditions of the planting area	3.7	2.93	-2.84	_
Growing	Knowledge of non-chemical methods including biological, agronomic and mechanical methods to control pests, plant diseases and weeds	2.13	3.92	5.91	1
	Knowledge of time, type, manner and the amount of organic fertilizers used	2.16	3.84	5.54	2
	Knowledge of useful biological organisms in the garden and how to use them	2.15	3.80	5.45	3
	Knowledge of properties of live mulch (clover) for garden floor management	2.29	3.71	4.69	4
	Knowledge of how to prepare and use green manure and compost using waste in the garden	2.50	3.50	3.3	5
	Knowledge of the importance of water testing methods to ensure safe and non-chemical use of water	3.02	2.98	-0.13	_
	Knowledge of the correct method of drip irrigation	3.34	2.66	-.2.24	_
	Knowledge of water needs and management of water consumption in the apple orchard	3.36	2.64	-.2.38	_
	Knowledge of the right time and how to prune apple trees	3.37	2.63	-.2.44	_
Harvest	Knowledge of the conditions and how to obtain organic product label for obtaining a sales license	1.70	4.30	9.83	1
	Knowledge of indicators, criteria and methods of inspection and monitoring of certification bodies	1.89	4.11	8.39	2
	Knowledge of proper packaging for organic apples	2.05	3.87	6.88	3
	Knowledge of the rules of transportation of organic products	2.14	3.86	6.50	4
	Knowledge of the method and time of timely harvest according to different cultivars	3.44	3.99	2.08	5
	Knowledge of non-chemical methods in pest and storage diseases control	3.45	2.55	-3.40	_

Needs training *Needs strengthened* *Does not need training*
Source: Authors' survey.

needs for organic apple production based on the Borich needs assessment model. According to this table, 12 training subjects scored above four which are considered as training priorities. The training subjects include: knowledge of the conditions and how to obtain organic product label for obtaining a sales license, knowledge of indicators, criteria and methods of inspection and monitoring of certification bodies, knowledge of appropriate non-genetic cultivars of organic apples in the region, knowledge of characteristics of standard organic apple seedlings, knowledge of proper packaging for organic apples, knowledge of the rules of transportation of organic products, knowledge of non-chemical methods including biological, agronomic and mechanical methods to control pests, plant diseases and weeds, knowledge of time, type, manner and the amount of organic fertilizers used, knowledge of the standard (permitted instructions) of organic apple production, knowledge of useful biological organisms in the garden and how to use them and knowledge of properties of live mulch (clover) for garden floor management. The results also showed that two cases, although they do not have training priorities, but need to be strengthened, which include: knowledge of how to prepare and use green manure and compost using waste in the garden and knowledge of timely harvest according to different cultivars. Other cases do not have training priority.

3.5. *Analysis of variance test results*

The results of analysis of variance (F-test) among gardeners with different characteristics (Table 5) show that the training needs of illiterate gardeners are higher than those with primary education, and the training needs of people with primary education are higher than those with secondary education. Also, gardeners who had less use of information resources had significantly more training needs than those with medium and high communication.

3.6. *Correlation test*

The results of correlation test show that there is a negative and significant relationship between education, work experience, cultivation level and the tendency to use information resources with the knowledge required to produce organic apples, but there is a positive and significant relationship between gardeners' age and training needs (Table 6).

Table 5 - Results of analysis of variance test to compare the training needs of gardeners with different characteristics for organic apple production.

Independent variables	*levels*	*Frequency*	*Dependent variable*	*Mean*	*SD*	*t*	*Sig*
Education	illiterate elementary school middle school diploma bachelor master	24 56 17 8 47 6	the knowledge required to produce organic apples	8.54 7.31 6.09 5.23 4.48 3.30	4.58 3.33 3.18 3.01 2.64 2.21	3.12	0.021*
the tendency to use information resources	Low Moderate High Very high	2 31 110 15		9.70 10.09 7.15 5.77	4.45 3.42 3.30 3.49	10.39	0.0001*

*Source: Authors' survey. * = p<0.05*

Table 6 - Relationship between individual characteristics of gardeners and the knowledge required (training need) to produce organic apples.

Independent variable	*Dependent variable*	*Correlation coefficient*	*Sig*
Age	The knowledge required to produce organic apples	0.532	0.015*
Education		-0.494	0.001*
Work experience		-0.601	0.001*
Cultivation level		-0.491	0.001*
The tendency to use information resources		-0.551	0.001*

*Source: Authors' survey. * = p<0.05*

3.7. *Multiple regression results between independent and dependent variables of the research*

The stepwise multiple regression test was used to explain the variance of the dependent variable and to determine the ability of independent variables in predicting the dependent variable of the research (knowledge required for organic apple production). The variables of age, level of education, level of cultivation, work experience and the tendency to use information sources that had a significant relationship with the research variable were entered into regression to calculate. The results showed that all these variables entered the regression equation in five stages. Indicators Durbin Watson (1.886) and VIF indicate the appropriateness of using regression test for these variables. Values of t and significant level for these variables also indicate the presence of an effect on the dependent variable of the research. Also, the beta values obtained for these variables show that for each change in standard deviation, the independent variable is changed as much as the beta in the dependent variable. The study of standardized regression coefficients shows that the age variable (X2) with a value of B = 0.471 has a more positive role in estimating the knowledge required by gardeners (educational need) to produce organic apples. In other words, a unit change in the standard deviation of the age

Table 7 - Values of the effect of independent variables on the knowledge required for organic apple production.

Variables	*B*	*S.E.B*	*β*	*t*	*Sig*	*VIF*
Constant	13.97	0.995		14.03	0.0001**	
The tendency to use information resources X1	-2.155	0.555	-0.227	-0.378	0.0001**	1.681
Age X2	5.523	0.632	0.471	8.59	0.0001**	1.313
Work experience X3	-0.771	0.404	-0.127	-1.918	0.04*	1.079
Education X4	-0.128	0.044	-0.149	-.2.78	0.005**	1.285
Cultivation level X5	-0.085	0.031	-0.168	-0.265	0.007**	1.362

Table 8 - Multiple regression to examine the relationship between independent and dependent variables of the research.

Model	*R*	*R^2*	*Adjusted R^2*	*Std. Error of the estimate*	*Durbin Watson*
1	0.490	0.240	0.238	3.26	1.886
2	0.598	0.357	0.350	3.01	
3	0.637	0.405	0.399	2.90	
4	0.648	0.419	0.411	2.81	
5	0.690	0.476	0.442	2.87	

variable causes the standard deviation of the dependent variable to change by 0.471. The beta coefficients of other variables indicate that they play a negative role. Also, the rate of change of dependent variable by independent variables, as shown by the adjusted coefficient (Adjusted R^2 = 0.442), these five variables estimate 44.2% of the knowledge changes required for organic apple production (Tables 7 & 8).

Accordingly, the following regression equation to estimate the knowledge required by gardeners (training needs) to produce organic apples is:

$Y= 13.97- 2.155X_1 + 5.523X_2 – 0.771X_3 – 0.128X_4 – 0.085x_5$

4. Discussion

The results show that at the planting stage, most of the respondents show very poor and poor knowledge in the planting stage, and less than the average level in the growing and harvest stages, of knowledge needed to produce organic apples. These conditions indicate a feeling of lack of knowledge required to produce organic apples for the planting growing and harvest process. The poor knowledge of gardeners is considered as one of the important obstacles to the transition from the conventional to the organic pattern. Gardeners can move in this direction if they have the necessary knowledge and ability for organic production. Appropriate and targeted agricultural extension training can help to provide the required knowledge and success in organic production. These results are consistent with that of Hameed and Sawicka (2016).

The results show the tendency of gardeners to use information resources to produce organic apples include consult experienced and prominent gardeners, consult with extension agents and agricultural experts and then participate in training courses, communicate with consulting service centers, participate in certifying institutions (inspectors), visiting organic apple orchards, using training magazines and extension al publications, using training videos and using radio and television training programs. These results indicate that the information-seeking behavior of gardeners is initially more focused on individual resources such as other experienced and prominent gardeners, and then extension agents and agricultural experts. Therefore, experienced and capable gardeners in organic apple production can be identified and organized and used in training and support of other gardeners in the region. Also, if they have the necessary professional qualifications, they should be provided with a valid certificate to provide services. According to these results, in promoting organic apple production, individual training methods and then group methods should be considered. At the same time, attempts should be made to design and establish an organic agricultural knowledge and information system. These results are consistent with that of Aryal *et al.* (2009) and Piadozo *et al.* (2014).

The results of needs assessment to determine the knowledge required by gardeners to produce organic apples based on the Borich model show that 12 training subjects scored above four which are considered as training priorities. The training subjects include: knowledge of the conditions and how to obtain organic product label for obtaining a sales license, knowledge of indicators, criteria and methods of inspection and monitoring of certification bodies, knowledge of appropriate non-genetic cultivars of organic apples in the region, knowledge of characteristics of standard organic apple seedlings, knowledge of proper packaging for organic apples, knowledge of the rules of transportation of organic products, knowledge of non-chemical methods including biological, agronomic and mechanical methods to control pests, plant diseases and weeds, knowledge of time, type, manner and the amount of organic fertilizers used, knowledge of the standard (permitted instructions) of organic apple production, knowledge of useful biological organisms in the garden and how to use them and knowledge of properties of live mulch (clover) for garden floor management. The results also showed that two cases, although they do not have training priorities, but need to be strengthened, which include: knowledge of how to prepare and use green manure and compost using waste in the garden and knowledge of timely harvest according to different cultivars. Other cases do not have training priority.

In fact, if the appropriate training is provided and in accordance with the needs of gardeners, we can be very sure of filling the knowledge gap between the existing knowledge and needed to produce organic apples. These results are consistent with that of Basha and Lal (2019), Häring *et al.* (2009), Sahu *et al.* (2010) and Stolze and Lampkin (2009).

The results of analysis of variance show that there is a significant difference between individuals with different levels of education in the amount of knowledge required to produce organic apples. People with lower levels of education feel the need for more knowledge. Higher education leads to more use of information resources and wider communication, and this leads to more knowledge acquisition and exchange. Therefore, due to the fact that people with higher levels of education felt less training need, so the agricultural extension system should account for these differences in the design and implementation of organic training programs and focus more on gardeners with lower levels of education and support them. This result is consistent with the findings of Al-Shayaa *et al.* (2021) and Ghadimi *et al.*, 2013. Also, the less people were willing to use information resources, the more they needed knowledge. These results indicate that if different sources of information about organic apple production are available to gardeners, it will increase their level of knowledge and awareness and can meet their training needs. This result is consistent with that of Alzaidi *et al.* (2013) and Parveen (2010).

The results of correlation test show that there is a negative and significant relationship between the variables of education level, work experience, cultivation level and the tendency to use information resources with the knowledge required to produce organic apples. This result indicates that the higher the level of education of gardeners, the more the possibility of using reliable sources of information about organic production and therefore their training need decreases. The same is true of the tendency to use information resources. In the case of work experience, the more it is, the less the sense of training need is felt due to the acquired experimental and local knowledge. However, the higher the area under cultivation, the more knowledge is needed to apply better farm management. However, the age of gardeners had a positive and significant relationship with training needs. Younger gardeners also need less training in organic agriculture. Therefore, the older the age, the more the training need. The results of multiple regression test also showed that the variables of age, level of education, area under cultivation, work experience and the tendency to use information sources can predict the dependent variable of knowledge required for organic apple production. Among these, the age variable had a positive effect, but the other variables had a negative effect. That is, as they increase, the amount of training need will decrease. Findings of Hameed and Sawicka (2016) and Wheeler (2005) confirm these results.

5. Conclusions

In recent decades, efforts to ensure food security have been within the framework of the CA model associated with the increasing use of fertilizers and chemical pesticides, which has led to the presence of illegal and substandard food waste and a variety of crises and challenges in human societies. Accordingly, the desire to produce and consume organic and healthy food is increasing worldwide. OA is an integrated, systematic and humane agricultural production system that strengthens the health of biological ecosystems, soil bioactivity, biological cycles and healthy crop production by utilizing the resources available on the farm. For the production of organic agricultural products, including apples, which ranks first in horticultural products in Iran and third in the world, the starting point is the work of the producer, namely, gardeners. The knowledge and awareness of gardeners plays a decisive and important role in changing the production phase from conventional to organic agriculture. Agricultural extension has a great impact on the knowledge of gardeners. The needs should be identified and then the appropriate training should be designed and presented prior to any training. Needs assessment is the starting point of any training activity. The results of the current paper showed that gardeners do not have

the necessary level of knowledge in the stages of planting, growing and harvesting for organic apple production. Also, the most important sources of information that gardeners are interested in to obtain information and knowledge for organic apple production were ranked. The results of the needs assessment based on the Borich model identified priority training issues. As gardeners grow older, the need for knowledge for organic production increases. However, this need decreases with increasing level of education, the tendency to use information resources, the level of cultivation and work experience.

Organic farming is more knowledge-intensive than inputs-intensive and requires improving the level of technical and managerial knowledge of gardeners. Therefore, designing and implementing extensional training programs is recommended using the capacity of media and social networks on the subject of organic apple production for producers. Creating local management networks of organic agriculture, organizing organic gardeners and creating demonstration and pattern gardens by agricultural extension centers can be effective in the transition from conventional to organic cultivation pattern. Given that increasing consumer awareness plays an important role in increasing demand for organic products, the necessary policies should be on the agenda for extensive information to urban households, especially women.

Adoption of organic farming policies by managers and policymakers as a good start can make gardeners feel the need to move from a conventional to an organic farming pattern. Of course, the higher prices of organic products alone do not play a major role in the adoption and development of organic agriculture. Rather, the development of organic agriculture requires the role of other factors such as increasing information and awareness, improving individual tendency and attitude, improving technical skills and farm management, social, cultural, institutional and infrastructure issues, as well as removing subsidies from some inputs such as pesticides and fertilizers, and in return supporting for the production and supply of organic inputs and subsidizing them should be considered by policy makers and managers in the agricultural sector. Also, in order to successfully implement organic apple production, the quality assurance system, how to label and provide certification of organic products, the required standards and regulations should be developed and the necessary mechanisms and monitoring should be done to implement them. Also Training in the production of organic products should be considered in the curriculum of agricultural colleges.

In order to complete and continue the present research, it is suggested that an educational needs assessment for the production of organic products to be performed for agricultural experts and extension agents. Also, study the factors affecting on the tendency of gardeners to organic farming, as well as the factors to be identified driving and barriers the production of organic apples.

It should be noted that one of the limitations of the present study is pointed the shortage of similar research on needs assessment to determine the knowledge required by gardeners to produce organic apples based on the Borich model in Iran, the use of questionnaire as research tool and the possibility of respondents making mistakes when answering questions, cross-sectional research, inability to fully control all Unwanted variables and non-generalizability of the results of this study to other areas.

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The informal sector and the challenge of regional development in Southeastern Tunisia

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Abstract

This paper tries to highlight the territorial development in the governorates of South-East Tunisia on the border with Libya. Our main objective is to show the existence of a direct relationship between regional diparity and work in informal trade.This work proposes to aggregate a set of regional development indicators of each delegation in order to draw up a typology of the delegations as well as to calculate a territorial development index for each delegation and to discern any failures hindering their development. Also, this analysis addresses the subject of informal trade in Southeastern of Tunisia. Following this, a survey will be made with the informal trade actors to analyze their situations and finally an analysis of the state intervention as well as recommendations will be proposed. Our work has shown that regional and local disparity is one of the causes of informal trade in the Southeast. As well as the workshops, that we organized confirmed that most of the players in the informal trade are unemployed young people. Here, there are also people who are currently working and who a fixed income, but they are informal traders.

Keywords: *Informal sector, Regional development, Southeastern Tunisia.*

1. Introduction

In Tunisia, the efforts made in terms of development are major. The different orientations are essentially aimed at integrating the entire population into the economic sphere in order to address global issues such as globalization and international competition. But despite these efforts, the fruits of development have been unevenly distributed across different parts of the country, and socio-economic growth has favored some governorates much more than others. This spatial inequality between regions is, in reality, the product of the concentration of services and production and poor governance. The regional imbalance in Tunisia between governorates and the territorial disparity between delegations were among the great revelations of the revolution of January 2011. Indeed, the popular uprising started in the disadvantaged Tunisian cities, first those of the Southwest (to cities of the mining basin of Gafsa governorate between 2008 and 2010) and Ben Guerdane in the south-east in 2010 (Chouikha and Gobe, 2009; Nawaat, 2010). This paper tries to highlight the territorial development in the governorates of South-

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East Tunisia on the border with Libya. Our main objective is to show the existence of a direct relationship between regional disparity and the work in informal trade. This work proposes to aggregate a set of regional development indicators for each delegation in order to draw up a typology of the delegations, as well as to calculate a territorial development index for each delegation and to discern any failures hindering their development. Also, this analysis addresses the subject of informal trade in the southeastern part of Tunisia. The towns of Ben Guerdane and Dehiba, on the border between Tunisia and Libya, are among the most marginalized places in Tunisia. In mainstream national discourse, they are seen as hotbeds of cross-border smuggling and terrorism (Ghazel, 2017). However, the experiences of people living in these towns show that restrictions on border trade and a lack of development caused by a history of marginalization by the center are the main sources of insecurity, rather than the terrorist threat (Ghazel, 2017). At present, the free movement of goods and people has made this region an important corridor of exchange and transit between Tunisia and Libya. For several years, the informal sector has grown in the region thanks to the neighborhood relations and the price differential. It would thus be essential to carry out a smuggling sector analysis and diagnosis in order to see the possibilities of formalizing the informal trade that is rampant in the South-East towards the formal. The recommendations in this article can extend to the realization of the studies and the organization of workshops on specific subjects with the concerned stakeholders. This study is among the first to analyze informal trade in southern Tunisia. The originality in our study is the meetings organized with the young people who work in smuggling. They note that it is very rare to see a smuggler discussing their work. In our research, we will analyze the situation. For this, the central question is: what are the causes and solutions to the informal trade in Southeastern Tunisia? We will propose two hypotheses:

- Regional and local disparities are one of the causes of informal trade; the delegations of the south-east are the most disadvantaged in Tunisia;
- The majority of those involved in the informal trade are unemployed youth.

Today, many (thousands) of young people work in the informal sector. It is an unemployment solution, according to them (Haddar, 2013). So some young people who would not even want to work in the private sector settle. In our work, to measure regional and local disparities, we will calculate a composite indicator of territorial development and show the least developed delegations in the Southeast.[1] Following this, a survey will be conducted with the informal trade actors to analyze their situations, and finally, an analysis of the state intervention as well as recommendations will be proposed. Our work has shown that regional and local disparities are one of the causes of informal trade in the Southeast. As well as the workshops that we organized, most of the players in the informal trade are unemployed young people. Here, there are also people who are currently working and have a fixed income, but they are informal traders.

2. Study zone

The study area is composed of three governorates (Gabes, Medenine and Tataouine) which are divided into 26 delegations (Figure 1) and with a population of 1,003,200 people. This zone is characterized by an arid climate marked by a low and irregular rainfall (50-200 mm / year) with high temperatures. At the economic level, the region is characterized by the presence of (Bechir *et al*., 2011a):

- An artisanal and industrial sector based on the exploitation of the oil resources of the extreme South and on the processing manufacturing units mainly in building materials, textile and agro-food industries, and also chemical industries in Gabes;

- A tourist branch with the tourist zone of Jerba-Zarzis which constitutes one of the main

[1] The administrative division in Tunisia is: governorate, delegation, and Imada.

places of concentration of the tourist establishments of the country;

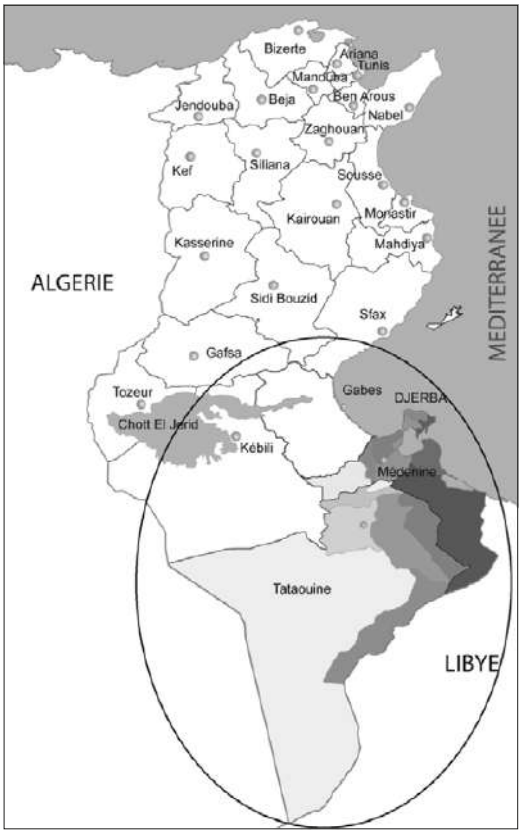
- An important activity of the fishing sector;
- An agricultural sector marked by olive growing;
- An informal trade with Libya.

The Southeast region is characterized by a high rate of unemployment compared to the national average estimated at 14.8% in 2014 (Table 1). Note here, the importance of the informal sector with Libya in reducing the number of unemployed in our region study. This trade has helped to improve the standard of living of several people in the border area with Libya where thousands of retailers, semi-wholesalers, etc. meet. if we compare the south-eastern region with the other regions we notice that our study area belongs to the poor and middle regions. The informal wholesalers of the South-East and especially of the city of Ben Guerdane supply several stores of the large Tunisian cities. According to Haddar (2013), the capital of a wholesaler was estimated at around 300 thousand dinars (800 thousand dollars). Each employs about 5 people and makes a daily turnover of about 50 thousand dinars. The number of Ben Guerdane retailers is estimated at around 1,200 retailers. They play a big role in the distribution of products (electronic materials, food products, wants). Regarding the "fuel chain", it has about 1,000 retailers. The carriers that deliver the imported goods to Ben Guerdane are estimated at about 600. Including a conveyor in addition to the driver, the sector creates about 1200 jobs. In addition to these, there are about 2,000 people working for them even crossing the border daily carrying small amounts of goods and fuel. These indicators show the importance of informal trade in the region and its role in job creation (Haddar, 2013).

Regarding the rate of poverty, in 2019, it reached 21.7% in our region of study in the governorate of Medenine, and 15% in the governorate of Tataouine, note that a disparity is noted between the regions of Tunisia went from 3.5% in the governorate of Tunis to 34.9% in the governorate of Kairouan (INS, 2019).

In the South-East three towns are the best known for smuggling and informal trade: Ben Guardane, Dehiba and Medenine. Ben Guerdane, in the centre of an arid plain, the Jeffara, is 526 kilometres from the capital, in the governorate of Medenine. Dehiba is a small town located 626 kilometres from the capital and three kilometres from the Libyan border, in the governorate of Tataouine. Certainly, the two cities have obvious differences – first, by their population: Ben Guerdane is a medium-sized city with 80,000 inhabitants, while Dehiba, with its 5,000 inhabitants, is more like a big village. Second, they are also

Figure 1 - Location of the study area.



Source: Author.

Table 1 - Unemployment rate in the Medenine and Tataouine governorates of Southeastern Tunisia.

Gouvernorat	*Total*	*Male*	*Female*
Médenine	14.5	8.6	31.5
Tataouine	25.8	18.7	46
Tunisie	14.8	11.4	22.2

Source: INS, 2019.

Table 2 - SWOT Analysis of the Medenine, Dehiba and Ben Guerdane Regions.

Strenghts	*Weaknesses*
• Existence of a real agricultural exploitation potential • Existence of two airports (one is international), two international ports and two border posts with Libya: RasJedir (Medenine) and Dhiba (Tataouine) • First-class geographical position as access to Libya, disposing the region of an important strategic economic space • Existence of several tourist regions • Existence of a very important fishing sector • Existence of several natural resources • Very dynamic civil societies	• Difficult climate and low level of precipitation • Difficult security situation that may affect any development plan in the region • Low level of valorization of agricultural products and absolute dominance of the olive tree despite other potentialities. • Low road infrastructure • Existence of several land problems • Administrative heaviness
Opportunities	*Threats*
• Important economic space justifying substantial investments for the sectors: agricultural, tourist, industrial and commercial. • Number of tourists who visit the region • Local, regional and external market requesting local agricultural products (especially olive, livestock…). • Configuration adapted to the setting up of a logistics and agribusiness platform. • A very important Libyan market. • 2020-2025 Development Plan	• Increasing the salinity of the aquifers and the unsustainability of their exploitation • Advanced desert • Disinterestedness of youth in agriculture • Increase in illegal immigration • Lengthening the situation of insecurity and instability in Libya. • Covid-19

different by the scale of their economies and the different ways they take part in the national and cross-border economy. While Ben Guerdane has emerged as the main currency market since the late 1980s (all the currency of the world), Dehiba is a very small place, where the border is utilized for economic survival. The analysis of the situation of the South-East delegations, using the SWOT[2] technique, allows us to summarize the state of development of the region (Table 2).

3. Methodology

In our study, the qualitative survey was based on a questionnaire developed from informal exploratory interviews conducted with local leaders and political activists, two focus groups, and seminars with the researchers. The first was composed of Dehiba activists (20 people) from local civil society and city officials. The other was held in Medenine and included activists belonging to local associations and young unemployed graduates from Medenine and Ben Guerdane (30 people). The representative sample of local inhabitants aged 18 and over Five control variables were used: the residential environment (urban or rural); age group; educational level; and economic activity. The qualitative survey was carried out during four visits to Ben Guerdane and Dehiba and was based on observations and informal and semi-structured interviews with unemployed youth, local civil society activists, and local government and security officials (governors, police officers, members of the National Guard, and customs agents) (10 interviews). We note here the use of our relations with civil society so that informal trade agents participate in our focus because they generally refuse to participate in official meetings.

[2] The term SWOT is an acronym derived from English: Strengths, Weaknesses, Opportunities, Threats.

4. The informal sector

4.1. *Theory evaluation*

The informal economy is now at the heart of economic and labor policy concerns. Because of two factors. First, because a large part of the population working in developing countries operates outside the frameworks established by labor standards and tax legislation, Then, because a significant portion of the goods and services produced and traded in these countries escape accounting scrutiny. The illegal economy covers all activities that contravene the penal code, either because they are prohibited by law or because they are carried out by unauthorized people. The term "smuggling" actually designates a variety of economic activities that it would be wrong to amalgamate. A struggle is playing out, in this sense, between economic operators who are "more than less" in the legal sphere and those who are "less than less". This smuggling is part of a set of resourcefulness and fraud activities, of which the trafficking of arms and narcotics constitutes the most dangerous part, but it is minimal. In 1993, the International Labor Organization (ILO) and the United Nations Statistics Division reached agreement on the definition of the informal sector (Hussmanns, 2005), also retained by the manual on the unobserved economy (OECD *et al*., 2002). The 15th International Conference of Labor Statisticians in 1993 defined the informal sector as "a set of units producing goods and services with a view, primarily, to creating jobs and income for those who are concerned." These units have a low level of organization, operate on a small scale and in a specific way, with little or no division between labor and capital as factors of production. Labor relations, where they exist, are predominantly based on casual employment, kinship relations, or personal and social relations rather than on contractual agreements with formal guarantees.

4.2. *The informal sector in the region*

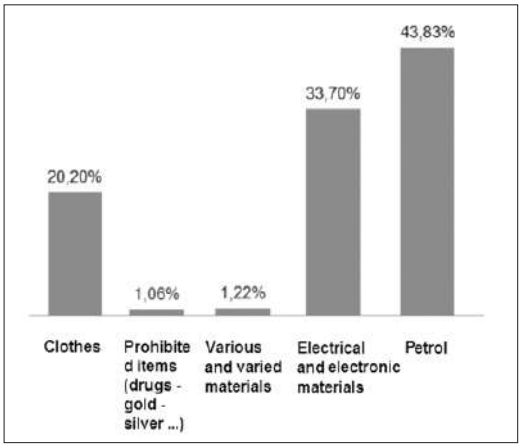
The informal sector, or "parallel economy", refers to economic activity outside the bounds of the law. This includes unlicensed business ventures and the trade in illicit (often smuggled) goods. In Tunisia, such activities make up a significant and growing part of the economy. At the time of Ben Ali, his family had a relationship with several smugglers and there was a strong network between them. From 2011-2015, the number of people employed in the informal sector jumped from 28% to more than 32%, topping 1 million workers in 2015, a study by the Research and Social Studies Centre (CRES) and the African Development Bank (AfDB) stated. In 2013, the parallel economy accounted for as much as 38% of Tunisia's GDP. But the fight against informal trade can be particularly tricky, if only because it is an activity that is difficult to define and estimate. The World Bank thus estimated in 2013 that the annual market value of the traffic in Ben Guerdane amounted to 590 million dinars, or about 200 million euros (Ayadi *et al.*, 2013). In 2015, fuel traffic alone on the Tunisian-Libyan border brought in between 100 and 200 million dinars per year, or 34 to 68 million euros per year (Erguez, 2015). This is why allowing the holders of this financial windfall to legally reinvest it in promising projects for the region could be an important axis, and we will see below under what terms. The informal economy in Tunisia is not confined to a class, region, gender, or age bracket. It is a "national" phenomenon and an established, perpetuated reality. According to smugglers, the period after the revolution (between 2011 and 2014) is better than the one before it. But after 2015, the shoes changed because of the secretarial problems in Libya. A fallacy is created and sustained as a result of the insistence of the state, media, and economic experts to focus on the subject of smuggling when talking about the parallel economy, whereas smuggling is only the tip of the iceberg. The official discourse on parallel economies is not very popular, as many consider it to be the only way to maintain a dignified lifestyle and some purchasing power. Like any social phenomenon, the parallel economy has its own roots and causes of emergence and development. The Tunisian state is the number one sponsor of this type of economy, first through its failed economic policies for development, which have created significant gaps between the different classes and rendered some of them economically dead;

secondly, through the pervasion of corruption inside its administrative and regulatory bodies and its security forces; and thirdly, through its ineffective and unjust tax policies. Of course, there are secondary factors that are out of the state's control, particularly the fact that Tunisia neighbors two wealthy countries, Libya and Algeria, which rely on a rentier economy based mainly on producing hydrocarbons whilst importing everything else (Abdelmoula, 2019). Informal economic activity is a significant part of south-east Tunisia's production and distribution. There are several phrases commonly used to describe informal economic activities, including the black market, underground economy, and shadow economy. Their particular meaning varies by country of usage and by social context. In addition to Ben Guerdane, Medenine, and Dehiba, in Southeastern Tunisia, provide the only official border crossings to Libya and occupy a space at the bottom of the "hierarchy of spaces" in the country. In addition, they are now characterized by a fluid political situation, both in Libya and in Tunisia. Both are marked by regional disparities, despite their different modes of engagement in the national and cross-border economies, and are subject to a stigmatizing national discourse that conflates borders and border regions with smuggling and terrorism. This prevailing discourse, shared by the Tunisian government, donors, and the media, ignores the reality, needs, and expectations of people living along the border (Laroussi, 2018). The populations of Ben Guerdane, Medenine, and Dehiba are known for their long traditions of immigration, especially to Libya. These populations have benefited from their geographical proximity to the Libyan border and have managed to translate this event into a socio-economic phenomenon. In the absence of the state, and with a very weak economy in this region, informal trade is an essential source of living.[3] This region has witnessed the emergence of what is called "souklibya", a mark of informal trade. This trade, despite these disadvantages affecting the national economy, has improved the standard of living of the population of the governorate and even other areas of the country. With the opening of the borders in 1988, all the social and economic data was disrupted in the governorate of Medenine thanks to the appearance of new economic operators (intermediaries, traders, etc.) and the emergence of a set of customer networks. The region has experienced an explosion of migration and trade, as well as an increase in smuggling. Today, the city of Ben Gardane is known in Tunisia for informal trade, smuggling, and the existence of millions of dollars (United States Dollars, Euros, Pound Sterling, Japanese Yen, Libyan Dinar, …) in an illegal way. It is an area located thirty-two kilometers from the Libyan border that lives off of this trade and has, in particular, a large market specialized in products imported from Libya at very attractive prices. Note here that several family members of former president Ben Ali have been actors in informal trade with Libya, so they have an intervention in the choice of post managers in Ras Jdir so that it facilitates prohibited transactions and a few illegal groups are supported by local political entrepreneurs, and it has existed until now. The delegation of Ben Gardane, which covers 51.6% (4,732 km^2) of the territory of the governorate of Medenine and has significant resources (pastoral, olive, maritime, mineral), remains totally dependent on the informal trade and contraband with Libyan territory. Despite the importance of the financial resources provided by this type of illicit activity, which impacts on the improvement of the living conditions of the local populations, it must be noted that the development of this delegation remains very fragile and a prisoner of the opening or not of the border crossing of Ras Jedir. In fact, the economy of Ben Gardane, like Dhiba, is integrated into Libya, which is based on the oil wealth of the country. On the other hand, neither local actors nor public institutions have adequately benefited from the border advantage by initiating a dynamic of sustainable accumulation based on solid economic

[3] Ben Guerdane's people.

activities while allowing the recovery and recycling of financial resources. Data collected[4] from our survey on the employment structure in both cities shows great weakness in the forms of institutionalized secondary integration thanks to a widespread precarious workforce, concerning 66% of those questioned in Dehiba and 77% in Ben Guerdane. For example, one respondent out of five in Dehiba reports working under unstable conditions on (government-sponsored) projects, 17% as artisans or independent workers, and 12% as construction workers. Only 1% report that they are middle managers or high school teachers. In Ben Guerdane, more than one respondent out of four reports working in the trade and services sector (35.1%), about one in five as an artisan or independent worker, and 14.2% work as sarafa (money changers) in the black market or at the border. The unpredictable nature of the labour market is confirmed by the importance of the "illegal" sector, in which 35% of respondents in Ben Guerdane and 49% in Dehiba work. As a consequence, there is a low rate of social security coverage in both cities. Also note that most of the actors work in an informal way in the gasoil and petrol sectors (43.83%) (Figure 2).

Figure 2 - Percentage of interventions in informal trade in Southeastern Tunisia.



Source: Results of our workshops.

4.3. *State measures to combat smuggling*

Tunisia has been trying for years to improve relations with Libya. This partnership between the two countries has given rise to several agreements and conventions of economic, social, political, and cultural nature. In fact, these agreements have not been realized and most of them even seem to be forgotten. However, in terms of trade, relations between the two countries are governed by the Convention Establishing a Free Trade Area, signed in Tripoli on June 14, 2001, which entered into force on February 19, 2002. This convention removes the customs and non-customs barriers. All products originating from one of the two countries are exempt from customs duties and circulate freely. Products prohibited under the Arab Free Trade Zone for reasons of safety, health, the environment or for religious reasons are excluded from this regime. But despite these conventions, informal trade exists in the governorate of Medenine and especially Ben Guerdane, so every time the border post of Ras Jedir is closed by politicians and Libyan actors, the entire economy of the region is paralyzed, whether formal or informal, because there is no substitute for border trade as a source of income.[5] When I spoke with some young people in the governorate of Medenine, I discovered that for the vast majority of them, marginalization is a "social destiny" that makes sense in the context of the punishment inflicted by the "central state" on the entire territory of southern Tunisia. Indeed, in Ben Guerdane, there is no infrastructure to facilitate investments. For this, and in order to find solutions to the informal trade, the state decided to create a commercial and logistic zone in Ben Guerdane. It is an integrated space for commercial activi-

[4] Despite the difficulty of organizing a workshop with traders and informal traders, we organized 3 focus groups in Medenine, Ben Guerdane, and Tataouine (Dehiba) with the total participation of 60 actors, so we contacted 10 local actors (delegate, mayor, national guard, customs, etc.).

[5] For example, it is forbidden to import wine between Tunisia and Libya, despite this phenomenon existing in an informal way. The same is for drugs; in Tunisia it is prohibited to export to Libya, but this export exists in an informal way through tracks to the deserts.

ties and services to support economic dynamics and employment in the region, to encourage the establishment of large international trading companies, to enhance the comparative advantages of the border area, and to strengthen cooperation with neighboring markets. Also, the state decided to accelerate the publication of the expropriation decree concerning the Medenine-Ras Jedir highway project. This project aims to make Ben Guerdane a pole of services and investment, as well as to fight against smuggling.

Thus, with a view to ensuring better surveillance of the Tunisian-Libyan borders and preventing informal trade and the infiltration of arms, the authorities have proceeded to the installation of a sophisticated scanner at Ras Jedir, which enables Tunisian Customs to better control these borders. This is reinforced by the construction of a large earthen wall and ditches between the two border crossings of Ras Jedir and Dehiba, to reinforce the security on the Tunisian-Libyan border and reduce contraband.

4.4. *The current situation and issues concerning informal trade and smuggling in Ben Guerdane and Dehiba*

In general terms, the informal sector is all economic activities that occur outside of social and fiscal legislation. Its main activities are imports and distribution. They are different from contraband activities outside the legal framework, such as drug trafficking. Paradoxically, the informal sector, supposed to evade the control of the state, works blithely in the light of all. Informal trade, migration, and smuggling have been a reality in the governorate of Medenine for several decades. Indeed, several examples confirm the hypothesis that informal activity in this governorate is tolerated. On the pavement leading to Ras Jedir, men wave huge bundles of tickets to attract motorists. The "sarafa" are responsible for the financing of informal trade and the transfer of foreign currencies abroad for supply in the international market, particularly in Asia. Informal trade agents in Ben Guerdane have relationships

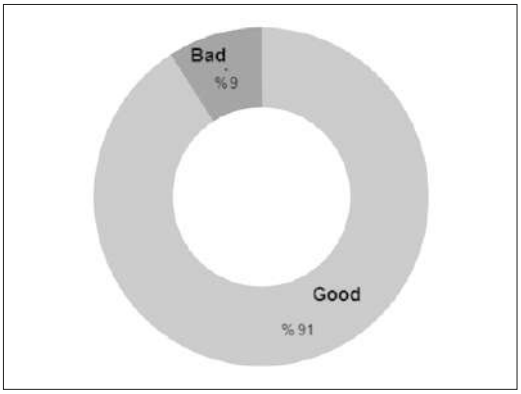
Figure 3 - Fuel smugglers at "Dhahret El Khos" (through the protective wall).
Source: Nasri, 2017.

with players in China, Turkey, Dubai and they use different quotes for the purchase of different products. Following a discussion with some of them, the amount transferred per day varies between 1 and 3 million dinars (MD). With an average of 2 MD per day, the annual amount transferred abroad, via the "sarafa" system, would be about 750 MD. Any quote and any quantity can be found at Ben Guerdane Swingers ("sarafa").[6] Also, the sale of fuel outside kiosks is theoretically illegal in Tunisia. The problem is that the delivery and sale of these products are done day and night on the roadway, and no one reacts, so many security agents work in the fuel smuggling sector, or sometimes they smuggle smugglers for them. Give Way. Smugglers bring thousands of liters of fuel through Ras Jedir or through an area called "Dhahret El Khos" in front of the armed forces. Thus, since the revolution until 2016, "Dhahret El Khos" was almost the only place where the smugglers allowed themselves to exchange goods with the Libyans and procure oil. After the terrorist attack in Ben Guerdane in March 2016, things have changed and the military forces have controlled this area and do not let the exchange of oil (Figure 3).

Note that the "wall of protection" built between Tunisia and Libya and the military zone have certainly reduced the extent of smuggling, but they have not eradicated it completely. Also, it should be noted that in Ben Guerdane, the "Souk Libya" gathers 960 retail traders, where the capital of a retailer varies from one to the other and each of them employs, on average, three employees. This results in the creation of approximately 4800 jobs (Haddar, 2013). The

[6] According to our discussion with Sarf Ben Guerdane.

Figure 4 – Citizen's opinion on the impact of informal trade.



Source: Results of our workshops.

most per capita population participating in our questionnaire believes that informal trade has positive results for the region. Ben Guerdane is a giant warehouse for Tunisia. Import taxes are non-existent there. The smugglers therefore transport their products from Europe or China to Libya, and then transport them fraudulently to Tunisia. Cross-border trade is what brings life to this deshiterated region where the state has withdrawn since independence. The inhabitants have since turned to what they consider to be their only wealth: the border, and according to our focus group, 91% of the participants showed the positive impact of informal trade on the region and on the improvement of living standards (Figure 4). Informal trade has always existed from the Bourguiba era until today. Here, we have to distinguish "smuggling" from "fraudulent trade". Smuggling takes place clandestinely, with goods passing through tracks, bypassing customs controls and official channels of exchange and registration.

4.5. *Alternatives to the informal economy and smuggling*

The analysis of the limited and less effective state intervention in the fight against the informal trade and contraband in the governorate of Medenine and especially in Ben Guerdane, made it possible to detect several deficiencies. For the citizens of the region, according to them, there are no other sources of income, so basic infrastructure and state intervention are minor. There is no mass investment in these areas, and the economy remains dependent on the decisions of Libyan politics. While informal trading and smuggling activities provide significant revenue for thousands of people in Medenine, they pose a serious threat to the country's economy and security. Because it is unregulated, the informal sector raises several concerns, such as the protection of consumers and workers, their health, and the country's security. It does not create added value, impoverishes the state and threatens the survival of the formal sector. In this context, the question of legalizing this sector is of crucial importance. The major problem in Ben Guerdane is the lack of short-term solutions for smugglers, for which the state gives them the green light for their transactions.

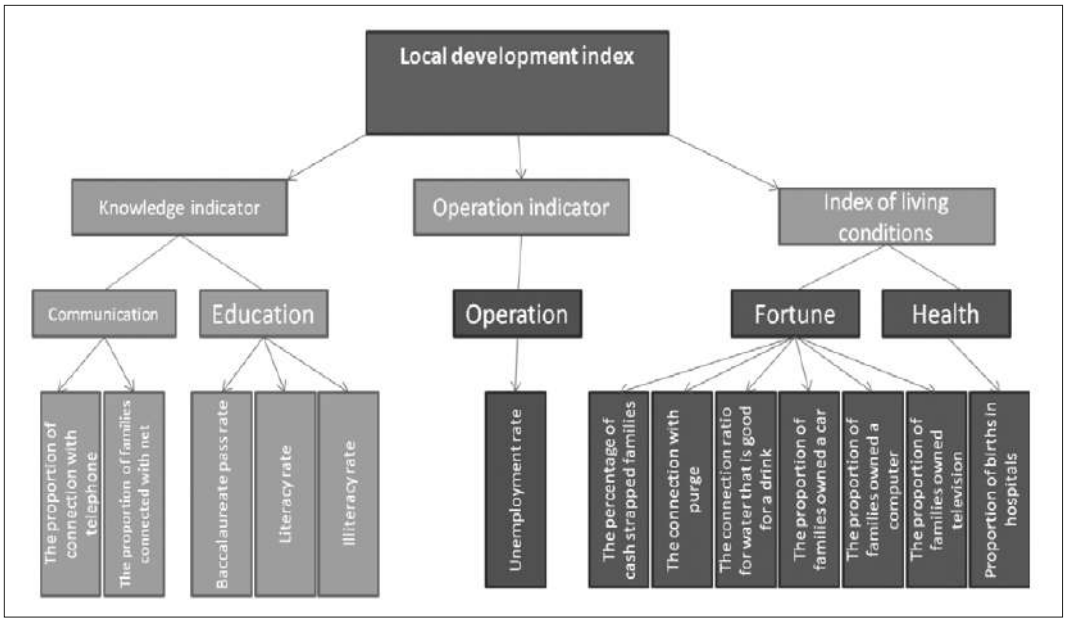
5. Regional disparity: is it one of the causes of informal trade?

5.1. *Method of analysis adopted*

Development indicators enable decision-makers to monitor and evaluate the state of socio-economic development in any region. To this end, the method of calculating the territorial development indicator will be used to answer this problem and show the disparity in development between the delegations of the governorates of Gabes, Medenine, and Tataouine. Our study is based on the report by Robert Prescott-Allen, *The Wellbeing of Nations* (2001) and the report of the Ministry of Regional Development (2012). Our work will give an idea of the territorial disparity between the delegations of the governorates of South-East Tunisia. In fact, the territorial development index (TDI) is made up of three different indices, namely the employment index, the knowledge index, and the living conditions index. To combine such disparate indicators, we must reduce all these indices to a common unit between 0 and 1, called "score." This method is comparative standardization. The calculation of the sub-indices takes the following form (Antony and Visweswara Rao, 2007):

$$I_j = \frac{\left(H_j - H_{\min}\right)}{\left(H_{\max} - H_{\min}\right)}$$

Figure 5 - Local development index.



Source: Author.

j = 1, 2, ... .16 (delegations of Medenine and Tataouine)
Hmin: the calculated minimum value of the score
Hmax score: the maximum calculated value of the score
Hj: the value found

The synthetic indicator of territorial development is the simple average of the 13 variables[7] (for each delegation) previously standardized by this method, so the closer the IDT is to 1, the higher the level of development (Figure 5). The data come from regional indicators determined by the South Development Office (ODS) for the year 2018 for the governorates of Gabes, Medenine and Tataouine. These indicators are essentially social and reflect the standard of living of the population of the different regions (ODS, 2018).

5.2. *Results and discussion*

5.2.1. *The territorial development index*

The examination of the synthetic indicator clearly shows the territorial disparity between the delegations of the study area. The analysis shows that an effort should be made, especially for the access of households to basic services, in the disadvantaged delegations that are inland regions that suffer from a lack of good governance that is shown by the lack of infrastructure in order to attract investors and the absence of a coherent long-term development policy on the one hand, and their weak integration into the regional and national fabric on the other. Benguela, Dehiba, and Medenine are among the least developed areas (Figure 6).

5.2.2. *Discussion*

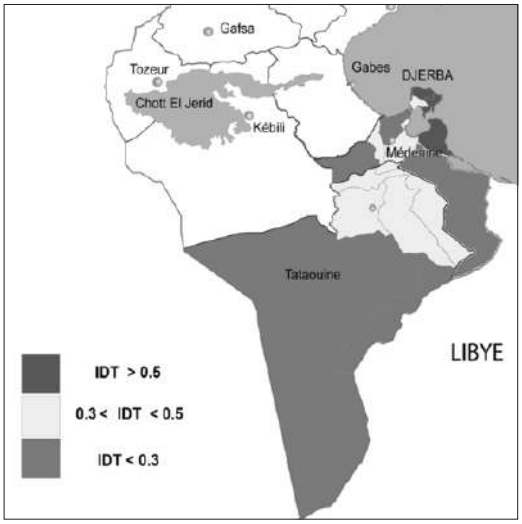
According to the table of the territorial development indicator, three groups of delegations can be distinguished: delegations with a low level of socio-economic development, delegations with medium territorial development, and the most developed delegations. If we analyze the situation of three delegations, Ben Guerdane, Dehiba, and Medenine, in the south of Tunisia by using PCA

[7] The indicators we got it from the South Development Office.

with the STATA software, we can show they belong to the poorest regions (Figure 7).

There are some important distinctions in usage that we address below. In most definitions, constituent economic activity typically refers to unregulated income generation activities that are illegal or that are legal but whose mode of operation does not fall under the formal regulatory body. In our focus group in Dehiba and Medenine, we asked the question about the direct relationship between regional disparities and informal trade, where most (85%) answered yes to the existence of this relationship (Figure 8). Our meetings have shown that poverty is a factor in the informal trade, but it is to be noted that rich people also work in the informal sector. Thus, one finds pharmacists, agents of public administrations, businessmen, etc.

Figure 6 - Map of territorial disparity of South-East Tunisian delegations (Medenine and Tataouine).



6. Extremism and corruption, is il one of the causes of informal trade?

Informal economy workers often lack standard legal protection and medical care while facing high levels of risk in the workplace. A study carried out by the arid land institute of Medenine and the UNDP has shown large proportions of respondents perceive that corruption is widespread in most public institutions. This negative perception is much more pronounced in the customs services, with a rate of 59.5% of respondents who believe that corruption is widespread in a very broad or to some extent (Jaoued *et al.*, 2020). Despite the risks, workers reported a relatively high rate of satisfaction with their income and often resisted moving to the formal sector, where job security is much better. Red tape is another impediment to the integration of informal activities into the formal economy. The smuggling business is especially rampant in Tu-

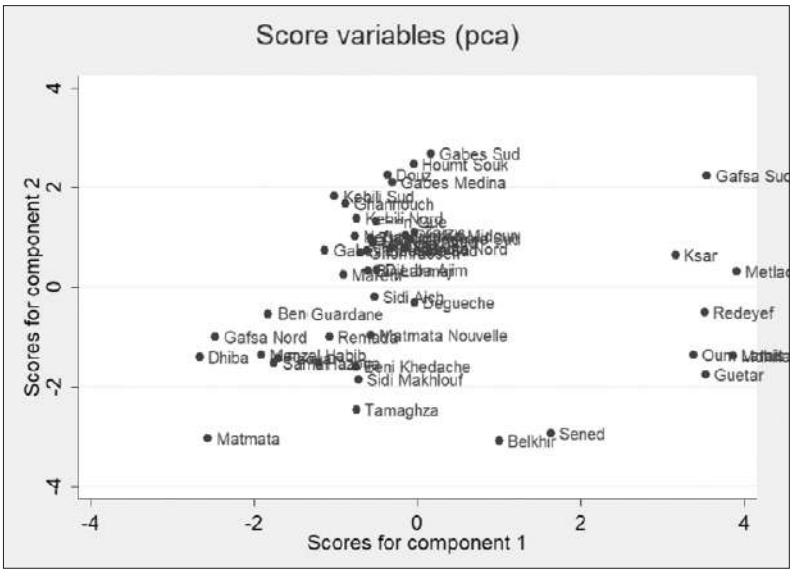
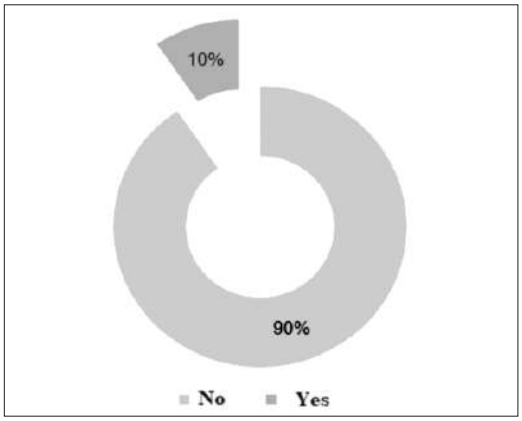


Figure 7 - Result of PCA.
Source: Author.

Figure 8 - Relationship between regional disparity and informal trade according to workshop participants.

Source: Results of our workshops.

Figure 9 - Relationship between extremism and informal trade.

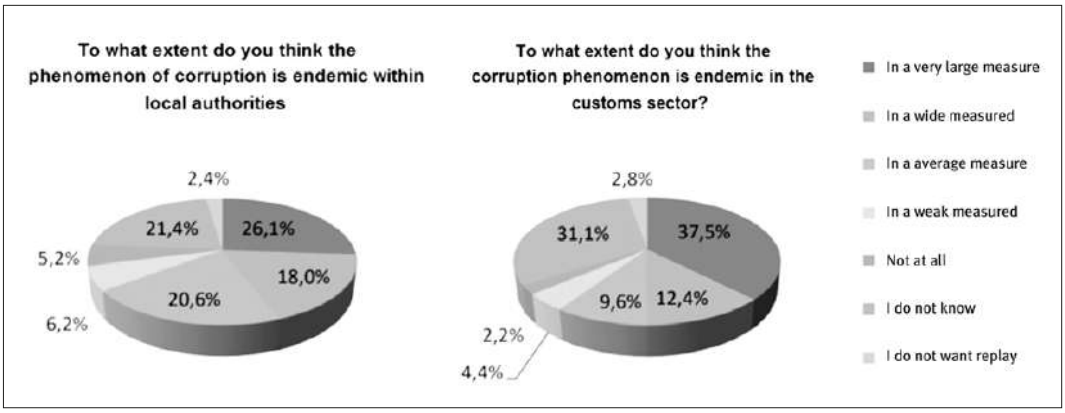


Source: Results of our workshops.

nisia's southern border towns of Medenine, Ben Guerdane, and Dehiba. Everything from oil to electronics to hard currency to video games can be bought and sold there, with the profits navigating a vast web of global business dealings. There is also suspicion of drug and weapons smuggling, though that type of trafficking is less conspicuous because of the increased vigilance of security forces. Some of the gatekeepers of this industry, long viewed as invulnerable in Tunisian society, may finally face justice in court, however. In our focus group, we asked the question of a direct relationship between extremism and informal trade in the region in this context. 10%, we replied that there is this tannic relationship. 90% said that there were no direct relationships (Figure 9).

The informal sector, supposed to evade state control, operates blithely in full view of everyone. Informal trade, migration, and smuggling have been a reality in the governorates of Medenine and Tataouine for several decades. Indeed, several examples confirm the hypothesis that informal activity in this governorate is tolerated. In Ben Guerdane, for example, you just have to cross the street called "Wall Street" in the center of the city to notice. Behind dozens of aligned blue counters occupying the entire street, money changers await customers, drawers filled with bundles. Libyan and Tunisian cars stop to exchange money, which is officially illegal in Tunisia. However, in Medenine, Dehiba, and Ben Guerdane, the small juxtaposed shops act as exchange offices. They operate in full view of customs officials and the police. Also, the sale of fuel outside kiosks is theoretically illegal in Tunisia. So, following our questionnaire, 94% of the participants indicated that they used corruption to smuggle their goods. The economic and social importance of informal trade in the region means that any attempt to strengthen controls at the borders would probably be costly in terms of equipment and infrastructure and have limited impact, probably leading to higher levels of corruption among customs officials based on the border, further undermining government control. In our study, 44.4% of respondents say they have little or no confidence in customs services, 46.2% in health services, 37.2% in the police and the National Guard, and 35.2% in courts. Regarding areas of state sovereignty, 49.9% of respondents consider that corruption is present within customs, 46.4% for security forces and 35.9% for justice (Figure 10). The general lack of confidence in public institutions is a factor predominantly contributing to vertical social degradation in Medenine, Ben Guerdane, and Dehiba. As such, the non-response rate focuses on customs matters, courts, and the National Guard and may be interpreted as a sign of defiance and sensitivities when responding. They are called upon to express themselves regarding state sovereignty services. One of the main sources of this mistrust is perceptions of

Figure 10 - Trust in actors.



Source: Results of our workshops.

corruption. Security and judicial bodies appear among institutions perceived as being the most affected by it, but basic public services would also include high risks of corruption. One source of these perceptions can be found in the way the authorities interact with users, which is perceived to be unfair. Coupled with negative emotions targeting power, low levels of trust and perceptions of unfairness in treatment by state officials can result in a propensity for collective action against the public authority for which it would be relevant to analyze the protests.

7. Proposed solutions for a fair local development

If you ask the inhabitants of Dehiba and Ben Guerdane about their views on southern Tunisia, the region to which they say they belong, they primarily refer to the idea of "marginalization" (Tahmîch in Arabic) (97.7% and 88.5%, respectively). This strong perception of exclusion transcends generations and genders, although it is more acute among the young unemployed. Tightening border controls with new equipment and infrastructure is unlikely to succeed in eradicating smuggling and corruption. It is necessary to opt for a comprehensive approach which reduces the incentives for traffic (with, among other things, a rethinking of trade policy) and introduces more effective surveillance of officials stationed at the borders. Differentials in tax burden and in the resulting consumer sale prices are the main drivers of informal trade. At a time when numerous discussions are taking place about whether to cut fuel subsidies, with further increases possible, it is important to remember that without greater harmonization of prices at the regional level, there is every chance that the level of informal trade will continue to grow. Therefore, this study calls for increased regional coordination between Tunisia and Libya in terms of tariffs, tax levels, and subsidies. Historically, Tunisia has experienced economic growth accompanied by an improvement, to varying degrees, in the living conditions of the population. But this improvement has often been accompanied by a growing spatial polarization and the aggravation of certain differences. The fruits of development have been unequally distributed across different parts of the country. In this context, the South-East governorates present themselves as regions that have not benefited much from the country's development. Thus, an inequality between their delegations is noticed. The territorial disparity in the same region fosters a feeling of injustice that generates several political, economic, and social problems, as is the case in our region of study, which after the Revolution witnessed several demonstrations, clashes, sit-ins, and social tensions in several delegations. The reduction of territorial disparities requires improving the basic infrastructure, with a redefinition of the role of economic spaces and regional redistribution in both rural and urban areas. The challenge today is, therefore,

the improvement of living conditions. For that, it is necessary to improve local governance by strengthening the role of the citizen and innovating in the methods of evaluation of the projects of development, and this by the application of decentralization, which is shown by the transfer of the power of the state to legal entities of public law distinct from him. This decentralization will aim for greater equality of rights and greater collective solidarity between developed and disadvantaged regions. In Tunisia, and despite the fact that a number of arid and difficult areas have embarked on a process called "territorial development", this type of development has not managed to set up a real development process that ensures both a certain increase in the value of production (creation of wealth), a better satisfaction of the needs of the population, and a real development of the agricultural and industrial sectors. These areas do not lack resources, but they exploit them poorly. Admittedly, it is in these areas that the poverty of today and tomorrow is rife if an adequate development process is not taken into account, but it is also in these areas that are well placed to invent and mobilize valuable resources. The ultimate purpose of development policies is to use a set of universally recognized processes for improving living conditions and individual and collective potential, namely health, nutrition, education, safety, and respect for the environment and future generations. Other indicators strongly correlated with the level of development are to be taken into consideration, such as poverty rates, urbanization, housing, household equipment in durable goods, electricity, drinking water network, workforce enrollment, demographic dependence, and the contribution of the secondary and tertiary sectors to GDP formation. Thus, in order to achieve results in improving the standard of living in the South-East, it is recommended to make the most of the strengths of the region, taking into account its opportunities, so that regional policies must adopt:

- The shift from Objective Management of Programs (GPO) to Results-Based Management (RBM);
- Innovation in evaluation methods for sustainability projects and programs;
- Strengthening the role of citizens and civil society in defining, implementing and evaluating public policies;
- Strengthening good governance of the administrative management of projects;
- The implementation of a participatory planning and evaluation approach to public policies.

In both cities, disparities with other parts of the country are evident in three key areas. The first relates to the weakness of the social state, illustrated by limited and poor-quality public services and infrastructure (sewerage, water networks, health, public transport) and weak social rights (social security, access to justice). The second refers to structural mass unemployment, with rates much higher than the national average, particularly for women (where the rate is two to three times higher than the average), as well as large numbers of people in precarious employment marked by low wages and/or a casual nature. This reveals the structural weakness of institutionalized forms of integration of local economies. The third area is education, where the school dropout phenomenon overwhelmingly affects young adults: their enrolment rate is half the national average. Five years after the revolution, the border remains a financial resource, generating jobs, mainly for youth, in the absence of other employment opportunities. In Dehiba, in particular, the border is the only means of survival. However, if networks of local and cross-border solidarity once allowed residents to keep some control over the border economy, that relative bargaining power now seems altered by the chaos in Libya and the disorganisation of the border area. This is particularly the case in Ben Guerdane, where there is increasing competition between new and old actors who deploy there, laying claim to income, legitimacy, and control. Last but not least, Tunisia needs political stability and a clear political direction. Because many traffickers living in isolated border areas feel forgotten by the people of the capital, containing informal activities requires political consensus and a stronger state. Otherwise, the traffic will continue. At the local level, political leadership

should support a team for several years at the head of customs with a mandate to strengthen internal controls of customs services. Whenever a director-general changes every six months, any reform in this area is bound to fail.

8. Conclusion

In order to develop the governorate of Medenine and especially the Ben Guerdane region and Dehiba (Province of Tataouine) to formalize informal exchanges, the state must improve the infrastructure of the region. Thus, the current relations of the region with Libya, which remain marked by the predominance of the informal sector and subject to the instability of the border situation, must progressively evolve. This requires ensuring a good relationship with all Libyan actors to implement the free movement of goods and people between the two countries, allowing the formation of an economic space without borders. Today, it is recommended to create an international economic space between the province of Medenine and Western Libya in particular. In addition, the risks associated with the development of this informal sector, particularly with regard to the economy, public finances, security, and hygiene, necessarily imply a mastery of this sector and its gradual integration into the formal economic dynamic, including through the creation of the cross-border economic space open to international trade. To develop border regions in the governorate of Medenine, we must create and enhance this international economic space; this is done in the long term by:

- The creation of a regional partnership and cooperation agency with Western Libya;
- The creation of a study center on Tunisian-Libyan integration;
- Collaboration with the Libyan authorities to open a Libyan consulate in Medenine; and
- The establishment of a structure for dialogue and cooperation between the region and Western Libya;
- The establishment of a business city in support of the development of the Tunisian-Libyan economic area;
- The creation of an industrial zone for the Libyan market;
- The creation of a space for an international fair at the Tunisian-Libyan border;
- The creation of a free trade zone for agricultural products in “choucha”;
- Construction of a communication infrastructure connecting the region to Western Libya;
- The completion of a railway project to Ras Jedir and the acceleration of the motorway project;
- The creation of a regular shipping line between Zarzis, Misrata, and Zouara.

Thus, the state must be strong and able to put in place an effective policy to dry up the sources of supply of illegal products and put an end to the activities of the counter-bandies. It is necessary to initiate a process of formalization of the informal sector in the short and medium term by:

- Conducting a study on the formalization of the informal sector;
- The legalization of bureaux de change by modifying the regulatory texts of organizations and the functioning of the foreign exchange market with a view to authorizing, by law, the sale and purchase of foreign currency;
- The creation of a development bank in the governorate of Medenine;
- The implementation of a transversal structure at the level of the presidency of the government responsible for the informal sector;
- The adoption of specific development projects for the Ben Guerdane region;
- Strengthening the human and material resources of the controllers as well as changing the control mechanisms to fight against corruption;
- The installation of an electronic surveillance system at the Tunisian-Libyan border;
- Integration of small traders, whose sole source of income comes from informal trading, the formal sector, and the tax system, thus benefiting from social coverage.

Choucha is an area that lies on the Tunisian-Libyan border, seven kilometers from the

Ras Jdir border post and 25 kilometers from the town of Ben Guerdane. Currently, Tunisia is going through an unprecedented crisis started by the interior regions of the country, which have nevertheless benefited from many development programs that claimed to develop them. But the findings have shown that the results are mixed, not to mention meager. The reasons are mainly related to regional development policies, which have been guided by strong centralization in management and decision-making. In this context, the situation in the governorate of Medenine requires rethinking the programs and development projects in this region. This governorate is marked by the lack of major projects and large factories, so the city of Ben Guerdane is known for the facilitation of the movement of goods and people that has made it an important corridor of exchange and transit between Tunisia and Libya. This has led to the appearance of smuggling and the informal sector for several years, which has grown in the region because of differential pricing. This sector has improved the living conditions of several families in the region, despite its negative effects on the national economy. Informal trade and smuggling in the governorate of Medenine are difficult phenomena to quantify. It requires carrying out an analysis and diagnosis of the contraband sector to see the possibilities to formalize informal trade and make it formal. Today, poor governance, combined with a lack of a regional development vision and corruption, is at the heart of the problem and is the main cause of the failure of regional development policy to consider that such a development policy existed in the governorate of Medenine. calls for a more inclusive process of reforms that can lead to informal-to-formal economic change with wider participation in decision-making, short-term adjustment measures, and development strategies. In the long term, their design and implementation must require visionary and transparent behavior, a learning attitude and sound decision-making with the participation of different stakeholders: the state, civil society, the private sector and interested citizens.

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Unravelling interactive innovation through a stakeholder-associated risk analysis: Evidence from two case studies in Spain

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Abstract

Interactive innovation is the innovation process that is co-produced by the interaction of actors, such as farmers, land managers, researchers, policy makers and consumers. It connotes complex and socio-scientific problems that utilize participatory methodologies to bring in diverse perspectives of stakeholders, who have control over the development and decision-making process. Most failure or information absence come from insufficient communication transfer, which can result in conflicts between stakeholders, especially in projects with multi actor partnership and multidisciplinary stakeholders. Rural innovation is addressed by measuring stakeholder interactions that take place in the project. By identifying the risks in the network and the stakeholders associated to the risks, we find the underlying cause of the problem in two case studies in Spain. Results reveal that lack of communication among internal stakeholders was the main threat in both projects. Recommended action plans included establishing an effective communication strategy, establishing a well-defined terminology to avoid miscommunication among internal stakeholders and taking into account ethical and cultural differences among stakeholders to avoid mistrust. The risk analysis provides stakeholders with a holistic view over the project in knowing the location of the resources and where the problem lies. This way stakeholders can scrape out the wound.

***Keywords**: Interactive innovation, Risk network analysis, Rural innovation, Stakeholder interaction.*

1. Introduction

Rural innovation is co-produced through interaction between actors, such as farmers, land managers, advisory services, brokers, intermediaries, consumers, researchers, private sector, policy researcher (Hall *et al.*, 2001; Imperiale and Vanclay, 2016; Quiedeville *et al.*, 2017; Smits and Kuhlmann, 2004). When stakeholders interact and jointly identify problems and come to a solution it creates knowledge, which gives advantages and disadvantages to the project (Gray *et al.*, 2012). The creation of potential solutions to a problem through the collective learning process of stakeholders is marked as co-innovation (Dogliotti *et al.*, 2014; Nederlof *et al.*, 2011). Co-innovation is still an abstract concept which combines systems theory, social learning, design and monitoring and evaluation and utilizes participatory multi-stakeholder methodologies (Botha *et al.*, 2014; Dogliotti *et al.*, 2014). As

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co-innovation has been widely conceptualized as a process, the integration of participatory environmental decision making into the process has become inevitable (Lee *et al.*, 2020; UCT and UNITAR, 2006; Wu *et al.*, 2014), where multi-stakeholders, including community are encouraged to take control over the development process and decisions over resources (Allen and Kilvington, 1999; Neumeier, 2012).

In the rural context, the innovation process is challenged by the complex environment where it unfolds calling for diverse perspectives from stakeholders with various background (Douthwaite *et al.*, 2017; Preskill and Gopal, 2014) and so their multiple perspectives have significant influence on decision-making (Graef *et al.*, 2018; Hall *et al.*, 2001; McNie, 2007). Bringing in their perspectives on the problem and their participative action is crucial to identify the underlying cause of the problem which can then motivate innovative thinking to find adaptive innovative solutions (Lee *et al.*, 2020; Tecco *et al.*, 2016).

Lee *et al.* (2020) have identified from literature review that stakeholders in their innovation projects are concerned with finding the fundamental cause of the problem. This is the first step toward finding a solution. Finding the cause of the problem then allows stakeholders to discuss and come to an agreement on what needs to be done and what further opportunities exist. However, in the process of looking for solutions, interdependent interactions exist among multiple stakeholders who are the participants along the process (Freeman, 1994; Rowley, 1997). Their continuous feedback are the valuable insights allowing for new perspectives thus creating value-added to the project. The value creation promotes the enhancement in a network through (innovative) capacity development and community empowerment (Douthwaite *et al.*, 2003; Graef *et al.*, 2018; Paz-Ybarnegaray and Douthwaite, 2017; Quiedeville *et al.*, 2017). The collaborative actions through innovative thinking and community empowerment can facilitate an innovative environment (Eichler and Schwarz, 2019), which is crucial in enhancing the decision-making process in a multi-stakeholder context.

A stakeholder-based life cycle assessment has been proposed by Thabrew *et al.* (2009) that provides stakeholders a holistic view over the whole project by visualizing a broader set of upstream and downstream consequences of decisions in planning and implementation. Another useful tool that to be applied for enhancing decision-making is a stakeholder map. A stakeholder mapping is the visualization of a network created through interactions between stakeholders and has been used in several studies in order to gain insight of resource allocation and interactions between stakeholders (Scott *et al.*, 2005; Thabrew *et al.*, 2009; Yang and Zou, 2014). Schneider and Buser (2018) went on further to analysing the degree of stakeholder interaction in specific projects. This increased the probability to reach the intended contribution goal; allocate efficiently and effectively time and resources and reduce participation fatigue and project failure. The study of Yang and Zou (2014) went on beyond analysing the interaction of stakeholders and created a stakeholder-associated risk map that enabled them to identify which type of risk was associated to whom. That way strategic management plans for reducing the risk or planning ahead for mitigation actions were possible.

Many problems in projects are associated to stakeholders and their interactions (Khan *et al.*, 2020; Thabrew *et al.*, 2009; Yang and Zou, 2014), thus analysing what problems stakeholders face and with whom that risk is associated to will give clues what actions to take to mitigate that risk. Previous studies show that the role of stakeholders in identifying the risks can no longer be left out. As stated by Prum and Del Percio (2009), in a project, risk sources should be analysed and each stakeholder should assess their risks and take measures to mitigate the possible impacts. Qin *et al.* (2016) studied the risk factors such as political, social, certification, financial/cost, quality/technological and managerial risks according to stakeholder's perception of risk importance. Similarly, in agricultural production, risk has been discussed in line with climate-related disasters, especially in areas where food insecurity is prevalent (Carter *et al.*, 2007; Gaiha and Thapa 2006; Drollette, 2009). To reduce the risk and make farmers and societies adapt to new farming practices and change their cropping patterns (IPCC, 2014; Jha, 2015;

Swami and Parthasarathy, 2020) studies on the level of farmer's perception, knowledge and awareness on climate-related risks were carried out by Khan *et al.* (2020) and Qin *et al.* (2016). Moreover, social problems such as food security and poverty involve more complex risks such as price stability, agricultural production and population growth. Understanding and analysing food security, therefore need to be conducted by digging deeper into the structure of the risks that exist along the value chain (Capitanio *et al.*, 2019; Lacirignola *et al.*, 2015). The results of these studies served as a reference point for policymakers in future appropriate adaptation policies to facilitate rural communities in sustaining their livelihoods. Eventually, analysing the risk contributes to effective decision-making and efficient communication.

What kind of risk analysis is important?

As projects, that embed economic, social, technical, and environmental risks seek for innovative solutions, society demands that these projects deliver more sustainable and efficient outcomes. Robichaud and Anantatmula (2011) emphasized the importance of stakeholder analysis and considered the most significant challenge to delivering a successful project to be "communication and coordination across a multidisciplinary team" to accommodate specific user, regulatory, or community needs and therefore mitigate the risks (Robichaud and Anantatmula, 2011, p. 54). One crucial problem during the planning process is that important information is not transferred or transparent enough to make a consent decision (Arts and Faith-Ell, 2012). Lack of information for decision making implies that social risk exist such as miscommunication and conflicts among stakeholders. In social contexts interorganizational and social networking play crucial roles and remain key factors to be investigated (De Hoyos-Ruperto *et al.*, 2013; Johannisson and Nilsson, 1989). In most cases, these relationships are locally embedded and engagement in local networks provides access to local resources (McKeever *et al.*, 2014).

Regarding agriculture and forestry projects, the abandonment of farmland can have severe environmental consequences, such as threatening farmland biodiversity (Plieninger *et al.*, 2014; Zakkak *et al.*, 2014) and provisions for ecosystem services (Benayas *et al.*, 2007). Terres *et al.* (2015) aimed to identify the main drivers in farmland abandonment in Europe and showed that low farm dynamism/adaptation capacity, aging farmer population, enrolment in specific agricultural schemes and weak land market, amongst others. The farming community faces multiple risks including climate change (global warming, climate variability and extremes), social, economic, market and political risks (Smit and Skinner, 2002). Even technical and environmental risk have social consequences. For example, modelling farmer's behaviour and perception is very important to find answers to farmer's adaptation to the socio-economic conditions, such as new agricultural practices (Javed *et al.*, 2020; Kuang *et al.*, 2020; Swami and Parthasarathy, 2020). The cause of the risk and moreover risk mitigation plans is associated with social issues, such as stakeholder's perception of risks or information flow and control. Social factors including the risk of people and their interaction should be discussed to take mitigation action and set up strategic plans. To study and explore on the risks faced by stakeholders in their project, a network map of stakeholder associated risk is drawn and coded to comprehend with a holistic view what risks are embedded in the project and which actions should be taken to reduce or eliminate the risk. A deeper look into what risks exist and with whom this difficulty is encountered by directly interviewing the stakeholder facing that risk will give us explicit answers.

This research aims to answer the following research questions in order to dwell upon stakeholder associated risks and the interactions between them to find out the critical risks that hinder the project from a successful outcome.

1. What risks are faced by stakeholders in the project and to whom are the risks related to?
2. Which of these risks are considered the most critical?
3. What could be the mitigation action plans?

The methodology chapter starts with the description of the two case studies that were used

for the analysis. It is followed by stakeholder's interview and then followed by the methods and steps used for this research. A list of stakeholders and their risks were obtained by conducting online interviews (Chapter 2.2). A visualization of the risk network and further interpretation along with a mitigation action plan is given in Chapter 3. Finally, authors conclude with implications of the research.

2. Case study and research activity

This section describes step by step the materials used for the study. The two case studies were taken as the two most interactive innovation case studies in Spain because of the long supply chain comprising of various stakeholders in their project. The descriptions are explained in Chapter 2.1 and is followed by a figure that explains the methods taken for this research. Finally, the stakeholder's interview and the categorizing of risks and stakeholders follow.

2.1. *Description of case studies*

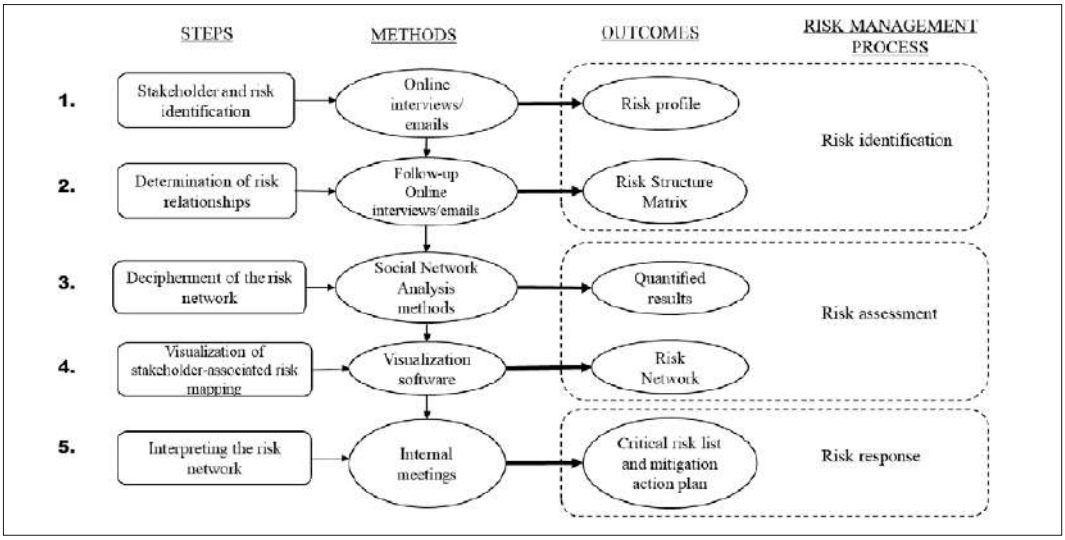
Two case studies were analysed to address the 'how' type of question in order to understand how risks are connected in the rural development sector. The case study selection was not random but was based on a prior systemic sampling. In Spain, 35 cases were identified to deal with interactive innovation based on stakeholder questionnaire that was funded by the European H2020 project LIAISON, which aims to optimize interactive innovation and networks and thus build capacities for more productive interaction and improve European innovation policies in agriculture, forestry and rural development. From the 35 selected projects, authors have identified two representative cases based on their multi actor partnership and multidisciplinary stakeholders. One deals with efficient water irrigation management (hereafter project 1) and the second deals with agroforestry management (hereafter project 2).

Project 1, which began in 2013, is an "Efficient Irrigation Management" project under the Research, Development and Innovation initiative promoted by a public company, with the aim of optimizing the energy and water efficiency of irrigated areas in Spain and thus achieve economic viability and social-economic sustainability. It is responding to the Irrigation Communities for the management and maintenance of the irrigation infrastructure works that the Ministry of Agriculture, Fisheries, Food and Environment executed during the years 2007 to 2012, within the framework of the National Irrigation Plan and the Irrigation Modernization Shock Plan. The project has 4 teams each having its own work: the electricity market that identifies the best alternatives for contracting electrical energy to reduce costs; the renewable energy team that identifies renewable energies (wind, photovoltaic, mini-hydraulic, or other) applicable to the intervention areas to produce clean and economical energy; the energy efficiency team that implements energy efficiency practices and procedures, making use of technology and considering characteristics of each irrigation community; and water efficiency team that studies and implements new technologies (humidity probes, remote sensing, or other) to optimize (timely) irrigation.

The key stakeholders in this project are besides the project coordinators, the four working teams responsible for electricity, renewable energy and its efficiency and water efficiency and the irrigation community. Irrigation communities are similar to pilot case studies to the whole project. The communities provide data on their irrigation for energy and water optimization, hence they are playing a crucial role to the whole project. Some large irrigation communities have participated in the design of the project, by offering their point of view. The long supply chain and stakeholders with different interests correspond to the multi actor setting in a project. Therefore, their interaction is assumed to be complicated and complex.

Project 2, that had ended in 2019 was an EU Horizon 2020 project, aimed to foster the exchange and the knowledge transfer between scientists and practitioners in agroforestry. The project emphasized on five specific objectives which was to establish the system and methodological basis for knowledge exchange on agroforestry further building on a knowledge cloud

Figure 1 - Steps and methods for the stakeholder-associated risk management.



that will not only enable the exchange of knowledge and practices but bring synergies between European, national, and regional policies related to the agroforestry sector to support the effective implementation. The project was based on a thematic network, where key stakeholders range from universities, research centres and NGOs in nine countries across Europe. Communication and information transfer and the transparency of information was key for knowledge transfer across the nine countries across Europe. Moreover, terminologies such as agroforestry and the relevant practices for agroforestry differed from country to country according to their culture. This multi actor partnership in a multinational setting awakened the interest to examine on the interaction between stakeholders.

2.2. *Stakeholders' interviews*

The first part was to gather information on risks that will feed into the network analysis. 50 online interviews were conducted with stakeholders from the two described innovative projects. The interviews were carried out from mid-March to the first week of July in 2020.[1] Before the online interviews, the project coordinators were contacted through email and were explained the intention of the project[2] and the intention of the risk network analysis. Authors were given a list of relevant stakeholders (researchers, practitioners, technicians…) to contact from the coordinators of the projects. All interviewees were then contacted by email prior to the online interview and were asked for consent. Interviewees were asked what risks they faced during the project process and with whom the risk was associated to (stakeholder-associated risk). They were then asked what impact the risk might have on the project outcome and were asked to rate the risk from 1 to 5; 1 being very low impact to 5 having very high impact. Inferring to risk occurrence and the likelihood of impact gave the authors exploratory answers.

2.3. *Methods taken in the research*

A figure that explains the methods and steps undertaken for this research is shown below (Figure 1). The most left column explains the

[1] Due to the COVID 19 circumstances travelling across the country was prohibited and therefore all 50 interviews were conducted via Zoom or Skype.

[2] This research has been carried out in parallel with the Europe H2020 project LIAISON.

Table 1 - Risk category.

Risk category	*Explanation*
Time	risk related to time management
Cost (financial)	risk related to cost increase and return; usually funds
Policy and standard	risk related to change in regulation and funding policy or environmental regulation
Organization and management (interaction and communication)	risk related to organization structure, knowledge and relationship management
Quality and technical	risk related to quality of material, technology advancement (or failure)
Environmental	risk related to environmental extremes (eg. weather)

five steps taken in this research. The method column explains each method or methodology undertaken for each of the five steps. The third column then shows what outcomes are expected from each step. The risk management process on the far right, is the process undertaken by the authors to get to the final outcome of this research.

The first step is the identification of stakeholder and risk and the data were gathered through online interviews and email exchanges. The second step was the determination of risk relationships. A Risk Structure Matrix was done through interviews from the first step and follow-up online interviews where necessary. Through the Risk Structure Matrix, the decipherment of the risk network in step 3 was possible. The third step was the risk network taking the Risk Structure Matrix in step 2 and deciphering it with STATA and UCINET, which are statistical tools for the Social Network Analysis method used to quantify the results. The fourth step was the visualization of the stakeholder-associated risk map. Software such as UCINET and Netdraw were used to draw the risk network. Finally, in the fifth step the risk network was interpreted with several internal meetings and discussions by authors. A critical risk list was made, and mitigation action plans elaborated using discussion outcomes by authors.

3. Results and discussion

3.1. *Risk profile*

This section explains the grouping of the risks and stakeholders. The sub chapters that follow explain thoroughly how the categorization for risks and stakeholders has taken place.

There is no standard classification of risks. However, this study has referred to the risk category used by Yang and Zou (2014). Although the study by Yang and Zou relate the risk category to the green building sector, there are several reasons why the authors have realized a small overlap and have referred to this: (1) risk analysis in green building projects is very much advanced and several attempts have been made to list the risks, which makes the risk category relatively reliable and suitable to the related sector (2) the complexity and problematic characteristics of the construction industry which are described as "extremely conservative and subject to slow rates of change due to regulatory… and limited technology transfer from other sectors of society" (Kibert *et al.*, 2000) are to a great degree comparable to those of the rural development sector.

The six risk category used for this study are: time, cost, policy and standard, organization and management, quality and technical and environment (Table 1). The risk organization and management are very much related to risk in communications and therefore problems in interaction. Below the table shows the risk categorization adapted and modified from Yang and Zou (2014).

3.1.1. *Categorizing the stakeholders*

In the rural development sector, there is no standard stakeholder list, because the characteristics of stakeholder are very much dependent on each project. Thus, this study does not refer to any of the stakeholder list identified in previous studies, instead refer to the five social interactions identified in the LIAISON project. LIAISON has determined five interaction types in innovation

Table 2 - Stakeholder category and risks for project 1.

Stakeholder category	*Number of risks*	*Stakeholders*
Internal stakeholder	26	S1: Energy Efficiency team; S2: Irrigation Community; S3 Group Tragsa (project coordinator); S11: Tragsatec; S13: renewable energy team
Government	3	S4: regional government
External stakeholder	2	S6: investors; S7: contractors
Consultant	1	S12: University of Valencia
Others (non-controllable)	6	S5: other (economical); S8: electric sector (supplier); S9: external risk (technical); S10: external risk (environmental); S14 energy (supplier)

Table 3 - Stakeholder category and risks for project 2.

Stakeholder category	*Number of risks*	*Stakeholders*
Internal stakeholder	4	S1: University of Santiago de Compostela (project coordinator); S3: all stakeholders in the project
Government	7	S2: European Commission; S6: regional government; S7: administration
External stakeholder	6	S4: farmers; S5: other actors related to case studies of the project; S8: all stakeholders not directly related to the project

systems (Cronin *et al.*, 2021): I) interaction with policy; II) interaction within the project; III) interaction with external stakeholders; IV) interaction of the project and the context and V) interaction with the surrounding environment. In the fourth interaction, the stakeholders are not related to the project and do not have direct authority or control over it, however their behaviour may influence the project indirectly. Authors have identified five groups of stakeholders according to these types. The groups are government, external stakeholders (including policy makers) associated to interaction I; internal stakeholder associated to interaction ii, consultant and other external stakeholders associated to interaction III and interaction IV. The fifth interaction is not related to a stakeholder group, because it cannot be controlled by them; these are environmental risks.

The internal stakeholder group refers to actors that are within the project network and can have effect on decision-making over the process of the project. When conducting the interview, authors have realized that quite an amount of risk arises from interaction with internal stakeholder. This also means that there have been discussions, communications and argumentation during the process of the project. The government is usually referred to as the government or regional government who sets out regulations and has decisions over the funding process. External stakeholders are other investors and (sub) contractors to the project. The fourth group, consultant, refer to advisors or research centres that provide knowledge to the project. Here any government advisory is excluded from the group. The fifth group, others, refer to external risks, which are often not controllable by stakeholders, for example, risks due to weather extremes or software failure. These are environmental risks not directly related to a specific stakeholder, but somehow involve a certain group of stakeholders.

Next, is the stakeholder category for project 1 (Table 2). It is evident that risks are confronted with internal stakeholders (within the project), with 26 risks counted. The second serious threat is non-controllable risks such as weather conditions or wage inflation and is not associated to a specific stakeholder category.

Table 3 shows the results of stakeholder category and the risks encountered. A total of 8 stakeholders were categorized into 3 groups: internal stakeholder, government and external stakeholder.

Table 4 - Risk category and associated stakeholders for project 1.

Risk category	*Number of stakeholders*	*Risks*
Time	2	Project timeout
Cost	9	R6: Wage inflation; R7: changes in price of materials/energy/water; R8: high sustainability costs; R9: additional costs; R16: budget cut; R20: inaccurate project cost estimate
Policy and Standard	6	R4: Change in government financing policy; R5: fiscal changes (in general); R10: opposition or lack of political support (government discontinuity); R11: delay in obtaining consent; R12: legislative or regulatory changes
Organization & management	3	R1: Pressure from internal actors (disagreements, lack of trust, demotivation); R3: lack of support from senior management; R29: social problems (raising awareness among farmers, new adaptation to sudden technological changes); R32: unavailable information
Quality & technical	5	R2: Ambiguity in the scope of the project / change; R13: Changes and problems in available technology; R14: Change in design and engineering; R19: Inadequate analysis of the complexity of the project; R21: Lack of experience in sustainable design and project management; R22: Unsuitable, untested or unreliable materials, products or sustainable systems; R23: Uncertainty in the performance of sustainable materials and equipment
Environmental	3	R15: Unfavourable climatic conditions to carry out the project

Results show that government is the stakeholder in the project with the most risk encountered, meaning that most of the risks in project 1 is associated with the (regional government). Funding issues, project implementation delay due to administration process or problems in the legislative requirements are critical risks associated with government.

3.1.2. *Categorizing risks*

This section shows the results of the risks and associated stakeholders in the two innovative projects in Spain. All risks identified during the interview were categorized according to the risk category (Chapter 3.1). The middle column shows the number of associated stakeholders encountering the risk described in the left column. On the right column of the table are listed the actual risks that were encountered during the project. Note that one risk can be associated to one or more stakeholder group.

A total of 47 risks were counted for project 1 with 14 stakeholders. These were then categorized according to the risk and stakeholder category (Table 4). Due to limited space availability not all risks are shown in the far right column of Table 3. However, all 32 risks were grouped during data process by authors.

In project 1 risk related to cost is the most threatening risk associated with numerous stakeholders followed by risks related to policy & standard. Risk related to time such as project timeout and environmental risks such as climatic conditions and land expropriations are minimal and not considered critical threats.

Table 5 is the risk category of project 2. A total of 14 risks were categorized into time, cost, policy & standard and organization & management with 8 stakeholders. One stakeholder can be associated with one or more risks, that is why the number of stakeholders (middle column) does not add up to 8. There are no risks related to quality & technical and environment. The rightest column shows in specific what the risks are.

Project 2 considers risks related to policy and standard the biggest obstacle to the project followed by risks related to organization and management, such as miscommunication among partners due to a lack of common language. From Table 5, we can see that the project is

Table 5 - Risk category and associated stakeholders for project 2.

Risk category	*Number of stakeholders*	*Risks*
Time	2	R7: Time delay at implementation stage because going to the next step was stuck at the level of recommendation, policy, regulation
Cost	1	R3: Lack of funds
Policy and Standard	6	R1: Project modification due to European Commission request; R10: ethical issue in different regions; R9: discrimination of policies and regulations; R14: lack of administration and legislation requirements for implementation
Organization & management	4	R2: unclear methodology; R4: lack of common definition of key terms; R5: Miscommunication or lack of communication; R6: difficulties to reach interested case studies/farmers/people due to large distances; R13: ignorance in management in silvopastoral

Table 6 - Risk Structure Matrix.

(frequency/impact)	*R1 S1*	*R2 S1*	*R3 S2*	*R4 S3*	*R5 S4*	*R6 S4*
R1 S1			(2,5)	(1,1)		(1,1),
R2 S1				(2,5)	(2,5)	(2,3)
R3 S2	(1, 4)	(3,4)				(3,4)

very much dependent on policies and standards, which means that policy making and change in policies can have significant effects on the project and its outcome.

3.2. *Risk Structure Matrix*

This step is defining the interrelationships of risks following Fang *et al.* (2012) and Marle *et al.* (2013). This method represents relations and dependencies among objects. The impact between the two nodes and the possibility of occurrence is designed in a Risk Structure Matrix (Table 6). The first row and column are the risk ID coded in the risk profile. The digital numbers inside the cells indicate frequency (calculated as possibility of occurrence) and impact: the left element is the impact between the risks (5 scales with "5" meaning extremely high, and "1" meaning extremely low); the right element is the likelihood of the impact (5 scales with "5" meaning extremely high and "1" meaning extremely low). For example, (1,4) indicates that the third risk associated to stakeholder 2 (R3S2) has low level of occurrence, however has a high level of impact on the first risk associated to stakeholder 1.

3.3. *Quantified results*

For a comprehensive overview of the risk-stakeholder network the density and cohesion were calculated first, then the degree, betweenness centrality and status centrality were measured to see individual nodes and links.

Density is the ratio of all possible existing ties in a network. The equation is given below (see equation. 1)

$$\text{Density } (G) = \frac{K}{N(N-1)} = \sum_{S*Ri,S\#Rj \in G} (RSM_{S*Ri,S\#Rj}) / N(N-1) \quad (1)$$

It is calculated by Network *G*, *K* the existing relationships, *N* the total number of risks in the data set, and the interrelated risks in the Risk Structure Matrix.

Cohesion is a measure of the complexity of risk network based on risk reachability. The higher the cohesion, the more complexity of the risk network is. It calculates the distance, or the

number of links, to reach nodes in a network. The equation to calculate the cohesion value is given below,

$$\text{Cohesion } (G) = \frac{\sum_{S*Ri,S\#Rj \in G;\, n \in N} \text{AdjMz}}{N(N-1)} \quad (2)$$

Where $AdjM^z$ is the adjacency matrices with network N, nodes labelled by *i*=1; 2; *n*. It is assumed that aij > 0 if there is a direct/indirect link from node *j* to node *i* and $a_{ij} = 0$ otherwise. $AdjM^d$, give the number of walks of length z from each node to each other node. Number z is calculated by the average walks between each pair of nodes in the network.

Further, in order to specify the location of the risks and the associated stakeholders in the network and see their interrelations, the degree, betweenness centrality and status centrality were calculated using the software UCINET and STATA (Borgatti *et al.*, 2002; StataCorp, 2015). Degree of nodes helps to identify risks which have higher immediate impact on others. In-degree (eq. 3) refers to risks that are impacted by other risks, whereas out-degree refers (eq. 4) to risks that have impact on other risks. The degree difference which is the Gap-degree (eq. 5) is the out-degree minus in-degree. The higher the difference, the stronger the impact of the risk to the others compared to impact received. The degree calculation only shows us the immediate connectivity from node to node.

$$\text{InDegree}_{S*Ri} = \sum_{S\#Rj \in G} \text{RSM } S\#Rj, S*Ri \quad (3)$$

$$\text{OutDegree}_{S*Ri} = \sum_{S\#Rj \in G} \text{RSM } S\#Rj, S*Ri \quad (4)$$

$$\text{GapDegree}_{S*Ri} = \text{OutDegree}_{S*Ri} - \text{InDegree}_{S*Ri} \quad (5)$$

The betweenness centrality identifies risks and interrelations which have control over the impact passing through it. It measures the node/link that falls between two or more other nodes/links based on the shortest path calculated. The betweenness centrality can be calculated with eq. 6 and eq. 7, where σ S#′ R*k*, S#R*j* is the number of shortest paths from node S#′ R*k* to node S#R*j*.

$$\text{Node Betweenness}_{S*Ri} = S\#'Rk, S*Ri, S\#Rj \in G;\ S\#'Rk \neq S*Ri \neq S\#Rj\ \sigma\ S\#'Rk, S\#Rj\ (S*Ri) / \sigma\ S\#'Rk, S\#Rj \quad (6)$$

$$\text{Link Betweenness}_{S*Ri \to S\#Rj} = S*'Rp, S*Ri,, S\#Rj, S\#'Rq \in G;\ S*'Rp \neq S*Ri \neq S\#Rj \neq S\#'Rq\ \sigma\ S*'Rp, S\#'Rq\ (S*Ri, S\#Rj) / \sigma\ S*'Rp, S\#'Rq) \quad (7)$$

Status centrality helps to identify risks which have higher overall impact in the whole network. It measuring the relative influence of a node within a network. The number of the immediate neighbours (first degree nodes) and all other nodes in the network that connect to the node under consideration through these immediate neighbours are measured so that the relative influence of a node within a network can be computed. The out-status centrality indicates the extent to which a risk can affect another risk, meaning the higher the value the greater the impact of the risk in the network. The equation for the out-status centrality is given…, where is the distance between the nodes, ∝ is the weight assigned to each path or connection between a pair of nodes andis the adjacency matrices given the number of walks of length d from each node to another.

$$\text{StaC}_{S*Ri} = \sum_{d=1}^{\infty} \sum_{S\#Rj \in G;\, S*Ri \neq S\#Rj} \propto^{d-1} (\text{AdjM}^d)_{S*Ri \neq S\#Rj} \quad (8)$$

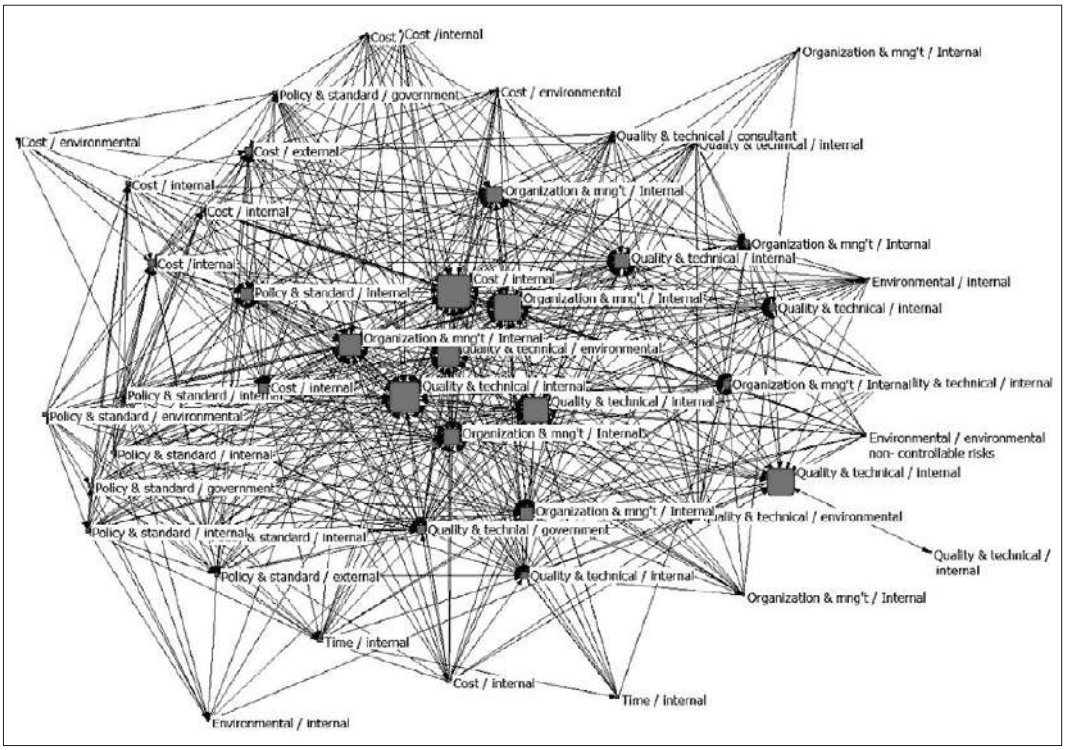
The Risk Structure Matrix from Chapter 3.5 and the deciphered results from 3.6 were used to draw a stakeholder-associated risk map. This followed by an elaborated critical risk list and mitigation action plan.

3.4. *Risk network*

The network measures, which is the density and cohesion show that the risk interrelations and complexity of the risk network was high for the two projects. Results for density, which ranges from 0 to 1, are 0.30 and 0.37 for project 1 and project 2, respectively. Results for cohesion are 0.93 and 1.2 for project 1 and project 2, respectively. An example of the risk network map is shown below in Figure 2. The figure demonstrates that the network is very complex.

The bigger the node the higher the control of that node in the whole network. Figure 2 shows that risk related to cost, quality & technical are critical more than risks related to organization

Figure 2 - Risk network of project 1.



& management. However, the mostly associated stakeholder group is the internal stakeholder group. Partners within the project have more control over these risks.

Figure 3 shows the risk network of project 2. It is less complicated than project 1, however we can see that risk related to policy & standard and associated to government is by far the critical risk. A closer look into the network shows that risk related to organization &management is another critical risk that should be paid attention to.

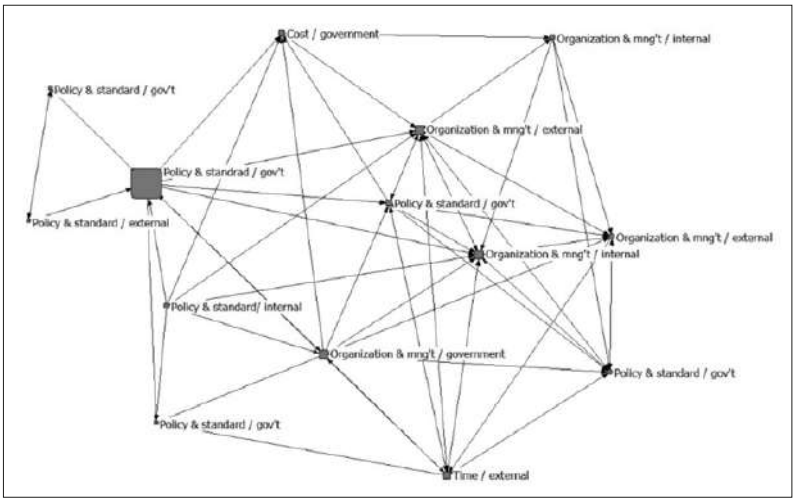


Figure 3 - Risk network of project 2.

Table 7 - Key risks according to betweenness centrality and status centrality for project 1.

Rank	*Risk ID*	*Node betweenness centrality*	*Risk ID*	*Link betweenness centrality*	*Risk ID*	*Out-status centrality*
1	R20 S3	162.90	R9_S1 => R9_S3	47.25	R10 S1	47.00
2	R19 S1	143.96	R22_S1 => R22_S2	47.00	R24 S13	47.00
3	R16 S3	112.26	R5_S2 => R5_S4	47.00	R15 S10	47.00
4	R5 S2	107.80	R3_S1 => R3_S3	46.10	R10 S2	46.5
5	R14 S9	87.13	R1_S1 => R1_S2	46.00	R12 S2	46.00
6	R23 S1	82.55	R16_S3 => R16_S11	46.00	R12 S4	46.00
7	R11 S7	81.95	R17_S3 => R17_S11	46.00	R12 S8	46.00
8	R22 S1	77.63	R19_S1 => R19_S2	45.00	R29 S2	44.00
9	R3 S1	63.02	R19_S1 => R19_S12	44.00	R7 S2	44.00
10	R25 S3	53.72	R16_S3 => R17_S3	42.15	R29 S14	42.75

3.5. *Critical risks and mitigation action plan*

Table 7 through table 10 show the critical ten risks and interactions for the two projects calculated by the software UCINET and STATA. Node and link betweenness centrality identify risk interactions passing through that node or link. This means that a node or a link with a high value of betweenness centrality has a high level of control over the impact, because more risks and are passing through that node/link. Out-status centrality calculates the extent to which the risk has an impact on other risks, differing with degree difference in that it looks at the whole network rather than individual node to node impact. Table 7 looks at the risk and its interactions through the whole network, whereas Table 8 looks at the single node as an individual risk.

The results for node betweenness centrality show that the critical nodes that have high control over the other nodes are mostly risks related to cost (R20, R16, R11, R5,) quality & technical risks (R23, R22, R19 and R14) followed by organization & management (R3, R25). The stakeholders are mostly internal, meaning that actors who are directly involved in the project and have high influence and control over the risks. R19 S1, which is 'inadequate analysis of the complexity of the project' and is associated to the internal energy efficiency team, appears to be a critical risk in terms of link betweenness. It is linked to the same risk faced by the irrigation community (internal) and with the University of Valencia (consultant).

The out-status centrality column shows that 'lack of political support' (R10) and 'legislative or regulatory changes' (R12) are two main risks in the whole network. There are also two non-controllable risks, which are 'risk due to weather conditions and 'unfavourable climatic conditions'. These differ significantly to the betweenness centrality, which face more cost and quality & technical related risks rather than political discontinuity or regulatory changes.

The degree difference (Table 8) gives us the results of risks that have higher impact on other risks than received. The results differ with the results of Table 7.

The top five risks that have higher impact on other risks than received, are related to lack of

Table 8 - Key risks according to degree difference for project 1.

Rank	*Risk ID*	*Degree difference*
1	R10 S1	22
2	R10 S2	20
3	R12 S2	18
4	R12 S4	18
5	R12 S8	18
6	R16 S11	16
7	R19 S2	16
8	R19 S12	15
9	R5 S4	14
10	R24 S13	14

Table 9 - Key risks according to betweenness centrality and status centrality for project 2.

Rank	*Risk ID*	*Node betweenness centrality*	*Risk ID*	*Link betweenness centrality*	*Risk ID*	*Out-status centrality*
1	R9S4	43.06	R8_S4 => R9_S4	20.58	R6S4	7.25
2	R8S4	29.49	R4_S3 => R1_S1	19.45	R4S3	7.25
3	R6S4	20.58	R6_S4 => R8_S4	14.17	R12S2	6.75
4	R4S3	15.51	R11_S2 => R9_S4	12.5	R8S4	6.5
5	R1S1	6.95	R10_S8 => R9_S4	12	R7S1	6.5
6	R12S2	6.58	R9_S4 => R11_S2	11.5	R5S4	6.25
7	R3S2	3.64	R9_S4 => R10_S8	11	R9S4	6.00
8	R13S7	3.13	R3_S2 => R6_S4	10.14	R3S2	5.87
9	R7S1	2.63	R5_S4 => R8_S4	7.83	R13S7	5.5
10	R5S4	2.43	R7_S1 => R8_S4	7.83	R2S1	5.25

political support/government discontinuity (R10) and legislative or regulatory changes (R12). The two main risks are associated to internal stakeholders of the project. The energy efficiency team that is responsible for the energy supply during the process of the project and the irrigation community are examples of internal stakeholders.

Other critical risks are 'inadequate analysis of the complexity of the project' (R20), 'lack of support from senior management' (R3), 'lack of access to funds' (R9), 'increase in price of materials (water, energy)' (R32), 'raise awareness among farmers' (R33) and 'unsuitable, untested or unreliable materials, products or sustainable systems' (R23). These are mostly associated to internal stakeholders. It proves that most of the risks are associated to internal partners of the project as it was proven in Table 3.

Table 9 shows the risk interaction for project 2. Like project 1, risk and their interactions were given attention, so the node/link betweenness centrality and out-status centrality were calculated.

Critical nodes (see node betweenness centrality) that have high control over the other nodes are mostly risks related to policy & standard (R1, R7, R9, R12) and risk related to organization & management (R4, R5, R6, R13). The risks are mostly associated with external stakeholders (for example farmers) and equally same with government and internal stakeholders. Results for critical risk interactions (see link betweenness centrality) R9_S4, which is 'discrimination of policy' associated with farmers (external stakeholder) seems to be the mostly influential risk throughout the whole network.

The degree difference (Table 10) shows the results of risks that have higher impact on other risks than received. The results do not differ much from Table 8, in that the most critical risks are related to policy & standard (R1, R9, R10, R11) and organization & management (R2, R5, R9).

In project 2, a common risk has been identified: lack of common definition of key terms. This risk is critical in that it is related to communication among all stakeholders, whether internal or external and also with government. Less or misleading communication can lead to mistrust and eventually to discrimination of policy, which has been identified has a critical risk interaction in Table 9.

Table 10 - Key risks according to degree difference for project 2.

Rank	*Risk ID*	*Degree difference*
1	R1S1	5
2	R13S7	5
3	R9S4	4
4	R2S1	2
5	R8S4	1
6	R11S2	0
7	R10S8	0
8	R5S4	-1
9	R12S2	-1
10	R7S1	-2

Table 11 - Risk mitigation action plan according to the main risk interaction for project 1.

Risk interactions	*Mitigation action plan*
R9_S1 => R9_S3	To apply to additional funding should not be difficult to stakeholders (otherwise lack of trust and miscommunication can happen)
R22_S1 => R22_S2	Project design before implementation should be thoroughly reviewed to avoid further malfunction of the project (untested materials, products etc.)
R5_S2 => R5_S4	Fiscal changes are unavoidable, but must be communicated in advance
R3_S1 => R3_S3	Communication between senior management and all partners should communicate closely throughout the whole project.
R1_S1 => R1_S2	All partners should be aware of the timing of the project. A timeline with milestones and deliverables are useful.
R16_S3 => R16_S11	Budget shortages should be communicated
R17_S3 => R17_S11	Time shortages can be flexibly responded by project coordinators at the same time notifying all partners
R19_S1 => R19_S2	Preparation plans for complexity of the project should be known before the implementation stage; additional complexity during the project should be verbally and often communicated.
R19_S1 => R19_S12	Preparation plans and mitigation action plan for the complexity of project should be verbally communicated with external stakeholders of the project.
R16_S3 => R17_S3	Additional budget should be planned to deal with sudden budget cut

To mitigate the risks and reduce their impact on the whole project, the critical risks were removed. The top ten risks according to the node betweenness centrality from Table 6 and Table 8 were considered as critical nodes to be removed, since they are the strongest nodes having high control over the impact in the whole network. When removing the ten risks the nodes have been reduced from 47 nodes to 37 nodes and 637 paths to 258 paths for project 1, and from 14 nodes to 9 nodes and 67 paths to 17 paths for project 2.

The network density has been reduced from 0.3 to 0.2 (a decrease of 34.3%) and the cohesion value reduced from 0.93 to 0.61 (a decrease of 34.4%) for project 1. For project 2, network density has been reduced from 0.37 to 0.24 (a decrease of 36%) and the cohesion value from 1.20 to 0.83 (a decrease of 31%).

The main risk interactions are identified with the link betweenness centrality values. By cutting of these links we can separate the main risks into simplified parts and reduce them by proposing possible mitigation action plans (Table 11 and Table 12).

According to the results in Table 11, communication between the risks and associated stakeholders could be improved. Proposed mitigation action includes, for example:

Communication between senior management (often the project coordinator) and all partners should happen regularly using effective measures and strategies before and throughout the project;

Communication on technical difficulties, time shortages, access to additional funds and other changes should be done (written communication, if necessary) using an effective communication platform.

From the results, we can see that communication enhancement between stakeholders will reduce lack of trust and miscommunication between partners. Unnecessary risks can be reduced with effective and efficient communication strategy plans.

Table 12 shows the top ten risk interaction for project 2. Here, like the results of project 1, communication enhancement is a key mitigation action plan that can improve many difficulties. Proposed plans are:

A well-defined terminology and transferring of the terminology to the different partners avoids future miscommunication;

Consideration of end-users (farmers, local community) culture, ethics, traditional practices into the project design and well communication of “new” practices will avoid mistrust between stakeholders.

Table 12 - Risk mitigation action plan according to the main risk interaction for project 2.

Risk interaction	*Mitigation action plan*
R8_S4 => R9_S4	Differences in agricultural practices between tradition and European policies must be acknowledged and well communicated.
R4_S3 => R1_S1	Differences in agricultural practices can begin by establishing a common definition of terms and communicating them well among partners
R6_S4 => R8_S4	Large distances between farmers (case studies) put more distances in terminology and communication, so other measures for communication strategy should be taken to shorten the gap
R11_S2 => R9_S4	Lack of common definition and guidelines should be overcome to avoid mismanagement and discrimination
R10_S8 => R9_S4	Dealing with end-users (farmers, local community) means considering their culture, ethics in working. This may avoid future and bigger discrimination.
R9_S4 => R11_S2	Well established management system may lead to full support of policies and less discrimination.
R9_S4 => R10_S8	Discrimination of policy is, when broken down into small parts, leads to ignorance of ethical difference among partners. This should be overcome by considering partners needs and accustoms first.
R3_S2 => R6_S4	A plan with all possible actions that could happen within the project should be made and a flexible funding system accordingly.
R19_S1 => R19_S12	Establishing a common definition on terminology and efficient communication will lead to a well project process.
R16_S3 => R17_S3	Adapting to new agricultural practices may lead to 'going to the next step (innovation)' level. Adapting farmers to new practices includes considering their perspectives in the project.

The most critical risk interaction and their mitigation action plan demonstrate that communication is a key tool to reduce the risk network. Careful consideration of what kind of communication with which stakeholder is a way to enhance the communication type and structure. Communication type and structure may differ by project according to their characteristics, but it has been proven that better communication can lessen the risk network. Recalling that communication is (inter) action between two or more stakeholders, careful revision and study of interaction is necessary.

As literature states that elaborating on stakeholder interaction and mitigating uncertainties can improve the overall performance of the project, this research supports through empirical analysis that the Social Network Analysis is a promising tool for analyzing risks and stakeholder interaction. Stakeholder interaction may be defined by their risk preference (Khan *et al.*, 2020), knowledge on their decision-making process (Senapati, 2020), their awareness on climate-related risks (Qin *et al.*, 2016). The knowledge of stakeholders and integrating them is described as complex. However, many innovative projects are required to find solutions to the complexity. Being aware of the diverse perspectives and knowledge of stakeholders and establishing a constructive and systemic way of thinking enhances critical reflections and assess the effectiveness of process. Thus, systemic thinking gives way out of complex situations. As such, the Social Network Analysis is proposed as an evaluation tool of comprehensiveness, integration and systemic approach in order to achieve a high performance in innovation management.

4. Conclusions

The study draws on a stakeholder-associated risk network map that provides the stakeholder with a more holistic view of interactions in the project. The social network perspective can improve stakeholders' insight of the whole interrelations of the risk and associated stakeholder and thus provide a better risk management and de-

cision-making process. Previous studies on risk analysis have evolved from analysing technical, environmental and social risk to stakeholder-oriented risk perspective. Adinolfi *et al.* (2020) in their study have analyzed women's rural economic participation, networking and access to rural policies and finds that more participation of women may lead to sustainable, developmental and innovation ways in the rural areas. As such, risk is no longer an individual phenomenon, but happens through the interaction of stakeholders and must be regarded at organizational and institutional level. Through exploratory analysis and empirical evidence this study finds several important points: (1) internal stakeholders play more important role than government or external stakeholders in allocating resources (2) communication among the stakeholders within the project is the most critical risk faced (3) establishing a well-defined terminology is critical for better communication among stakeholders (4) acknowledging the diversity, such cultural and practice differences among stakeholders is a critical risk to overcome and a step to start better communication.

A key finding from the risk network analysis, is that communication is the key risk that is stretched over the network and is critical to reduce the negative impact. Like the above example, an analysis based on stakeholder interaction is promising in examining the impact or evaluating interactive innovation processes. In line the study brings forward two main findings for future policy implications.

First, stakeholder interaction should be regarded as an essential subject in the analysis of risk network and network management due to their impact on better decision-making process and sustainable development. The diversity of stakeholders and their networks result in more distributed control and requires more cooperation and network management (Kemp *et al.*, 2007). Networks can facilitate collective action (Powell and Grodal, 2005; Lejano and de Castro, 2014) and boost innovation by steering knowledge acquisition and transfer, resource mobilization and cooperation (Bodin and Crona, 2009; Dessie *et al.*, 2013; Reed and Hickey, 2016). However from a micro perspective, knowing stakeholder's preference and perception on their decision-making processes will help to identify the determinants of how they adapt to new agricultural management practices (Swami and Parthasarathy, 2020).

Second, stakeholder interaction and risk network mapping as an integrative innovation process should be regraded with a system thinking approach. Stakeholders co-produce knowledge, experiences and practices that are often described as complex socio-scientific problems and by integrating diverse knowledge into management their ideas contribute to bringing more resilient outcomes and adaptable system (Agrawal, 1995; Berthet and Hickey, 2018; Ingram *et al.*, 2020). The knowledge produced should be continuous and feed into repeated learning cycles so that it can adapt to new changing circumstances during the process of the project (Paz-Ybarnegaray and Douthwaite, 2017). The adaptation itself allows us to see the developmental process of a project, which then allows to view the project from a broader perspective to see overall structures and interaction patterns within the structure.

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The effect of robotic milking systems on economic performance of dairy farms with a simulation model

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Abstract

The most remarkable technology brought to dairy farms by the digital transformation in agriculture is undoubtedly robotic milking systems (RMS). Knowing the economic impact of this technology is essential for farmers to adopt. For this purpose, in the study; a simulation model was created that gives possible economic analysis results as a result of the use of RMS by using the current economic analysis results of dairy farms. For the economic analysis of dairy farms, data obtained from face-to-face surveys from 148 dairy farms were used. Assumptions used in the simulation model for comparing RMS and conventional milking systems (CMS) were 8.66% increase in milk yield, 58.46% increase in investment costs, 36.66% increase in energy consumption, 1.33% increase in feed costs and 27.84% decrease in labor input. The economic analysis of the dairy farms was made again with these new input and output values obtained. While the simulation results show that the use of RMS is a preferable investment that increases profitability for 10-60 head and 121 + head groups; it shows that it will be an investment that negatively affects profitability for the 61-120 head group. The simulation model was used by taking the average values of the data belonging to the dairy farm groups. A dairy farmer considering an RMS investment can be able to obtain a result specific to his farm if he combines the simulation model with his own economic analysis results.

Keywords: *Robotic milking systems, Simulation model, Economic analysis.*

1. Introduction

Innovation in agriculture and the food sector is particularly important in countries such as Turkey, where agriculture has a high share of national gross domestic product (GDP) (Ben Hassen and El Bilali, 2021). The main element of innovation in the production process is the use of innovative technology. For this reason, it is extremely critical for the sustainability of livestock activities that farmers keep up with these changes by following new technologies and innovations (Yener Ögür, 2021).

The most important technological innovation in the dairy industry in recent years is undoubtedly robotic milking systems (RMS). In 1992, Lely, a Dutch company, installed the first milking robot as part of a project in its own coun-

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try (Schewe and Stuart, 2015). After the introduction of the first RMS, the adoption of the new technological innovation proceeded slowly and in 1996 only about 45 installations were used on commercial farms with the majority in the Netherlands. By the end of 2009, RMS was estimated to be deployed on more than 8,000 dairy farms in over 25 countries worldwide. The number rose to 10,000 by 2010 and to 30,000 in 2017 (Jiang *et al.*, 2017). Today, the number of RMS has risen to 50,000 (Simões Filho *et al.*, 2020).

Different simulation studies have been carried out to reveal the benefits and disadvantages of RMS. Dijkhuizen *et al.* (1997) examined the economic consequence of using this technology in place of a conventional parlor system on dairy farms. Some assumptions with respect to size of operation, general costs and tax rates were made to perform the study. Cooper and Parsons (1998) used a simulation model to test the benefits and drawbacks of robotic or fully automated milking systems. In their study, they used a three-phase discrete simulation model to study system performance under different management options and to analyze the effect of herd size, milk yield and calving pattern. As a result of the study, they presented the findings obtained under different scenarios. In their next study, Cooper and Parsons (1999) examined the economic and logistic results of dairy farms using robotic or fully automatic milking systems with this simulation model they established. They combined the A three-phase discrete simulation model with economic analysis of real farms with a herd size of 85-95 heads. As a result of the study, they revealed economic benefits and costs.

Veysset *et al.* (2001) applied a questionnaire to 44 dairy farms using RMS in their study. By using the survey results, simulations were carried out in three types of dairy farms with 60, 80 and 100 dairy cows. They interpreted the simulation results through economic factors. Hyde and Engel (2002) used Monte Carlo simulation methods to estimate the breakeven value for a RMS on a dairy farm. The analysis simulates several scenarios under three herd sizes, 60, 120, and 180 cows. As a result of the study, the breakeven values where the costs of production equal the revenues for a product, were $192,056, $374,538, and $553,671, respectively. Tranel and Schulte (2013) developed a partial budget spreadsheet tool, in order to assist dairy producers to make informed decisions on the economic variables associated with RMS. This tool they have developed reveals positive and negative impacts by making calculations on the economic assumptions about RMS. Generally, the technical features of milking robots and their effects on animal welfare were studied in Turkey and there are hardly any studies on their economic performance. Örs and Oğuz (2016, 2018) compared the economic performance of robotic milking system (RMS) and conventional milking system (CMS). In their study literature about economic comparison of RMS and CMS was reviewed by using the data from 33 studies carried out in 13 different countries from 1998 to 2017.

Although the use of RMS is increasing day by day in Turkey, question marks remain on the economic performance of these systems. The aim of the study is to simulate the economic performance results of dairy farms using robotic milking systems and to compare the results with their current economic situation. For this purpose, economic analyzes were carried out with the data collected through questionnaires from 148 dairy farms. The results of these economic analysis and the new results simulated with the economic performance assumptions of the RMSs are compared.

2. Materials and methods

2.1. *Materials*

The analysis was carried out through the 148 dairy farm data which were obtained through the interviews in Konya. Survey data span the period between May 2017 and November 2017. In addition to these data, previous research findings and publications were also used as a secondary material. In this study, $1 = 3.58 Turkish Liras calculated that was the average exchange rate of the dates of the field study was done.

2.2. *Methods*

2.2.1. *The method used in sampling*

As a research area, Konya province was selected according to the "judgment sampling method". By the presence of cattle and milk production,

Konya is the first province in Turkey. In Konya the cattle number was 740.148 head and milk production were 1.018.917 tons (Turkish Statistical Institute). The main frame of dairy farms was determined as 4.209 establishments in 16 districts of Konya. The Neyman method from the stratified sampling method was used in the calculation of sample volume. According to the Neyman method, the equation that determines the sample volume was formulated as follows (Yamane, 1967).

$$n = \frac{[\sum(N_h S_h)]^2}{N^2 D^2 + \sum[N_h (S_h)^2]} \quad (1)$$

In formula; n = sample volume, N = total unit number belonging to the sampling frame, S = standard deviation of sample mean, S^2 = variance, D = d / t, d = derivation from the average, t = standard normal distribution value. The sample volume was determined by using the number of milking cows. The sample size was calculated for a confidence interval of 95% and an error margin of 5%. As a result, 150 dairy farms were determined as total sample volume.

2.2.2. *The method used in the economic analysis of dairy farms*

In the milk production cost and profitability calculations of the farms, they evaluated only by taking into account the dairy cattle production activity. The inputs and outputs of the dairy cattle farms used in calculations were given in Figure 1.

Total production costs of the dairy cattle farms were calculated separately as variable and fixed operating costs (Geetha and Lavanya, 2013; Oğuz and Bayramoğlu, 2015; Tapkı, 2019). In the research, the costs which were increasing or decreasing depending on the production volume were evaluated as variable costs and the costs not related to production amount were considered as fixed costs (Güneş, 2004; Hanrahan *et al.*, 2018). The items used in the variable and fixed cost calculations were shown in Figure 1.

The gross production value for dairy cattle was calculated by adding up the value of total milk, which was the main product, the increase in productive stock value (PSV) and farm fertilizer which were by-products (Aşkan and Dağdemir, 2016; Çetin, 2013; Kumawat *et al.*, 2014; Ramsbottom *et al.*, 2015). The increase in productive stock value (PSV) was calculated by taking into account factors that cause animal movements such as birth, death, changing age, buying, selling and consumption of animals. For this purpose, the following formula was used (Kıral *et al.*, 1999; Örs and Oğuz, 2019).

PSV = (year end stock value + value of the sold stock + value of the stock slaughtered) – (value of the stock at the beginning of year + value of the stock bought)

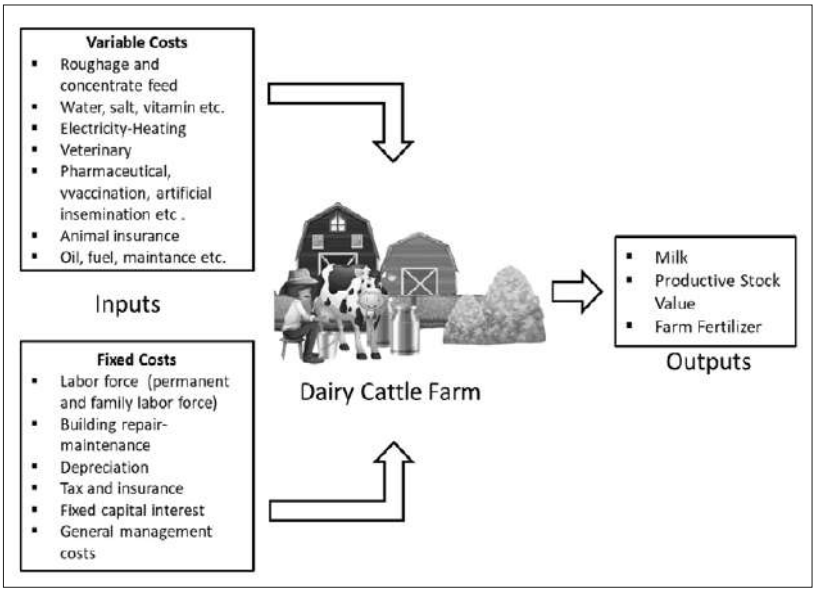
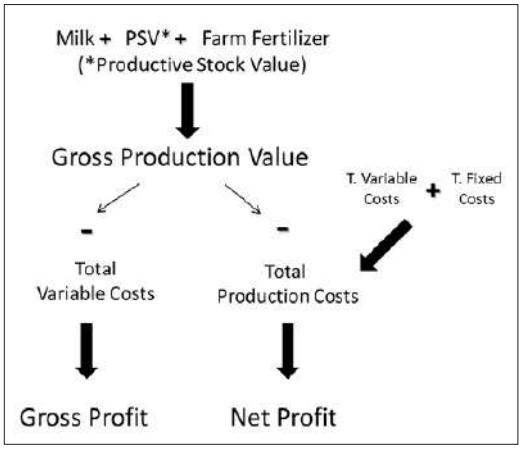


Figure 1 - Inputs and outputs scheme of dairy cattle farms.

Source: Research results.

Figure 2 - Gross and net profit calculation scheme of dairy cattle farms.



Source: Research results.

Gross profit was calculated by subtracting the variable costs from the gross production value while net profit was calculated by subtracting total production costs from gross production value (Açıl and Demirci, 1984; Demircan *et al.*, 2006; Hanrahan *et al.*, 2018; Ramsbottom *et al.*, 2015; Shoemaker *et al.*, 2008).

The relative sales value method was used to calculate the unit milk cost. In this method, the total production cost was distributed according to the contribution of each compound product to the gross production value and the cost of each product was divided by the amount of production and the unit costs are calculated (Kıral et al., 1999). The following formula was used to calculate the unit milk cost:

Unit Milk Cost = Milk Production Cost ($) / Total Milk Production Amount (kg)

2.2.3. *The method used in the economic simulation model of the robotic milking system*

For economic analysis of dairy farms, the data obtained from 150 dairy farms as a result of a face-to-face survey in the study of Örs and Oğuz (2019) were used. Two dairy farms already using milking robots had not been evaluated, and the data of 148 dairy farms had been used in the economic analysis. Since one milking robot for every 60 dairy cattle is recommended by the RMS manufacturers, economic analyzes were carried out by forming farm size groups as 10-60 head, 61-120 head and 121 head and above dairy cattle.

Table 1 - Assumptions used in the economic analysis of dairy farms using RMS.

Affected factor	*Percent change (%)*
Milk yield	8.66
Investment cost	58.46
Energy consumption	36.66
Feed cost	1.33
Labor input	- 27.84

For the economic performance assumptions of RMS, the results of Örs and Oğuz (2018)'s study in which 33 research results from 13 countries were analyzed were used. Assumptions used in the simulation model for comparing RMS and conventional milking systems (CMS) are; 8.66% increase in milk yield, 58.46% increase in investment costs, 36.66% increase in energy consumption, 1.33% increase in feed costs and 27.84% decrease in labor input (Table 1). These assumed percentage change values had been applied to the respective input and output items. The economic analysis of the dairy farms was made again with these new input and output values obtained.

Percentage change assumptions in the economic performance of the RMS and the affected input and output items were schematized in Figure 3 to form the main frame of the study.

2.2.4. *Paired samples t-test*

In the study, paired samples t-test was used to test whether there is a significant difference between the economic performances of dairy farms as a result of using CMS and RMS systems.

The parametric test performed to determine whether there is a statistically significant difference between the means of the data values obtained as a result of two consecutive measurements on the same data source is called the paired samples t-test. In order for the test to give reliable results, the data set should show a normal distribution. In the paired samples t-test, the effect size can be found by dividing the mean value by the standard deviation by using paired differences table (Can, 2018).

Net profits of CMS and RMS were used in paired samples t-test. Firstly, normality test was

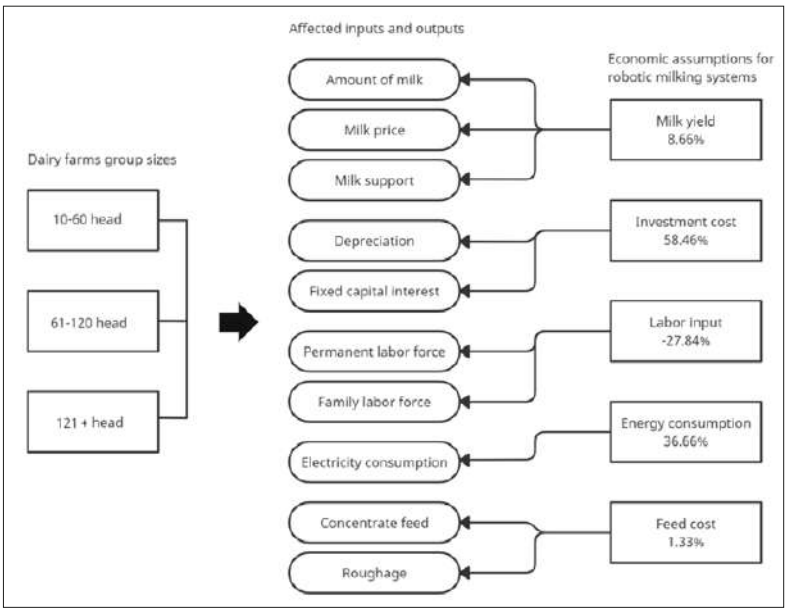


Figure 3 - The main frame of the study and the assumptions.

performed by using the package program. Data of all groups show normal distribution. Then, paired samples t-test was performed separately for each of the three groups. The effect size value (d) was evaluated above 1 as very large, 0.8 as large, 0.5 as medium and 0.2 as small effect (Green and Salkind, 2013).

3. Results

3.1. *General information about the dairy farms examined*

As a result of the analysis of the survey data, general information about dairy farms is presented in Table 2.

As a result of the study, the average economic performance indicators for dairy farms were calculated as gross production value (GPV) $428,967.56, gross profit $183,620.58, net profit $76,224.20 and unit milk cost $0.31/kg. Oguz and Yener (2018) calculated the GPV as $194,492.69, the gross profit as $90,257.46 and the unit milk cost as $0.31 in the Konya region. Özsayın (2019), calculated the average GPV as $53,583.48, gross profit as $23,302.29, net profit as $44,80.41 and unit milk cost as $0.30. Although the gross production value and profit values differ according to the size of dairy farms, unit milk costs were close to each other in all studies.

3.2. *Economic analysis of dairy farms with 10-60 head milking cows*

CMS and RMS economic analysis results for 10-60 head dairy farm group is presented in Table 3 comparatively.

As a result of the use of RMS, the increase in concentrate feed, roughage and energy costs in-

Table 2 - General information of the dairy farms.

Groups (head milking cows)	*Dairy farms (number)*	*Milking cows (head)*	*Gross production value ($)*	*Total production costs ($)*	*Gross profit ($)*	*Net profit ($)*	*Unit milk cost ($/kg)*
10-60	96	24	93,079.30	95,930.85	30,625.23	-2,851.55	0.39
61-120	39	97	415,375.08	362,831.98	166,442.17	52,543.10	0.34
121+	13	165	778,448.32	599,467.26	353,794.33	178,981.06	0.31
Total /Av.	148	95	428,967.56	352,743.36	183,620.58	76,224.20	0.35

creased the total variable costs from $62,454 to $63,471. Despite the decrease in the family labor force and permanent labor force, the total fixed expenses increased from $33,477 to $38,187 as a result of high depreciation, interest on fixed capital and general administrative expenses. With this increase in variable and fixed costs as a result of the use of RMS, the total operating costs increased from $95,931 to $101,658. With the increase in yield resulting from the use of RMS, there had been an increase in milk income and livestock support (including milk support). The total income of dairy enterprises increased from $102,771 to $119,759. Looking at the profitability values, the gross profit ranged from $30,625 to $45,470; net profit increased from -$2,852 to $7,283. This dairy farm group, which made a loss in terms of net profit, became profitable as a result of using RMS (Table 3).

When we look at the unit milk cost values, the unit milk costs before and after the support are very close to each other in the use of CMS and RMS. However, as a result of the use of RMS, there is an increase in the unit milk cost, even if it is less than 1 cent.

3.3. *Economic analysis of dairy farms with 61-120 head milking cows*

CMS and RMS economic analysis results for 61-120 head dairy farm group is presented in Table 4 comparatively.

As a result of the use of RMS, the increase in concentrate feed, roughage and energy costs increased the total variable costs from $248,933 to $254,106. Despite the decrease in the family labor force and permanent labor force, the total fixed expenses increased from $113,899 to $140,157 as a result of high depreciation, interest on fixed capital and general administrative expenses. With this increase in variable and fixed costs as a result of the use of RMS, the total operating costs increased from $362,832 to $394,263. With the increase in yield resulting from the use of RMS, there had been an increase in milk income and livestock support (including milk support). The total income of dairy enterprises increased from $459,560 to $490, 748. Looking at the profitability values, the gross profit ranged from $166,442 to $190,568. However, net profit including fixed costs decreased from $52,543 to $50,411 due to the high investment cost of the RMS system. Looking at net profit, this dairy farm group has lost profits as a result of using RMS (Table 4).

When we look at the unit milk cost values, the unit milk costs before and after the support are very close to each other in the use of CMS and RMS. However, similar to the first group, as a result of the use of RMS, there is an increase in the unit milk cost, even if it is less than 1 cent.

3.4. *Economic analysis of dairy farms with 121 head and above milking cows*

CMS and RMS economic analysis results for 121 head and over dairy farm group is presented in Table 5 comparatively. As a result of the use of RMS, the increase in concentrate feed, roughage and energy costs increased the total variable costs from $424,654 to $433,749. Despite the decrease in the family labor force and permanent labor force, the total fixed expenses increased from $174,813 to $208,726 as a result of high depreciation, interest on fixed capital and general administrative expenses. With this increase in variable and fixed costs as a result of the use of RMS, the total operating costs increased from $599,467 to $642,476.

With the increase in yield resulting from the use of RMS, there had been an increase in milk income and livestock support (including milk support). The total income of dairy enterprises increased from $861,007 to $921,068. Looking at the profitability values, the gross profit ranged from $353,794 to $401,277; net profit increased from $178,981 to $192,551. This dairy farm group, which makes a profit in terms of net profit, has increased its profits as a result of using RMS (Table 5).

When we look at the unit milk cost values, the unit milk costs before and after the support are very close to each other in the use of CMS and RMS. Similar to the first two groups, there is an increase in the unit milk cost after supports, although it is less than 1 cent as a result of the use of RMS, while unlike the first two groups, there is a decrease in the unit cost of milk before supports in this group.

Table 3 - CMS and RMS economic analysis results for 10-60 head dairy farm group.

CMS (10-60 head)		*RMS (10-60 head)*
$/Year		*$/Year*
	Costs	
	Variable Costs	
29,941.99	Concentrate Feed	30,340.21
26,467.48	Roughage	26,819.50
619.38	Water-Salt-Vitamin	619.38
727.28	Electricity-Heating	993.89
1,513.17	Veterinary-Pharmaceutical-Vaccination	1,513.17
839.07	Artificial Insemination	839.07
259.47	Animal Insurance	259.47
2,086.24	Oil-Fuel- Maintenance	2,086.24
62,454.07	*Total Variable Costs (A)*	*63,470.93*
	Fixed Costs	
12,134.25	Depreciation Expenses	17,405.89
2,853.40	Building Repair-Maintenance Expenses	2,853.40
2,612.92	Permanent Labor Force	1,885.49
7,505.02	Family Labor Force	5,415.62
51.05	Tax and Insurance	51.05
6,446.52	Fixed Capital Interest	8,671.38
1,873.62	General Management Costs (%3)	1,904.13
33,476.78	*Total Fixed Costs (B)*	*38,186.96*
95,930.85	*Total Production Costs (C) = (A+B)*	*101,657.90*
	Incomes	
72,369.33	Milk Value (D)	88,230.84
17,778.17	Productive Stock Value (E)	17,778.17
2,931.80	Farm Fertilizer Value (F)	2,931.80
9,691.98	Livestock Supports (G)	10,818.65
102,771.27	*Total Incomes (H) = (D + E + F + G)*	*119,759.46*
93,079.30	*Gross Production Value (I) = (D + E + F)*	*108,940.80*
30,625.23	*Gross Profit (J) = (I - A)*	*45,469.87*
-2,851.55	*Net Profit (K) = (I - C)*	*7,282.91*
53,760.86	Milk Production Amount (kg) (L)	58,416.55
74,586.42	Milk Production Costs (M) =(C x %D/100)	82,332.43
0.37	Milk Sales Price ($/kg)	0.39
0.388	*Unit Milk Cost (N) = (M / L)*	*0.394*
0.337	*Unit Milk Cost by Livestock Supports (P) = (M - G) / (L)*	*0.342*

**Grey colored cells are positively affected values; Black colored cells are negatively affected values.*

3.5. *Comparison of economic performance of dairy farm groups*

Table 6 was created by subtracting the economic performance results of CMS from the economic performance results of RMS. The difference values are presented in the table in dollars and percentages. When Table 6 is examined, it is seen that the use of RMS increases operating costs and total income at the same time. As a result of the use of RMS, there has been an increase in gross profit in all dairy farm groups; Net profit increased in dairy farm groups with 10-60 heads and 121 heads and above. In the group of dairy farms with 61-120 head milking cows, there was a decrease in net profit as a result of the use of RMS.

RMS and CMS economic performance dif-

Table 4 - CMS and RMS economic analysis results for 61-120 head dairy farm group.

CMS (61-120 head)		*RMS (61-120 head)*
$/ Year		*$/ Year*
	Costs	
	Variable Costs	
115,971.55	Concentrate Feed	117,513.97
99,038.51	Roughage	100,355.72
4,711.36	Water-Salt-Vitamin	4,711.36
6,310.70	Electricity-Heating	8,624.20
6,577.85	Veterinary-Pharmaceutical-Vaccination	6,577.85
5,470.56	Artificial Insemination	5,470.56
3,173.53	Animal Insurance	3,173.53
7,678.84	Oil-Fuel- Maintenance	7,678.84
248,932.90	*Total Variable Costs (A)*	*254,106.04*
	Fixed Costs	
48,098.88	Depreciation Expenses	70,583.21
12,245.65	Building Repair-Maintenance Expenses	12,245.65
16,507.95	Permanent Labor Force	11,912.14
3,834.16	Family Labor Force	2,766.73
635.22	Tax and Insurance	635.22
25,109.22	Fixed Capital Interest	34,390.56
7,467.99	General Management Costs (%3)	7,623.18
113,899.07	*Total Fixed Costs (B)*	*140,156.69*
362,831.98	*Total Production Costs (C) = (A+B)*	*394,262.73*
	Incomes	
338,323.08	Milk Value (D)	367,621.86
65,914.63	Productive Stock Value (E)	65,914.63
11,137.37	Farm Fertilizer Value (F)	11,137.37
44,184.73	Livestock Supports (G)	46,074.23
459,559.81	*Total Incomes (H) = (D + E + F + G)*	*490,748.09*
415,375.08	*Gross Production Value (I) = (D + E + F)*	*444,673.86*
166,442.17	*Gross Profit (J) = (I - A)*	*190,567.82*
52,543.10	*Net Profit (K) = (I - C)*	*50,411.13*
242,430.11	Milk Production Amount (kg) (L)	263,424.56
295,526.71	Milk Production Costs (M) =(C x %D/100)	325,945.85
0.39	Milk Sales Price ($/kg)	0.39
0.341	*Unit Milk Cost (N) = (M / L)*	*0.346*
0.290	*Unit Milk Cost by Livestock Supports (P) = (M - G) / (L)*	*0.297*

**Grey colored cells are positively affected values; Black colored cells are negatively affected values.*

ferences are presented in Figure 4. When we look at the graph given in dollars, it is seen that there is a greater difference in production costs, total income and gross profit in dairy farms with more animals in proportion to the size of the enterprises. However, the situation changes when net profit is taken into account. In the chart, the difference between the 10-60 head group and the 121 head and above group are very close to each other for net profit, while this difference is low and negative for the 61-120 head group.

When we look at the graph given as a percentage, we can talk about the opposite of the dollar graph. The percentage difference of the 10-60 head group with the fewest animals is much higher than the other groups. The percentage increase in gross profit and net profit values, espe-

Table 5 - CMS and RMS economic analysis results for 121 head and above dairy farm group.

CMS (121+ head)		*RMS (121+ head)*
$/ Year		*$/Year*
	Costs	
	Variable Costs	
196,092.18	Concentrate Feed	198,700.20
164,754.42	Roughage	166,945.65
10,249.25	Water-Salt-Vitamin	10,249.25
11,718.95	Electricity-Heating	16,015.12
13,472.28	Veterinary-Pharmaceutical-Vaccination	13,472.28
8,917.06	Artificial Insemination	8,917.06
6,414.18	Animal Insurance	6,414.18
13,035.67	Oil-Fuel- Maintenance	13,035.67
424,653.99	*Total Variable Costs (A)*	*433,749.41*
	Fixed Costs	
70,908.84	Depreciation Expenses	102,919.65
15,076.48	Building Repair-Maintenance Expenses	15,076.48
36,791.58	Permanent Labor Force	26,548.80
2,041.79	Family Labor Force	1,473.36
715.01	Tax and Insurance	715.01
36,539.95	Fixed Capital Interest	48,980.53
12,739.62	General Management Costs (%3)	13,012.48
174,813.27	*Total Fixed Costs (B)*	*208,726.32*
599,467.26	*Total Production Costs (C) = (A+B)*	*642,475.73*
	Incomes	
653,325.84	Milk Value (D)	709,903.86
106,789.86	Productive Stock Value (E)	106,789.86
18,332.62	Farm Fertilizer Value (F)	18,332.62
82,559.09	Livestock Supports (G)	86,041.57
861,007.41	*Total Incomes (H) = (D + E + F + G)*	*921,067.91*
778,448.32	*Gross Production Value (I) = (D + E + F)*	*835,026.34*
353,794.33	*Gross Profit (J) = (I - A)*	*401,276.92*
178,981.06	*Net Profit (K) = (I - C)*	*192,550.61*
446,815.21	Milk Production Amount (kg) (L)	485,509.41
503,112.98	Milk Production Costs (M) =(C x %D/100)	546,205.53
0.41	Milk Sales Price ($/kg)	0.41
0.315	*Unit Milk Cost (N) = (M / L)*	*0.314*
0.263	*Unit Milk Cost by Livestock Supports (P) = (M - G) / (L)*	*0.265*

**Grey colored cells are positively affected values; Black colored cells are negatively affected values.*

cially in the 10-60 head group as a result of the use of RMS, is much higher than other groups.

3.6. *Results of paired samples t-test*

It is investigated whether there is a significant difference between the CMS and RMS results of the Dairy farm groups and the effect size. The results of the paired samples t-test performed to determine the difference between the net profitability of CMS and RMS are given in Table 7.

As a result of the t-test, a significant difference ($t_{10\text{-}60}$ =-14.50, $p_{10\text{-}60}$ = .000; $t_{61\text{-}120}$ = 17.34, $p_{61\text{-}120}$ =. 000; t_{121+} = -8.03, p_{121+} =. 000) was observed between the average net profits of the current production ($\bar{X}_{CMS10\text{-}60}$ = 31,615.04; $\bar{X}_{CMS61\text{-}120}$ = 357,624.34; $\bar{X}_{CMS121+}$ = 890,481.49) and the average of the net profits after the economic simulation

Table 6 - Comparison of economic performance differences of dairy farm groups.

	10-60 head ($)	*10-60 head (%)*	*61-120 head ($)*	*61-120 head (%)*	*121 + head ($)*	*121 + head (%)*
Total Production Costs	5,727.05	5.97	31,430.75	8.66	43,008.47	7.17
Total Incomes	16,988.19	16.53	31,188.28	6.79	60,060.50	6.98
Gross Profit	14,844.64	48.47	24,125.65	14.49	47,482.59	13.42
Net Profit	10,134.46	355.40	-2,131.97	-4.06	13,569.55	7.58

model of the robotic milking system ($\bar{X}_{RMS10\text{-}60}$ = 86,878.12; $\bar{X}_{RMS61\text{-}120}$ = 539,328.29; $\bar{X}_{RMS121+}$ = 1,054,636.02) for all three groups. As a result of the test, the effect sizes of all groups ($d_{10\text{-}60}$ =1.48; $d_{61\text{-}120}$ = 2.78; d_{121+} = 2.23) were above 1 and this show that the difference is at a very large level.

4. Conclusions

In this study, RMS economic analysis results of dairy farm groups were created as a result of the simulation performed by combining real dairy farm economic analysis data and RMS assumptions. While the simulation results show that the use of RMS is a preferable investment that increases profitability for 10-60 head and 121 + head groups; It shows that it will be an investment that negatively affects profitability for the 61-120 head group.

As a result of the use of RMS in the study, it is seen that the net profit for the 10-60 head group increased at a very high rate, such as 355%, and turned from negative profitability to positive profitability. When the data is examined, it is seen that this increase is not due to the use of RMS alone. The most important factor affecting this increase is that most of the 10-60 head group enterprises sell uncooled raw milk. As a result of the use of the RMS system, these enterprises will sell the raw milk as chilled, and the increase in unit raw milk sales prices affects their revenues and therefore their net profits.

It is seen that it is not possible to cover the increased investment cost for the 61-120 head group as a result of the use of RMS with the income to be obtained with the current number of animals. According to the simulation result of this dairy farm group, the use of RMS will not be economically preferred. For 121 + head group, the use of RMS increases net profitability depending on the increase in milk yield. This shows that the RMS is economically preferable for the 121+ head group.

The paired samples t-test has shown that the net profit change that occurs as a result of the

Figure 4 - Economic performance difference graphs.

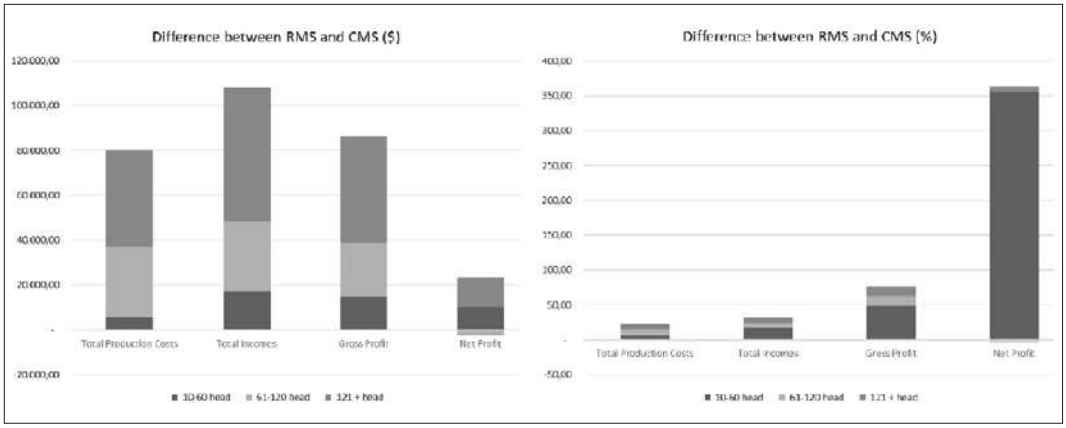


Table 7 - Paired samples t-test results for CMS and RMS.

Groups (heads)	*System*	*N*	*Mean*	*Std. Deviation*	*t*	*Sig.*
10-60	CMS	96	31.615,04	112.632,04	-14,50	.000
	RMS	96	86.878,12	134.716,59		
61-120	CMS	39	357.624,34	261.684,97	-17,34	.000
	RMS	39	539.328,29	288.935,99		
121+	CMS	13	890.481,49	473.741,65	-8,03	.000
	RMS	13	1.054.636,02	533.735,32		

dairy farm groups conversions from the CMS to the RMS is not a coincidence but is significant and the effect size of the change is very large. This shows that farmer's investment in this new technology will make a significant contribution to their profitability. But low enterprise income is a major barrier to enterprises access to technology (Ben Hassen and El Bilali, 2021; Yener Ögür, 2021). For this reason, businesses need to be supported economically in order to make RMS investments. The Eleventh Development Plan (2019-2023), prepared by the Presidency of the Republic of Turkey, presents priorities and policies on Digital Transformation and innovation in agriculture. Within the scope of these policies, economic support can be provided by the state for the dissemination of new technologies in agriculture.

Within the scope of the study, the simulation model was used by taking the average values of the data belonging to the dairy farm groups. A dairy farmer considering an RMS investment will be able to obtain a result specific to his farm if he combines the simulation model with his own economic analysis results. This simulation model created with this aspect can be used as an important tool for enterprises to decide on RMS investment.

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Le degré d'efficacité des contrats formels dans la nouvelle politique laitière algérienne

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Abstract

The new aspect of the dairy policy obliges dairies already registered with the State to offer producers and collectors of raw milk formal and written contracts which must, in practice, help resolve or limit the multiple market failures. This article will analyze exhaustively the nature of these formal contracts that bind dairies to their raw milk suppliers by using the tools of the theories of contracts and transaction costs. This review will shed light on contractual practices through a vertical coordination process of a dynamic sector propelled by the various supports and bonuses from the State. This case study is original insofar as the contractual relationship is imposed by the State as a sine qua non for obtaining these bonuses and subsidies. It is therefore not surprising that clauses are applied in incomplete and circumvented ways when relations become too unequal. Informal relations participate in finding solutions to the difficulties encountered in practice. These contracts are nonetheless tools for structuring and modernizing the milk sector.

Keywords: *Value chain, Vertical coordination, Formal contract, Dairy policy, Algeria.*

1. Introduction

Sous la contrainte des chocs externes, liée à la forte volatilité des cours mondiaux des principales matières premières agricoles, l'Etat adopte, à partir de 2009[1], une nouvelle politique laitière qui doit réduire les importations[2] massives de poudre de lait, pesant lourdement sur son budget, en développant durablement la production nationale de lait cru (Makhlouf et Montaigne, 2017). Pour atteindre ces objectifs, l'Etat a mis en place, outre le système incitatif, davantage revalorisé[3], de primes à la production et à la collecte du lait cru local, un dispositif de coordination verticale le long de la filière, basé principalement sur des contrats formels et obligatoires, entre les principaux acteurs de la filière laitière.

La présente étude examinera, de façon détaillée, les différents contrats formels qui lient les laiteries à leurs principaux fournisseurs de lait cru et analysera les conditions de leur élaboration ainsi que leur degré d'exécution sur le

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[1] Date de la mise en œuvre de la Politique Nationale de Renouveau Agricole et Rural (PNRAR).

[2] Les importations de poudre de lait (soit ~ 16% de la facture alimentaire en 2018) se sont accrues en volume entre 2010 et 2018 passant 298 631 tonnes à 443 676 tonnes (CNIS, 2020).

[3] Les primes de production et de collecte étaient respectivement de 04 DA/l et de 02 DA/l en 1996, de 05 DA/l et de 02 DA/l en 2001 et enfin revalorisé fortement à 12 DA/l et à 05 DA/l à partir de 2009 (Makhlouf *et al*., 2015a).

terrain. Cet examen apportera des éléments de réponse sur les pratiques contractuelles dans un processus de coordination verticale d'une filière en dynamique, propulsée par les différents soutiens et subventions de l'Etat.

Le niveau d'application des engagements contractuels de la part des co-contractants ainsi que la nature des sanctions encourues, en cas de non-respect des clauses des contrats, sont autant d'éléments qui vont nous renseigner sur le degré d'efficacité de ces contrats et leur impact sur la performance globale de la filière locale. Nous allons ainsi identifier les principales contraintes qui limitent l'amélioration de l'efficacité de la contractualisation entre les acteurs de base de la filière. Il sera question ensuite d'inventorier tous les différents services qu'apportent les laiteries à leurs éleveurs respectifs, apport qui déterminera la nature du contrat proposé par les laiteries et ses conséquences sur les transactions laitières. Le niveau d'organisation, la nature des soutiens et le niveau d'assistance des laiteries vis-à-vis de leurs éleveurs permettront également de mesurer le degré de participation et de convergence de ces laiteries dans le développement de la production laitière locale, développement qui reste l'objectif prioritaire de la politique laitière de l'Etat.

2. Le dispositif de coordination contractuelle mis en place dans la filière lait

Le nouveau mécanisme de gouvernance verticale adopté dans la nouvelle politique laitière depuis 2009, source de stabilité des transactions laitières, se matérialise par trois principaux contrats-types qui définissant les droits et les obligations des principaux acteurs de la filière lait.

Contrat ONIL-Laiterie : l'Etat instaure un partenariat sur la base d'une convention spécifique, entre l'Office National Interprofessionnel du Lait (ONIL)[4], en sa qualité d'instrument de régulation publique, et les laiteries conventionnées, en leur qualité d'opérateurs économiques privés pour le développement de la production laitière nationale, la collecte de lait et son incorporation dans les produits transformés de l'industrie laitière.

Selon Makhlouf *et al*. (2015a), l'une des clauses essentielles de ce contrat, porte sur l'acquisition par certaines laiteries d'un quota de poudre de lait, fixé annuellement, en fonction de leur capacité de production, à un prix subventionné[5]. En contrepartie, ces laiteries s'engagent à la transformation de la poudre de lait en lait pasteurisé partiellement écrémé (reconstitué), conditionné en sachets en polyéthylène d'un litre, dans les conditions d'hygiène requises et de le mettre à la disposition du consommateur, aux normes réglementaires (15 g de matière grasse /litre), et au prix administré[6] de 25 DA le litre. Actuellement, un grand nombre de laiteries « dites mixtes » (107 sur un total de 210 laiteries conventionnées) intègrent, comme l'atteste le Tableau 1, le dispositif d'intensification et de développement de la production laitière et procèdent à la collecte du lait cru local.

D'après Daoudi *et al.* (2017), ce programme semble donner des résultats satisfaisants, depuis son lancement en 2009, en termes d'adhésion des acteurs. Les subventions incitent les entreprises, habituellement tournées vers le marché international pour assurer leur approvisionnement en matière première, à collecter la production locale (197 laiteries sur un total de 210 laiteries conventionnées).

Pour les rendre éligibles aux différentes primes de l'Etat (soit de collecte pour les laiteries utilisant exclusivement du lait cru ou bien de collecte et d'intégration pour les laiteries mixtes), ces laiteries doivent obligatoirement faire des propositions de contrats formels aux éleveurs et aux collecteurs privés de leurs zones d'intervention.

[4] L'Office national interprofessionnel du lait est un Etablissement Public à caractère Industriel et Commercial (EPIC). Il a pour mission l'organisation, l'approvisionnement et la stabilité du marché national du lait pasteurisé élaboré à partir de la poudre de lait importée et subventionnée. En outre, l'office est chargé de gérer les différentes primes qu'accorde l'Etat, aux différents acteurs de base, dans sa politique de développement de la filière laitière.

[5] Depuis 2007, le prix de cession du kg de poudre de lait aux laiteries est fixé, indépendamment des fluctuations du marché international, à 159 DA, soit ~ 1 €/kg (Banque Algérie, 2020).

[6] Prix administré du lait standard LPS à 25 DA/l depuis 2001, soit ~ 0,16 €/l (Banque Algérie, 2020).

Tableau 1 - Typologie des laiteries conventionnées avec l'Office.

Matières premières utilisées	*Type de Produit*	*Nombre de Laiteries*	*Observation*
Lait de vache exclusivement	lait de vache en Sachet	68	Elles vendent du lait de consommation exclusivement à partir du lait de vache local collecté sans avoir à recourir à la poudre de lait subventionnée. Le prix de vente du lait de vache reste libre.
	Dérivés exclusivement	22	Elles sont intégrées dans le dispositif de développement de la production laitière nationale. Elles procèdent à la collecte du lait de vaches et elles le transforment exclusivement en produits dérivés. Ces laiteries ne bénéficient pas de primes d'intégration.
	Sous total	*90*	*Elles ne bénéficient pas de matières premières subventionnées*
Poudre de lait subventionnée et Lait de vache (Mixte)	lait en Sachet	107	Elles bénéficient des matières premières laitières subventionnées et participent à la collecte du lait de vache
Poudre de lait exclusivement	lait en Sachet	13	Elles sont intégrées exclusivement dans le dispositif de régulation du marché national du lait dont 11 laiteries du grand sud qui bénéficient de la poudre de lait sans obligation de collecter du lait cru.
	Sous total	*120*	*Elles fabriquent du lait pasteurisé vendu à un prix administré de 25 DA/litre*
	Total	*210*	*Nombre des laiteries conventionnées avec l'ONIL en activité*

Source: ONIL, 2020.

Contrat laiterie-éleveur : ce type de contrat concerne tous les éleveurs de bovins (et même de caprins) répondant à des conditions fixées par l'administration agricole (attestation d'éleveur et agrément sanitaire ou numéro d'identification du cheptel), sans limitation d'effectif de vaches laitières et ni de condition pour le foncier.

Ce contrat, comme le fait remarquer Makhlouf *et al*. (2015a), doit normalement préciser les engagements sur les volumes, la durée du contrat, les caractéristiques des produits à livrer, les critères et les modalités précises de détermination du prix, les modalités de paiement, de révision et de résiliation dudit contrat. En outre, les laiteries doivent, en fonction de leurs propres moyens, apporter leur contribution technique, matérielle et financière au niveau des exploitations afin de stimuler davantage la production laitière locale qui va améliorer, à son tour, l'approvisionnement régulier et durable en lait cru de ces unités. L'adhésion au dispositif contractuel conditionne l'accès des éleveurs à une prime de production de 14 DA/l. Grâce à ce dispositif, le nombre d'éleveurs sous contrat avec les laiteries a, selon Kalli *et al*. (2018), presque triplé entre 2009 et 2018 (de 13 726 à plus de 32 000 éleveurs).

Contrat « laiterie-collecteur » : la collecte peut être réalisée par des groupements d'éleveurs, des laiteries, des collecteurs privés et des centres de collecte agrées. Le contrat concernant les collecteurs ou les centres de collecte qui assurent le rôle d'interface entre les laiteries et les éleveurs, fixe les quantités de lait à livrer par jour, l'effectif d'éleveurs et de vaches laitières concernées, les critères de qualité et les modalités de paiement de l'éleveur. En outre, le collecteur s'assure de la qualité du lait à la ferme et le livre à la laiterie. La seule rémunération du collecteur, versée par l'ONIL (via les services agricoles), correspond à une prime de collecte de 5 DA/l de lait collecté et livré. La revalorisation de cette prime (de 02 à 05 DA/l) a contribué largement, selon Lazereg et Brabez (2020), à l'augmentation du nombre de collecteurs privés (de 659 en 2009 à 1721 collecteurs en 2016).

3. Revue de littérature

La coordination entre les agents économiques passe par la construction d'arrangements institutionnels, également appelés structures de gouvernance. Cette coordination prend trois formes : le marché, la forme hybride et la forme hiérarchisée avec un seul objectif qui est celui de réduire les coûts des transactions (Williamson, 1985).

Selon Royer et Gouin (2016), les produits agricoles ont toujours posé des problèmes de coordination et de contrôle à travers les différentes étapes de la chaîne d'approvisionnement, engendrant d'importants coûts de transaction, en raison de leur nature périssable[7], l'impact de leur qualité sur les consommateurs, leur approvisionnement fragmenté, leur vulnérabilité aux variations climatiques et aux épidémies de nature diverse.

Actuellement, sous les effets de la concentration, des nouveaux modes de consommation et des mutations technologiques, le secteur agroalimentaire entame à l'échelle mondiale un remarquable processus de transformation qui a accéléré le passage de marchés indépendants à des filières agroalimentaires beaucoup plus étroitement contrôlées (Vavra, 2009).

Très souvent, ces changements se sont accompagnés d'un recours accru à la contractualisation qui constitue, selon Bouamra-Mechemache *et al*. (2015), un outil de coordination, alternatif au marché spot, pouvant améliorer l'efficacité d'une chaîne d'approvisionnement.

L'analyse des relations verticales dans les filières agricoles, est un champ d'application par excellence du courant néo-institutionnaliste (Lazereg et Brabez, 2020). Selon la théorie de l'agence, les principales raisons de recourir aux contrats sont le transfert de risque (assurance) et l'alignement des incitations. En revanche, la théorie des coûts de transaction considère les contrats comme des dispositifs d'amélioration de l'efficience permettant de structurer les ajustements ex post et de décourager les efforts réduisant la rente et qui cherchent à influer sur la répartition des gains, notamment les négociations *ex post*, les problèmes de « *hold-up* », et les coûts de recherche et d'évaluation *ex ante*. Dans ce contexte, les contrats devraient être déterminés par : i. le besoin d'investissements spécifiques qui crée des interdépendances, de sorte que les partenaires cherchent des dispositifs de protection (ce qui devrait déterminer le type des contrats et leurs clauses) ; ii. la nécessité d'améliorer l'efficience de la chaîne d'approvisionnement en réduisant les coûts ; iii. la nécessité d'établir une coordination étroite dans un contexte où la qualité, la variété et l'innocuité des produits sont des aspects essentiels (Vavra, 2009).

Au regard de l'économie néo-institutionnelle, les contrats en agriculture témoignent d'une diversité de formes « hybrides » (Cook *et al*., 2008 cité dans Cholez *et al*., 2017). D'après Bignebat *et al.* (2017), deux types de contrats sont à distinguer en fonction de l'objet à coordonner : i. les contrats de production qui portent sur des schémas d'intégration ou de quasi-intégration de la production par les industries agroalimentaires et, ii. les contrats de commercialisation qui portent eux exclusivement sur la coordination des flux. Selon Cholez *et al.* (2017), ces formes de coordination permettent aux agents d'encadrer leurs transactions en combinant incitations financières, mise en commun de certaines ressources entre deux entités juridiquement autonomes et mécanismes internes de résolution des conflits.

Le recours à cette diversité contractuelle permettrait, en outre, aux entreprises de mieux maîtriser (quantitativement, qualitativement et dans le temps) l'approvisionnement en produits agricoles afin d'utiliser au mieux les capacités de transformation, en évitant les risques induits par un approvisionnement sur le marché au comptant et en réduisant les contraintes d'une production directe exclusive (Glover, 1984 ; Glover et Kusterer, 1990 ; Jaffee, 1994 ; Little et Watts, 1994 ; Key et Runsten, 1999 ; Eaton et Shepherd, 2002 cité dans Daoudi *et al*., 2017).

Cependant, la contractualisation peut se traduire par des coûts de transaction élevés lorsque l'entreprise contracte avec de nombreux petits producteurs et un risque de pratiques opportunistes de leur part : vente d'une partie de la production sur le marché parallèle (lorsqu'un mar-

[7] Voir Brousseau et Codron (1998) dans le cas des fruits et légumes.

ché local existe pour la production sous contrat), détournement d'intrants fournis par l'entreprise, fraude lors de la livraison du produit, non-respect de la quantité et de la qualité prévue. De leur côté, les agriculteurs sous contrat, notamment les plus petits, peuvent être victimes de l'inégalité des relations qui les lient à l'entreprise. Ces dernières peuvent utiliser cet avantage pour imposer leurs conditions, en particulier en l'absence « d'options de sortie » pour les producteurs.

Par ailleurs, même lorsque l'agriculture contractuelle présente un réel intérêt pour les producteurs impliqués, elle présente un risque d'exclusion des producteurs les moins bien dotés en facteurs, les plus pauvres (Carter et Mesbah, 1993 ; Key et Runsten, 1999 ; Dolan et Humphrey, 2000 ; Simmons, 2002 ; Singh, 2002 cité dans Daoudi *et al.*, 2017).

4. Matériel et méthodes

4.1. *Présentation de la zone d'étude*

L'étude a été conduite dans la région de Tizi-Ouzou située dans la partie nord du pays. Le choix de cette zone part du fait qu'elle recèle un potentiel productif bovin laitier important et dispose de l'un des plus importants réseaux de collecte de lait cru au niveau national. Ce dernier a connu un développement considérable (Tableau 2), prouvant ainsi l'essor de la filière locale, essor qui s'est traduit par l'émergence d'un grand nombre de nouveaux acteurs.

L'examen du Tableau 2, montre bien le poids relatif de l'industrie laitière et sa forte concentration au niveau local (25/107 laiteries au niveau national, soit 23%). L'arrivée de ces laiteries est indissociable du développement de la production laitière (5ème rang au niveau national) et de l'efficacité du réseau de collecte (taux de collecte moyen autour de 70%). Une première typologie de cette grappe d'industrie laitière fait ressortir deux principaux groupes selon l'origine de la matière première principale utilisée pour la fabrication des produits laitiers.

- *1eme groupe* : largement dominant (17/25, soit 68% du total), ce groupe est composé essentiellement de fromageries s'approvisionnant uniquement en lait cru local pour la fabrication de différentes gammes de produits laitiers ;
- *2eme groupe :* ce groupe *« dit mixte »* (8 laiteries soit 32% du total) intègre, en plus de la poudre de lait (prix subventionnée et/ou du marché), du lait cru dans son processus de production (surtout pour les différents fromages). La moitié de ce groupe, produisant du LPS, bénéficie, en fonction de ses capacités de production installées, d'un quota mensuel de poudre de lait subventionné par l'Etat.

Actuellement, notre zone d'étude dispose de 22 centres de collecte agréés (avec un agrément sanitaire). Ces derniers, véritables relais entre les producteurs et les industries laitières, permettent d'économiser les frais de transport du lait d'une part (minimisation des coûts de transaction) et d'améliorer sa conservation (démarche qualité, incertitude sur le produit).

En parallèle, le nombre de collecteurs indépendants (privés), signataires d'un contrat de livraison du lait cru, a était multiplié presque par 8, dans la région, passant de 26 à 173 collecteurs

Tableau 2 - Composition et évolution du réseau de collecte de lait cru au niveau de la wilaya.

Années	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2017**	*2018**	*2019**
Nombre de collecteurs privés	26	37	71	89	99	142	148	162	173
Nombre d'éleveurs sous contrat avec laiterie	1 919	3 262	3 568	4 124	4 200	4 590	3840	3500	3 667
Nombre de laiteries et fromageries	10	8	8	8	12	13	22	23	25
Nombre de centres de collecte de lait	17	18	18	19	19	19	20	21	22

Source : De 2009 à 2014 (Makhlouf, 2015b) ; 2017 à 2019* (DSA, 2020).*

entre 2009 et 2019, contribuant efficacement à la concentration d'une offre atomisée de lait cru et un approvisionnement régulier des laiteries. Enfin, le nombre d'éleveurs, rejoignant le nouveau dispositif laitier par la signature d'un contrat laitier avec les différentes laiteries, a plus que doublé entre 2009 et 2014, avant de voir ce nombre chuter progressivement ces dernières années du fait des épisodes de sècheresse récurrents, causant ainsi une envolée vertigineuse des prix de l'alimentation du bétail.

4.2. *Méthodologie*

Rappelons ici que notre objectif est de répondre à nos principales interrogations qui sont, en premier lieu, l'évaluation du degré d'efficacité des contrats laitiers formels adoptés, nécessitant en priorité une analyse fine du niveau d'exécution sur le terrain des engagements contractuels de la part des co-contractants et, en second lieu, d'identifier, qu'elles soient institutionnelles ou organisationnelles, les principales contraintes qui entravent et limitent durablement les avantages de la coordination verticale entre les acteurs de base de la filière locale.

Pour apporter des éléments de réponses à nos questions, nous avons entrepris au cours de ces dernières années, à chacune de nos sorties de terrain, des enquêtes directes, des entretiens structurés et semi-structurés et des observations directes, aux moyens de questionnaires, de guides d'entretiens et de fiches de collecte d'information. Ces informations concernent un ensemble d'acteurs de terrain identifiés et complètent une base de données[8] déjà exploitée dans des travaux de recherche antérieurs. Des monographies, touchant certaines laiteries, des centres de collecte et des collecteurs privés, ont sont venues affiner davantage les logiques de comportement de ces acteurs. L'analyse de cet ensemble visant les principaux acteurs de la filière sous contrat, nous permet de cerner les points saillants suivants :

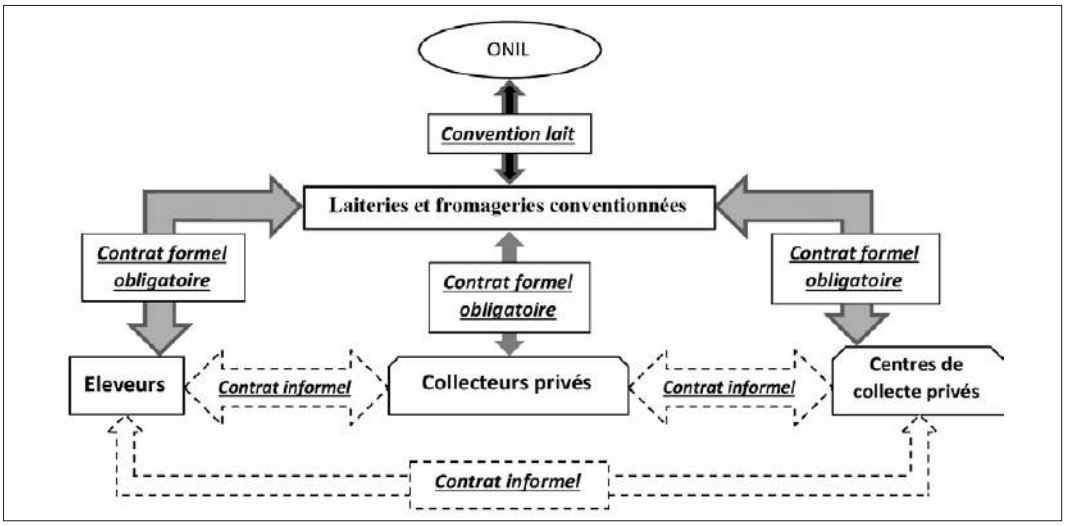
- les différentes clauses contractuelles qui lient les industriels–éleveurs, industriels-collecteurs et collecteurs-éleveurs de la filière locale et les conditions d'applicabilité de ce mode de coordination ;
- le pilotage de la filière par les transformateurs et leur degré d'implication contractuelle ;
- la perception des producteurs par rapport au processus de contractualisation et ses implications sur leur comportement stratégique ;
- les propositions des différents acteurs pour l'amélioration durable des engagements contractuels.

In fine, pour mesurer finement le degré d'exécution ou d'applicabilité, dans les conditions réelles du terrain, de l'ensemble des clauses contractuelles, composant initialement les différents contrats formels engagés entre les transformateurs et leurs principaux fournisseurs de lait cru, nous avons jugé pertinent de recourir à la grille proposée par Brousseau (1993), grille qui permet de repérer les différents éléments constitutifs d'un contrat. Pour cet auteur, ces contrats reposent sur sept clauses. Chaque clause peut être constituée de 2 à 4 modalités.

La coordination stratégique (clause A) met l'accent sur la fixation de l'objet de la transaction. Pour la coordination organisationnelle (clause B), il s'agit de savoir comment les agents s'organisent pour satisfaire les objectifs fixés précédemment. Quant à la coordination opérationnelle (clause C), elle concerne la date et le lieu de livraison ainsi que les opérations de service que les agents fournissent. Le système de garanties (clause D) et le mécanisme de punition (clause E), sont mis en place pour se protéger du comportement opportuniste. En réalité, le revenu de chaque co-contractant dépend du comportement de l'autre. Il s'agit donc de deux mécanismes garantissant le respect du contrat ou la réalisation des engagements. La clause F concerne la rémunération et l'assomption du risque. Il s'agit de connaître le montant de la commission et de savoir qui supporte les risques techniques ou ceux dus aux aléas du marché. Enfin, la durée du contrat (court ou long terme) est fixée par la clause G.

[8] Cette base de données a connu une forte variabilité au cours de ces dernières années. Actuellement, elle est composée d'une cinquantaine d'éleveurs, de 14 centres de collecte, de 35 collecteurs et enfin de 17 laiteries implantées dans la zone d'étude.

Figure 1 - Relations contractuelles entre les acteurs de base de la filière laitière locale.



Source : Makhlouf, 2015c.

5. Résultats et discussions

La mise en place de la nouvelle politique laitière a une incidence considérable sur la structuration de la filière laitière locale mais également sur les modes de coordination des échanges. Celle-ci évolue vers le rapprochement des acteurs de base en s'appuyant sur des contrats écrits et formels pour échanger un produit spécifique. En effet, le recours obligatoire à ce mode de coordination a sensiblement amélioré la stabilité transactionnelle au sein de la filière locale. Néanmoins, ces transactions reposent également sur des engagements contractuels informels entre les éleveurs, les éleveurs et les collecteurs privés et enfin les éleveurs et les centres de collecte privés (voir Figure 1). Ce système informel reste un véritable système d'organisation économique et sociale dans la mesure où il parvient à assurer une coordination conjointe au-delà du marché ponctuel, en recourant à des accords réciproques fondés sur la confiance et des relations contractuelles orales (Djermoun *et al*., 2014 in Msaddak *et al*., 2019).

L'attrait et la fidélité des éleveurs et des collecteurs vis-à-vis de certaines laiteries s'expliquent par le niveau de solvabilité de chaque laiterie, son respect des délais de paiement (y compris les primes) et le respect des différents engagements contractuels. Le prix du lait cru appliqué, la distance à parcourir et le degré de contrôle de la qualité (nombre de tests) sont autant de facteurs supplémentaires qui conditionnent le choix de la laiterie à approvisionner par les fournisseurs.

5.1. *La spécificité des transactions laitières*

Les transactions entre producteurs et industriels ont un fort degré de spécificité. La dégradation rapide du lait cru impose un fonctionnement en flux tendu des chaînes d'approvisionnement de l'unité de transformation et rend impossible la constitution de stocks de ce produit. Au niveau des exploitations, toute augmentation du cheptel se traduit par des risques supplémentaires en termes financier, alimentaire et sanitaire.

Une fois engagés dans la relation, les fournisseurs dépendent souvent de l'activité de transformation pour l'écoulement de leurs produits.

Compte tenu des coûts de transport du lait cru, les éleveurs de la région, en majorité de petite taille et très enclavés (Makhlouf et Montaigne, 2017) peuvent difficilement avoir d'autres moyens de livraison que ceux offerts par des laiteries dont certaines intègrent totalement l'opération de collecte du lait cru par leurs propres moyens (prime de collecte totale pour la laiterie). Parallèlement, les laiteries totalement dépendantes du lait cru sont dépendantes du maintien de l'élevage dans leur zone d'intervention et font face au risque de voir une

bonne partie des éleveurs abandonner leur activité pour d'autres plus rentables et moins risquées.

Compte tenu des spécificités et des incertitudes analysées ci-dessus, le contrat entre laiterie et producteur dépend d'un dispositif de coordination et de mécanismes incitatifs spécifiques. Pour maîtriser les incertitudes et les risques techniques que les caractéristiques de la matière première font peser sur l'activité de transformation, l'industriel est dans l'obligation de planifier ses approvisionnements en s'articulant davantage avec ses fournisseurs et en prévoyant une forme de coordination plus complexe que la simple transaction commerciale d'achat/vente. De plus, pour limiter l'opportunisme de ces fournisseurs, il doit mettre en place des dispositifs de surveillance et d'incitations spécifiques.

5.1.1. *Les dispositifs de contrôle*

Afin de prévenir les manifestations de l'opportunisme des contractants et de garantir l'exécution des contrats, les transformateurs ont aménagé des systèmes de surveillance qui consistent à mesurer la quantité et la qualité des lots livrés.

Certaines laiteries exigent de leurs chauffeurs - ramasseurs et des collecteurs privés, d'effectuer le test d'acidité sur le lait au niveau des fermes et ensuite de bien mesurer sa quantité car le lait se trouve souvent dans des bidons de contenance différente. Des tests supplémentaires sont encore réalisés au niveau des centres de collecte rattachés à une laiterie ou bien indépendants (privé). Enfin, des contrôles ultimes sont effectués directement au niveau de certaines laiteries sur les différents volumes de lait réceptionné (directement des éleveurs, des collecteurs et voire même des centres de collecte propres à laiterie). Ces livraisons peuvent être refusées et, le cas échéant, une rupture de contrat est envisageable.

5.1.2. *Les dispositifs d'incitation et de paiement des éleveurs*

Les mécanismes incitatifs ont pour objectif de pousser les acteurs à adopter le meilleur comportement possible. Le paiement s'effectue en fonction du volume de lait cru réceptionné par la laiterie et de sa qualité. Un système[9] de bonus/malus est appliqué par la majorité des laiteries pour inciter les éleveurs à offrir un lait de qualité supérieure. Ce système vise également à dissuader les éleveurs et les collecteurs fraudeurs (écrémage et mouillage du lait).

De son côté l'éleveur, subit aussi un risque inhérent à un autre type d'asymétrie informationnelle : le risque de sélection adverse. Comme l'éleveur ne connait pas précisément les conditions de marché en aval, il est soumis au comportement loyal (ou déloyal) du transformateur par rapport aux résultats des différentes analyses physico-chimiques et bactériologiques effectuées sur le lait, de la précision du jaugeage des volumes de lait qu'il livre quotidiennement et enfin de la méthode de calcul choisie par la laiterie pour le rémunérer.

5.2. *Les transactions bilatérales*

5.2.1. *Eleveur – laiterie*

Les transactions bilatérales de la collecte du lait cru, entre les éleveurs et les laiteries, passent par des accords entre les éleveurs et éleveurs-collecteurs ou entre les éleveurs et les collecteurs indépendants pour le transport et la livraison du lait cru. La rémunération de ces collecteurs n'est pas à la charge de l'éleveur. Elle est garantie totalement par l'Etat qui accorde à ces collecteurs privés, via tout d'abord les laiteries et maintenant les services agricoles, une prime de collecte de 5 DA/l ramassé et livré aux transformateurs.

Des accords souvent informels mais assez crédibles sont engagés à ce niveau entre ces collecteurs privés et les éleveurs qui sont surtout éloignés des centres urbains, enclavés et démunis de moyens de transport adaptés. Les liens familiaux ou ethniques, la réputation et surtout la confiance sont les déterminants de base des relations qui lient ces éleveurs et les collecteurs privés. Cette confiance est basée non seulement

[9] Un bonus de 0,50 DA/gr est appliquée pour un lait cru titrant une teneur en matière grasse au-dessus de 34 gr/l et plafonnée à 38 gr/l. Une réfaction de 0,50 DA/gr est appliquée pour un litre de lait titrant une teneur en matière grasse en dessous de 34 gr/l. Les autres bonifications (prime à la réfrigération, prime de matière protéique…) ne sont appliquées que par deux laiteries.

sur la réputation acquise suite à des transactions répétées, mais également à travers les relations non marchandes entretenues avec les éleveurs (règlement des conflits entre éleveurs et éleveurs - collecteurs, avances numéraires, achats divers en ville…). Tout un système d'entraide, d'échange d'informations, et voire même de solidarité, s'installe entre ces acteurs et renforce ainsi durablement leurs relations.

5.2.2. *Collecteur privé – laiterie*

Les collecteurs, prestataires de services, assument seulement une fonction d'intermédiation entre les éleveurs, moins préoccupés par la livraison du lait (délégation de responsabilité sur le produit), et les industries laitières qui se déchargent d'une tâche contraignante ce qui leur permet, par la même occasion, de standardiser et normaliser les coûts hétérogènes de la collecte du lait cru.

Les liens privilégiés avec ces collecteurs donnent des avantages informationnels que les laiteries exploitent pour une meilleure maitrise des incertitudes sur les quantités et la qualité du lait de chaque éleveur de la région.

Ils sont considérés aussi comme les seuls « porte-parole » des éleveurs vis-à-vis de leur laiterie car ces collecteurs sont capables de négocier des aides et des moyens pour leurs éleveurs qui en expriment le besoin. Enfin, ces collecteurs ne participent pas aux échanges laitiers et de plus, leur rémunération est fixe et garantie totalement par l'Etat.

5.3. *Les transactions liées : très peu de laiteries engagées*

Pour consolider leurs réseaux de collecte et garantir la stabilité de leur approvisionnement en lait cru, plusieurs contrats avec fourniture de services sont proposés par certaines laiteries à des éleveurs considérés comme les plus performants dans leur zone d'intervention.

Différents types de crédits[10] (remboursement souvent en équivalent lait sur une période de 10 mois et sans intérêt), ainsi que des cuves de stockage de lait de 500 à 1 000 litres et enfin différents intrants à des prix préférentiels (aliments du bétail[11], poudre de lait pour veaux, bidons en inox…), sont accordés par un très petit nombre de laiteries en fonction de leur degré de dépendance vis-à-vis du lait cru pour la fabrication de produits laitiers nécessitant à la base du lait frais. En contrepartie de ces aides, les laiteries confisquent, à leur niveau, le cachet personnel de l'éleveur pour que ce dernier ne puisse rompre son contrat tant que sa situation n'est pas totalement assainie vis-à-vis de sa laiterie.

5.4. *Analyse du degré d'exécution et d'applicabilité des relations contractuelles entre l'industrie laitière et ses fournisseurs de lait cru*

En confrontant et en comparant toutes les clauses qui figurent dans les contrats signés entre les laiteries et leurs fournisseurs de lait cru aux différents résultats de nos enquêtes de terrain, basées essentiellement sur des observations directes et récurrentes sur des pratiques quotidiennes de transactions laitières entre acteurs au niveau des étables, des centres de collecte et des laiteries, il nous a été possible de vérifier, clause par clause synthétisées dans les deux tableaux suivants, leur degré d'exécution et/ou d'applicabilité dans les conditions réelles de terrain de la zone d'étude.

A la lumière des tableaux ci-dessus, il ressort que la majorité des clauses des contrats examinés sont souvent mal ou partiellement appliquées par les acteurs de base de la filière. A l'exception des systèmes de contrôle de la quantité et de la qualité du lait cru mis en place par les laiteries, ces dernières n'appliquent aucun système de surveillance et de suivi des conditions de la production au niveau des étables et des conditions de transport du lait de la part des collecteurs. Ces laiteries n'apportent aucune assistance technique à leurs fournisseurs, bien que celle-ci soit mentionnée dans le contrat initial.

La gestion et l'affectation des primes de produc-

[10] Ces crédits sont destinés normalement à l'achat de nouvelles vaches laitières, d'équipements et de l'aliment du bétail. Ces crédits sont souvent déviés de leur vocation initiale par les éleveurs (construction, fête, etc.).

[11] Plus de 20% de réduction par rapport au prix du marché. La laiterie réalise un achat groupé aux noms de ses éleveurs sous contrat.

Tableau 3 - Analyse des principales clauses du contrat formel liant les laiteries aux éleveurs.

Clauses		*Clause initiale dans le contrat*	*Ecarts constatés dans l'application de la clause*	*Nature du contrat*
Clauses A, B et C	*Caractéristique du lait*	- Lait tirant 34 grammes de matière grasse, non mouillé ni écrémé - Non mélangé avec le colostrum et non issu de vaches malades ou traitées aux antibiotiques - Réfrigéré à une température de 4° à 8°C ; - Ne contenant pas d'impuretés physiques, ni être coloré, ni avoir de mauvaise odeur ; - De densité à 20° C, comprise entre 1028 et 1033 - Non acide au moment de l'enlèvement	- Absence de contrôles inopinés des techniciens des laiteries au niveau des étables - Faibles moyens de contrôle chez les collecteurs - Cas de mouillage assez fréquent - Acidité et température rarement respectée surtout en été	*Autorité centralisée (hiérarchique)* : La laiterie a un pouvoir discrétionnaire sur les caractéristiques du lait *Autorité décentralisée* : les quantités de lait produites et livrés par les éleveurs ne peuvent être maitrisées (l'éleveur peut aussi modifier son système de production)
	Quantité	- Evaluée en fonction des vaches laitières déclarées par l'éleveur - Exclusivité et intégralité - Fournir à la laiterie, exclusivement du lait cru frais de vache avec les spécifications conformes à la législation en vigueur	- Aucune limite de la quantité de lait à livrer au cours de l'année - L'éleveur reste le seul arbitre de la répartition de sa production laitière (autoconsommation, alimentation du cheptel, vente directe, crémerie) - Apport du lait supplémentaire de certains éleveurs n'ayant pas d'agrément ou d'attestation d'éleveur (avec partage des primes de l'Etat) - Aucune limite de la quantité de lait à la réception (sous réserve du respect de toutes les qualités physicochimiques) - Problème de jaugeage du lait à tous les niveaux	
	Heure et lieu de ramassage	Chaque matin au niveau de l'exploitation	- En fonction de la disponibilité et du planning du collecteur - Le ramassage peut se faire à des endroits différents (sur la route du collecteur, le commerçant du village…) et à des heures différentes (le soir ou la nuit)	*Routine* : Opération de collecte routinière et adaptative
	Fourniture de services	En fonction des moyens disponibles, accompagner l'éleveur pour améliorer les conditions d'élevage et augmenter les quantités de lait en apportant une assistance technique multiforme	- Elle concerne uniquement certaines laiteries fortement dépendantes du lait cru - Les services fournis par les laiteries ne sont pas assez diversifiés - Ils ne touchent pas un grand nombre d'éleveurs (hautement sélectif)	*Otage unilatéral* : la laiterie confisque le cachet de l'éleveur
Clauses D et E		La laiterie se réserve le droit d'effectuer des contrôles inopinés au niveau des élevages	- Aucun contrôle n'est effectué directement par les laiteries au niveau des étables. - Contrôle uniquement de l'acidité du lait, par le biais du collecteur (privé ou autres), au moment du ramassage du lait à la ferme	*L'autorité centralisée (hiérarchique)* : contrôles multiples de la qualité du lait (à la ferme, au centre et à laiterie)
Clause F	*Prix du lait (DA/litre)*	- Prix unique pour tout type de lait de vache - Le prix est fixé pour toute l'année	- Prix non négocié. Il est fixé unilatéralement par la laiterie. - Prix ajusté sur les cours du marché mondial et non sur les coûts de production - Aucune possibilité de renégocier le prix par l'éleveur. Il est « *preneur* » de prix - Certaines laiteries modifient le prix en fonction des saisons, sans aucun préavis et accord des éleveurs - Le prix réel appliqué est souvent inférieur à celui affiché (moins les pénalités liées à la qualité du lait)	*L'autorité centralisée (hiérarchique)* : la laiterie a un pouvoir discrétionnaire sur le montant du prix du lait cru, les primes de qualité et aussi du délai de paiement - Rémunération proportionnelle à l'effort du producteur
	Primes de qualité	- Système bonus-malus pour la M.G. fixé ex ante. Il concerne toutes les laiteries - Autres bonifications : prime de matière protéique, germes…)	- Le plus souvent, il s'agit uniquement de la prime de M.G. - Aucun moyen pour l'éleveur de vérifier les résultats. Ils sont affichés par la laiterie mensuellement sur le bulletin de paie	
	Délai de paiement	- A régler, sur la base des factures, dans un délai de 15 jours, le prix d'achat du lait cru et la subvention - A verser les primes dans les mêmes délais - Paiement par chèque bancaire ou par virement auprès de la BADR	- Toutes les laiteries s'accordent sur un paiement différé et mensuel. - Plusieurs mois de retard sont observés pour le versement de la prime de production de l'Etat. - La laiterie peut exercer un pouvoir (ou du chantage) de rétention des primes.	
Clause G	*Durée du contrat Reconduction*	- Effet à partir de la date de signature - Durée égale à 12 mois à partir de la date de signature - Reconduction tacite	- La durée est rarement respectée - Sans aucune possibilité de négocier une des clauses	Court terme avec possibilité de sortie de la relation
Litige et conflit		- Règlement à l'amiable	Aucune poursuite judiciaire de la part des acteurs (lenteur judicaire et coût excessif dissuadent les acteurs)	*Décentralisé*

Source : De l'auteur.

Tableau 4 - Analyse des principales clauses du contrat formel liant les laiteries aux collecteurs privés.

Clauses		*Clause initiale dans le contrat*	*Ecarts constatés dans l'application de la clause*	*Nature du contrat*
Clauses A, B et C	*Caractéristique du lait*	- Elles sont identiques à celles appliquées à l'éleveur - Les résultats d'analyses feront l'objet de communication officielle à l'attention du collecteur et aux producteurs	- Les collecteurs sont parfois enclins à la fraude (mouillage du lait, lait acide…) et à la recherche des laiteries moins exigeantes dans le contrôle de la qualité du lait. - La plupart des collecteurs privés sont en contact permanent avec les gérants des crèmeries (en cas de refus du lait par la laiterie) - Les résultats des analyses ne sont jamais remis en cause par les collecteurs par manque d'expertise (connaissances) et de moyens de vérification.	*Autorité centralisée (hiérarchique)* : La laiterie a un pouvoir discrétionnaire sur les caractéristiques du lait. *Autorité décentralisée* : la laiterie et le collecteur ne peuvent arrêter la quantité journalière de lait cru à livrer
	Quantité	- Engagement à livrer de manière exclusive l'intégralité du lait cru à la laiterie - Les quantités sont établies sur la base d'un cheptel de vaches laitières appartenant à un ensemble de producteurs - Le collecteur s'engage à fournir à la laiterie exclusivement du lait cru de vache avec les spécifications conformes à la législation en vigueur - La laiterie s'engage à réceptionner l'intégralité du lait fourni par le collecteur	- Aucune mesure et contrôle ne peut contraindre le collecteur à ne pas livrer une partie du lait vers à autre circuit (crèmerie) - Les quantités livrées quotidiennement varient fortement. Elles sont rarement identiques à celles déclarées au moment de la signature du contrat - Les collecteurs subissent souvent des pertes lors du jaugeage du lait cru soit au niveau des centres de collecte, soit au niveau des laiteries (absence d'équipements performants et bien étalonnés)	
	Heure et lieu de livraison du lait	- Normalement tous les matins avant 10 h 00 Soit au niveau des centres de collecte de la laiterie ou bien directement à la laiterie	- Heures de livraison rarement respectées : les livraisons se font à longueur de la journée et même pendant la nuit - Le montant de la prime et la distance kilométrique orientent le choix du lieu de livraison du lait cru des collecteurs	*Routine* : lieu de livraison désigné *Autorité décentralisée* : adaptation du temps de la livraison en fonction des saisons
	Fourniture de services	Accompagner le collecteur pour améliorer les conditions de collecte et augmenter les quantités de lait cru en apportant une assistance technique multiforme	Ni assistances et ni aides sont apportées aux collecteurs par les laiteries	*Pas d'otage*
Clauses D et E		Actifs non mentionnés dans le contrat des deux parties	- Les collecteurs privés sont propriétaires de leurs matériels de transport. Ils assument la totalité de l'entretien du matériel - Pas de mécanismes de surveillance du travail du collecteur et absence de mesures coercitives	Aucun système de garantie des actifs Autocontrôle des flux laitiers par la laiterie
Clause F	*Prime de collecte (DA/litre)*	Le montant de la prime de collecte est réglé sur la base des bons quantitatifs de réception (en 3 exemplaires) dument signés par l'éleveur et le collecteur d'une part et le collecteur – laiterie d'autre part	- Les laiteries ont un pouvoir de gestion de la prime des collecteurs privés. Elles communiquent mensuellement, à l'ONIL, les volumes de lait ramassé par chaque collecteur - Les collecteurs sont parfois victimes d'un *holdup* de leur prime de collecte versée par l'Etat de la part de certaines laiteries qui ne versent pas la totalité de cette dernière - Aucune laiterie n'accorde de prime spécifique pour le collecteur privé soit pour augmenter les volumes, soit pour rechercher un lait de meilleures qualités	*L'autorité centralisée (hiérarchique)* : la laiterie a un pouvoir discrétionnaire sur le calcul du montant global de la prime du collecteur et du délai de payement - Rémunération proportionnelle à l'effort du collecteur
	Délai de paiement	- Le paiement se fera par virement ou par chèque bancaire BADR sur la base du total des volumes collectés établis par les bons de collecte - Le délai de paiement n'est pas explicité	Généralement, les laiteries pratiquent un paiement différé et mensuel	
Clause G	*Durée du contrat*	- Elle est normalement annuelle - La convention entre en vigueur dès sa signature	- Les collecteurs multiplient les signatures de contrats avec plusieurs laiteries à la fois - Parfois la durée du contrat ne dépasse pas un mois	Court terme avec facilité de sortie de la relation
	Reconduction	Tacite reconduction	Aucune renégociation n'est possible	
Litige et conflit		Tout litige ou différend pouvant survenir, entre les deux parties, lors de l'exécution de la présente convention sera soumis au règlement à l'amiable	- Forte taux de résiliation des contrats de la part des collecteurs (sans préavis et motivation)	*Décentralisé*

Source : De l'auteur.

tion et de collecte, octroyées par l'Etat, pour les fournisseurs de lait cru sont confiées à ces laiteries ce qui leur confèrent un pouvoir supplémentaire sur les éleveurs et les collecteurs. Enfin, le pouvoir des laiteries se manifeste encore par la confiscation des cachets et des griffes personnelles des éleveurs (otage), confiscation qui contraint les éleveurs à subir parfois les comportements opportunistes de ces laiteries (changements de prix, refus du lait, calcul opaque des factures…). Ces laiteries ne peuvent être sanctionnées, à leur tour, sur des défaillances bien observées, comme les retards dans le ramassage du lait cru, l'approvisionnement irréguliers en intrants des producteurs et du paiement tardif des primes. Toutefois, ces contrats restent en faveur des laiteries qui détiennent des pouvoirs de marché supplémentaires en matière de fixation de prix du lait cru, du montant des primes et des sanctions liées à la qualité du lait et enfin du mode de paiement des fournisseurs.

Le rythme de rupture des contrats, basés seulement sur une coordination par les prix, entre les acteurs de base est assez élevé dans la zone d'étude. Néanmoins, ces fréquentes ruptures permettent surtout aux éleveurs et collecteurs de sortir de la transaction sans aucune contrainte ou sanction de la part des laiteries. En ce qui concerne les contrats avec fourniture d'intrants (voire d'actifs productifs), bien qu'ils soient faiblement proposés par les laiteries, ils affichent, au contraire, une meilleure stabilité contractuelle et renforcent la coordination au sein de la filière locale.

6. Conclusion

Le recours aux contrats formels, entre les laiteries et leurs fournisseurs, est devenu le mode obligatoire de coordination verticale dans les transactions laitières. Bien qu'il soit relativement récent, ce nouveau mécanisme institutionnel a contribué largement à réduire les comportements opportunistes des co-contractants et améliorer le processus d'échange en minimisant certains coûts de transaction relatifs aux moyens de transport du lait (camion de grand tonnage), de stockage et de refroidissement (réduction des pertes) et enfin de contrôle de la qualité du lait cru (risque de transformation et de marché).

Compte tenu de leur faible pouvoir de négociation et d'organisation, les fournisseurs de lait cru, attirés essentiellement par les primes de l'Etat, acceptent cependant la signature (« *signature à l'aveugle* ») des contrats (« à prendre ou à laisser ») largement en faveur des laiteries. De leur côté, ces dernières, n'accordent que peu de contrats spécifiques aux éleveurs, au risque élevé du non-remboursement des prêts financiers de la grande majorité de petits éleveurs et du caractère aléatoire et non durable de leur activité. Cet état de fait accentue l'exclusion d'un grand nombre de petits éleveurs d'un accès aux intrants agricoles et aux crédits.

En outre, l'absence de mécanismes d'*enforcement* publics et privés dans la conception et l'exécution de ces contrats fragilise la crédibilité des engagements contractuels. Cet état de fait se traduit par un fort taux de rupture des contrats au cours de leur exécution, rupture qui affecte négativement la stabilité transactionnelle au sein de la filière.

Enfin, la faiblesse institutionnelle constatée dans notre zone d'étude, c'est-à-dire une absence presque totale de groupements laitiers, d'associations d'éleveurs et de collecteurs, de coopératives agricoles ou laitières, ont des répercussions négatives dans l'organisation de la filière et affaiblissent le poids des éleveurs dans les négociations pour des contrats moins inégaux. Le déséquilibre de la filière locale, entre un aval plus concentré et bien informé et un amont dispersé et mal organisé, risque d'affaiblir l'effet de tous les efforts consentis, publics et privés, pour améliorer durablement la performance globale de la filière.

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Comment on Book *"Empowering Knowledge and Innovation. Challenges for the Arab Countries"*

by Omar Bizri & Mouin Hamze

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This is a rather unique book in more ways than one. For, on the one hand it updates so much information regarding scientific, research, technological development and innovation institutions and their activities in the Arab countries, which, incidentally, lag behind many other countries with similar income levels in terms of research publications and industrial patents. However, on the other hand, and unlike so many other books of its genre, it lends a good deal of attention to crucial issues that impede the region's progress in various domains of science technology and innovation, including the need to invigorate higher education and improve gender parity within concerned institutions and policy making bodies.

Having established the policy groundwork upon which scientific, technological and innovation activities are based, the book delves into detailed analysis they have undertaken with particular attention to emerging areas, including artificial intelligence, new materials, biotechnology and genetic engineering.

At the very outset, the book highlights the importance of inclusive and sustainable socioeconomic development, which requires the adoption of sound policies all around, with particular attention to science, technology and innovation as well as the achievement of basic needs for all citizens with water and food security at the very forefront.

As to food security the book's authors estimate that the Arab food gap expanded from $18 billion in 2005 to about $29 billion in 2010 and $34 billion in 2014. This is due to factors that include population growth estimated at around 1.92% per year against 1.11% for the world at large. Additionally, the Arab countries face continuous deterioration in natural resources, with frequent droughts, rising temperatures, and seawater infiltration of groundwater systems. Political turmoil and civil strife in many Arab countries over the past ten

years and the resulting rural migration into urban areas are also considered as contributing to diminished food security.

With regard to water security, they indicate that the average annual per capita freshwater supply in 22 Arab countries declined over the past ten years, from around 990 to less than 800 cubic meters, which incidentally is about one tenth of the world's average. If Mauritania, Iraq, Sudan and Lebanon are excluded, the average annual per capita freshwater rate drops to less than 500 cubic meters per year, and in 9 countries it is now below 200 cubic meters, which means that about 40% of the Arab population already lives in conditions of absolute water poverty.

The book rightly acknowledges that recent years witnessed the launch of initiatives at the regional and local levels aimed at improving water availability for a variety of uses. An Arab Ministerial Council for Water established by the League of Arab States in 2008 issuing a Water Security Strategy for the Arab Region covering the years 2010-2030. Additionally, a unified water strategy was launched by the GCC covering the years 2016-2035. However, they also remark that to achieve lasting water security would require urgent and comprehensive interventions through national water strategies and vigorous regional cooperation targeting the acquisition of related scientific and technological knowledge as well as effective tools. Only then would it be possible to attain integrated resource management as well as the adoption of rational groundwater extraction, wastewater management and improved irrigation systems within the agricultural sector.

Education in the Arab countries

The book takes a look at education in the Arab countries and arrives at the conclusion that these countries are outperformed by many others around the world and that there is a strong need to reform and improve the quality of education in general and that regarding earlier stages of education, in particular. Thus, the authors quote findings of the 2018 exercise conducted by the Organisation for Economic Cooperation and Development (OECD) aimed at examining and ranking educational performance across several countries around the world, namely, the Programme for International Student's Assessment (PISA). The fact that according to this exercise six Arab countries covered, namely Jordan, Lebanon, Morocco, Qatar, Saudi Arabia and the United Arab Emirates, generally known for relatively well-developed educational systems ranked below average scores for OECD countries as well as their closest neighbours, namely, Cyprus, Israel, Turkey and Malta for reading, science and maths.

With special reference to higher education, the authors underline the fact that the Arab region, like so many others, witnessed a deluge of private higher educational establishments over the past two decades. In many ways, and particularly with regard to the proliferation of profit-seeking institutions of higher education, an issue facing many Arab countries now is how to ascertain that private ventures maintain standards that ensure quality outcomes, furthering moves towards inclusive and sustainable development. It makes sense that only limited progress may be made by higher educational systems, when previous educational stages suffer serious discrepancies.

Overall, many Arab countries suffer a lack of educational opportunities within their higher education systems, while some continue to witness lack of demand for higher education in the first place. Reasons for this latter observation is inadequate enrolment

in secondary education and the narrow prospects that secondary education offers its entrants, compared to developed and some developing countries. Available data indicate a disruption in the distribution of students and graduates across various specializations, reaching critical proportions in disciplines that are intended to train educators in general, which threatens even further deterioration in the quality of within various stages education. The same is true in view of the small number of specialists holding a PhD in various fields, while it is on their shoulders that the burden for enhancing the quality of education and research activities often rests.

The authors point out that, it would simply be impossible to overcome the obstacles facing inclusive and sustainable development, which requires the generation and adaptation of knowledge in a wide spectrum of specialisations based on graduate programs that lack meaningful research content. The authors furthermore pose the goal that enrolment rates for postgraduate studies that include conducting scientific research within disciplines linked to attaining sustainable development goals should always exceed 20% of the total of the population of higher education students. Additionally, realising knowledge-based economies requires critical masses of higher competencies in all fields of science and technology, with particular accent on specialists in branches of information and communications technologies. The percentage of PhD holders in many developed countries represents an average of 1.3% of all age groups, while enrolment rates in all stages of higher education exceed 50%, around 10% of whom are postgraduate, with at least 2-3% doctoral candidates, actively engaged in basic and applied research within various branches of knowledge. On that basis, the authors call upon policy makers in the Arab countries to attain similar standards in order to effectively attain their sustainable goals and create the knowledge economies and societies they all seem anxious to achieve.

Human and financial resources dedicated to research and development activities

In relation to human and financial resources dedicated to R&D activities in the Arab countries, the book underscores the fact that both these resources are generally below the world's average. Several tables with most recent figures clearly indicate that resources dedicated to R&D activities in the Arab countries fall below what some of their closest neighbours, namely Cyprus, Iran, Israel, Malta and Turkey have managed to dedicate over the recent past. Thus, the average number of researchers per million of the population within the Arab countries is around 770, while the corresponding figure for their five closest neighbouring countries, namely Cyprus, Iran, Israel, Malta and Turkey, exceeds 2,700, per million. In effect, the Arab countries' average is a little over half the world's average, which amounts to around 1,480 per million. The proportion of human resources dedicated to R&D in some Arab countries with substantial incomes, such as Oman and Iraq, falls much lower, down to 16 and 7%, respectively, of the world's average. An even more negative picture is observed in relation to numbers of technicians per million of the population in the Arab countries, with the Arab average close to one fifth of their abovementioned neighbours' average, and around 12% of the corresponding figure for the OECD countries.

With regard to funding R&D, and despite increased R&D spending by several Arab countries, average spending by the entire group of Arab countries taken altogether is put at 0.46% of their GDP values. This is considerably less than what is allocated by their clos-

est neighbours, which is estimated at around 1.4% of GDP. Additionally, while no recent figures are available for R&D expenditure for the entire world or specific country groups, figures going back to the period 2005-2014 put average R&D spending for the entire world at 2 of their collective GDP values.

Government funding accounts for an average of around 60% of R&D expenditure in the Arab countries. However, wide variation in such spending is observed between one country and another. Thus, public resources constitute nearly 100% in some countries, such as Iraq, while they go as low as 25% in the case of Morocco, for instance. Higher education institutions and business enterprises provide comparable but rather small average percentages of R&D expenditure in the Arab countries taken altogether.

In relation to research output, the book finds that both the volume and quality of research publications by the Arab countries as monitored by a specialised database were inferior to three of their closest neighbours, namely Iran, Israel and Turkey. Thus, while the Arab countries' rankings fell below that of Egypt's, which significantly ranked 39th worldwide, those of their three neighbours exceeded the 25th rank.

With regard to promoting innovation in general, the book relates that Arab strategies aimed at promoting innovation in enterprises as well as in other domains appear to lack focus on tackling some of the most acute development challenges, such as creation of widespread employment and poverty reduction. Indeed, several initiatives intended to promote innovation appear to offer opportunities for multinational technology firms to establish national and regional offices, with benefits channelled towards elite segments of society. Little is done in order to resolve long-standing problems facing sectors in dire need for innovative inputs, including agriculture, which employs the vast majority of impoverished populations in Arab countries such as Iraq, Sudan, Morocco, among others.

Promoting a science-friendly culture in the Arab countries

The book is one of very few that seems to have taken active interest in a report published by the Wellcome Foundation in 2018, intended to underscore the need to pay greater attention to creating a culture conducive to science, technology and innovation. The Wellcome Foundation's report included the results of an opinion survey aimed at measuring the confidence that populations in quite a few countries had in science and scientists. The report also attempted to gauge scientific knowledge possessed by respondents as well as their position when contradictions arise between religious beliefs and scientific findings. The results of the survey present a rather unflattering view of scientific culture in the Arab countries. Thus, smaller percentages of respondents from the Arab countries appeared to know much about science, or attempt to gain scientific information. Smaller percentages of respondents had trust in scientists or thought that scientists benefited them. Additionally, some stark differences of opinion were manifested with regard to possible contradictions between religious beliefs and scientific knowledge. Incidentally, the latter issue was not presented within opinion surveys undertaken in all of the Gulf Arab countries, with the exception of the United Arab Emirates.

With the need for promoting a science-friendly culture in mind the authors call for more effective roles by the media in general and that disseminated by science and technology institutions in particular. Both the public and specialised media will have to exercise roles

on a number of fronts, uppermost among which is the need to highlight and investigate issues relevant to human development that are directly linked to scientific and technological inputs as well as support endogenous scientific research and technological activities as well as promoting STI cooperation, both regionally and internationally.

Among issues that would drastically help in promoting a viable science-friendly culture within Arab societies, the authors underscore the importance of using the Arabic language in educating youth in various scientific domains while improving their skills in languages that constitute main vehicles for the exchange of scientific and technological information. With this in mind, digital media are expected to play prominent roles, especially is guided by astute initiatives that guard linguistic values while disseminating reliable and useful knowledge.

Gender equality

No less important for promoting better research standards in disseminating a scientific culture and moving towards knowledge societies are issues linked to women's participation in the creation and implementation of scientific and technological knowledge and stimulating innovation. This as the authors state is especially important in societies where females have suffered marginalization through the ages, while they have in several Arab countries assumed notable improvements in relation to enrolment in higher education.

As the authors emphasise, formulating and implementing regional and national strategy to enhance women's participation in scientific innovative and technological projects, and to promote fresh thinking with regard to attaining inclusive and sustainable goals.

In order to achieve tangible results within a reasonable length of time, the book calls for changing established norms with regard to women's participation in scientific, research, technological advancement and higher education must begin with reconstructing prevailing stereotypes concerning females and their roles within society. Moreover, while changing established norms may not take place overnight, allowing current patterns of discrimination against women occupying top positions in academic as well as research establishments to continue unabated would undermine efforts aimed at achieving tangible sustainable development goals.

Promoting Arab and international cooperation

The book calls for intensive cooperation between higher education policy-makers and practitioners in the Arab countries as an urgent necessity. Exchanging experiences may constitute one aspect of such cooperation while sharing resources and expertise would be another area of immense promise.

Additionally, the book's authors adopt views that strongly favour continued and improved cooperation between Arab universities and their counterparts around the world. Such cooperation ought to allow intensive training of qualified graduates, enhancing their countries' abilities to meet a global future fraught with challenges on many fronts.

For such cooperation to produce viable outcomes, alliances and partnerships are needed with particular emphasis on shared access to resourceful regional and international networks on the Internet, so that the benefits of available educational courses and auxiliary material are spread as widely as possible.

Concluding remarks

One of the main theses of the book relates to the Arab countries' inadequate focus on STI capacity building with view to tackling strategic challenges, provide employment for the Arab countries' youthful populations and alleviate poverty. This is claimed as main reason for conflicts, political turmoil and poor economic performance that has gone on for too long.

As the authors remark, creating viable STI capabilities may not proceed in the shadow of prevailing rentier systems, that engender limited incentives for the masses; while the import of the latest STI equipment and expertise is prioritised, instead of developing the necessary national capabilities.

On the other hand, the authors stress that sound policies, judicious implementation strategies, as well as an atmosphere that allows academic freedom, open expression and free debate ought to allow Arab STI systems to upgrade, and effectively contribute to inclusive and sustainable development.

About the authors

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*Arabic & English versions of the book are available on IKitab & Amazon

The war in Ukraine and the blown agreement for early recovery in Syria. A missed opportunity

Lorenzo Trombetta

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The agreement has been blown

This is the story of a missed opportunity. Since the end of February 2022, the war in Ukraine and the consequent sharp rift between Russia and the Western community has abruptly interrupted high-level diplomatic efforts aimed at creating the preconditions for a gradual solution to the 11-years long armed conflict in Syria.

The Mediterranean country is devastated by a war that has killed at least half a million people and pushed more than half of the twenty million Syrians to flee their homes, some millions in other Syrian regions, millions more abroad, scattered in the Middle East and beyond. According to the UN, more than 90% of Syrians live in a state of poverty.

At the beginning of 2022 the two global powers involved in the conflict, the United States and Russia, were painstakingly reaching a political compromise to unblock the international impasse on the question of a gradual return of refugees towards areas under governmental control. According to the sources, this return should have been entirely voluntary, the refugees' civil and political rights should have been protected during and after their return, as well as their socio-economic prospects should have been guaranteed in the short, mid and long term.

In view of a possible future return of Syrian refugees in governmental areas, in January 2022 advanced contacts were underway between the United States and Russia to reach a framework agreement allowing the beginning of *early recovery*-labeled humanitarian projects aimed at restoring essential services and basic structures in such areas.

A fragmented territory

The central government of Damascus is represented by President Bashar al-Asad, in power since 2000 and last year re-elected for his fourth term until 2028. Asad's power has been decisively supported for decades by both Russia and Iran.

This alliance controls large portions of the national territory: the Damascus-Aleppo urban backbone, passing through the main capitals of Daraa, Homs, Hama; the Mediterranean coastal region, where Russia has strengthened its historical presence in the Eastern Mediterranean; part of the steppe area between the Euphrates and the Palmyra oasis.

Eastern Syria is controlled by a coalition of Kurdish and Arab forces led by the Kurdish Workers' Party (PKK), hostile to Turkey and supported by the United States as part of the global anti-Isis coalition.

The jihadist insurrection, formally declared defeated in March 2019, continues to operate and proselytize, carrying out hit-and-run attacks increasingly frequent along the two banks of the Euphrates. In the north-west around Aleppo and in a part of the north-east, Turkey and local forces have controlled much of the territory for years.

The deadlock and the official position of the EU

Seen from this rugged and fragmented terrain, the conflict in Syria has appeared for years and still today without any prospects for a solution. Since 2012, the UN has held a table of mediation between the Damascus government and exiled oppositions. Despite the efforts of a series of high-level UN officials, the UN envoys have few tools to leverage the parties involved in the conflict. Since 2018, the position of UN special envoy for Syria has been held by the experienced Norwegian diplomat Geir Pedersen, who tries to keep alive the only negotiating forum formally still active: the inter-Syrian Constitutional Committee.

This inter-Syrian body, composed of 150 members (50 pro-government, 50 pro-exiled oppositions, 50 representatives of the 'civil society') was founded back in 2019 after Russia took the helm of the international diplomatic initiative on Syria with the consensus of the United States.

It should be noted that 2015 UN Security Council resolution n. 2254, which provided for the gradual achievement of a political solution to the armed conflict, still remains the main regulatory and diplomatic reference for most of the international and regional actors involved in the Syrian crisis.

According to UN resolution n.2254, the constitutional committee should have been formed at the end (and not at the beginning) of the initial post-armed conflict period characterized by a nationwide armed truce. Nowadays, even after eight subsequent Constitutional Committees meetings in Geneva, the war still rages over large Syrian territories.

After almost three years of unsuccessful UN mediated negotiations, it became clear that the Moscow-led initiative, embodied by the Constitutional Committee, aims to gain time without helping to create, either from above or from below, the conditions for a gradual and political solution to the conflict.

This impasse favors not only Russia but all the other forces that, inside and outside Syria, have been betting for years on territorial division and on the exploitation, in a short-term perspective, of the resources of the territory in the center of the Middle East.

The European Union, which instead seems interested in breaking this deadlock, remains anchored to its political line, crystallized on the positions of the first years of the Syrian crisis: no intervention for the reconstruction of Syria before the start of a political transition in the country. As if to say, Brussels does not intend to provide political legitimacy to the Asad government by investing in the reconstruction of the local and strategic infrastructures of the Mediterranean country.

The missed opportunity

In light of this stalemate, diplomats and officials of European development countries' cooperation agencies have pushed for a medium-term compromise between the parties involved to start *early recovery* projects in the areas under government control. The agreement provided that the UN refugee agency (UNHCR), which has always kept its channels open with Damascus, would offer formal and logistical coverage to the action supported by Russia, the United States and by the European Union.

The launch of these projects would have sent signals of openness to Damascus and its Russian partner. In exchange, Moscow would have ensured periodic approval of the UN resolution to keep open the cross-border channel of humanitarian aid from Turkey to areas of the north-west, out of government control and under Turkish influence.

This would have been a tactical, not necessarily strategic, exchange between Washington and Moscow. In fact, the negotiations did not concern the political and institutional future of Syria, nor were they explicitly aimed at ending the war and starting peace.

The steps forward made between 2021 and the beginning of 2022 were apparently minimal, yet they could have constituted the first slab of a floor to be built to generate trust between the parties, inside and outside Syria.

The Russian military invasion of Ukraine and the stance taken by the United States and its international allies have had inevitable repercussions, including on the parable of the failure to agree on *early recovery* in Syria. The Syrian events that followed the Russian invasion of Ukraine adamantly showed the fragility of the entente between Moscow and Washington.

Since March, Moscow has left more room for Iran to expand into central Syria and the south-western regions, troubling US interests. Starting from April, Washington strengthened its positions in the Northeast, and so did Russia. Since April, Turkey has obtained more room for maneuver to intensify attacks against the PKK in Syria and neighboring Iraq. In May, the United States decided to lift some trade sanctions on Syrian partners in the north-east and north-west, effectively deepening the commercial, social and political fragmentation between Syrian regions divided by military trenches. Again, in May Russia has announced that it does not intend to vote in favor, in the Security Council, for the resolution that extends the green light for cross-border humanitarian aid from Turkey to the Idlib region.

In the face of these politico-military developments, at the April Brussels international conference on Syria and the region, 75% of the promised funds came from the European Union and from European donors. This constitutes an expression of Euro-Mediterranean interests once again defeated by a trajectory on a global scale based on short term military and political confrontation.

NEW MEDIT

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