# TECHNOLOGICAL INNOVATION, SUSTAINABLE AGRICULTURE AND ECONOMIC GROWTH:

# EFFECTS, CAUSES AND CONSEQUENCES

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**Résumé:**

Ce document fournit une nouvelle preuve pour expliquer l'impact de l'innovation technologique qui génère la durabilité agricole pour une première fois et l'amélioration de la croissance économique dans un second temps, à partir des données de 3 pays du Maghreb (Algérie, Maroc et Tunisie) sur la période de 1990-2012.

En utilisant l'équation simultanée (3SLS), nous avons constaté qu'il existe une relation importante entre les trois dépendantes variables: l'innovation technologique, la productivité agricole et la croissance économique.

Nos résultats ont également montré que la mécanisation a endommagé la productivité agricole et la durabilité à cause de la détérioration des ressources (consommation d'énergie, les émissions de CO2 et l'empreinte écologique) et de la croissance démographique. Mais, elle a amélioré la croissance.

Inversement, les dommages du système d'irrigation à la croissance économique diminuent via l'investissement direct étranger en favorisant la productivité agricole.

**Mots- clés:**

Croissance économique; Innovation technologique; Durabilité agricole; Les pays du Maghreb; 3SLS.

Classification JEL: C81, F43, N7, O31, Q01, Q16.

**Abstract:**

This paper provides a new evidence for explaining the impact of technological innovation that generate agricultural durability in first time and improving economic growth in a second time, using data from 3 Maghreb countries (Algeria, Morocco and Tunisia) over the period of 1990-2012. Using simultaneous equation (3SLS), we found that an important relationship exists between the three depend variables: technological innovation, agricultural productivity and economic growth.

Our results also showed that the mechanization founded damage the agricultural productivity and durability through resource deterioration (energy consumption, CO2 emission and ecological footprint) and demographic growth. But it improved the economic growth.

Inversely, irrigation system damages the economic growth through foreign direct investment and exchange term decreases. But it promotes agricultural productivity.

**Keywords**:

Economic Growth; Technological Innovation; Agricultural Durability; Maghreb countries; 3SLS.

**JEL Classification**: C81, F43, N7, O31, Q01, Q16.

## 1. Introduction

The world food crisis appeared in 2008, where the problem of hunger developed in the world because of inflation linked to the agricultural raw material. In fact, this attack is not a fatality, nor a confirmation of a "natural" law according to which the population increase was limited to the constraints of scarce food resources.

Since the eighteenth century, the successive agricultural revolutions indicated the adjustment of agriculture, following the demographic growth and to the transformations in lifestyles that led to the poverty growth during 2003-2005.

At the beginning of the third millennium, an agreement was signed regarding the problem of hunger and undernourishment. The increase in food commodity prices and the demographic growth has caused, it was considered causes that international organizations to rethink development strategies of developing countries (CIHEAM; 2009).

The soaring price of agricultural products could be in the next year providing an opportunity for developing countries to start their agricultural revolution in a context characterized by challenging the conventional model.

Because the repercussions of a poorly regulated globalization on the agricultural world, taking into account drops productivist agriculture, linked to the return of development problems focused on the agricultural production development, could contribute to the achievement of food security objectives of the most vulnerable countries facing fluctuating commodity prices.

A consensus has emerged to protect the environment, to ensure food and to save water, its shares are strong and important to every nation (C.P.Timmer, 1992) and not only for intergenerational ethics reasons, but for economic reasons.

Indeed, the natural resource of productive factors is widespread in the case of agriculture. Therefore, deterioration may affect the future productive potential. Agriculture as productivity



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and economic activity can affect both actively deterioration on the protection of natural resources and the environment.

In this context, it appears that conventional agriculture a devastating impact on the environment. This is why the introduction of a new technique calling "sustainable agriculture" appears clear and sharp to solve problems.

While the question of whether technological innovation promote agricultural durability and economic growth has gained considerable attention in academic and policy works, there are little theoretical and empirical studies on the determinants of agricultural innovation durability and her impact on the development in Maghreb countries. Hence, the aim of this paper is to fill the void in the literature and make an in-depth analysis of the Maghreb agricultural sector in order to identify their main factors.

To better understand what drives the agricultural innovation development in this region. The scope of our study covered 3 Maghreb countries during the 1990-2012 periods. We employed an econometric methodology (3SLS). Our results show that two methods of technological innovation (mechanization and irrigation system) are important determinants of economic growth and agricultural productivity but cannot achieve the purpose of sustainable development.

## 2. Literature Review

Major prior studies related to the present paper include Kuznets (1955), wheelwright and Clark (1992), Ranis (2003), David Sunding and David Zilberman (2003), Fields (2004), C.P.Timmer (1992), M. Lasram (1992). These studies focused on the effects of technological innovation in agricultural sustainability and development of economic growth in developed and developing countries.

C.P.Timmer (1992) confirmed that since the second world little, two basic types of developments are recently built, the first is the scientific revolution of agriculture that ensures

the transformation of the potential productivity of land and rural population levels of subsistence use traditional techniques to levels that produce substantial trade surpluses that are available to nourish and increase the population quickly.

The second is the understanding of the market role in determining the economic development process and on behalf of government in the support.

The second decade of the twentieth century characterized by the emergence of the General Agreement of agricultural development strategy requires market - oriented capable of stimulating rapid technological change in agriculture. But this agreement masks the considerable contradiction of the political picture and their implementation for three main reasons:

First, the agriculture is a declining industry in the process of economic growth (increase over time from agricultural production workers in the form of income is more robust).

Second, the development strategy " market - oriented " based on the adoption of technology to modernize agriculture in each country is developed. Historically, research and development of a substantial share of agriculture are developed outside the public sector. Privatization is a development strategy that leads to substantial risk eliminates the public investment needed to make a private market economy advantageous.

Third, most are intrigued to the community of the modern economy, the agricultural sector in developing countries can be crucial to the process of economic growth in ways that are not well reflected in markets and market prices (if the strategy development "getting the prices right "is vastly more complex than the use of free trade to send prices of global products to domestic producers and consumers) C.P.Timmer (1992). The discussion related to the role of agriculture in the participatory process of economic development has two major causes: economic and political. If the role is passive, this requires only a gradual transfer of capital and labor in industry and the role of government in the agricultural sector will be minimal or

even discriminatory because the heavy taxation. Agriculture plays a positive role in stimulating growth in other sectors, but must be cultivated to ensure the effectiveness of stimulation, in this case the government needs a more active role such as: providing technical modern and rural infrastructure, these are minimum tasks performed by governments in a more organized manner to achieve market - oriented economy that has led the investment efficiency.

Several studies have appeared in half the twentieth century as wheelwright & Clark (1992) and Kuznets (1955) involved the role of agriculture in the process of economic growth particularly in developing countries. These facts strongly reflect the basic neoclassical view that the agricultural sector is considered a "***black box***" in which participate the labor, food and capital. These phenomena are important efforts to modernize the industry. The agricultural sector modernization doesn't require any effort, because naturally it declined. Ranis (2003) & Fields (2004) explained that in these analyzes the main studies become paradigms that ignore the need factors to modernize the traditional agricultural sector as this sector plays an important and positive role. Moreover, it contributes to the development of the economy rest.

The absolute necessity of new technologies to produce the highest revenue streams of traditional producers has been accentuated by David Sunding and David Zilberman (2003).

The market failed to achieve price stability, food security, poverty alleviation, rapid stimulation of economic growth and environment protect, causes the birth of a search for interventions appropriate government solves these failures. The good aspect of public agricultural research has been recognized by governments for centuries, long before economists have provided a ceremonial analytical reasoning for public support responded to improve agricultural technology.

Optimal incentives for private companies allow investment in innovation of new technologies that require new streams of income appropriate production to a considerable degree cover

research costs. Although the different seeds, chemical formulas patented brands are applied in developed countries, they are private sector activities.

Searches that are financial public sector directly improve technological innovations in private companies processing and development of the agricultural product.

The transition from a traditional view of agriculture to a new vision marked by the appearance of new objectives take priority such as the environment, nature ( landscape ), health and well-being, thus inducing the notions of alternative agriculture that ensures durability . Here are some patterns emerged, such as agriculture led to the ecosystem.

The soil forms a vital resource that occurs slowly, is capable of being deteriorated rapidly. In addition, the soil is prepared to erosion and although the short-run impacts may be weakened and amortized changes. Murua and Laajimi (1995) confirmed that in the long run, it is necessary to consider alternative techniques such as work that protects the soil. For this purpose, a recent analysis of PNUE (2011) indicates that the management of the arable soil layer becomes a matter of control unnecessary activities.

Labor (mechanization) is considered a technique of energy consumption in production operations. However, these various operations not only use energy without necessity, but also worse soil degradation and can also lower production capacities that eventually the massive demand for energy. It is essential to research on the uses of land preparation for long-run sustainability of agriculture and resources. This is very necessary for developing countries where resources are limited (in the case where the source of energy can be animals or even human beings, rather than tractors). In this context, the application must take into account the link cultivable plant layer to participate in saving energy and time and enhance understanding of the concepts of work that respects the environment. Water is considered as a factor of production which forms an ardent desire of all agriculture. So not to waste fraction in culture should emerge within acceptable levels of safety.

In recent years , the potential of agriculture and technological advances have led to a growing base alarm distributes, for example, nitrates , contamination is inadequate in some areas of intensive agriculture , which forms a pattern more to rationalize fertilizer nutrients by creating well-defined appropriate times .

The transmission of a contagious disease distributes the traces of herbicides, admitted some attention though several studies have indicated that in most analyzes of groundwater is not exceed the limits laid down officially. Murua and Laajimi (1995) examined the impact negative of CO2 air contamination through the greenhouse effect that can be caused. Indeed, some alternative uses show that the grinding of straw associated with tillage helps to increase the soil organic matter that prevents CO2. The use of some cultural techniques such as crop rotation, fertilization (quantity adjustment) , work ( energy saving and labor , etc. . ) to protect the fauna and flora of the soil and enhance both the quality of the economic viability life.

## 3. The agriculture innovation in the Maghreb country

Agriculture is an importing economic sector in the Maghreb region. It called to raise some challenges, in particular the challenges of the exchange liberalization, as well as the realization of the sustainable agriculture objective. The agricultural sector of the three Maghreb countries is dominated by small and middle agricultural exploitations (more of 3 million of exploitations, FAO; 2011) and their varied forms necessary actors in the development and working agricultural.

**Table1: Evolution of the exploitation number, cultivated surface, number of mechanization, spending in R&D and irrigated surface in the three Maghreb countries in 2005 (WDI, 2011).**

| country | GDP | number of exploitation | Agricultural productivity | Number of mechanization | Irrigated surface ($10^3$ ha) |
|---|---|---|---|---|---|
| **Algeria** | 5.1 | 7401.00 | 8.221 | 1693.00 | 569.00 |
| **Marocco** | 2.978 | 9146.00 | 14.677 | 1397.00 | 1453.00 |
| **Tunisia** | 4.019 | 2205.00 | 10.127 | 1700.00 | 411.00 |

**Source: WDI, 2011**

The land and water are rarely factors in the Maghreb. The arable lands and the permanent cultures only represent a weak part of the agricultural surface 38%. More than 25% of population access to 22 million ha of productive lands in the Maghreb countries, Morocco (9 millions of ha), Algeria (8 million), then Tunisia (5 millions) (WDI, 2011).

Because of the climate, the irrigation is an essential productivity factor, but the Maghreb countries are not able to irrigate that a few more than 20% of their arable and orchard lands, with strong disparities between the countries. Algeria and Tunisia, of which a vast portion of the territory is in semi - desert zone and without resources in the water, are too less of 10% of lands irrigated (FAO, 2010).

M. Lasram (1992) investigate that in the Maghreb countries, the permanent culture doesn't answer as needed because of the demographic growth in this country that induce poverty increases in the middle. The Maghreb countries are endowed with weak resources in renewable water. All countries are per capita below the fateful doorstep of 1000 $m^3$ and per year, considered as the minimum permitting to assure the needs of a country correctly. Resources in water are in constant and fast reduction because of the demographic and economic growth, including since 2000, in spite of many national and international plans dedicated to a better management of water. From an economic viewpoint, the agriculture of the Maghreb countries represents 3 to 10% of the GDP according to the countries. The growth

of the agricultural value added has been raised everywhere in the world, including in the Maghreb countries in the decade 2000 a doubling because of the increase in the prices noted in 2008. Algeria and Morocco represent 10% of the agricultural value added (WDI, 2011).

The agricultural productions of the Maghreb countries are dominated by the cereals, the legumes and the fruits and vegetables. The output levels are heterogeneous, what reveals very varying states of the techniques used, but also of progress potential under condition of natural and technological resources and formation: some radical innovations should be introduced in the agricultural production. The Maghreb countries resort to the productivity factors (manure, products phytosanitairy, improving seeds or to high outputs) and to the equipment (tractors, materials of harvest, of treatment, hydraulic pumps, irrigation sophisticated materials…) for the agricultural modernization. Some policies have been thrown in 2004 and 2005, for the purpose the durability development realization in the agricultural sector from the Maghreb through the natural resource conservation, the improvement of the life condition and of farming population return and the promotion of the farming woman (Montontaigne, Bessaoud, 2009).

## 4. Empirical Model Specification, Variables Discriptions and Data Source

### *4.1 Econometric Methodology*

The main objective of this study is to estimate the role of technological innovation in the agricultural growth improvement in order to reach the objectives of sustainable development. To do this, we specify a simultaneous equations model which consists of a series of three equations describing the behavior of technological innovation (mechanization and irrigation system), agricultural productivity and economic growth as one of the three variables improves the situation of another (Danièle Clavel, Albert Barro, Tesfay Belay, Rabah Lahmar and Florent Maraux; 2008).

The model to be estimated is the following:


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$$TI_{i,t}=\alpha_0+\alpha_1 AP_{i,t}+\alpha_2 GDP_{i,t}+\xi_{i,t} \quad (1)$$

$$GDP_{i,t}=\beta_0+\beta_1 AP_{i,t}+\beta_2 TI_{i,t}+\beta_3 INF_{i,t}+\beta_4 TE_{i,t}+\beta_5 MSP+\beta_6 FDI+\beta_7 GMR_{i,t}+\zeta_{i,t} \quad (2)$$

$$AP_{i,t}=\gamma_0+\gamma_1 TI_{i,t}+\gamma_2 LFA_{i,t}+\gamma_3 RP_{i,t}+\gamma_4 GDP_{i,t}+\gamma_5 SC_{i,t}+\gamma_6 WA_{i,t}+\gamma_7 EC_{i,t}+_8 FC_{i,t}+\lambda_{i,t} \quad (3)$$

*4.2 Variables descriptions and Data Sources*

Our methodology is demonstrated by an estimation based on the simultaneous equations, a sample of three Maghreb countries (Algeria, Morocco and Tunisia) and over a period from 1990 to 2012.

In this study, data is combined from three data sources: the World Bank (WDI 2012), the International Finance Statistics and FAOstat.

**Table 2: Description of Variables and Their Sources**

| Variable | Explanation | Source |
|---|---|---|
| **EC** | represent Energy consumption | WDI, 2012 |
| **FC** | represent fertilizer consumption | FAO, 2012 |
| **MSP** | represent the memberships schooled to the primary | WDI, 2012 |
| **GDP** | Growth in real GDP per capita | WDI, 2012 |
| **INF** | The inflation rate is index of consumer prices | WDI, 2012 |
| **WA** | represent the quantity of water used for agriculture: is the quantity of water used for agriculture in % share in total water use | FAO, 2012 |
| **FDI** | represent Foreign Direct Investment | WDI, 2012 |
| **TE** | represent term of exchange, defined as the sum of exports and imports as a share of GDP | WDI, 2012 |
| **TI** | Technological innovation measured by mechanization (M) (WDI, 2009) and the area of irrigated land (AIL) | WDI, 2012 ; FAO, 2012 |
| **Mechanization (M)** | represents agricultural machinery (tractors per 100 sq km of arable land, WDI; 2011) | FAO, 2012 |
| **Area of irrigated land (AIL)** | defined as the surface of land irrigated for 1000 hectares (FAO, 2010) | FAO, 2012 |


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| | | |
|---|---|---|
| **AP** | Agricultural productivity is Agriculture value added per worker (% of GDP) (WDI, 2009) | FAO, 2012 |
| **LFA** | defined as labor force in agriculture | FAO, 2012 ; the International Finance Statistics (IFS), 2009 |
| **FP** | Farming population represent him the producers, the consumers and the manpower | FAO, 2012 |
| **SC** | represent surface cultivated | FAO, 2012 |
| **EC** | considered as energy consumption | WDI, 2012 |
| **IVTA** | investment in agriculture through investment in telecommunications | WDI, 2012 |
| **GMR** | gross mortality rate | WDI, 2012 |

To test the effect of technological innovation (mechanization and irrigation system) on agricultural productivity and economic growth, we base on the analysis of Hayami and Ruttan (1985) looking to test the hypothesis of aggregate agricultural production in the context of the historical development of the long run.

**Results**

**Mechanization, agricultural productivity and economic growth*

**Table 3: Estimation of the model by the method 3SLS**

| **Variables** | **TI** | **GDP** | **AP** |
|---|---|---|---|
| **TI** | | 1.512908<br>(0.000)* | -0.6520133<br>(0.000)* |
| **GDP** | 0.5320296<br>(0.000)* | | 0.4575899<br>(0.000)* |
| **AP** | -0.7644132<br>(0.000)* | 1.200297<br>(0.002)* | |
| **INF** | | 0.1878186 | |

| | | | |
|---|---|---|---|
| | | (0.341) | |
| **TE** | | 0.0001808<br>(0.987) | |
| **MSP** | | 0.1683357<br>(0.549) | |
| **FDI** | | -3.97<br>(-1.1) | |
| **GMR** | | 0.0882987<br>(0.952) | |
| **LFA** | | | -0.2088817<br>(0.782) |
| **SC** | | | -0.042792<br>(0.584) |
| **EC** | | | 0.0539786<br>(0.007)* |
| **FC** | | | 0.0002066<br>(0.987) |
| **FP** | | | 0.0818435<br>(0.786) |
| **WA** | | | -.0404168<br>(0.080)*** |
| **Observations** | 70 | 70 | 70 |
| **$R^2$** | 0.3865 | 0.7227 | 0.9384 |

Variables in parentheses are at the significance level of 1% *, 5%** and 10%***.

Table 3 summarized the results of three least squares (3SLS) models for the sample of the 3 Maghreb countries from 1990 to 2012. In the first column, we present results of technological innovation equation (mechanization). In the second column, we indicate the results of the economic growth equation. In the third column, we present results of agricultural productivity.

The estimated model shows that the relationship between technological innovations (mechanization) and agricultural productivity is negative mainly to several factors (Table 3,

column1), the relationship between technological innovation and economic growth is positive for the same relationship between agricultural productivity and economic growth (Table 3, column1).

In light of the estimation results, we note that:

According to table 3 (column 1), where technological innovation increases by 1% point, the agriculture productivity decrease by 0.7644132% point. This result can be interpreted by the following effects:

Sunam Bedrani, Guilio Maorgio and Gérard Miciet, (2001) showed that the increase in non qualified labor is not able to operate farm machinery can harm farm land on succeeding years , which leads to the reduction of soil fertility and thus lower crop yields these effects affect social sustainability by increasing poverty in rural areas.

The non qualified labor in rural areas increases the footprint, pollution in the area, and increases the use of water resources, which leads to overexploitation of water resources and natural resources that prevents the achievement of environmental sustainability of the sector (CHILEAM, 2009).

According to neo- classical authors the massive introduction of farming techniques that reduces the use of labor is seen as a response to the rising cost thereof which causes a deterioration of the economic sustainability in the agricultural sector. However, they support it yet had imbalances in relative prices, are they not considered that examine the rural exodus that has seen since.

On the one hand we could subsidize the equipment and products that reduce labor and other costs of labor would certainly increase because of social protection measures (minimum wage, paid leave, insurance, illness, etc. . .). These grants were given under pressure from landowners.

The estimation result confirmed that 1% point increase for the agricultural productivity reduce cultivated surface by 0.042792% point (table3, colomn 3).

V.Ruttan (1977) investigate that despite the increase in agricultural productivity and yield, the machinery liberates pollution in the soil can degrade the soil fertility (Table 3).

When the agricultural productivity increases by 1% point, the energy consumption rise by 0.0539786% point (table3, colomn 3).

The Maghreb country's exports energy produced (oil and gas) of the outside. The intensive energy use by the mechanization increases the quantity of energy consumption and increased the CO2 emission (IPMED, 2009).

The use of machinery requires energy; mechanization deteriorates renewable and non-renewable natural resources.

The results showed that the technological innovation increases by 1% points when the economic growth increases by 0.5320296% points (Table 3). This result can be interpreted by the following effects:

Technological innovation contributes to the achievement of economic growth through lower index of consumer prices (Table 3) since the mechanization helps increase the production of food products, technological innovation prevents bad nutrition of the rural population and thereafter decreases poverty and attracts direct foreign investment especially in the food industry.

Despite the negative effect of mechanization on agricultural productivity their impact on economic growth is positive.

Productivity of production factors is a main component of economic growth such as land, human capital, physical capital and labor.

A 1% point of agricultural productivity increases where economic growth rises by 0.45% points, (table 3, column 3).



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*Irrigation, agricultural productivity and economic growth*

We will empirically test the effect of technological innovation (TII) (percentage of land makes irrigation) on agricultural productivity and economic growth, is replacing technological innovation based on mechanization through technological innovation based on irrigation.

**Table 4: Estimation of the model by the method 3SLS**

| Variables | TII | GDP | AP |
|---|---|---|---|
| **TII** | | -0.0980147<br>(0.000)* | 1.050402<br>(0.080)*** |
| **GDP** | -0.2113427<br>(0.000)* | | 0.5460956<br>(0.000)* |
| **AP** | 1.033327<br>(0.000)* | 2.105306<br>(0.000)* | |
| **INF** | | -.1505036<br>(0.414) | |
| **TE** | | 0.0027759<br>(0.556) | |
| **MSP** | | 1.081977<br>(0.000)* | |
| **FDI** | | -4.91<br>(0.118)*** | |
| **GMR** | | -7.859212<br>(0.002)* | |
| **LFA** | | | 0.4300247<br>(0.05)**** |
| **SC** | | | 0.2190296<br>(0.000)* |
| **EC** | | | 0.016586<br>(0.063)*** |
| **FC** | | | 0.0073987<br>(0.091)*** |
| **FP** | | | 0.4057092 |

| | | | |
|---|---|---|---|
| | | | (0.000)* |
| **WA** | | | 0.0019622<br>(0.069)*** |
| **Observations** | 70 | 70 | 70 |
| **$R^2$** | 0.9316 | 0.7057 | 0.9845 |

Variables in parentheses are at the significance level of 1% *, 5%** and 10%***.

The estimate shows that the direct relationship between technological innovation (irrigation), agriculture productivity and economic growth has been modified.

Table 4 summarized the results of three least squares (3SLS) models for the sample of the 3 Maghreb countries from 2000 to 2012. In the first column, we present results of technological innovation equation (irrigation system). In the second column, we indicate the results of the economic growth equation. In the third column, we present results of agricultural productivity. The first column in table 4 shows that where irrigation system increases by 1% point's economic growth reduces by 0.211% points. This result explained through FDI and exchange term decreases. The foreign direct investments (FDI), one of the international exchange forms, are greatly correlated with the economic growth and the export intensity.

The deficit of FDI noted in the Maghreb countries in relation to the emergent countries explains himself by several reasons (Galal and Reiffers, 2010):

-unstable political environment;

-growth Differ with the emergent countries and so the market perspective a less attractive;

-insufficient institutional device (fragile banking sector and insurances, stock and obligation market less structured, bureaucracy);

-Monetary device weakness;

-real interest rate elevated;

-state of embryonic right (uncertain legal protection);

-The business climate uncertain (opacity, corruption). (IPMED, 2009)



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The second column (table 5) explains that when economic growth increased by 1% points, the technological innovation (irrigation system) decreased by 0.098% points.

The population growth in the Maghreb countries increases the amount of water consumed and used in other areas other than agriculture as an industry and urbanization which leads to the decrease in the amount of water used in irrigation (Lasram, 1992).

The innovation technological increased by 1% points where agricultural productivity rose by 1.03% points (table 5, column 1). This result explained through the cultivated surface increases and fertilizer consumption decreases and inversely (when agricultural productivity increase by 1% point, technological innovation increase by 1.050% point, (table 5; column 3).

The third column (table 4) shows that agricultural productivity increased by 1% points where economic growth raised by 0.546% points and inversely (when economic growth increase by 1% point, productivity agricultural increase by 2.105% point, table 5; column 2).

Economic growth is the combination of physical capital, human capital, labor and land are also factors in agricultural productivity, so we cannot talk about economic growth without total productivity of factor and screw poured. The irrigation system doesn't answer if need be on demand in the Maghreb because of climatic change and demographic growth. Therefore one can say that the system of irrigation doesn't achieve the objectives of lasting development in the Maghreb countries (Lasram; 1992).

## 5. Conclusion and Politicy Recommendations

According to previous studies the technological innovation is an important factor to affect the economic growth and agricultural productivity level. This paper sets out to tackle three very specific research questions concerning (1) the importance and magnitude of agricultural innovation (mechanization and irrigation system) on productivity alleviation (2) the role of agricultural innovation on the aims durability realization (3) the relationship between technological innovation, agriculture productivity and economic growth. Using an aggregate


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annual panel data, it was a sample composed of 3Maghreb countries, from 1990-2012 to estimate a simultaneous equation model that capture the interrelationship between agriculture productivity, technological innovation and economic growth, our findings indicate that technological innovation contributes significantly to economic growth in Maghreb countries. But it contributes negatively to agricultural productivity and doesn't achieve the objectives of lasting development in the Maghreb agricultural. The some exploitation method either the mechanization or the system of irrigation participates in the natural resource deterioration (use of the chemical manures, consumption of energy, ecological footprint, etc.).

The techniques of intensive farming produced soil depletion, an allocation of water resources and a high salinity and loss of biodiversity. The intensive use of fertilizers and pesticides causes uncontrolled pollution. The hyper- selection of seeds contributes to deterioration of biodiversity. The hormones and antibiotics use in animal feed, it is regarded as a health risk. Besides, because of the strong consumption of inputs and the generalization of the mechanization, agriculture becomes a factor of gas emission to the greenhouse effect, of which the impacts on the climate are indicated scientifically (C.P.Timmer; 1992).

We can say that the Maghreb agricultural until has the hour is considered like a conventional agriculture.

Our findings have important policy implications for Maghreb countries.

First, the water Politics: we find that, in several Maghreb countries, the mobilized water is not used and valorized sufficiently, what lets more non negligible margins to intensify the production in the irrigated sector. In the same way, a politics of water economy are necessary to avoid all wasting. The worn-out water recycling also permits to increase resources in available water. Finally, now and already, some efforts must be invested in the use of resources in the water non conventional, notably the desalination of the brackish waters and the water of sea to prepare some solutions to the difficulties that will put themselves to the

future. Secondly, the fortifying of the potential human by the professional formation, information and the diffusion of the knowledge, the young agriculturist installation;

Third, the investment in the farming infrastructure and the creation of viable farming institutions loaded to provide the services that make defect, as the agricultural credit, the merchandising and the transformation.

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