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Anissa GARA[1,2*], Dorra AJABI [1]

EFFECT OF ANIMAL HUSBANDRY ON ENVIRONMENTAL PROFICIENCY

SUMMARY

Sustainable agriculture is an application of the concept of sustainable development to the agricultural sector and more specifically at the farm level. It takes into account the three dimensions - economic, social and environmental - in a global framework. It is in this context that this study aims to assess the effect of the integration of livestock into the production system on the sustainability of farms in the Mornag region, located in the northeast of Tunisia. Two groups of farms were derived: with livestock and without livestock. The Farm Sustainability Indicators (IDEA) method was used to meet this research objective. From the analyses of the previous results and the comparisons between the means of the indicators of each component according to the mode of production, we were able to deduce that this factor considerably influences agricultural sustainability on both agro-ecological and socio-territorial scales. Indeed, the group of farms that include livestock have better averages in most indicators. These results could be explained by the fact that the association of crops with livestock within a production unit is considered an asset in the sustainability of an operation since it allows positive interactions and synergies between the different elements of the system. Indeed, in the mixed crop-livestock system, the diversification of production, crop rotation and the use of animal manures contribute to improving soil fertility. In addition, animal husbandry makes it possible to diversify income and distributes it over time and, therefore, ensures a certain stability in the economy. Some farmers even have a daily income from animal products such as eggs and chickens; others take advantage of some products for family consumption.

Keywords: Sustainability, Farms, Livestock, Tunisia

INTRODUCTION

Applied to the field of agriculture, the concept of sustainable development implies that the operator's concerns no longer relate solely to the objective of achieving economic profitability, but takes into account other dimensions, namely

[1]Institut national agronomique de Tunisie (INAT), Tunis, TUNISIA; [2]Institut national de recherches agronomiques de Tunisie (INRAT): Laboratory of Rural Economy, Tunis, TUNISIA
[*] Corresponding author: anissa.gara@gmail.com

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respect for the environment (preservation and good management of non-renewable resources, of the biodiversity of ecosystems and landscapes, optimization of production factors, etc.), social integration (promoting the integration of the farmer, integrating an ethical dimension, ensuring a certain social equity and well-being for the farmer, etc.), the viability and transferability of the farm (the economic efficiency of the operating system, financial autonomy and dependence on aid, transferability of capital and transmission of knowledge, etc.)(Massin et al. 2016). Agriculture that simultaneously takes into account the three dimensions makes it possible to generate sufficient income for the household, it applies agricultural practices that do not affect the environment, it contributes to job creation and the social integration of farmers, and it is transmissible, so it can be qualified as "sustainable agriculture". Landais (1998) indicates that sustainable agriculture is economically and socially viable agriculture, ecologically reproducible and transmissible. However, this growing need to integrate and assess the new concept of sustainability within farms has prompted the scientific community to question the methods and tools that make it possible to assess a production system and translate sustainability of the three dimensions in an operational way. Indeed, for an assessment to be relevant it must be based on reliable indicators that describe the main aspects of an operating system, namely environmental, economic and social. In this context, several assessment methods have been developed since the 1990s and they are based on a set of indicators covering certain aspects that assess sustainability within a farm. In Tunisia, the evaluation of sustainability is a relatively recent subject and the tests carried out in this field, despite their importance and usefulness, remain limited and they have not gone beyond the descriptive character and the diagnostic aspect (Laajimi et al., 2009). Similarly, Nabradi (2011) affirms that: "Utilizing livestock in agriculture often improves the sustainability of the system of an environmental (ecological), economic, and social viewpoint. Animal production can be economically sustainable because of its role in trade, market and feed supply disruptions, as it diversifies the activities of producers, decreases controls risk at the farm and national levels, enhances farm maintenance and increases the possibilities for employing the rural population".

Likewise, this study constitutes an assessment of the level of sustainability of different farms in Tunisia, in the region of Mornag, delegation of Ben Arous. The study region is a periurban region located at 10 km from the down-town of the capital Tunis. therefore, we remark a conflict between rural and grilcultural activities comprsing animal husbandy and urbalization. The latter is conquering fertile land at a rapid rhythm. In accordance with Parsipour et al. (2019): "We note Peri-urban environments are some spaces where are strongly under effect of daily growth of urban population and experience constitutional changes. Firstly, their land use which turns from agricultural and husbandry into residential use and secondly they merge with urban fabric".

The goal of this research is to find out the effect of livestock integration on farm sustainability. Hence, two groups of farms are derived: farms with livestock and farms without livestock (only crop farming system). It is with this in mind that the methodology adopted for this study has three stages: the farmers' inquiry and data collection then IDEA tool application and results discussions.

MATERIAL AND METHODS

Data collection

The Mornag delegation is located in the governorate of Ben Arous in northern Tunisia and covers an area of 6,900 ha. Enjoying a Mediterranean climate, the average temperature varies between 11°C in winter and 26°C in summer. The Mornag delegation is predominantly fruit-arboriculture (65%). It is essentially a communal region and the rate of urbanization exceeds 90% of the total population of the governorate in 2009 (Ministry of Environment, 2011). Moreover, this pole continues to record urban growth in the form of housing estates sometimes to the detriment of natural and agricultural areas.

Besides, we encountered reluctance on the part of the farmers to answer the questionnaire. This difficulty has worsened, particularly during the confinement period due to the COVID-19 pandemic. Mornag's delegation contains 14 regions (called in Arabic 'Imedat'). The present study concerned only one region, which bears the same name as the delegation: Mornag Imedat or Mornag Region. In this region of Mornag, a number of 29 completed questionnaires were recorded. The sample is exhaustive because it contains farms with breeding and others without breeding in equal shares. The sample represents 5% of the total number of existing farms in the Mornag region.

IDEA scoring

The IDEA method (Indicateurs de durabilité des exploitations agricoles or Farm sustainability indicators) was designed by a multidisciplinary group made up of agronomists, socio-economists and ecologists belonging to various institutions (teaching, research, development). According to Vilain (2003) this method was designed to allow a diagnosis of farm sustainability from direct surveys of farmers. This method is the most suitable for achieving the objective of this work, which is to assess the sustainability of farms. Indeed, this project will allow us to qualitatively assess the sustainability of private farms and development in the study area in order to highlight systems and strategies in favour or not of agricultural sustainability. The indicators of the IDEA method have all been designed in such a way that they can respond, directly or indirectly, to a number of objectives for sustainable agriculture. These objectives are formulated around three scales of sustainability, namely: good management and protection of natural resources (ecological scale), respect for certain qualities of citizenship and a certain social level (social scale), and the guarantee of a good economic and productive function of farm (economical scale). The IDEA method has three scales, which represent the dimensions of sustainability in a production

system. They are of the same weight, the values of which vary between 0 and 100 points, and each scale is subdivided into components which themselves have specific indicators and which characterize a sustainable system. The components bring together 42 indicators. Each characterizes a practice in a sustainability scale and having an assigned and quantified score. The indicators seek to reflect the systemic dimension of the farm, but also each indicator aims to deliver a message in order to identify possible paths of progress towards increased sustainability (Briquel et al, 2010). It is proposed by relying on the indicators of the IDEA method (Indicators of the sustainability of agricultural holdings), which offers operational content to the concept of sustainability at the farm level, to compare the level of farm sustainability based on the factor of farming mode, that is to say animal breeding integrated or not to crop farming. The overall sustainability rating of a farm is the scale with the lowest score. This principle allows for the simultaneity of the three dimensions and therefore an integrated approach to sustainability. The scores obtained for each component will make it possible to identify the factors affecting the sustainability of the operation in the dimension concerned. The higher the score on a scale, the more sustainable the operation is considered on that scale. The minimum score associated with most indicators is zero score. This note can simply mean that the farm is not affected by the indicator. For example, the animal diversity or endangered breeds indicators do not apply to farms that do not have livestock. For the farms concerned, the zero score does not necessarily mean irreversible handicaps to sustainability, but rather that the farm has room for improvement. The maximum scores for each indicator have been set to cap the total number of sustainability units.

RESULTS AND DISCUSSION

In order to better explain these differences, we will study and compare the results of the components within each scale of the three groups of farms according to land size.

Agro-ecological scale

In the agro-ecological scale, we can see that farms that integrate livestock into the production system are more sustainable in all components of the scale (Figure 2). Farms that integrate livestock have very good averages in the Agricultural Practices component, followed by the Diversity component. Farms with a purely plant production system, on the other hand, have very low averages in the two components “Space organization” and “Diversity”.

The “Diversity” component reflects the weight given to the autonomy and diversity of production systems to achieve a model of sustainable agriculture (Table 1). The low averages of farms in the plant production system can be explained by the fact that they are sanctioned with a score of zero in indicator A3: 'Animal diversity', and a low score in indicator: 'Diversity of annual crops' as they generally do not have meadows or fodder crops. More the production system is diversified more sustainable is the agroecology aspect. This is in accordance with

results of assessment of agrocecological sustainability at Souk Ahras in Algéria where Latreche *et al.* (2019) found out that: "The highest sustainability was assigned to cereal other crops, followed by cereal potatoes system; due to good economic performance (high incomes).

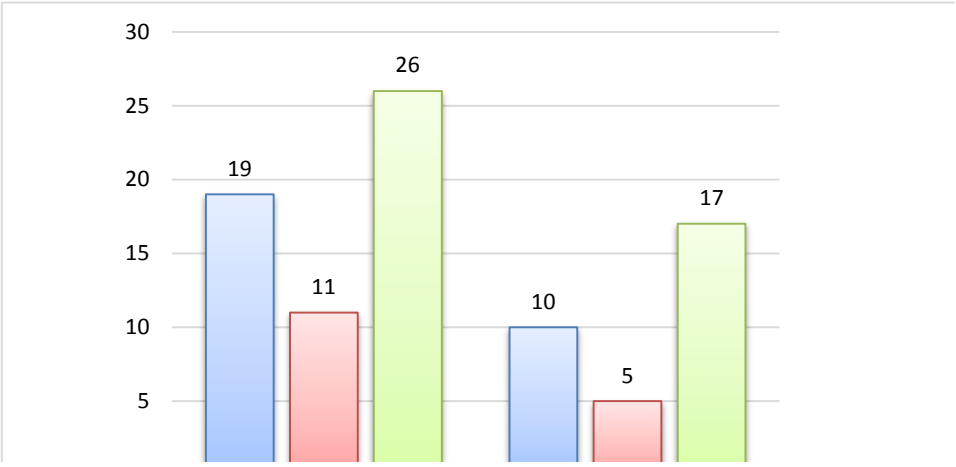

Figure 2. Averages scoring of the components of the agro-ecological scale according to the farming mode.

However, both systems have low agro-ecological sustainability due to increased pesticide use and high energy consumption and treatment frequency; high values of these indicators affect negatively durability. The cereal grain legumes system has a good durability increased by the agro ecological effect linked to the introduction of a leguminous in the rotation.

Table 1. Means of the indicators of the "Diversity" component according to the farming mode.

	Diversity of annual crops (/14pts)	Diversity of perennial crops (/14pts)	Animal diversity (/14pts)	Valorization and conservation of the genetic heritage (/6pts)	Total (/33 pts)
Livestock	4.75	5.25	7	1.86	18.9
Without livestock	3.1	6.9	0	0.1	10.1

This system is very appreciated by the farmers, in addition it concords with the strategy of the State which aims is to replace fallow land with a grain legume. Cereal pastured and worked fallow have low durability with a priori for cereal pastured fallow; but the edapho-climatic conditions, the socio-economic context and the vocation of the region ensure the persistence of these two systems".

This imbalance considerably affects the autonomy and sustainability of the farm. Indeed, the integration of animal breeding offers synergies and complementarities within production systems that make it possible to better develop resources.
Also, the absence of livestock induces low or zero scores in the indicators of the component "Organization of space" having a close relationship with the practice of breeding: 'Management of organic matter' because livestock ensures self-sufficiency in organic matter and maintains soil fertility; 'Contribution to environmental issues' because the protection of certain plant and animal species through compliance with territorial specifications is necessary for the conservation of natural biodiversity and genetic heritage; 'Valuation of space', which is an indicator related to breeding and which assesses the stocking of livestock per area intended for animals and which will, therefore, penalize farms without livestock with a zero score; and forage areas (A11: Management of forage areas), which sanctions farms with a plant production system only because they do not have an area intended for permanent meadows of grasslands or pastures (Hoernlein, 2014) (Table 2).

Table 2. Means of the indicators of the "Organization of space" according to farming mode component.

	Rotation (/8pts)	Parcells dimension (/6pts)	Management of organic matter (/5pts)	Ecological regulation zones (/12pts)	Contribution to environmental issues (/4pts)	Valuation of space (/5pts)	Management of forage areas (/3pts)	Total (/33 pts)
Livestock	1.75	2.625	2.875	0.25	0.625	1.25	1.875	11.25
Without livestock	0.5	2.6	0.9	0.9	0.0	0.0	0.0	5.0

With regard to the 'Agricultural practices' component, farms practicing only vegetable production recorded low scores, in particular because of indicators related to 'fertilization treatments', 'liquid 'organic effluents' and 'pesticides' (Table 3).

Table 3. Averages of the indicators of the 'Agricultural practices' component according to farming mode.

	Fertilization (/8pts)	Liquid organic effluents (/3pts)	Pesticide (/13pts)	Veterinary treatment (/3pts)	Protection of soil resources (/5pts)	Management of water resources (/4pts)	Energy dependency (/10pts)	Total (/34pts)
Livestock	3.75	2.25	6.75	1.125	1.875	3.875	6.25	25.875
Without livestock	0.8	1.9	2.6	0.0	1.8	4.1	6.0	17.1

In fact, monocultures and poorly diversified production systems require treatment. Indeed, the presence of livestock and rangelands delays the harmful effects on the environment and offers several agronomic advantages to the farm.

On the one hand, permanent meadows and areas intended for animals, especially if they are cultivated in a mowing-pasture rotation, improve soil

fertility and slow down runoff. On the other hand, some production systems are more sensitive and, therefore, require excessive use of treatments and pesticides such as viticulture and monocultures, unlike large crops and meadows, which are not as demanding.

Socio-territorial scale

In this scale, we will determine the influence of livestock on the degree of integration of the farm in its territory and in society as well as on the quality of life of the farmer.

The results of the calculations of the means of the three components of the socio-territorial scale for the two groups of farms are presented in figure 3. We can see that the integration of breeding practice has a positive impact on the "Ethics and human development" component and a little less on the "Employment and service" component. On the other hand, this impact is negative in the "Quality of products and terroir" component.

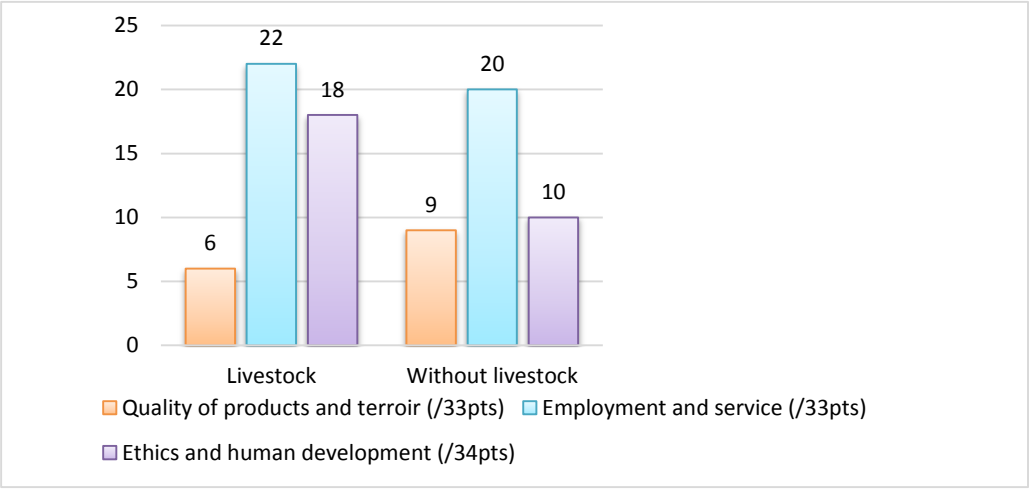

Figure 3. Averages scoring of the components of the socio-territorial scale according to the farming mode.

Regarding the first component 'Ethics and human development' (Table 4), the significant difference between the averages is due to the indicators: 'Contribution to the global food balance' and 'Animal welfare', which sanction the systems of production without breeding. Indeed, the notion of responsibility for the global food balance, illustrated by indicator 'Contribution to the global food balance', considers that the massive use of imported products reinforces the dependence of the farm on the world market to the detriment of the autonomy of resources. The indicator calculates imported area equivalents, which it compares to the farm's useful agricultural area (UAA), (with 4 tons of concentrated

purchased livestock feed are equivalent to 1 ha of UAA). Farms that do not practice animal husbandry, which do not produce protein crops or for which the "import rate" exceeds 50%, will score zero in this indicator. The scores in the other indicators are slightly closer and reflect aspects related to the living, working and training conditions of farmers and employees. This shows that the practice of breeding has no significant effect on the latter.

Table 4. Means of the indicators of the “Ethics and human development” component according to the farming mode.

	Contribution to the global food balance (/10pts)	Animal welfare (/3pts)	Training (/6pts)	Labor intensity (/7pts)	Quality of life (/6pts)	Isolation (/3pts)	Reception, hygiene and security (/4pts)	Total (/34pts)
Livestock	8	2.75	0.25	0.875	3.25	1	2.25	18.375
Without livestock	0.5	0.0	1.6	0.4	3.8	1.5	2.4	10.1

As for the “Employment and services” component, the averages for the two groups come closer with a slightly higher score for holdings engaged in livestock farming (Table 5). Indeed, the first group slightly exceeds the second mainly in the indicator ‘Autonomy and development of local resources’, which assesses the capacity of the operation to be self-sufficient in terms of resources and raw materials. The score for this indicator incorporates the percentage of autonomy in livestock feed, fertilizer, development of local and renewable resources as well as seed autonomy. The score can, therefore, be penalized if the farm does not breed livestock or if it does not have autonomy of at least 50% of cattle feed from the territory. This explains the low score (1.2 / 10) of the second group.

Table 5. Average indicators of the “Employment and services” component according to the farming mode.

	Valuation by short chains (/7pts)	Autonomy and development of local resources (/10pts)	Services and pluriactivities (/5pts)	Contribution to employment (/6pts)	Collective work (/5pts)	Probable continuity (/3pts)	Total (/33pts)
Livestock	6.875	4.875	0.625	5.5	1.125	2.75	21.75
Without livestock	6.7	1.2	1.7	5.5	1.9	2.7	19.7

Finally, the "Product and Terroir Quality" component is the only one to record better averages among the group of farmers who do not practice livestock (Table 6). It is a component that assesses the notion of authenticity of the identity of the terroir (Girardin *et al.*, 1999), the development of buildings and the surroundings of the farm (enhancement of the built heritage and the landscape), as well as the recognition of the quality of products at the national or international

level through labels or certifications (quality approach). The latter indicator has a very low average for the two groups of farms who do not value their products enough due to the lack of required financial resources. The same for indicator B3 "Management of non-organic waste", which has an almost zero value in the two groups, which reflects a general lack of awareness among operators in the Mornag area regardless of the production system.

The concepts of selective sorting, disposal by collection and recovery of waste are almost absent. In addition, farmers seem to practice burning, a practice unfavourable to the environment that the IDEA method sanctions with a negative score (-3pts). This component then reflects an aspect of farmers' practices and commitment that does not depend on the farming system.

Table 6. Average indicators for the 'Product and terroir quality' component according to the farming mode.

	Quality approach (/10pts)	Enhancement of the built heritage and the landscape (/8pts)	Management of non-organic waste (/5pts)	Accessibility of space (/5pts)	Social involvement (/6pts)	Total (/33 pts)
Livestock	0	2.25	0	1.5	2.25	6
Without livestock	0.8	3.1	0.3	2.2	2.2	8.7

Economic scale

The last sustainability scale looks at farmers' practices from an economic perspective. Under market conditions, the farm must generate sufficient current income to ensure the farmer certain autonomy in his choices and to allow him to move towards a sustainability approach (Briquel et al, 2010). From the radar graphic representation of the results (Figure 4), we can see that farms with integrated agriculture have slightly higher averages in the three components: 'Viability', 'Independence', and ‘Efficiency’.

For the "Viability" component, the averages of the two groups are very close and do not really depend on whether or not the practice of breeding is integrated. However, the first group has an acceptable average and a little higher than the second in the indicator 'Economic viability', which reflects a larger gross surplus (Table 7).

For farm independence, the averages are also similar in the two indicators ‘Financial autonomy’ and ‘Aid sensitivity’ with a slight advantage for the first group. For the third component ‘Transmissibility’, the two groups recorded low averages due to too much capital or the absence of partners and family labour; which represents a handicap to resuming operations in the event of cessation of activity or the departure of the manager.

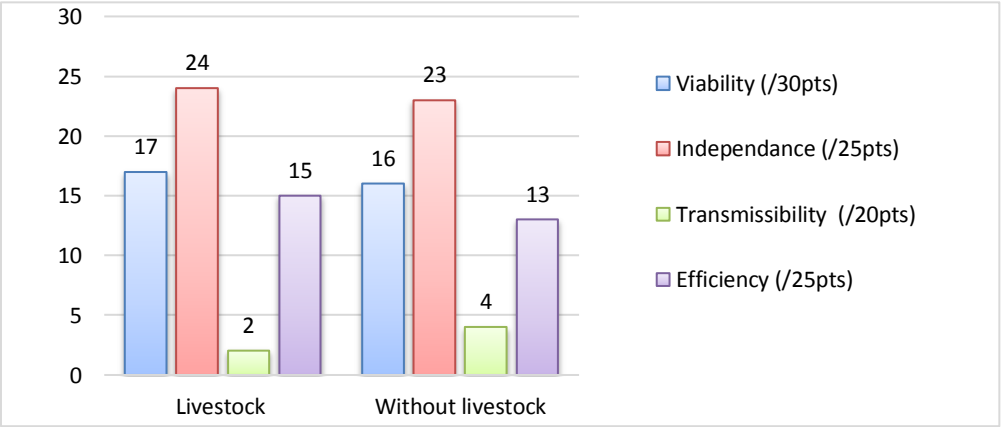

Figure 4. Averages scoring of the components of the economic scale according to the farming mode.

Table 7. Scoring of economic scale indicators according to farming mode

	Viability			Independence			Transmissibility		Efficiency	
	Economic viability (/20pts)	Economic specialization rate (/10pts)		Financial autonomy (/15pts)	Aid sensitivity (/10pts)		Transmissibility (/20pts)		Productive process efficiency (/25pts)	
Livestock	14	2.5	16.5	13.875	9.75	23.6	1.5	1.5	14.625	14.625
Without livestock	12.7	3.2	15.9	13.7	9.0	22.8	3.7	3.7	12.8	12.8

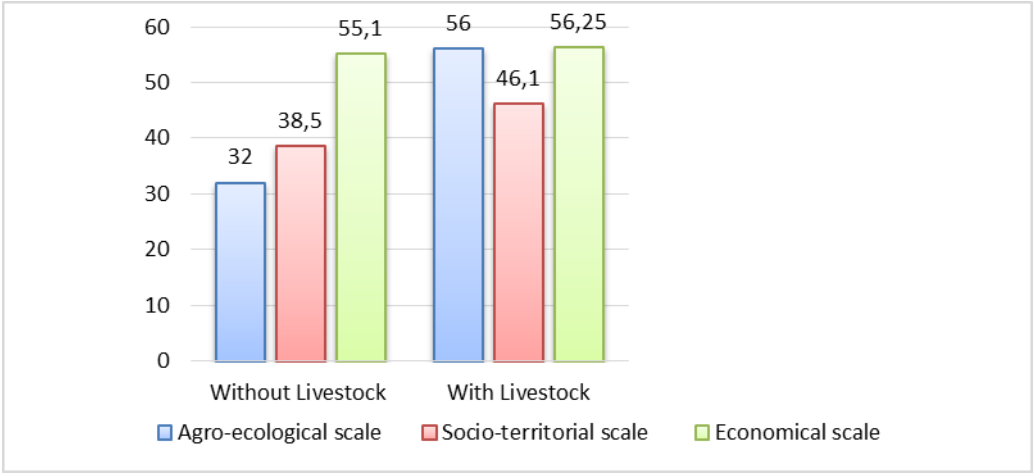

Figure 5. Representation of the averages of the three sustainability scales according to the farming method

The last component, "Efficiency", demonstrates the ability to generate value added by limiting operating costs and making the most of resources. Farmers practicing integrated agriculture have a better efficiency of the production process. In order to be able to confirm everything that is said previously, we decided to compare the sustainability of the farms surveyed in the Mornag zone according to the two farming ways: with livestock and without livestock farming (only cropping system).

Subsequently, we can see (Figure 5) that the group of farms that integrate livestock is more sustainable than the group of farms without livestock in all three scales. The biggest difference is found in the agro-ecological scale (32 points and 56 points), then the socio-territorial scale and, finally, the economic scale where the means of the two groups are similar.

CONCLUSIONS

From the analyses of the obtained results and the comparison between the means of the indicators of each component according to the farming mode, we were able to deduce that this factor considerably influences agricultural sustainability on both agro-ecological and socio-territorial scales. We can conclude that the group of farms that incorporate livestock has better averages in most indicators, in deed the association of crops with livestock within a production unit is considered an asset in the sustainability of a farm since it allows positive interactions and synergies between the different elements of the system. Indeed, in the mixed-crop-livestock system, the diversification of productions, crop rotation and the use of animal manures contribute to improving soil fertility.

In addition, animal husbandry allows income to be diversified and spread over time, thus ensuring certain stability in the economy. Some farmers even have a daily income from animal products such as eggs and chickens; others take advantage of some products for family consumption. The association of plant production with livestock makes it possible to promote the complementary relationships between cropping systems (fodder production, nitrogen fixation and soil fertility) and livestock systems (production of organic matter). Indeed, these complementarities make it possible to reduce the use of chemical fertilizers and concentrated feed. It also allows the use and exchange of by-products and allows them to be used as an input for the other system as animal feed and fertilizer, which saves resources but also preserves the soil resource. Crop-livestock integration is therefore a very important characteristic for a sustainable farming system.

Actions such as grazing animals inside or outside the farm, planting legumes or fodder crops have a positive impact on the environment, improve soil fertility and reduce inputs consumption. In addition, the integration of crops and livestock has a positive effect on the social and economic domains by creating jobs and increasing the level of productivity.

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