# AGRO-TEXTILES – THE CONNECTION BETWEEN SCIENCE-SUSTAINABLE DEVELOPMENT-ENVIRONMENT

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**Abstract**

*Food and drink are some of the greatest traditions and pleasures of our society. Today we have access to an impressive variety and quality of food and drinks. The food sector is an indelible part of the social, economic and cultural edifice of Europe. But, like most progresses, this comes with challenges. The European food and drink industry wants to play its role as an active partner in addressing these challenges to ensure that Europe continues to have the highest quality and safest food in the world, taking care of the environment. Agricultural development is critically important to improving food security and nutrition.*

*Major economic, social and environmental changes in agriculture around the world provide a starting point for understanding the issues surrounding sustainable agricultural development as a whole. The magnitude and complexity of the socio-economic context in the agro sector requires finding additional ways to adapt. In this context, the textile sector, respectively the field of technical textiles, through the potential of the functionalities, can make a special contribution to achieving a level of coherence between the field of functionalized materials destined for – environment - consumer health - sustainable development of agriculture.*

*Technical textiles, a modern concept in the textile field, can be defined generically: industrial textiles/functional textiles/hi-tech textiles/textiles of the future, and are considered as change factors for all economic, social and infrastructure fields.*

*Agro-textiles intelligently "manipulate" the micro-environment, helping growers to reproduce perfect growing conditions and protect crops from Mother Nature's less desirable forces, imposing themselves on performance, durability and functionality.*

*The paper will present the role of agro-textiles - as a bridge between science and agriculture - in the system of complementary solutions for the development of a sustainable agriculture in the context of the circular economy.*

**Keywords:** *circular economy, sustainable agriculture, agro-textiles, interactions*

## 1. INTRODUCTION

An extremely important goal for the future of mankind is to ensure constant improvement of quality of life for the present generation and for the future ones, so that it is respected our common heritage - the planet we live on.

In conformity with the Report presented in the ONU Program for Development, there are 8 dimensions of international security (collective security) and national security: economic and social security, food security, environmental security, community security, personal security, political security and individual security, to which can be added demographic and military security.

We are living in a period marked by the process of globalization, accentuation of inequalities and aggravation of environmental problems. The Earth can deplete its re-renewable and non-renewable physical resources, leading to a catastrophic imbalance. Sustainable development is the solution that encompasses economic, social and environmental considerations that can evolve in interdependence, supporting each other [1].

Sustainable development promotes the concept of reconciling between economic and social progress without endangering the natural balance of the planet [2].

The concept of sustainable development also includes the concept referring to sustainable agriculture, which essentially refers to the harmonization of the development of agriculture with the preservation of the ecological balance. Sustainable agriculture is one that can operate profitably from an economic point of view, but compatible with the constraints of an ecological nature. A closer knowledge of the intimate mechanisms of sustainable agriculture, perfectly integrated in the general harmony of nature, can be a non-negligible asset in the fight to ensure food security for the population.

Climate change brings two major challenges: drastically reducing of greenhouse gas emissions and adapting, through sustainable development, to a decoupled carbon economy that ensures, at the same time, a good quality of life for citizens and effective protection of their lives and property, in the event of new vulnerabilities and risks of natural disasters. It is now internationally accepted that global climate change is the result of human intervention in the bio-geo-chemical circuit of matter and water. Climate change is caused directly or indirectly by human activities that change the composition of the global atmosphere and add to the natural variability of climate observed over a comparable period of time. Climate change is caused by anthropogenic activities that produce greenhouse gas (GHG) emissions: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs). And sulphur hexafluoride ($SF_6$). The universal unit of measurement, to indicate the global warming potential of the 6 "greenhouse" gases, is carbon dioxide equivalent ($CO_{2eq}$).

Climate change affects many economic sectors, and agriculture is one of the most exposed, as agricultural activities depend directly on climate factors. This is important for the European area because 90% of this area is made up of agricultural land and forests. Adaptation is a critical challenge for agriculture and rural areas.

Agriculture represents an important source of emissions of two strong greenhouse gases: nitrous oxide ($N_2O$) and methane ($CH_4$). Both $CH_4$ and $N_2O$ emissions occur from the storage and spreading of animal fertilizers (figure 1):

- $N_2O$ is released into the atmosphere from agricultural land, mainly due to the microbial transformation of nitrogen-containing soil fertilizers. $N_2O$ emissions account for more than half of total agricultural emissions;
- $CH_4$ emissions are largely due to fertilizers from the digestive processes of ruminants (mainly cows and sheep).

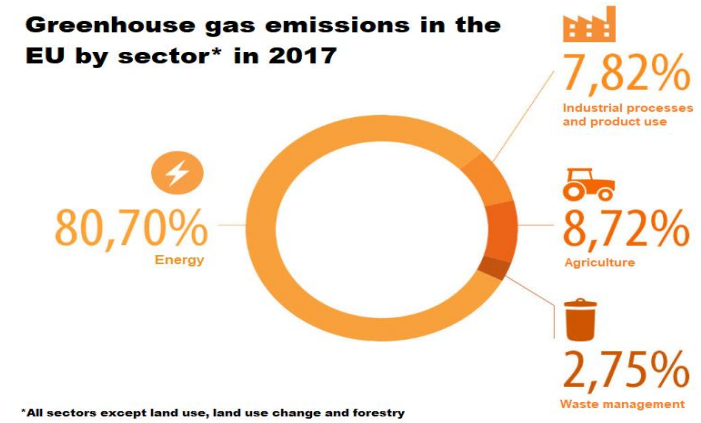



**Fig. 1.** Greenhouse gas emissions in the EU by sector in 2017 [3]

The consequences of the increasing frequency of extreme weather events such as hail, heavy winter rainfall, heat waves and drought will be felt throughout Europe. The succession of floods, droughts and storms in the last years has demonstrated Europe's vulnerability to extreme conditions. Their frequency could increase in the short and medium term [4].

The economic consequences of climate change are considered severe and critical, but the costs of stopping the phenomenon can also be very high.

Today it is unanimously acknowledged that the current agricultural system, in addition to outstanding contributions to social progress, has also caused serious damage to the environment and even to its vital resources - the soil and its own genetic resource base.

The practice of a sustainable agriculture aims at: maintaining the quality of the soil and ensuring an optimal correlation between the quantity and quality of food, human health and maintaining the quality of the environment. The achievement of these equilibrium correlations can be ensured by practicing an alternative agriculture whose objective function is determined by ecological and production restrictions.

As a basic branch of our national economy, agriculture asserts itself as a very complex and complicated field of activity. The complexity of agriculture, as a branch of material production, of the national economy, is determined by the role of agriculture in economic development and by its technical, economic and social particularities, which give to the general economic legitimacy a specific manifestation in agriculture.

The breadth and complexity of the socio-economic context in the agricultural sector requires finding complementary solutions to adapt. Technical textiles, "agro-textiles", through the potential of functionalities, can have a special contribution to achieving a level of coherence between agriculture, environment and rural development through the intelligent and sustainable capitalization of agricultural land, labour and human capital.

In this context, the vision 2020/2030 is:

*"Romania will have a sustainable and competitive agri-food sector, focused on the export of products with high added value, resistant to global challenges, which ensure well-being and living conditions in rural areas close to those in urban areas".*

## 2. MATERIALS AND METHODS

The sustainable development of agriculture is a vast and extremely complex issue, which aims to achieve and maintain a balance between the need to preserve the material and moral values of rural areas and the pace of change caused by the modernization of this sector [5].

The use of agro-textiles as complementary solutions for the implementation of a sustainable agriculture represents the scientific reaction to the challenges that determine the appearance and installation of the imbalance in an agro-system.

Agro-textiles are part of the technical textile sector, a sector that has registered positive economic and employment trends in the EU, being an example of a "traditional sector" able to "redefine its identity" according to a new business model, adapted to the needs of the new industrial revolution (smarter, more favourable and more sustainable). The technical textiles sector is constantly changing in terms of fields of use and innovations and performance in technology. Technical textiles offer solutions for various technical challenges existing in our society (environmental protection, personal safety, general protection, health, well-being, etc.).

The market value of agro-textiles is expected to reach US$ 16.3 billion by 2020 [6].

Agriculture is considered the "backbone of a country" and agro-textiles can be considered the "backbone of agriculture" [7].

According to the report published by Credence Research, "Agro Textile Market - Growth, Future Prospects and Competitive Analysis, 2016 – 2024", the agro-textile market is expected to grow to over US$ 14.363.2 million by 2025 (figure 2).




**Fig. 2.** Global Agro Textile Market, 2015-2025 [8]

The "agro-textile sector" includes the application of textiles in agriculture, forestry, horticulture, floriculture, fishing segments, landscape, gardening, animal husbandry, aquaculture and agro-engineering. Agro-textiles can be woven, non-woven or knitted [9] and offers multidimensional solutions for the variety of problems in the agri-food industry due to the advantages of textile structures (flexibility, strength, low weight, protection, etc.)

The research for the design and development of multifunctional/smart/interactive agro-textiles is a transdisciplinary research with well-defined directions of activity having as starting point the establishment of interdependencies between the needs of a sustainable agriculture, the potential of agro-textiles functionalities, the size of social and environmental economic effects and the improvement of knowledge in the field.

Agro-textiles - complementary to agricultural activities - must take into account the factors influencing these activities, namely:

- Sunlight - direct and indirect;
- The water;
- Climatic conditions, including wind, hail, humidity;
- External factors such as birds, insects, weeds;
- Post-harvest storage and packaging of products.

Using raw materials with high performance characteristics (natural and/or chemical fibres), and technologies for obtaining woven, knitted, non-woven textile structures, agro-textiles with the following main characteristics can be obtained [10]:

- resistance to solar and ultraviolet radiation;
- high capacity to retain water;
- capacity to prevent soil drying - protection against the effects of climate change;
- flexibility and biodegradability.

The choice of the optimal variant of an agro-textile element or system has the following advantages:

- decreasing the requirement for fertilizers, water, pesticides and herbicides;
- contribution to obtaining a healthy culture;
- incorporation in environmentally friendly techniques;
- increasing crop yields;
- ensuring a thermal protection, saving up to 40% of the energy needed to heat greenhouses;
- preventing staining and improving colour uniformity;
- reducing the maturation period of crops;
- ensuring protection against climate change;
- increasing crop production;
- maintaining clean cultivation areas.

Considering the mentioned aspects, a logical matrix of relations was elaborated between (figure 3):

- the requirements of an ecological agriculture;
- the field of use of agro-textiles that defines the functionalities and basic characteristics of textile structures;
- physical-mechanical, chemical and biodegradability characteristics of fibres/ yarns;
- processing technologies (weaving, knitting, non-woven).

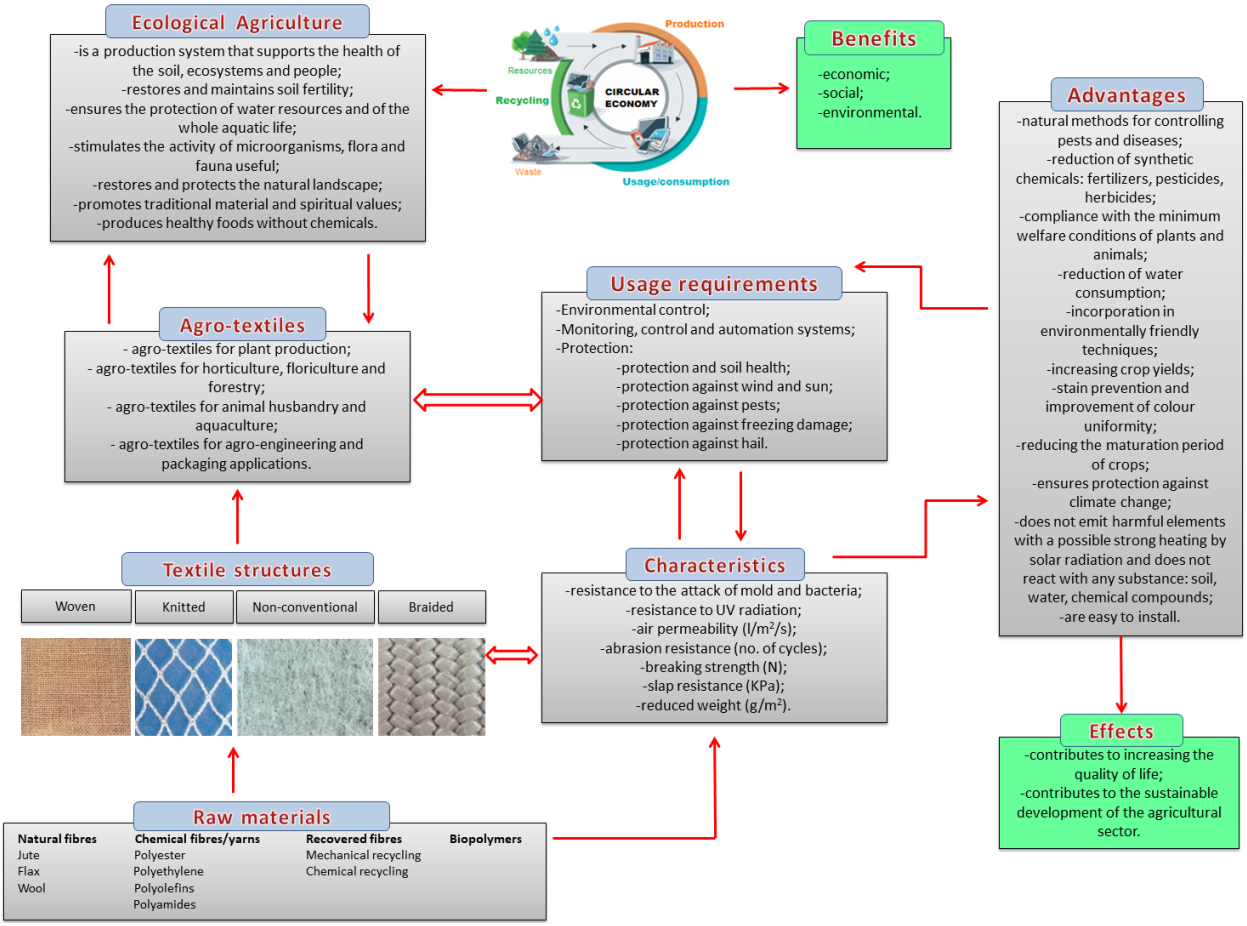



**Fig. 3.** Logical matrix of relations between the requirements of an ecological agriculture, the field of use of agro-textiles, the characteristics of fibres/yarns and processing technologies of agro-textiles

## 3. RESULTS

**The elaboration of the analysis and decision matrix used in the design of agro-textiles is based on:**

- Establishing the optimal variants of textile element/system to ensure the functionalities, respectively: environmental control, monitoring systems, control and automation, intelligent systems for monitoring crop irrigation, protection (protection and health of the soil, protection against wind and sun; protection against weeds, birds, frost, protection against the weather, protection against hail);

- Defining the textile structures according to the field of use (table 1):

| **Product Name** | **Woven** | **Knit** | **Non-woven** |
|---|---|---|---|
| Shading nets | | ☺ | |
| Wind protection nets | ☺ | ☺ | |
| Soil coverings | ☺ | ☺ | ☺ |
| Plant support nets | | ☺ | |
| Roots support nets | | ☺ | |
| Harvesting nets | | ☺ | |
| Mulching support/soil coverings | ☺ | | ☺ |
| Anti-hail nets | | ☺ | |
| Fishing nets | | ☺ | |
| Lawn protection nets | | ☺ | |
| Pallet covering nets | | ☺ | |
| Insect protection nets | | ☺ | ☺ |

**Table 1.** Textile structures according to the field of use

- Establishing the correspondence between the characteristics of the raw material used and the answer offered in the agro-textile functionality (table 2):

| **"Required" fibre characteristic** | **"Expected" agro-textile characteristic** |
|---|---|
| Breaking and elongation strength | Long-term durability and service life |
| Resistance to solar radiation | Long-term durability and service life |
| Resistance to ultraviolet radiation | Light permeability 80 to 90% |
| Biodegradability | Biodegradation in nature |
| Abrasion resistance | Long-term durability and service life |
| Protection | Wind protection and the creation of a suitable climate |
| Resistance to microorganisms | Resistance to microorganisms to protect the living being |
| Dimensional stability | Stability regardless of application |
| Low weight | Easy to use |
| Resistance to toxic agents in the environment | Long-term durability and service life |

**Table 2.** The correspondence between the characteristics of the raw material used and the answer offered in the agro-textile functionality

## 4. DISCUSSION

Sustainable agriculture is proving to be a viable alternative to intensive agriculture, as it has the essential role of promoting "environmentally friendly" systems and technologies, which also respect the needs of future generations to develop harmoniously.

The conversion to organic farming practices and methods requires the promotion of research strategies for the development of appropriate technological tools to help reduce the effects of climate change, improve food production and reduce labour costs.

Conversion solutions in which agro-textiles play an important role have the following benefits:

- increasing productivity;
- reducing the degree of pollution;
- effective use of pesticides, chemical fertilizers, water;
- real-time monitoring and intervention;
- reducing pollution and environmental impact.

Agriculture is a key branch of sustainable development and one of the objectives that the Ministry of Agriculture and Rural Development proposes for the next period is for agriculture to become eco-friendly.

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