

# Creativity, innovation and future – the key points regarding the “architecture” for the production of agro-textiles

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## ABSTRACT – REZUMAT

### Creativity, innovation and future – the key points regarding the “architecture” for the production of agro-textiles

*The twenty-first century represents the period of the most remarkable discoveries and transformations of the human civilization, but also the period of the most important changes regarding the evolution of the environment. At the present stage of the evolution of the society, the knowledge of the behaviour of the world economy cannot be conceived outside the environmental approach, as a system, structure and dynamics, its connections and implications on life on earth.*

*Agriculture is an important source of emission of two greenhouse gases with a significant share in the influence of the global warming process. The key to protecting the environment from the harmful effects of widespread and unsafe farming practices is through implementing sustainable practices. Sustainable agriculture incorporates both the conservation of available resources and the use of agricultural practices aimed at protecting the environment.*

*Given the increasing awareness of the environment and the specific knowledge of the various interdisciplinary technologies, special attention has been paid to unconventional technical applications, such as the use of textile structures in the agriculture and horticulture sectors to increase the quality and efficiency of agro-food products in terms of ensuring a healthy environment, social economic equity and a profitable economy.*

*In this context, the textile sector and the field of technical textiles, through the potential of functionalities, can make a special contribution to achieving a level of coherence between agriculture, environment and rural development through the intelligent and sustainable capitalization of agricultural lands and labour force.*

*For agro-textiles – weight domain for the technical textile sector – design is a problem-solving approach, based on common human technical/scientific skills or knowledge, which starts from understanding and observing the phenomena of the field in which these textile elements/products will be used. In this sense, the paper presents the logical matrix regarding the interactions between the problems that need to be solved, the elements that can influence the studied phenomenon the functions that the designed product has to fulfill and the effects produced by its use under real conditions of use.*

**Keywords:** agro-textiles, sustainability, interaction

### Creativitate, inovație și viitor – punctele cheie privind “arhitectura” de realizare a agro-textilelor

*Secolul XXI reprezintă perioada celor mai notabile descoperiri și transformări ale civilizației umane, dar și perioada celor mai importante schimbări în ceea ce privește evoluția mediului înconjurător. În etapa actuală a evoluției societății, cunoașterea comportamentului economiei mondiale, nu poate fi concepută în afara abordării mediului înconjurător, ca sistem, structură și dinamică, conexiuni și implicațiile acestuia asupra vieții pe pământ.*

*Agricultura reprezintă o importantă sursă de emisie a două gaze cu efect de seră, cu pondere semnificativă în influențarea procesului de încălzire globală. Cheia protejării mediului împotriva efectelor dăunătoare ale practicilor agricole extinse și nesigure este prin implementarea unor practici durabile. Agricultura durabilă încorporează atât conservarea resurselor disponibile, cât și utilizarea practicilor agricole care vizează protecția mediului.*

*Având în vedere creșterea gradului de conștientizare a mediului și cunoașterea specifică a diferitelor tehnologii interdisciplinare, o atenție deosebită a fost acordată aplicațiilor tehnice neconvenționale, cum ar fi utilizarea structurilor textile în sectoarele agriculturii și horticulturii pentru a spori calitatea și randamentul produselor agroalimentare în condițiile asigurării unui mediu sănătos, a unei echități economice sociale și a unei economii profitabile.*

*În acest context sectorul textil, respectiv domeniul textilelor tehnice, prin potențialul funcționalităților, poate avea o contribuție deosebită la atingerea unui nivel de coerență între agricultură, mediu și dezvoltare rurală, prin valorificarea inteligentă și durabilă a terenurilor agricole și a forței de muncă.*

*Pentru agro-textile – domeniu de pondere pentru sectorul textilelor tehnice – proiectarea este o abordare de soluționare a problemelor, bazată pe capacități/cunoștințe tehnice/științifice umane comune, ce pornește de la înțelegerea și observarea fenomenelor domeniului în care se vor utiliza aceste elemente/produse textile. În acest sens, lucrarea prezintă matricea logică privind interacțiunile dintre problemele ce se impun rezolvate, elementele ce pot influența fenomenul studiat, funcțiile pe care trebuie să le îndeplinească produsul proiectat, precum și efectele produse de utilizarea acestuia în condiții reale de utilizare.*

**Cuvinte-cheie:** agro-textile, sustenabilitate, interacțiune

## INTRODUCTION

Megatrends that will change the world in the coming years – demographic change, globalization, resource scarcity, climate change, dynamic technology and innovation, knowledge-based society, mass customization, global responsibility – define the critical moment in history [1]. Of these, the environmental changes, which will continue in the coming decades, represent growing challenges for food, health and welfare systems and include climate changes, increased ozone at the ground level, changes in water availability, increased carbon dioxide levels, soil degradation, deforestation and land use change. In these circumstances, Europe must embrace a new logic of global socio-economic sustainability, which, in essence, addresses economic success, population well-being and contributes to the conservation of the environment and resources and which is based on adaptation and mitigation strategies aimed at overcoming and/or reversing these changes.

Currently, Romania is in an important moment in which it must adopt a strategic position towards the challenges and the opportunities of wide. In this respect, Romania must maximize the favourable global and European trends, as well as its own competitive advantages. To meet the climate challenges it is necessary to apply the existing interdisciplinary knowledge, as well as to develop a new range of technical and institutional innovations. The research and development activity to facilitate the development of solutions regarding the challenges we have to face can be divided into two categories. One of these is defined from the point of view of a type of research in the field of social sciences, by which can be analyzed the ways chosen by a society to respond in case of future specific changes and can anticipate the types of actions to prevent the occurrence of problems and conflicts. The other is essentially established by the research and development

applied strictly in the field of technology and its development. Many technologies can be developed in laboratories, but they will not bring benefits if there is no market price and force to enable and promote their dissemination [2].

The Intergovernmental Panel on Climate Change (IPCC) has a long-term approach, analyzing the potential effects of climate change in relation to their determinants. Table 1 presents these elements synthesized by the IPCC for Europe [3].

Agriculture is an important source of emission of two greenhouse gases with a high potential for global warming: nitrogen oxide (N<sub>2</sub>O) – with a potential of 310 times higher than CO<sub>2</sub> and methane (CH<sub>4</sub>) – with a potential of 21 times higher than CO<sub>2</sub>. Adaptation to climate change must be fully in line with the activities of the agricultural sector, promote and protect food security and support the sustainable development of the rural environment [4].

To support the development of the agricultural sector, a strategic approach is required, which takes into account, on the one hand, the effects of climate change, by increasing pressures on primary resources – of water and soil and, on the other hand, on the increase in demand of agricultural products and food, related to the prospects of population growth at global level.

The EU pursues three objectives through the Common Agricultural Policy (CAP):

- ensuring a viable food production;
- ensuring the sustainable management of natural resources and actions in the field of climate;
- balanced territorial development.

Member states and regions develop their rural development programs based on the needs of their territories and address at least four of the following common EU priorities set for 2021–2027 [5].

The activity of the CAP, for the period 2012–2027, will focus on nine general objectives that reflect the

Table 1

RISKS – ESTIMATIONS – DETERMINING FACTORS		
Risks	Estimations	Determining factors
Negative impact due to climate change on: – grain yields; – increasing the variability of yields.	– The estimated impact varies according to the cultures, region and adaptation scenarios, with approximately 10% of the projections for the period 2030–2049. – After 2050 the risk of a more severe impact increases and depends on the level of heating.	– Heating trend; – Drought trend; – CO <sub>2</sub> fertilization; – Extreme temperatures; – Extreme precipitation.
– Increasing water restrictions. – Significant reduction of the amount of water available from rivers and underground sources; – Increasing the demand for water (for irrigation, energy and industry, population consumption); – Increasing the evaporation phenomenon, especially in southern Europe.	– Potential of adaptation proven by adopting more efficient technologies in terms of water use and water saving strategies; – Implementation of best practices and governance tools in river basin management plans and integrated water management	– Heating trend; – Drought trend; – Extreme temperatures.

importance of the policy from the economic and social point of view and from the environmental point of view [5]:

- supporting a reliable income and the resilience of farms throughout the EU, in order to improve food security;
- improving market orientation and increasing competitiveness, including a strong emphasis on research, technology and digitization;
- improving the position of farmers within the value chain;
- contribution to sustainable energy, as well as mitigation and adaptation to climate change;
- promoting the sustainable development and efficient management of natural resources such as water, soil and air;
- contribution to the protection of biodiversity, improvement of ecosystem services and conservation of habitats and landscapes;
- attracting young farmers and facilitating the development of enterprises in rural areas;
- promoting employment, growth, social inclusion and local development in rural areas, including bioeconomy and sustainable forestry;
- improving the response that EU agriculture offers to the demands of society in terms of food and health, including safe, nutritious and obtained foods through sustainable production, as well as animal welfare.

The key to protecting the environment from the harmful effects of widespread and unsafe farming practices is through sustainable practices. Sustainable agriculture incorporates both the conservation of available resources and the use of agricultural practices aimed at protecting the environment.

Given the increasing awareness of the environment and the specific knowledge of the various interdisciplinary technologies, special attention has been paid to unconventional technical applications, such as the use of textile structures in the agriculture and horticulture sectors to increase the quality and efficiency of agro-food products in the conditions of a healthy environment, of a social economic equity and a profitable economy.

In this context, the textile sector and the field of technical textiles, through the potential of functionalities, can make a special contribution to achieving a level of coherence between agriculture, environment and rural development through the intelligent and sustainable capitalization of agricultural lands and labour force.

## METHODOLOGY

The “agro-textile sector” includes the application of textile products in agriculture, forestry, horticulture, floriculture, fishing segments, landscape, gardening, animal husbandry, aquaculture and agro-engineering and it offers solutions for the major problems in the field, namely: globalization, demographic pressure, resource constraints (water, energy), environmental protection and human health. Agro-textile products can be woven, non-woven or knitted [6] and offers multidimensional solutions for the variety of problems in the agro-food industry as a result of the advantages held by textile structures (flexibility, strength, light weight, protection, etc.).

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 over \$ 14,363.2 by 2025, with an average annual growth rate (CAGR – compound annual growth rate) of 5.5% from 2017 to 2025.

In a conceptual century – based on knowledge – the new social, technological and cultural contexts demand a new perspective through a new approach to innovation. The need for new products, with multiple functionalities, able to balance the economic, social and environmental needs, must receive the answers based on a new way of thinking – putting the same concept of human needs, technological resources and constraints, establishing the cognitive link between the knowledge, processes/technologies and the requirements of the field of use.

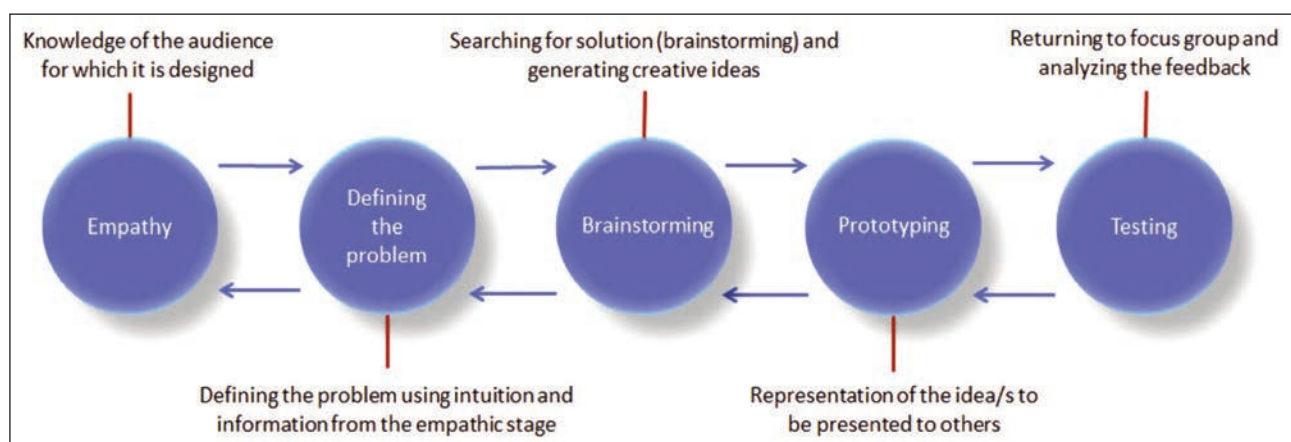


Fig. 1. Design Process Scheme [8]



INTERCONNECTIONS BETWEEN BASIC ELEMENTS FOR THE CONCEPTUAL DESIGN OF AGRO-TEXTILES			
Problems that require complementary solutions	Starting points in the designing/production of agro-textile elements/products	Key functions of agro-textiles	Effects of agro-textile use
<ul style="list-style-type: none"> <li>– globalization;</li> <li>– demographic pressure;</li> <li>– limiting resources;</li> <li>– reducing greenhouse gas emissions (GHG);</li> <li>– adaptation to the anticipated effects of climate change;</li> <li>– the extension of cultivable areas (mowing, drying, etc.);</li> <li>– increasing the acute, sub-acute and indirect toxic effects of the chemicals used on individuals and ecosystems.</li> </ul>	<ul style="list-style-type: none"> <li>– soil type;</li> <li>– the required limits of protection;</li> <li>– climate and irrigation requirements.</li> </ul>	<ul style="list-style-type: none"> <li>– wind resistance;</li> <li>– resistance to microorganisms;</li> <li>– light weight;</li> <li>– resistance to solar radiation;</li> <li>– resistance to ultraviolet radiation;</li> <li>– long life;</li> <li>– biodegradability;</li> <li>– water conservation;</li> <li>– stable construction;</li> <li>– elasticity;</li> <li>– abrasion resistance;</li> <li>– protective properties.</li> </ul>	<ul style="list-style-type: none"> <li>– improving the quality of agricultural products;</li> <li>– preventing the growth and spreading of the weeds;</li> <li>– reducing the effects due to the climatic changes (wind, hail, high temperatures);</li> <li>– reducing heating and cooling costs by 10–40% in a greenhouse, improving the microclimate;</li> <li>– adjusting the soil temperature;</li> <li>– reducing the consumption of chemical substances;</li> <li>– enhancing the intensive character through timeliness, production and high quality, with minimal costs;</li> <li>– adjusting the humidity in the soil, maintaining the phytosanitary status;</li> <li>– reduces soil fertilizer losses;</li> <li>– reducing soil compaction;</li> <li>– reducing of root cutting;</li> <li>– protecting crops against UV radiation;</li> <li>– protection of workers to chemical substances;</li> <li>– reducing the amount of work that the worker must do;</li> <li>– reducing the ‘cocktail’ effect of pesticide mixtures;</li> <li>– raising the awareness of the population regarding the correct use of pesticides based on the principle of respect for the environment and human health and promoting alternative methods of plant protection.</li> </ul>

Designing, in the case of agro-textiles, is a problem solving approach based on common human technical/scientific skills or knowledge, which starts from understanding and observing the phenomena of the field in which these textile elements/products will be used. Innovation (discovery through empathy – empathy being a way of looking at the world through many other eyes), designing, experimentation and realization are steps that impose a significant order in the process of making agro-textiles (figure 1).

In this sense, the selection of the textile structure/fibrous composition/technology for the production of agro-textiles, it is made taking into account the requirements of the domain of use based on a logical matrix regarding the interactions between the problems that need to be solved, the elements that can influence the studied phenomenon, the functions that must be fulfilled by the designed product and the effects produced by its use under real conditions of use (table 2).

The choice of the fibrous composition for the yarns intended for the realization of the textile structures (fabric, knit, non-woven) is a distinct step of the conceptual design, result of the correlation of the requirements of use with the characteristics of the fibers/yarns and not lastly with the specific of the processing technologies.

The fibers/yarns used for the production of agro-textiles must ensure certain functionalities of the final product (table 3) [9].

Table 3

CORRESPONDENCE REQUIREMENTS OF FIBER-PRODUCT/AGRO-TEXTILE	
Fiber characteristic – “required”	Agro-textile characteristic – “expected”
Resistance and elongation at break	Long-term sustainability and service life
Resistance to solar radiation	Long-term sustainability and service life
Resistance to ultraviolet radiation	Light permeability between 80-90%
Biodegradability	Biodegradation in nature
Abrasion resistance	Long-term sustainability and service life
Resistance to microorganisms	Resistance to microorganisms to protect the living being
Dimensional stability	Stability regardless of application
Light weight	Easy to use
Resistance to toxic agents in the environment	Long-term sustainability and service life

## CONCLUSIONS

At the planetary level, governments and international bodies are looking for solutions and thinking strategies for the global problems of humanity: food security, climate change, excessive dependence on non-renewable resources, job creation, sustainable economic growth, etc.

The national economy is an extremely complex system requiring the study of economic and social phenomena in a systemic vision as a whole of their interdependencies.

The need for new products, with multiple functionalities, capable of balancing the economic, social and environmental needs, must receive the answers based on a new way of thinking – putting in the same concept human needs, technological resources and constraints, establishing the link between knowledge, processes/technologies and the requirements of the field of use.

The design, in the case of agro-textiles, is an approach to solving problems, based on common human technical/scientific knowledge or skills, which starts from understanding and observing the phenomena of the field in which these textile elements/products will be used. Innovation (discovery through empathy–empathy

being a way of looking at the world through many other eyes), designing, experimentation and realization are steps that impose a significant order in the process of making agro-textiles.

The basic characteristics imposed on agro-textiles are:

- Resistance to solar radiation;
- Weatherproof;
- Biodegradation capacity;
- Tensile strength;
- Resistance to ultraviolet radiation;
- High water retention potential;
- Protection properties;
- Light-weight;
- Stable construction, easy to handle.

Agro-textiles are part of the group of complementary, innovative solutions, which can be used in the agricultural field in order to find a balance of the interaction between four systems: economic, human, environmental and technological, in a dynamic and flexible functional process.

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