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Bioeconomy based on Scientific Research and Entrepreneurship

Gómez-Garay[1], A; Torrejón, A[2]; Gómez-Flechoso[3], M.A; Georgieva[4], F; Pintos[1], B; Avalos[1] A; Martín[1] L.; Lahoz-Beltrá[3], R; Saco[5], M.D.; & Pérez-Urria[1], E.

Abstract

The bioeconomy can be defined as an activity that provides solutions to problems arising from the imbalance between increasing world population and the availability of resources and difficulties in supplying those needs. Bioeconomy is based on best and new uses of natural resources among which are important and essential plant species in areas such as agriculture, food industry, cosmetics and pharmaceutical industry, textile industry, landscaping and architecture, design of interior and exterior gardens, bioenergy, and the conservation and restoration of soils and natural ecosystems. Once checked problems, how to propose solutions in the context of the Bioeconomy? The universities base their activity in teaching and learning and scientific research. Furthermore, human societies and the habitats they occupy are social structures in which problems occur. If scientific research provides results that may constitute solutions to problems, it is necessary to build bridges between the academic activity and problems of society, bridges to convert research results in an entrepreneurial activity that allows its application as a solution to a given problem. That bridge is entrepreneurship to develop spin-offs and start-up. Something else to consider? The entrepreneurship is a process, it is learned, tested and developed, but solves nothing if not based on an entrepreneur, so the bridge is the entrepreneur instead of entrepreneurship. Consequently we must devote the effort to form new mindsets and attitudes to modern societies. If we have the necessary tools, learn to use them to be resolute and ask governments environments and mechanisms necessary to carry out the task.

Keywords: bioeconomy; entrepreneurship; entrepreneur; and scientific research

1. Bioeconomy Based on Plant Resources

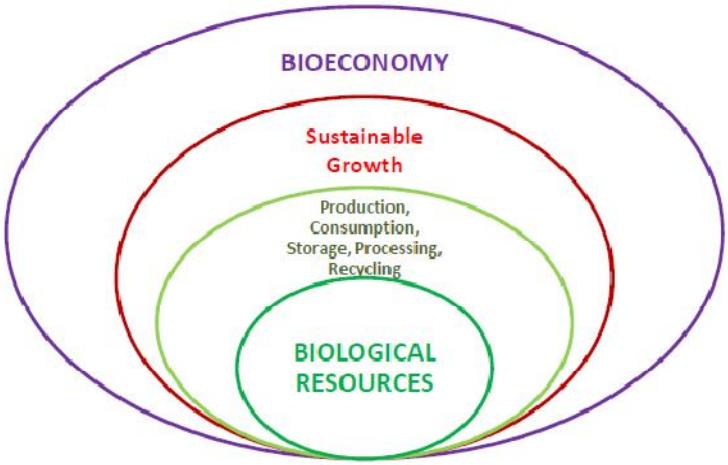
Economy can be defined as the set of effective and reasonable methods to meet the material human needs through the use, management and distribution of material resources, goods and activities that integrate the wealth of a country. The growth of the world population, increased demand for resources associated with that growth, and climatic and environmental factors that are exerting strong pressure on natural resources, which are an essential part of material resources, they are all issues that pose the need changes in the way we produce, consume, transform, store, recycle and eliminate biological resources. As shown figure 1, all these changes require research and innovation.

[1] Department of Plant Biology I, Faculty of Biology, Complutense University of Madrid
[2] Director Sergio i+E, Innovation, Entrepreneurship and Enterprise Center, Sergio Arboleda University, Bogotá, Colombia.
[3] Department of Biomathematics, Faculty of Biology, Complutense University of Madrid
[4] CEO and Founder Loquieroenmicasa.com
[5] Department of Plant Biology II, Faculty of Pharmacy; Complutense University of Madrid

Figure 1: Research and Development as Basic Elements to Address Current Problems Arising from the Increase in World Population

In this sense, agriculture, forestry or aquaculture require essential and limited resources to produce biomass for food use. These resources include fertile soils or marine areas, water, healthy ecosystems, mineral resources and energy. We can not abusing our natural resources but the world needs to *produce more with less* increasing productivity, reducing the pressure on the environment, making ecosystem-based management, making accessible alternative sources of carbon, by-products and energy (agricultural and forestry wastes, production residues and by-products) and researching on renewable resources. The response to increased global demand for biomass and foods must support sustainable growth (Fig.2).

Figure 2: Bioeconomy Activity Containing Use and Management of Natural Resources



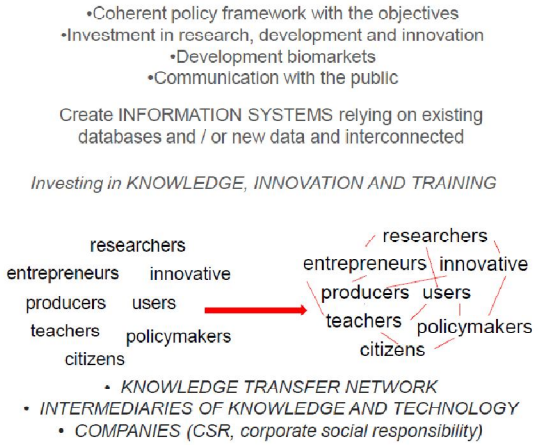
The contribution of Biology and Biotechnology to the Economy (local, national or global level) is unquestionable.

The technologies in Biology allow handling food plants and crops for biofuel production, and biotechnology also allows manipulation of physiological processes to optimize growth and plant development and production of phytochemicals. Plants and Plant Physiology are basic elements of agriculture whose aim should be sustainable productivity, combining the use of natural resources required (soils, for example) with their conservation.

There is a great biological industry producing foods, phytochemicals, bioactive compounds, plant extracts, modified organisms, bioplastics, biofuels, dyes, etc. Like others, this industry standardizes processes and follows a decision making process based on the analysis of risks and impacts. The biological industry must work for sustainability facing challenges as pollution, loss of biodiversity, water scarcity and salinity, degradation/nutrient loss/erosion of soils, decreased natural resources or carbon footprint. When the objectives of Biology, Biotechnology and Life Science Industry are established to solve or minimize these problems, then that is Bioeconomy, an activity that provides solutions to problems arising from the imbalance between increasing world population, the availability of resources and difficulties in supplying those needs. Only by recognizing and knowing the causes of the problems can then raise and propose effective solutions. Bioeconomy is based on the Life sciences, Agronomy, Ecology, Biotechnology, Information technology and communication, and Social sciences. Its activities seek sustainable and significant growth that requires a coherent policy framework with its objectives, investment in research + development + innovation, new ways of developing biomarkets, and communication to publicize their pinciples and objectives becoming popular and public this field of science. We need to invest in knowledge, education and training, to build networks of knowledge transfer and research results that contribute to the objectives of the Bioeconomy. Knowledge-Based Bio-Economy (KBEE) is the primary aim the "Food, Agriculture and Fisheries, and Biotechnology" research theme under the Seventh Framework Programme (FP7, European Commission) and develops activities around three areas: a) sustainable production and management of biological resources from land, forest and aquatic environments, b) fork to farm: Food (including seafood), health and well-being, c) life sciences, biotechnology and biochemistry for sustainable non-food products and processes.

Really the Governments of Nations, international institutions such as Food and Agriculture Organization of United Nations (FAO) and the World Economic Forum develop agendas and cooperation programms to promote and enhance economic activities in response to the growing demands of basic services related to food, environmental conservation and, ultimately, growth sustainable. Bioeconomy refers to the sustainable production and conversion of biomass into a range of food, health, fibre and industrial products and energy. Renewable biomass encompasses any biological material as a product in itself or to be used as raw material. Looking back we see that agriculture has always been, and remains today, the support of human societies, agriculture has been the activity on which it has based much of its growth and development, and also their collapse. Consequently we are not talking about anything new, we can say that at all times there has been a powerful bio-economy based on agriculture. Therefore bioeconomy currently focuses its objectives to new uses, best uses of biological resources within an overall framework of problems and solutions, making decisions based on knowledge, spread of education at all levels within these global issues (Fig. 3).

Figure 3: Networks of Knowledge Transfer that Serve to Make Decisions



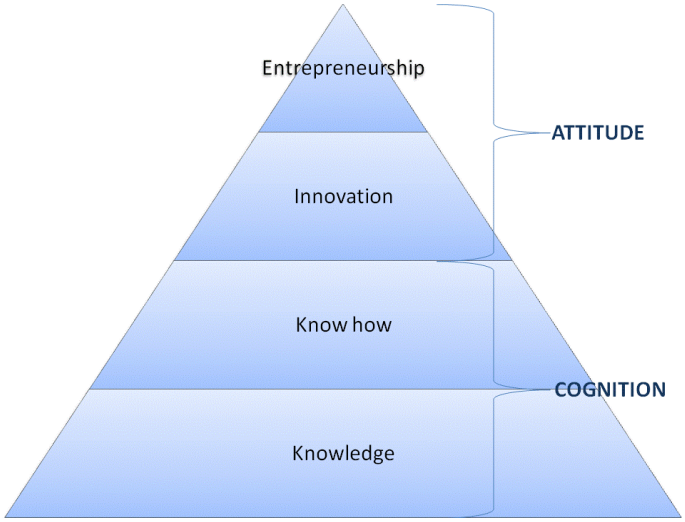
If the problem is to increase food production, the solution is not only increase crop productivity consistent with the conservation of the environment, the solution should include other actions to address collateral and derived problems.

It is known that food system, poverty, malnutrition, hunger, development, political systems, etc., constitutes a complex problem because it has different causes and thus many factors that determine it. Education which extends to all levels and stages of life is a cause and therefore is one of the solutions. Education and training to solve the serious disorder in the global food system has at least three lines of action:

1) In the current food system, introducing and following initiatives to improve the system, reduce imbalances and create awareness of needing a new order, a better deal, a new behavior and a new active attitude, both individually and collectively.
2) In the education system, at all levels, from children in schools, youth in high school and college, in the continuing education and learning throughout life, significantly and useful learning beyond data, numbers, statistics, education and learning in solving problems, how to solve problems, in this case about food order, food system. Children and young people today are politicians, doctors or presidents of governments in the very near future, they will take transcendent decisions and to make decisions that improve the current they must have another way of training and other knowledge. Education is part of the problem and part of the solution, perhaps the most important and effective solution at medium y long term.
3) Globalization can not exclude local actions that generate immediate solutions. For example, the establishment of local crops to supply local needs is a performance that is solving problems that the food system not only does not solve but even makes it worse.

Secondary education and higher education in academic disciplines are evolving slowly to include programs to learn to entrepreneurship and innovation. Innovation has two important dimensions: the first is the accumulation of knowledge that a university or corporation can make, and the second is to use successfully, such knowledge to transform inventions into innovation. Today's world offers solutions based on knowledge and innovation. An analogous to Miller 's pyramid (Fig. 4) can be applied to this new way of managing knowledge. From “knows” to “does”.

Figure 4: Miller’s Pyramid Adapted to Teach and to Learn Entrepreneurship



Three major findings emanate from the case studies by Levinson, F. James, and Yarlini Balarajan (2013) about addressing problems multisectorally as international experience. First, the value of the convergence approach, where combined nutrition-specific and nutrition-sensitive interventions are jointly targeted to vulnerable geographical areas and populations within them; both the concept of convergence and what this means in practice are explored further in the case studies and discussion.

Second, the importance of results-based incentives to sub-national governmental bodies with elected officials, to encourage more proactivity and accountability for results relating to the reduction of malnutrition. Third, the importance of active and sustained civil society advocacy. At the policy level, this advocacy serves to ensure political and administrative commitment to nutrition and food security (addressing the two simultaneously has multiple advantages); at the programmatic level, it helps to ensure adequate budgeting, well-designed and implemented programmes and programme impact that addresses the needs of the population.

2. Scientific Research, Knowledge Society and Knowledge Systems. Transfer of Knowledge and Research Results

University Technology Transfer Offices (TTOs) play an essential role in promoting startup companies as a result of research results and their transfer to the private sector. Remain important all areas of knowledge, the truth is that life sciences are an engine and a force of particular importance in the transfer of research results. Universities must find the bridge between academic activities with business activities. The transfer of knowledge and technology is an opportunity to develop ideas, work plans, progress, growth and development, both for academic institutions to the business sector. In this sense, an excellent way to transfer to society the results of the research is to create technology-based companies by professors and university researchers. This is called spin-off companies with technological nature and a high level of innovation that arise from results of research conducted at the university and often protected by patent. These companies base their activities on applications of new scientific or technical discoveries for the generation of new products, processes or services. The importance of these companies to enhance the technological environment and economic development, promote the creation of highly skilled jobs, providing high value-added industrial environment has made universities and other public research institutions devote increasing attention to them as genuine engines in the transfer of knowledge. Transforming knowledge and research results in a business is an orderly and regulated process following a legal procedure in any country in the world. This process requires effort and care but not problematic. The most important issue is to innovate, create something new as a result of a significant learning experience for a specific activity (Fig. 5).

Innovation means something to some extent unpredictable.

Figure 5: Innovation in Training

Universities, science-research parks and other public and private institutions develop training programs focused on transforming ideas into business projects. The aim of these programs is explore how to identify and develop great ideas into great companies, examine how to identify opportunities based on real customer needs, and discuss methods for developing solid business models for the creation of successful companies. These programs include a second phase of support for the business enterprise design, financing and finding investors (Enterprising Laboratory First and Second edition, Parque Científico de Madrid). Explore, examine and discuss are the way to develop a business based on knowledge and research activity, and on more than activities, are attitudes that make the person an entrepreneur. There are entrepreneurs rather than entrepreneurship. The classical scientific paradigm consists in the following steps: a scientist has an idea, conducts research and results are published in a scientific journal. However in recent years universities and research centers have undergone a paradigm change. At present, a scientist has an idea, conducts research and results are commercialized through a patent or through the foundation of a small business. For some countries without an entrepreneur tradition, for example Spain, this new paradigm has compelled universities and research centers to revisit their legislation and employment relations with its employees. For instance, as a result of the 'business ventures' of some of their professors the Complutense University of Madrid was forced to approves the BOUC 19/01/07 regulation that would allow professors to be entrepreneurs (Ponti and Ferras, 2006).

However, the chances of failure in this adventure are extremely high, which implies a high cost in time and money. Also, during that time the scientific production, i.e. the number of articles published in peer journals, may be diminished. Therefore, the adventure of creating a small technology company is a personal bet whose risks must be weighed before jumping into the adventure.

Once adopted the decision to establish the company in the coming years we will faced with the following difficulties. On one hand, we have to transform the 'results of laboratory' into a service e.g. via customized software, or a product. In the latter case, we have to translate the results into a physical object such as a device, drug, etc. conveniently presented in a good-looking container with a logo reporting on the corporate brand of the company. In addition, we will have to spend some time and money to patent the product, register the software, etc. In some cases it is not easy succeed in all these tasks. For example, the transformation of a plant or transgenic mouse in a commercial product; or selling specialized information, e.g. land cover maps. On the other hand, where there is nothing, we have to create a company. Starting a business can be a frustrating experience for a scientist or someone from the academic world. Let us consider broadly the main steps of the process of setting up a company. First, we have to design a Business Model Canvas (Osterwalder, 2014; Maurya, 2012). In this first step will experience the early setbacks: What is the value proposition? What about infrastructure? Who are the customers? What about finances? Once we have built the business model with the help of someone skilled in the Canvas modeling technique, then we move on to the second phase consisting of writing the Business Plan. Writing a business plan is not an easy task. Although we have the help of experts the researcher will need to spend some time learning the basics of running a business, marketing, accounting and finance. In the particular case of Spain, today universities spend money on contests whose prize is a course about 'how to create your business', coaching oriented to entrepreneurs, etc. Also in Spain many universities have a Scientific Park. However, what is profit returning to universities and entrepreneurs working in such institutions? For example, one problem that arises at this stage occurs when performing the marketing plan: Who will be our market segment? In other words who are our customers? Moreover who are the competitors? On this last question a SWOT analysis can help the success of the business plan. Third, within the marketing plan, other very important issues for the success of the company arise. For example, how do we calculate the price of the service or product? A crucial and frustrating issue for a scientist used to calculate 'more complex' problems. Finally, and fourthly, we now face the financial plan. At present, this is another issue that is popular in Spain, publishing books for entrepreneurs that explain how to write a financial plan (Manzanera, 2010; Martin, 2011). Again with the help of someone skilled, dedicating some time to learn the basics and using a spreadsheet already developed, it is possible to make a financial plan. If successfully overcome all these steps, we will see the birth of the university spin-off company.

3. Social Application in Research. Towards an Entrepreneur University

Globalization, sustainable development, the revolution of media and communication channels (internet and social networks), changes in labor market, global crisis define a new scenario in which universities are involved. It is in those moments when their third mission takes more relevance than ever. Without forgetting its importance as an institution that generates knowledge, universities must now dedicate a biggest effort in applied research, collaborate with the industry and promote entrepreneurship, not only among students but also among teachers and researches. In this way, universities will generate funds and will contribute in socio-economic development of countries.

3.1 University-Company Relations: Reality or Utopia?

Relationships between universities with socioeconomic environment and their role in the innovation process have been a recurrent topic. Knowledge transfer and promotion of entrepreneur spirit must become in key activities for the university system in order to play a relevant role in R&D+i system in the society. In general, universities have been aware of the need to intensify and organize properly these relationships; however not in all the countries the institutions know how to implement the proper strategy that stimulate these processes. The capability of generating resources from applied research is bigger as a consequence of their scientific specialization and their focus in technological development activities and the collaboration with companies. Universities that produce more research have bigger capability to gain specific resources. According to diverse studies, there is a positive relation between scientific productivity (documents by teachers and researchers (PDI)) and gained resources for the research for PDI.

Universities that appear in the first places of world rankings, as shows table 1, are those that have integrated in their strategy as core research, knowledge transfer, collaboration with companies and the promotion of entrepreneurship. The MIT in Harvard, Silicon Valley in Standford, Isis Innovation of Oxford have become in paradigms whose key element is knowledge transfer and generation of startups and spin-offs (Table 1).

Table 1: Source: The World University Rankings 2014

RANK	INSTITUTION	COUNTRY	SCORE
1	CALIFORNIA INSTITUTE OF TECHNOLOGY (Caltech)	United States of America	94.3
2	HARVARD UNIVERSITY	United States of America	93.3
3	OXFORD UNIVERSITY	United Kingdom	93.2
4	STANFORD UNIVESITY	United States of America	92.9
5	CAMBRIDGE UNIVERSITY	United Kingdom	92.0
6	MASSACHUSETTS INSTITUTE OF TECHNOLOGY (MIT)	United States of America	91.9
7	PRINCETON UNIVERSITY	United States of America	90.9
8	UNIVERSITY OF CALIFORNIA, BERKELEY	United States of America	89.5
9	IMPERIAL COLLEGE LONDON	United Kingdom	87.5
10	YALE UNIVERSITY	United States of America	87.5

Therefore, most of the funds for research do not accomplish its role to stimulate research productivity as it is not linked to the results. Most of the researchers are professors who get their salary regardless their performance in the results of the research. Legal regulations give to the University the intellectual property of the results of the research work performed by its staff using the University resources. The University and the research group agree on the value of the transferred knowledge. The expenses of the research, the expected future incomes and the market value for similar technologies are taken into account. In return, the researchers get part of the royalties, a percentage of the incomes or participation in capital the resulting company. Difficulties appear at this level, when Universities try to compensate the cost of the research increasing the price of the products or services offered. In this way, the resulting price is not competitive nor adjusted to the market in most of the cases. Additionally, not all companies are prepared to cooperate with universities or willing to do it. Size, innovation capability, human resources skills, sector of activity are some of the key elements that determine the level of cooperation with universities. The dialogue with big companies, especially in high technology sector (aerospace, chemistry pharmacy, electronic, etc.) is usually fluid because these company staff have technical expertise and are used to similar scientific language. However, this is not true for companies in other fields. Time scale and priorities of research projects are not the same in companies and academy. Different culture, different business model, different regulations are elements that could complicate a stronger cooperation between universities and companies.

3.2. Towards an Entrepreneurial University

Universities must adopt an attitude with an active role in the promotion of entrepreneurship for young people, investigators and teachers. A university spin-off is a company that emerges from a research group. The number of spin-off companies is an indicator of the usability of the research developed in the University. Spin-offs are created to take advantage of knowledge and technologies produced in the university. They are companies based on innovation that generate products and services with a high added value and demand highly qualified staff. They contribute to generate competitiveness and wealth, enhance relationships and synergies between university and business which may result in new research projects. They open work opportunities for researchers beyond the University. Spin-off companies are also an alternative option for students, teachers and researchers who can leave their comfort zone to begin the adventure of starting a business. "The University must serve as an agent of change, to show opportunities in technological sectors as well as to benefit the creation of mixed and multidisciplinary entrepreneurial teams" (GEM 2012). Universities have a commitment with the society to optimize people's talent for the development of the country. Entrepreneurship is an engine of any economy,. Universities must provide the means to facilitate that those who have innovating ideas and dreams do not give up due to the lack of resources, support or accompaniment to materialize them.

Starting a business is not an easy task and challenges self-confidence, courage, leadership and determination. Entrepreneurs have to face constant discouragement, assume risks and pursue their ideas to the end.

Those ideas are usually a life project and entrepreneurs are initially guided by instinct, creativity and passion more than capability, knowledge and resources. To promote entrepreneurship providing tools and the support of experts is as important as the theoretical training. The task of the Universities is essential especially during the phases of pre-incubation and incubation of startups. In these phases, the entrepreneurs have minimal support from companies and investors due to the high level of risk without enough profitability. In the case of University staff who want to create a startup, the difficulties may be even larger. Besides the above mentioned difficulties of the entrepreneurship, they also have to face against their own academic institutions rigidity. Regulations and bureaucracies are in some cases a barrier that could discourage the entrepreneur-teacher. Academic Institutions should increase flexibility, adapting their internal regulations to estimulate not only the publications of scientific papers and reports but also the registration of patents and the creation of companies. This task requires dedicated resources and budget. Additionally, business incubation centers providing these resources to support the researchers with the procedural initial steps and management, diminishing the bureaucratic overhead. They can then focus on the technical aspects while they are familiarizing with the business environment. Unfortunately, the current university structure are very rigid and slow, and the personnel do not have the necessary skills and business vision and become the bottleneck in the process.

4. **Cases, Success Stories: where does Success?**

Two examples selected by the Entrepreneur Laboratory – Parque Científico de Madrid program and developed as a business project through its training program in entrepreneurship are shown. e-GreenNUTRITION, as a spin-off of the Complutense University, has the support of the Complutense Technology Transfer Office (OTRI). Loquieroenmicasa.com, is a project of business on design, interior design and decoration including as a resource indoor and vertical gardens.

4.1. e-GreenNUTRITION (@eGreenNUTRITION)

e-GreenNUTRITION emerges as an idea in the context of e-health, ICT for knowledge management and information systems in the field of nutrition based on consumption of plant foods. The basic idea of the project responds to one question: what do we eat when we eat vegetables? This question takes at least three other associated questions: What plant foods we consume? What compounds are in these foods? Why they are important for our health or what significance do they have? The answers to all of them can be grouped into three conceptual blocks: Gastronomic Botany, Nutrition and Health, Bioeconomy. The background for these issues is not only the perception of not really knowing what we eat, being this an important issue from different points of view, but also the need of knowledge to promote better and healthier eating habits.

e-GreenNUTRITION project aims to integrate information from multiple sources in nutrition and organizing in an efficient and useful way these resources. Accordingly, it offers the following solutions: 1) access to a huge amount of knowledge regarding nutrition, 2) promoting health through good eating habits, 3) education and awareness through the dissemination of information to different population groups and different levels of knowledge, through broadcast media and internet, 4) professional development and continuing education through the electronic learning (e-learning) and learning throughout life (lifelong learning). The project would be an application of information and communication technologies for the creation of a network of knowledge and information at multiple scales, and web tools on plant foods, nutrition and health.

The first steps are to provide the network structure: technological infrastructure and human infrastructure. In the current context that promotes scientific research, development of new processes, systems and services and innovation, transformation of this project in a spin-off or star-up would create new employment opportunities for graduates from different fields. After months of training in the field of entrepreneurship and business creation, e-GreenNUTRITION became a business project created by professors from the Complutense University of Madrid who consider the transfer of knowledge and technology as an opportunity to develop new ideas, new work plans, progress, growth and development.

It offers advice and scientific and technological consultancy, which aims to provide added value to plant foods and derived products highlighting and emphasizing quality differentiators through information, analysis and training on them. Initially, addressed to the wine and oil sectors, and therefore producers of wine and oil, and producers of organic plant foods.

Key activities of the company are: 1) differentiating quality information services, including wine and oil analysis of compounds and proposed use of waste, 2) personalized training courses service, 3) web e-GreenNUTRITION: an application of information and communication technologies, formalized in a network of knowledge and information at multiple scales, and web tools on plant foods, vegetable products, nutrition and health. This framework includes the development of a wine ontology and a vegetable oil ontology (an ontology is a tool to organize information, entities and properties of a domain field).

4.2. Case Loquieroenmicasa.com (@Loquieroenmicsa)

A green wall is a wall partially or completely covered with vegetation that includes a growing medium, such as soil. Most green walls also feature an integrated water delivery system. Green walls are also known as living walls or vertical gardens. Green walls have seen a recent surge in popularity. The idea is to include the Green Walls in the special pack of decoration, eco-decoration with the selection of furniture made from sustainable materials and eco-labeled materials including everything inside the ecological parameters. What is sustainability and the use of sustainable materials? It is to use the resources that are easily regenerated. It is the responsible use of wood or products derived from this, such as cellulose, which are backed by the FSC or PEFC certified, the certification of the Chain of Custody of Forest Products ensures that the product comes from certified forests, properly managed. We ensure consumption thereof responsible extracted from forests that are replanted while exploited. We offer a new way to decorate with producers and professionals that work with environmentally friendly materials and a range of eco-labeled products that have an environmental seal. In this way, we think we help the future of the economy demonstrating our commitment to corporate social responsibility, environment, and society. Through Biosalud design and toxic free construction, we can also mention the vertical or Green Gardens Indoor Walls that are designed to promote health and wellness. A space built for people who care about themselves and for their environment. Decorating the interior of a home (whatever space) is somewhat expensive and somewhat difficult to maintain. However it can become highly decorative, giving a natural and ecological space to your home.

5. Conclusions

Relationships between universities and industry are keys for the development of a country. In the same way, entrepreneurship stops being an opportunity to become in a need, and the Universities plays a relevant role in the task of sensitization and promotion. The technology transfer and its labor in the promotion of entrepreneurship acquire a relevant role in advanced economies. Therefore, it is required that the University crosses its walls and reverts in the society the creation of scientific and innovative knowledge in an applied research way and in the creation of companies with a technological base. In the University there are not only knowledge, subjects, disciplines and degrees but there is an innovative talent. But, what do the research groups need to bring in the market?

At country level:

1. *A suitable innovation system*: The core missions of a suitable innovation system is count with an organism in charge of coordinate the scientific-technological politics, many programs that promote the creation of companies based on technology and a powerful academic system. Scientific world must be connected to the companies.
2. *Cultural change and even in some cases legislative*. Publications in scientific magazines are more valued than the registration of patents and creation of companies.
3. *A proper strategy of valuation of research results*, in which the prices were not defined by costs, but by benefits, profitability and competency.
4. *Promote a strong entrepreneur culture*, capable to assume and manage the risk.

At academic level:

5. Universities must intensify and organize properly relationships between university-industry, and promote the *knowledge transfer*, in products or services or in generation of innovative companies. It requires to create an appropriate structure where coexist offices, transfer and incubation centers and scientific parks.

6. *A suitable strategy of transfer and commercialization investigation results*, where theirs staffs look for in an active way companies and investors.
7. Research with *high marketable value* and cooperation with industry since the beginning of the project, in order to avoid the risk of dedicating resources in a research that is not demanded by the society.
8. A *global focus of research* towards the transference of results.

As conclusion it is necessary to consider knowledge as a service for the society.

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