Project Deliverable D 2.2

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D 2.2 SWOT of DIBBAUG, Socio-economic analysis and Strategic development plan of DIBBAUG

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293514	BIOPARTNERS	D 2.2 SWOT of DIBBAUG, Socio-economic analysis and Strategic development plan of DIBBAUG

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Abstract:
The current document presents the SWOT analysis of DIBBAUG, Socio-economic analysis and Strategic development plan of DIBBAUG.
The SWOT analysis represents the basis of the future project work. It aims to detect the strengths, weaknesses, opportunities and threats for DIBBAUG, focusing on the BIOTECHNOLOGY research and thus diagnose and guide the future strategy for development of DIBBAUG.
The SWOT analysis results are based on information, collected during in-depth discussions with the DIBBAUG's staff as well as with DIBBAUG's external partners. The interviews have demonstrated that the DIBBAUG biotechnology department plays a critical role in the national research and, undoubtedly can be ranked in the top 3 of the national research organization.
The present social-economic analysis (SEA) is a tool for detecting keys sectors for DIBBAUG R&D in the field of biotechnology**.** Its key objective is to assess the overall trends and capacities for improvement and to highlight their importance for the economy and society.
Strategic Development Plan of DIBBAUG is presented. This is based on DIBBAUG policies, the SWOT and socio-economic analysis as well as on the results already obtained by the BIOPARTNERS project implementation;

Keywords: Evaluation, BIOTECHNOLOY, DIBBAUG, SWOT, Strategic Development Plan

Table of Content

1. SWOT ANALYSIS OF DIBBAUG

1.1. Introduction

This present report describes the methodology, implementation phase and key conclusions of the DIBBAUG's SWOT analysis.

DIBBAUG's SWOT analysis is one of the operational tasks of the Work package 2 of the BIOPARTNERS project.

The SWOT analysis was carried out at the beginning of the project in order to prepare the basis for the future project activities, and particularly for the DIBBAUG's strategic development plan. Detecting the strengths, weaknesses, opportunities and threats for DIBBAUG will give a clear overview of the achievements that DIBBAUG should do during the project and beyond. The SWOT analysis will "diagnose" DIBBAUG and will thus guide the future strategy for development of DIBBAUG.

In order to implement the twinning between DIBBAUG and UMU, it is important to identify the position of DIBBAUG biotechnology R&D and what is the best way to introduce it to the European R&D in the domain of BIOTECHNOLOGY. The SWOT analysis is a useful tool for understanding DIBBAUG's internal and external environment and assessment the forces and weaknesses, opportunities and threats of the Georgian university.

The current SWOT analysis will be focused on the assessment of the DIBBAUG's capacities to integrate the European Research Area and to play a role in the enhancement of the cooperation opportunities between EU and its neighbours. The SWOT will help to develop a strategic vision for the next steps of the twinning activities and will pave the way for future reinforcement of the research links between the EU and Georgian partners.

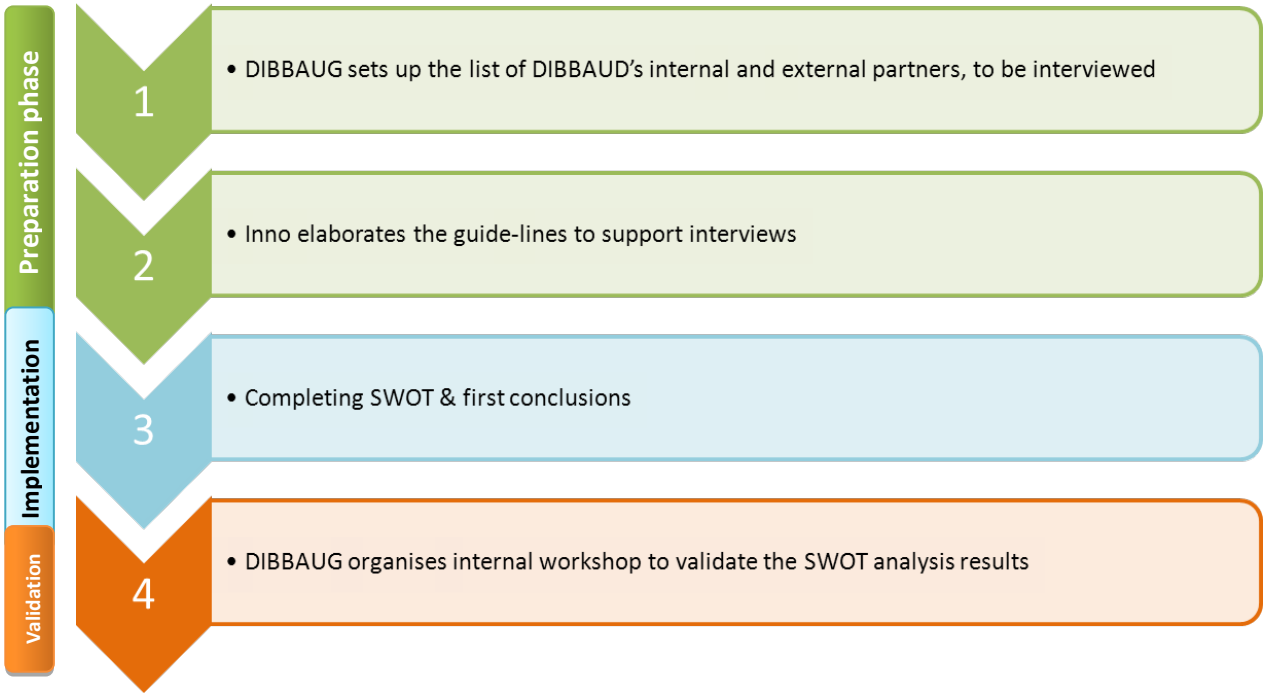
The present SWOT consists of four sections:

- Methodology
- Analysis of the data
- Results and synthesis
- Conclusion

1.2. Methodological approach

It is expected that the results of the SWOT analysis will provide a framework for reviewing strategy, research orientations, development capacities, international partnerships or any other idea. The results of the survey will have a direct impact on the identification of the DIBBAUG's strategic development axis.

The methodology of work is composed of the 4 following steps:



1.2.1. *Step 1: Set up the list of persons to be interviewed*

In order to collect quantitative and qualitative data on the DIBBAUG's ability to drive the implementation of a twinning in the field of BIOTECHNOLOGY, it has been planned to organise about 5 telephonic interviews with DIBBAUG's internals and DIBBAUG's external partners. The selection of people has been made by the project coordinator in line with a strategic vision of the exercise. 5 persons were interviewed;

1.2.2. *Step 2: Design of the guidelines*

The general objective is to collect homogeneous data and key figures, in order to evaluate DIBBAUG's capacity to implement a twinning based on BIOTECHNOLOGY. The guide-lines are composed of four panels of questions referring to the four fields of the SWOT analysis:

- DIBBAUG's Strengths
- DIBBAUG's weaknesses
- Opportunities for DIBBAUG
- Threats related to the reference topic

The forces and weaknesses refer to the **internal environment** of the DIBBAUG and help up to evaluate Georgian research centre's capacities to forward with the project and further cooperation with EU teams in the field of BIOTECHNOLOGY. The opportunities and threats are related to the **external environment** and constitute action areas in which DIBBAUG can expect to enjoy a differential advantage (opportunities) and to consider unfavourable trends or disturbances of the environment external to the project. A threat is particularly serious because it strongly harms the project and the risk that it will happen is relatively high. The content of the guide-lines is based on the set of specific criteria that will be presented below. The guide-lines are adapted respectively to the DIBBAUG's internals and DIBBAUG's external partners.

1.2.3. *Step 3: SWOT exercise and first conclusions*

We remind that DIBBAUG SWOT analysis is **a subjective assessment** of data which is organized by the SWOT format into a logical order that helps understanding, discussion and decision-making on the subject related to the DIBBAUG positioning as a strong partner in the field of BIOTECHNOLOGY The SWOT format represents a matrix that has been developed by inno with a number of criteria corresponding to each analysed area. We underline that the criteria is a subjective fluctuated parameter and accordingly to the response of the interviewee can illustrate strength or a weakness.

Each criterion covers a number of indicators which provide basis for the questions asked during the interviews.

SWOT AREA	CRITERIA
STRENGHTS	➢ Research Capabilities ➢ Competitive advantages ➢ Involvement in EU/ international cluster ➢ Human resources ➢ Young scientists attractive capacity ➢ Management experience ➢ Financial Reserves

	➢ Marketing-awareness ➢ Geographical location ➢ National reputation
WEAKNESSES	• Gaps in research capabilities • Gaps in management capabilities • Gaps in marketing capabilities/awareness • Lack of competitive strength • Reputation, presence and reach • Financials (insufficient state funding) • Cash-flow, start-up, cash drain • Continuity, commercialization chain robustness • Morale, commitment, leadership • Location
OPPORTUNITIES	• Commercialization potential of research • Research competitors' vulnerability or Competitive advantages • Industry trends • Lifestyle trends • Global influences • New Markets • International partnerships
THREATS	• Political effects • Legislative effects • Environmental effects • EU Competitor intentions • Market demand • Industry supporting research • Start-up commercialization potential • Obstacles faced • Insurmountable weaknesses • Brain Drain • Sustainable financial backing

The set of indicators corresponding to each of the criteria is given in the following table:

SWOT AREA	CRITERIA	INDICATORS
STRENGHTS	Research Capabilities: Do you think that DIBBAUG has strong research capacities (in term of researcher, equipment and possibility of publication)?	• Number of scientists/ young scientists and number of PhD holders as well as Master degree holders • Adapted equipment (difficulty to work and

	progress because of the equipment) • Number of publications in international revues (Applied Biochemrmistry and Microbiology, Ecotoxicology and Environmental Safety, .International Biodeterioration and Biodegradation, Fresenius Environmental Bulletin, Advances in Food Sciences, Journal of Biological Physics and Chemistry, Plant Science, Biochemistry USA, Zeitsschrift fur Naturforschung, Z. Naturforschung Global Journal of Biochemistry, Journal of Biotechnology, International Journal for Medicinal Mushrooms Food Research International, Thermochimica Acta)
Innovation potential: Do you think that DIBBAUG has a high innovation potential? Do you know industries that can be interesting in technology transfer from DIBBAUG?	Licenses (domestic, European, International Patent of Germany 2151265. 1972; Patent of Switzerland 583777: Patent of USA 3826716. 1974; WO 2006/114787 A3, 2006; Patents of USSR: # 659617. 1979; # 1161549. 1983. # 1252336. 1984; # 1490953. 1989. # 1509402. 1989; # 1643608. 1907. # 1667374; Patent of Georgia: # 861, 1991; N1121, 1993; #861, 1994; # 002621, 1997; # 1025, 1997; # 2708, 2001; #Au 2004; 001261, #Au 2004; 001260, P 4610, 2009; P 4609, 2009 • Number of industrial partners (who, where, since when) • Agreements with industrials (number, with who) • Technology transfer (to local companies or outsiders, technologies/products that are already commercialized) • Number of spin offs created through cooperation with the structure • Liberty of research to innovate/propose new idea
Networking/ Integration: How will you define the involvement of DIBBAUG in the European research area?	• Collaborations with clusters (Number and name of European/ International clusters), other research structure • Awareness of clusters • DIBBAUG's position: leadership/ head of network • Covered Sector, domain of research • Participation in conferences, workshops, showrooms (where, importance of these events in the scientific area, target of these events) • Benchmarking performance, awareness of other initiatives
Human Resources: Do you think that	• Trainings for young scientists, exchange with

	the human resources are enough and are adequately distributed in terms of tasks and projects?	other international/European universities (which one, how often, in which framework, financial support) • Communication between manager and scientists • Recruitments conditions (what is the salaries, advantages), comparison with other research structure • Attractiveness of young scientists or foreign scientists • Foreign student and their nationalities • Is someone in charge of technology transfer, funding opportunities, investor attractiveness • Someone in charge of international relation
	Financial reserves What are the funding resources? Do you receive financial State support?	Open question
	National Reputation: What is the reputation of DIBBAUG in Georgia? Does DIBBAUG have competitive advantages in comparison to other structure in Georgia?	
	Location: Do you think that the structure is geographically attractive?	• Accessibility (airport, train) • Distance, time
	Accreditations: Do you have any international accreditation/ international label	
WEAKNESSES	Gaps: What are in your opinion, the main gaps of DIBBAUG? In which BIOTECHNOLOGY field of research DIBBAUG has obstacles to overcome and why?	• Research Capabilities (international trend, willing/capacity to extend the domains of research) • Technology and Innovation management capacity • Marketing Capabilities: Communication capacities/ Presence/ Reach (website)/ Reputation
	Marketing-Awareness: How do you define DIBBAUG marketing strategy? International Visibility: Do you think that there are some efforts to be made by DIBBAUG to improve its international visibility?	• Communication/ Visibility/ Attractiveness (website, flyers etc.) • Participation in European/ International Events for foreign partners • Partnerships/ Number of contracts/ Investors • Location
	Financial reserves: Do you think that the lack of funds could be a hindrance to the development of innovative	• Commitments could prevent the smooth running of some projects with European and internationals partners

	projects or strategic initiatives? Idea? What do you think of the merge of DIBB with the Agrarian University of Georgia?	
	Human Resources: What do you think of the Young scientists' attractive capacity of DIBBAUG? Do you have any idea how to attract scientists to stay at DIBBAUG?	• Brain Drain phenomena
OPPORTUNITIES	Leader Capacity: What do you think about DIBBAUG's leader capacity?	• Industrial partnerships • Licenses given to spin offs • Lifestyle trends (ex use of biofuel in Georgia?)
	Competitive advantages in research: Which are the BIOTECHNOLOGY fields of research where DIBBAUG is on the cutting edge of technology?	Open question
	Commercialisation potential/Market Opportunities: Do you think that DIBBAUG has a sufficient research & management competences to play a leading role in the creation of EU-Georgian consortia? Any idea on the markets of future for DIBBAUG?	• Standardisation (envie de se caller sur le modèle européen) • Technology and Innovation Management • Influences of government policies (Help from the government for the biotechnology area) • Influences of technological market (security) • Investment trend: attraction of Funds • European Union intentions (aware of funding opportunities?) • Environmental context • New market • Industry trends (example in comparison of their research area)
THREATS	Political & Legislative effects	• Emergence of regulations/initiatives that could prevent or help contracts or partnerships to be done
	Do you consider that the referenced field can be affected by the following gaps?	• Lack of creativity • Lack of funds • Lack of equipments/infrastructures at a national level/compare to other • European intention goes against the Georgian intention • Lack experience of administrative staff • Bureaucracy
	Brain Drain Phenomena: Do you think that a closer interaction with the EU could push the brain drain phenomena to occur?	• High qualified scientists that leave the structure • Movement of financial/movement capital • Political instability (now and in the recent past)

	Competition: Do you know the competitor in your field of research at national/international level? Economy	• Target for exportation: Caucasian region, European countries or broader • Impacts on the Georgian Economy

The assessment has been made by inno on the basis of the data collected through interviews, DIBBAUG reports, and internet search. The results of the assessment are a subject of the chapter 3.

1.2.4. *Step 4: DIBBAUG internal meeting*

SWOT analysis is an excellent support for brainstorming meetings. Therefore draft version of the SWOT analysis has been discussed at the DIBBAUG internal meeting, organised in July.

The objective of this meeting was three fold:

- To report on the SWOT analysis results;
- To provide feedback and validate the results ;
- To debate on DIBBAUG's ability to play the role of catalyze for creating a twinning in the field of BIOTECHNOLOGY.

The final SWOT analysis was submitted to the UMU team for approval.

1.3. Analysis of the data

1.3.1. *DIBBAUG SWOT analysis matrix*

STRENGTHS	**WEAKNESSES**
Research Capabilities	Gaps in research capabilities
Competitive advantages	Young scientists attractive capacity
Involvement in EU / international cluster	Gaps in management capabilities
Human resources	Gaps in marketing capabilities
Management Experience	Lack of competitive strength
Financial reserves	Reputation (internationally?), presence and reach
Marketing - awareness	Financials (insufficient state funding)
Accreditations	Cash flow, start-up cash-drain
	Continuity, commercialisation chain robustness
	Morale, commitment, leadership
	Location
OPPORTUNITIES	**THREATS**
Commercialisation potential of research results	Political effects
Research Competitors' vulnerabilities	Legislative effects
Industry trends	Environmental effects
Lifestyle trends	EU Competitor intentions
Global influences	Market demand

New markets
International Partnerships

Obstacles faced
Insurmountable weaknesses
Brain drain
Sustainable financial backing

DIBBAUG SWOT Analysis

Interviews transcripts/bibliographical analysis outcomes

STRENGTHS

CRITERIA:

- **Research Capabilities**
- **Human resources**
- **Innovation Potential (idea generation)**
- **Networking /integration**
- **Management experience**
- **Marketing-awareness**

- **Excellent Research Capabilities :**
  - World excellence in the following areas :
    - *Microbiology*
    - *Plant biotechnology*
    - *Phytoremediation*
    - *Industrial Enzymes*
    - *Functional food*
    - *Natural Colorants*
    - *Biosurfactants*
    - *SSF technologies*
  - Position recognized at a national level, one of the best institute in Georgia
  - Research capabilities in accordance with international trend
  - Publishing performance

- 10-15 scientific publications per year, among them 6-10 international ones including conference abstracts.

- **Human resources**
  - up to 40 scientists (most of them are all PhD holders), among them 5 young scientists
  - Highly qualified and experienced scientists(most of them are PhD And Doctors of Sciences)

- **Innovation potential:**
  - Collaboration with 2 industries: Inagrosa, LTD (Spain) and Joint-stock company "Kolkheti 93 (Georgia)
  - DIBBAUG has a big collections of micro-organisms (accounting around 4 000 cultures of microorganisms - fungi, bacteria, actinomycetes, yeasts including extremophiles) that actively producing different low-molecular-weight metabolites and enzymes (amylases, cellulases, xylanases, proteases, laccases, Mn-dependent peroxidases, etc) including a new generation of enzymes for lignocelluloses hydrolyses.
  - Potential application:
    - *Industrial production of food, beer and alcohol;*
    - *Production of ethanol and glucose from cellulosic agricultural wastes.*
    - *Cleaning/ washing products*
    - *Production of fruit juices, functional natural food additives such as colorants*
    - *Soil remediation (polluted by military waste, oil products and other toxic compound)*
    - *New microbial technologies*

- **Networking / Integration**

Cooperation of 1 lab with Brussels, Finland, USA, France (Aix en Provence and a potential collaboration with Marseille)

DIBBAUG has scientific cooperation with universities of EU, USA, Canada, Japan, Korea and

	Institutes from the former Soviet Union countries. ➢ **Marketing-awareness** o Communication tools: - Internet, phones, faxes and face to face communications - Lectures taught by scientists to university students. - Books and articles published in well known journals. - Participation in several conferences (Georgia, EU and US) ➢ **Facilities to attend the DIBBAUG location**
WEAKNESSES **CRITERIA:** ➢ **Gaps in research capabilities** ➢ **Lack in scientists attractive capacity** ➢ **Gaps in management capabilities** ➢ **Gaps in marketing capabilities** ➢ **Lack of competitive strength** ➢ **Financials (insufficient state funding)** ➢ **Location**	➢ **Gaps in research capabilities** o Healthcare technology o The equipment is suitable for the work carry out but need for more modern equipment and specific equipment (e.g. Mass spectrometer, high speed centrifuge, ultra low freezer, mini spray dyer) ➢ **Lack in scientists attractive capacity** o Insufficient efforts to attract young scientist o Salaries are comparatively low Qualified scientists often leave the structure for the private sector ➢ **Caps in marketing capabilities** o Lack of visibility for potential foreign partners, communication tools efficient ✓ *DIBBAUG is not well known by the EU partners* o Communication mostly through the network o Lack of attractiveness for EU people ➢ **Lack of competitive strength**

	○ Lack of industrial partner ➢ **Financial reserves** ○ Funding from the Agrarian University of Georgia, local and international research grants like ISTC (International Science&Technology Center), STCU (Science and Technology Center in Ukraine) ○ No funding from the state ○ No sufficient financial resources for funding innovation projects or strategic initiatives ○ The lack of financial reserve is a hindrance to the attractiveness of DIBBAUG ➢ **Location** ○ DIBBAUG is located in Tbilisi, the capital of Georgia about 20 km from the airport ○ Not much public transport to facilitate the access to DIBBAUG
OPPORTUNITIES **CRITERIA:** ➢ **Commercialisation potential of research** ➢ **Industry trends / New Markets** ➢ **Lifestyle trends /social trends** ➢ **Global research influences** ➢ **Integration to ERA** ➢ **International partnerships** ➢ **Sustainable financial backing**	➢ **Commercialisation potential of research** ○ Need for enhancement of technology transfer infrastructures in Georgia ➢ **Industry needs/ News market** ○ Food processing industries ○ Agricultural industries ○ Plant protection microbial means industry ○ Biofuel industry ➢ **Lifestyle trends/social trends** ○ Overall level of education in Georgia is high (Most disciplines are in line with international standards of education) ➢ **Integration to ERA** ○ Integration to ERA will be good for exchange of research capabilities, technologies and experience in order to improve the research capacities of DIBBAUG. It will also allow access and communication with scientists from Europe (in both directions) and

	identification of new partners with similar scientific interests. ➢ **International partnerships** o Mainly with EU partners (Brussels, Finland, France…)
THREATS **CRITERIA:** • **Political effects** • **Legislative effects** • **Environmental effects** • **EU Competitor intentions** • **Market demand** • **Obstacles faced** • **Insurmountable weaknesses** • **Brain Drain** • **Limited financial backing**	➢ **Political effects** o Political situation is considered as stable state. ➢ **EU Competitor intentions** o Efforts in research should be made in Nanotechnology and genetic engineering of plants and microorganisms ➢ **Obstacles faced** o Lack of technology transfer units and infrastructures ➢ **Brain Drain** o Brain Drain from Georgia to EU. Greater recourse to knowledge coming from outside o The risk of brain drain phenomena is moderate (people are attached to their countries) ➢ **Limited financial backing** o High risks identified: Low investment in DIBBAUG's infrastructure development

1.4. Results and synthesis

The SWOT analysis is a subjective assessment focused on a specific topic, which is Biotechnology and not an in-deep evaluation of the DIBBAUG capacities at research and management levels.
Based on appreciations of persons from the DIBBAUG and external stakeholders, the idea is to give some thoughts that can be helpful to develop DIBBAUG development strategy, to overcome potential threats in reinforcement of DIBBAUG's networking on the larger European level. The SWOT outputs will nurture the two other work packages, and in particularly the Reinforcement of international cooperation capacities of DIBBAUG, as well as sustainable plan and exit strategy.

With this regard, the results of the SWOT analysis are summarised below.

DIBBAUG has a strong expertise in the following Biotechnology fields of research:

- Microbiology
- Plant biotechnology
- Phytoremediation
- Industrial Enzymes
- Functional food
- Natural Colorants
- Biosurfactants
- SSF technologies

Even though there are several Biotechnology topics where DIBBAUG has strong competences and research capacities, there is a lack of name recognition outside the country and the Georgian Biotechnology research is not well-known at EU level. There are few European projects dealt in Georgia, which demonstrates the need to develop research capacities and notably promote them abroad. Researchers at DIBBAUG participate in Biotechnology conferences and workshops in Georgia, Europe and USA but it needs to be intensified. Because as the promotion of DIBBAUG is mostly done using the network of the researchers (through face-to-face communication, internet, phones…); participation in conferences and workshop is the best way to promote DIBBAUG's capacities.

DIBBAUG needs to increase its participation in EU events in order to promote its competences and capacities in Biotechnology research.

Currently there is low level of public-private partnerships in due to different reasons. One of the main causes for the weakness of public-private partnerships is the lack of technology transfer infrastructures, establishing the connection between industries and academia. In this context, the

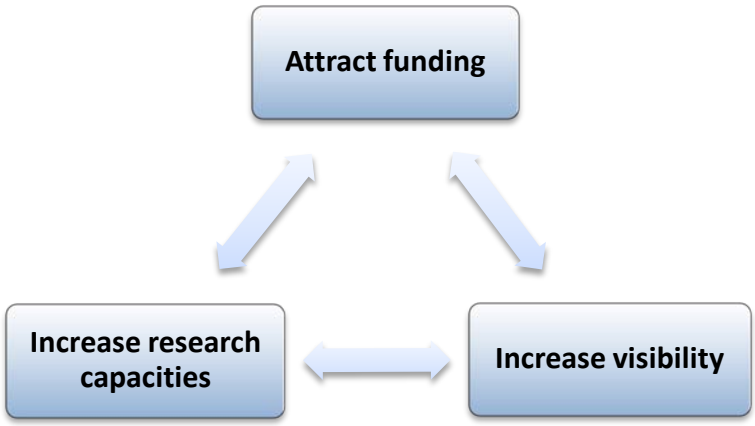
role of DIBBAUG in the technology transfer process in particular for small and medium-sized firms need to be reinforced.
Although the potential of innovation of DIBBAUG is high, the lack of relation and partnership with industry is a hindrance to industrial applications.

DIBBAUG needs to develop innovation culture and increase collaboration with industry, technology transfer units need to be created. An international relation department needs to be developed as well, in order to increase awareness and to enable externalization, and the diffusion of information at an international level. Training in commercialization would also be an asset.

DIBBAUG needs to develop interactive learning and to manage better the innovation and technology transfer, increase public-private collaboration and provide more practical learning.

The lack of funds is an important issue which limits the development of DIBBAUG's Biotechnology research. Currently, DIBBAUG is mostly funded by the Agrarian University of Georgia, local and international research grants. There is no research area favoured in terms of investments by the government. This lack of funding restricts the wages level and thus renders DIBBAUG unattractive for foreign researchers. Besides, it is difficult for DIBBAUG to find young Georgian scientists, even though the education level in Georgia is high. Moreover, qualified scientists often leave the structure when they find better opportunities in the private sector. This lack of funding has also an impact on the innovation potential of DIBBAUG because they cannot afford modern equipments that would allow DIBBAUG to carry out more innovative projects.

The attractive capacity of DIBBAUG needs to be improved. To do so, 3 factors that are linked to each other must be considered:



1.5. Conclusion

The results of the SWOT analysis demonstrate that research and managerial capacities of DIBBAUG in Biotechnology have to be developed in order to become a key player at international level.

The current situation shows that Georgian research in Biotechnology is not of high priority for the country. The research efforts need to be more oriented to the market needs and to create state-of-the art technologies. Therefore, the high quality research work cannot be attained due to impregnable hurdles caused by the lack of adequate research infrastructure.

SWOT analysis highlighted that DIBBAUG has all requested capacities to develop efficient communication and to better manage available resources such as equipment, knowledge, education and technology transfer.

With respect of this vision, the SWOT analysis will continue the project activities and provide the key orientations to Strategic Development Plan of DIBBAUG. In particularly, SWOT analysis results will be taken into consideration during the implementation of the following tasks:

- Task 3.3: Twinning activities implementation
- Task 3.4: Sustainability model development
- Task 4.1: Visibility, ERA integration and dissemination campaign
- Task 4.2: FP7 training and integration in European Technology Platforms, FP7 consortia and international teams/networks
- Task 4.3: DIBBAUG participation in the international conferences in EU and brokerage sessions
- Task 4.5: Expansion of DIBBAUG's BIOTECHNOLOGY activities on wide regional (Caucasian level)

2. Socio-economic analysis (Georgian, Caucasian and European needs)

2.1. Introduction

2.1.1. *Outline*

This report provides an analysis of the status of the biotechnology sector and presents general trends in the biotechnologcal market landscape. It analyses the biotechnology sector on two different perspectives, looking in particular at the EU and at the Caucasian region including Georgia.

"Socio-economic analysis of relevant Georgian, Caucasian and European needs will be done. Collection of data will take into account both the geographical and the R&D and SME/Industries' dimension. The necessary information will be acquired by the analysis of relevant documents, including strategic research agenda of main ETP, oriented in Bio-research; and by 10+ face-to-face or phone interviews with experts in the bio-field, both in Georgia, in Caucasus and in Europe. A small scale round table may be organised.
The obtained results of the study will allow the detection of main priority sectors for DIBBAUG R&D. Recommendations will be provided at the end of the Socio-economic analysis exercise."

In respect with the contract, the analysis was based on bibliographical analysis as well as on interviews with key biotechnological stakeholders i.e. actors implementing biotech R&D programmes or key representatives of the research and business communities (Annex 1). In addition, the analysis concludes on a set of preliminary recommendations in order to improve the research activities of DIBBAUG.

The analysis has been lead by inno with assistance of DIBBAUG, the project coordinator.

2.1.2. *Objectives*

The present social-economic analysis (SEA) is a tool for detecting keys sectors for DIBBAUG R&D in the field of biotechnology**.** Its key objective is to assess the overall trends and capacities for improvement and to highlight their importance for the economy and society.

The operational objectives are the following:

Provide current state-of-the art of biotechnology:

- R&D landscape,
- Market landscape;

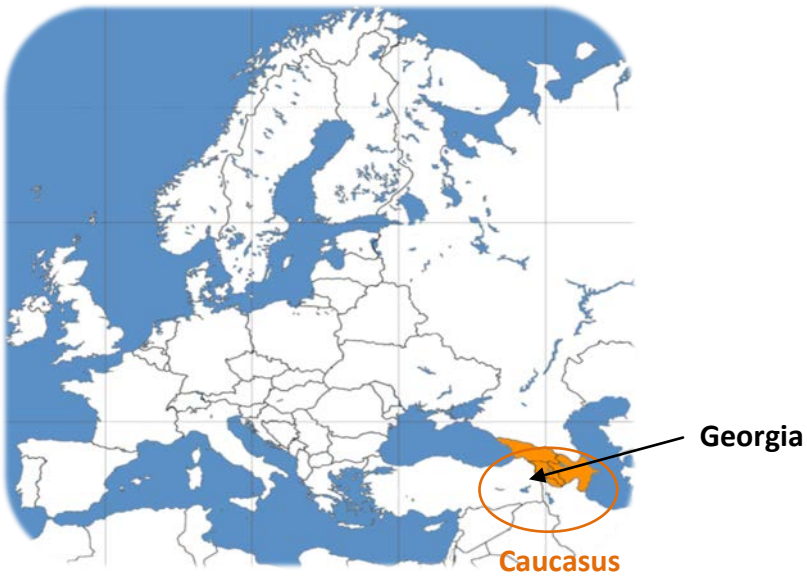
- **Identify scientific and technological trends**;
- **Assess major impacts, positive and negative** of biotechnology:
  - Impact on health,
  - Impact on environment,
  - Impact on economy and society (growth, employment, life conditions).

Given the breadth of the referenced field that comprises numerous aspects, the report does not have the ambition to be complete or to cover all aspects referred to the field of biotechnology. The idea is to identify most important trends in the field and to give them as examples to help the project teams with a formulation of main priorities for DIBBAUG's R&D directions.

2.1.3. *Geographical focus*

The study area is geographically bounded on the Europe and Mediterranean area. The geographic bounds of these sub-areas are as follows:

- **Study Sub-Area 1** Europe
- **Study Sub-Area 2** Caucasus region
- **Study Sub-Area 3** Georgia



2.2. Biotechnology definition and key applications

2.2.1. *Biotechnology definition*

Biotechnology is defined by the OCDE as "*the application of science and technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services*"[1].

The biotechnology sector is divided in several sub-domains, including:

- **Healtcare or red biotechnology** refers to the use of living organisms to produce pharmaceutical or diagnostic products or vaccine to treat and prevent human diseases.
- **Agricultural or green biotechnology** uses plant breeding techniques like genetic modification to improve the crops. These crops can subsequently be use for food, biomaterials or energy production.
- **Industrial or white biotechnology** aims to improve enzymes and micro-organismes (e.g. fungi, bacteria, yeasts) used in the industrial sector in order to make bio-based products (chemicals, detergents, bioenergy…). In doing so, industrial biotechnology expects to improve industry's performance and lower the impact on the environment.
- **Marine or blue biotechnology** refers to the application of molecular biological methods to marine and freshwater organisms

2.2.2. *Biotechnology applications*

2.2.2.1. Medical applications

One of the major application in biotechnology is in the medical sector. These applications include:

- **Pharmacogenomics** studies the impact of the genetic inheritance of a person on drug response. The objective is to improve personalized medicine in order to maximize the effect of a drug or vaccine while avoiding adverse effect such as overdose, damage of healthy cells or adverse immune response.
- **Drug production:** Modern biotechnology is now used to produce large molecules of protein that can target mechanisms not easily addressed by small molecules. It concerns for example diseases like hepatitis, cancer or cardiovascular disease. Biotechnology also enable the production of drug in a vast quantities at relatively low cost usually by using genetically engineered microorganisms.

[1] http://stats.oecd.org/glossary/detail.asp?ID=219

- **Genetic testing:** This application is used to find a specific DNA sequence amongst the gene pool of a patient. For example, genetic testing is used to determine sex, for prenatal diagnostic screening, for forensic and identity testing or to predict a disease/disability or the risk of developing one.
- **Disease treatment:** Different type of therapy can be employed to treat a disease including gene therapy, xeno-transplantation or stem cell therapy. For example, gene therapy works by introducing a new gene into the patient in order to compensate or replace the defective gene. Such techniques can be used to cure AIDS or cancer.
- **Medical imaging.**

2.2.2.2. Agro-food applications

The agro-food application of biotechnology are used to improve crops mainly by genetic engineering. That's why these crops are called GMO – Genetically Modified Organisms. The benefits of these applications are:

- **Increase the yield and productivity** of existing land. According to studies by the European Commission, these crops could produce 6 to 30% more food without needing more space.
- **Increase the nutritional qualities** of products in order to fight malnutrition or dietary micronutrient deficiencies, especially of children. For example, Golden Rice was created to combat vitamin A deficiency by modifying the β-carotene (provitamin A) synthesis in the edible part of the rice.
- **Reduce vulnerability to environmental stresses** like salt, cold or heat.
- **Reduce the use of fertilizers, pesticides or other agrochemicals** on crops
- **Improve the taste, texture and appearance of food**: For example, genetic engineering enable to produce grapes that can give a wine with better taste or to transform vegetables in order to delay their ripening.

2.2.2.3. Energy and environmental applications

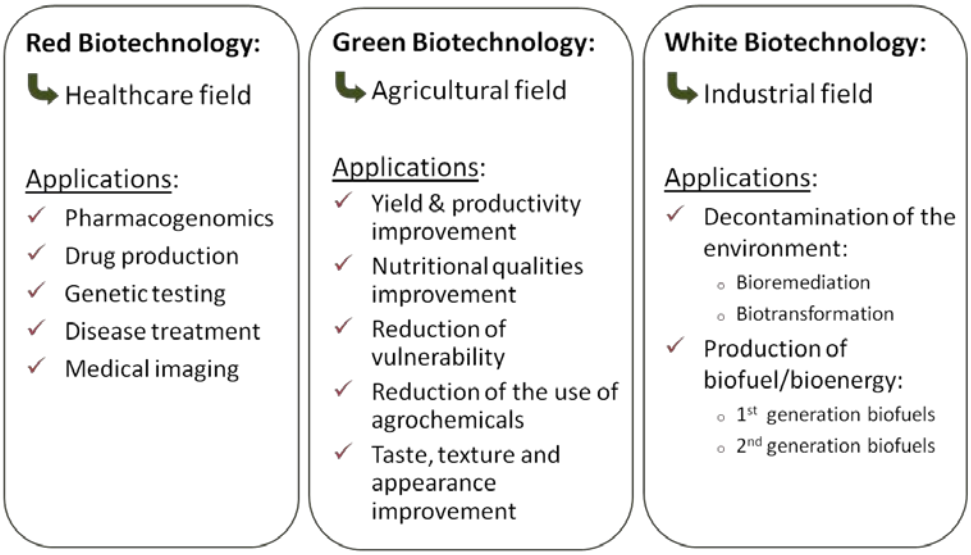
The energy and environmental applications of biotechnology concerns mainly the **decontamination of the environment** and the **production of bio-fuels/bio-energy**.

There are two types of decontamination:

- The **bioremediation** : Micro-organisms are used to remove pollutants through their metabolism. Some plants can also accumulate heavy metals (that can not be absorbed by micor-organism) and then be removed by incineration or recycling.
- The **biotransformation** : It refers to the modification of a chemical compound by an organism into mineral compound like CO_2, NH^{4+} or H_2O. One of the most remarkable organism capable of bioremediation is the hydrocarbonoclastic organism *A. borkumensis.* This organism is used in seawater environment to degrade oil or petroleum into harmless compounds.

Two types of biofuels are currently produce in Europe:

- **First generation biofuels**, including bioethanol and biodiesel, are obtained from cereal/oil and sugar crops.
- **Second generation biofuels**, also called advanced biofuels, refers either to biofuels that are produce from non-food feedstocks (cellulosic material, wates, algae, agricultural and forestry residues) or biofuels with advanced properties (chemically closer to fossil fuel). The advanced biofuels are considered more sustainable as they do not compete with food production.



2.3. Research and Development landscape

2.3.1. *Biotechnology R&D landscape in the European region*

2.3.1.1.Key Biotechnology research topics and technological needs

Key biotechnology research topics based on EU priorities:

Activity	Area	Description	Element/call potentially interesting for DIBBAUG
Sustainable production and management of biological resources from land, forest and aquatic environments	Enabling research	Sustainable production and management of biological resources (micro-organisms, plants and animals) including the exploitation of biodiversity and of novel bioactive molecules within these biological systems	
	Increased sustainability of all production systems (agriculture, forestry, fisheries and aquaculture); plant health and crop protection	Development of new technologies, equipment, monitoring systems, novel plants and production systems, crop management through selected plant breeding, plant health and optimised production systems	KBBE.2013.1.2-02: increase the competitiveness and cultivation of grain legume crops KBBE.2013.1.2-05: Biological control agents in agriculture and forestry for effective pest and pathogen control KBBE.2013.1.2-06:developing a network of national reference collections relevant to national and EU phytosanitary policy
	Optimised animal health, production and welfare across agriculture, fisheries and aquaculture	Improved understanding of animal physiology and behaviour and the better understanding and control of pests, parasites and infectious animal diseases and other threats	
	Socio-economic research and support to policies	Providing the tools needed by policy makers and other actors to support the implementation of relevant strategies, policies and legislation	KBBE.2013.1.4-10: The research project will aim at investigating the development of the agriculture, food and non-food sectors and of the policies implemented in Armenia, Azerbaijan, Georgia, Kazakhstan, Moldova, Russia, Belarus and Ukraine => it will address biomass availability and possible trade opportunities for the European

	"The Ocean of Tomorrow 2013" call - Joining research forces to meet challenges in ocean management	focus on marine technologies	
Fork to farm: Food (including seafood), health and well being	Consumers	Understanding consumer behaviour and consumer preferences	KBBE.2013.2.1-01: analyse the role of food, nutritional behaviour, bodyimage perception and anorexia or obesity as risk factors for depression, along with the protective role of certain food composites such as omega-3 fatty acids, vitamin D, actives or ingredients to control the glycemic index of the food formula and other nutritional elements.
	Nutrition	Understanding beneficial and harmful dietary factors as well as the specific needs and habits of population groups	KBBE.2013.2.2-03: Food-based solutions for eradication of vitamin D deficiency and health promotion throughout the life cycle
	Food processing	integration of advanced technologies into traditional food production including fermented food, tailored process technologies to enhance the functionality, quality and nutritional value of food	
	Food quality and safety	Assuring chemical and micro-biological safety and improving quality in the European food supply.	
	Environmental impacts and total food chain	Protecting both human health and the nvironment through a better understanding of the environmental impact on and from food/feed chains.	
	European Research Area		

Life sciences, biotechnology and biochemistry for sustainable non-food products and processes	Novel sources of biomass and bioproducts	Bio-mass that will deliver feedstocks and precursors for nearly all bioindustries or directly saleable end-products => optimisation for industrial purpose	KBBE.2013.3.1-01: Plant High Value Products - from discovery to final product => The focus is on the efficient exploitation of the novel bioactivities (high value agro-chemicals, pharmaceuticals, biomaterials, cosmetics, flavours, food additives, food supplements etc), especially in case of unusual and/or underutilised plant species/ecotypes
	Marine and fresh-water biotechnology (blue biotechnology)		
	Industrial biotechnology: novel high added-value bio-products and bio-processes	Development and application of industrial biotechnology for the production of high-value products such as fine and speciality chemicals, antibiotics, vitamins, detergents, etc./ replacing chemical processes by more resource efficient biotechnological methods/ discovery of novel enzymes and micro-organisms with novel applications	KBBE.2013.3.3-02: Bioeconomy and bioregions => development of rural, coastal and industrialised regions by improving the sustainable exploitation of their natural and industrial resources KBBE.2013.3.3-04: Optimal and cost-effective industrial biocatalysts => The aim of the topic is to expand the number/type of chemical transformations carried out by enzymes (isolated enzymes or whole cells) at industrial scale. The approach involves optimising enzymatic performance for a targeted reaction and in the industrial context in which it is to be applied.
	Biorefinery	Conversion of renewable raw materials into sustainable and cost-efficient bulk bio-products (e.g. chemicals such as lactic acid, biopolymers), and/or bio-energy. Regarding biofuels, the focus will be on the development of second generation biofuels with improved energy and	KBBE.2013.3.4-01: Preventing and valorising bio-waste in biorefineries => The objective of this topic is to develop biotechnology approaches for the conversion of biorefinery by-products into added value bio-based products, such as chemicals and chemical building blocks, biopolymers, materials, bioactive compounds.

	environmental balance and which avoid the potential food/fuel conflict.	
Environmental biotechnology	Application of biotechnologies for the design, manufacture and use of more environmentally benign products and processes as well as for applications such us bio-sensors, ioremediation, waste treatment and recycling	
Emerging trends in biotechnology	The potentials of e.g. meta-genomics, bioinformatics, systems biology, virtual cell, synthetic biology, and nano-biotechnology have become rather concrete. These and other fields deserve appropriate measures in terms of research and development to facilitate effective transfer and implementation into industrial applications.	KBBE.2013.3.6-01: Novel bioinspired materials and processes => exploit the progress in **nanobiotechnology** in order to develop innovative bioinspired materials, devices and technologies. KBBE.2013.3.6-02: **Synthetic Biology** towards applications (Key challenges to be considered are the engineering of minimal cells, de novo design of robust and sustainable biomolecular circuits, orthogonal modules, synthetic pathways, new microorganisms and more robust metabolisms)

One of the objectives of **industrial biotechnology** is to develop production process that are cost- and eco-efficient by using renewable raw materials and performant biocatalysts.To do so, some research area and technologies need to be improved:

- ✓ Novel enzymes and micro-organisms

- ✓ Microbial genomics and bio-informatics
- ✓ Metabolic engineering and modelling
- ✓ Biocatalyst function and optimisation
- ✓ Biocatalytic process design
- ✓ Fermentation science and engineering
- ✓ Innovative downstream processing

Concerning the **biofuels production**, the complete value chains (from the biomass supply through conversion technologies to end markets) should be considered for the research development:

- ✓ New type of biomass supply (that do not compete with the food chains) should be use like algae, waste, by-products… According to the *Renewable Energy Directive 2009/28/EC* "Biofuels from waste, residues, non food cellulosic material, and lignocellulosic material will count twice for RES transport target".
- ✓ In order to improve the conversion processes toward an environmental and economic performance, new technologies should be developed like synthetic biology and catalytic conversion technologies.
- ✓ Adapt the processes to new end uses like air, marine and rail transportation

The main focus for the **agro-food domain** concerned the food safety. Some research area and technologies need to be improved/developped in order to avoid food contamination:

- ✓ "omics" technologies and systems biology in order to correlate genomics to functional metabolomics to physiology and ecology
- ✓ Biomarker
- ✓ Risk-benefit analysis (toward an holistic way)
- ✓ Chemical contaminant

2.3.1.2.Key research institutions

Universities:

- ✓ Agricultural University of Athens (Greece)
- ✓ Alma Mater Studiorum – University of Bologna (Italia)
- ✓ University of Natural Resources and life Sciences, Vienna (Austria)
- ✓ Imperial college of science, technology and medicine (UK)
- ✓ University of Stuttgart (Germany)
- ✓ University of Copenhagen (Danemark)
- ✓ Swedish University of Agricultural Sciences (Sweden)
- ✓ Wageningen University (Netherland)
- ✓ University of Helsinki (Finland)
- ✓ Technical University of Denmark (Denmark)
- ✓ Lund University(Sweden)
- ✓ Ecole Polytechnique fédérale de Lausanne (Swiss)
- ✓ University of Milano – Bicocca (Italia)
- ✓ Universityu of Minho (Portugal)
- ✓ University of Agronomic Science and Veterinary Medicine – Bucureşti (Romania)
- ✓ University of Oviedo (Spain)
- ✓ Université de la Mediérranée d'Aix-Marseille II (France)
- ✓ Slovak University of Technology in Bratislava (Slovakia)
- ✓ Budapest University of Technology and Economics (Hungary)
- ✓ University of Ljubljana (Slovenia)
- ✓ University of Zagreb – Faculty of Food and Biotechnology (Croatia)

Research centres and Institutes:

- ✓ Centre for Renewable sources and saving (Greece)
- ✓ Institut national de la Recherche Agronomique (INRA) (France)
- ✓ VIB (Belgium)
- ✓ VTT Technical research Centre of Finland –Business from Technology (Finland)
- ✓ Centre National de la Recherche Scientifique (France)
- ✓ National Institute for Chemical Pharmaceutical Research and Development (Romania)
- ✓ A.N. Bakh Institute of Biochemistry of the Russian Academy of Science (Russia)
- ✓ Winogradsky Institute of Microbiology, Russia Academy of Science (Russia)
- ✓ Institute of Natural Fibres & Medicinal Plants (Poland)
- ✓ National Agricultural Research Foundation (Greece)
- ✓ National centre for scientific research " Demokritos" (Greece)
- ✓ Austrian Centre of Industrial Biotechnology (ACIB) (Austria)

2.3.1.3. Scientific conferences

Date	Name of the events	Place	Topic
16-18 December 2012	**Microbial resource management for agriculture in arid lands**	Tunis, Tunisia	Desert microbial extremophiles for supporting agriculture research potential in Tunisia and Southern Europe
3-5 April 2013	**3rd International Conference on Lignocellulosic Ethanol**	Madrid, spain	- Progress on Pretreatment & Enzymes - R&D needs to deploy the technology - Supply chain commercial development - Biorefineries - From ethanol to paraffinic biofuels
4-7 June 2013	**PYFF - 5th Conference on Physiology of Yeast and Filamentous Fungi**	Montpellier, France	Latest advances in the basic and applied aspects of the physiology of these eukaryotic models and for exchanges between the yeast and fungal research communities
17-21 June 2013	**Olomouc Biotech 2013 Plant Biotechnology: Green for Good II**	Olomouc, Czech Republic	Crop yield improvement, Plant stress tolerance, Phytoremediation, Molecular farming, Bioenergy
21-25 July 2013	**11th BIOTRANS Conference**	Manchester, United Kingdom	- Enzyme discovery, - Bioinformatics, - Protein engineering, - Directed evolution of enzymes, - Enzyme immobilisation, - Process development - Scale-up and manufacture of chemical products using biocatalysis.

2.3.2.Biotechnology R&D landscape in the Caucasian region

2.3.2.1.Key Biotechnology research topics

The Caucasian region is characterized by **unique and extremely various ecological and geographical conditions reflecting the great diversity** of microorganisms, plants and animals. It represents a huge Genetic Fund and Potential for biotechnology and attracts a keen interest of many scientists. Due to detailed study of revealed biological species this area could be considered as one of the well-characterized regions in the world.

As a result of long-term and wide-scale researches the regularities of ecological distribution of different species of microorganisms in the soil and other natural substrates have been revealed. Many new species of fermentation yeast, lactobacteria and other microorganisms have been isolated, characterized and some of them implemented in the food and other branches of industry.

For many centuries, in the South Caucasus countries, **for the production of acido-lactic products**, **bakeries and wines** as a result of continuous and sustainable application, the intuition selection of many efficient forms of lactic-acid bacteria, yeasts and other practically useful forms of microorganisms and their associations took place. The exclusively valuable natural forms of lactic-acid bacteria, thermophilic, alcohol resistant and osmophilic fodder yeast and other extremophilic forms of microorganisms have been selected, representing now high biotechnological interest. Quite a few of them have been successfully applied.

The microbial strains of valuable significance have not been kept in appropriate conditions and the majority of them have been lost. The systematic and comprehensive studies in this area have not yet been carried out.

In the South Caucasus Countries were well-accepted as the basically developed countries and from the middle of 60-ies on the governmental level had been realized substantial measures for development of microbiological/biotechnological industry. Several plants (for example, in Armenia and Georgia) have been constructed and brought to exploitation, but after the drastic events of the fall of FSU they stopped functioning.

At the moment based on the geo-biological potential of these countries, biotechnology is accepted on the governmental level as a priority area for scientific and technical progress, to solve nutrition, energetic and ecology problems.

In spite of events of the fall of FSU what caused severe situation in Caucasian Republics it has to be mentioned that their **basic scientific and industrial potential was maintained**. The main scientific potential of the Republics are within the auspices of National Academies of Sciences (NAS), including well-known research institutes carrying out wide-scale investigations in many fundamental and applied fields of biology and chemistry, related to molecular biology and biotechnology.

After the fall of FSU and followed economical crisis several national programs in biotechnology have been proposed in South Caucasus Countries.

Main Biotechnological Programs in Armenia

Food Security

- SCP (Spirulina)
- Topinambur (saccharides, ethanol)
- Microbial pest control
- Microbial fertilizers
- Biotransformation / Biocatalysis

Biogeotechnology

- Bioleaching of copper and other metals

Bioenergetics

- Biogas, Biofuels: liquid and gas
- Hydrogen

Main Biotechnological Programs in Azerbaijan:

- Microorganisms degrading oil hydrocarbons
- Microbial conversion of cellulase-containing wastes into rich in protein biomass
- Microbial conversion of oil wastes to different secondary metabolites
- Microbial utilization of municipal wastes

Main Biotechnological Programs in Georgia:

- Semi industrial production of enzymes (amylases, cellulases, proteases, etc) for food industry
- Secondary metabolites of microbial origin (citric acid, etc.)
- Genetically modified microorganisms producing heat-stable enzymes
- Selection of microorganisms of different taxonomic groups degrading organic pollutants
- Biogas production and microbiological treatment of agricultural wastes

2.3.2. *2.Technological needs*

Essentially important for the Caucasus is the **large-scale application of bacterial leaching** (bioleaching) of copper and other metals what is largely used in some countries for recovery of copper, iron, arsenic, uranium, gold, cadmium, nickel and other heavy and rare metals from sulfide ores. The bioleaching process can be successfully applied to control the environmental pollution which is very important limiting problem for the development of the recovery of metals by commonly accepted pyrometalurgical and hydrometalurgical methods. In many Caucasian regions there are large reserves of low-grade copper containing ores. Enormous mass of dumps and abandoned mines in Armenia, Georgia and Azerbaijan are available for bioleaching processes.

Many institutions of the South Caucasian **countries have sufficient experience and developments in the use of efficient biotechnologies for pollution control**. In combination with efficient microbiological treatment of wastes these methods have to be important tools for amelioration of environment control, especially in petroleum polluted regions, what is of urgent importance for Azerbaijan and Georgia. For this goal planning to apply the strains of microbial degradants of synthetic polymers isolated from the space technique and kept in the Culture Collection of RCDM (around 1000 well-studied strains).

There are perspective areas for **the production and use of bacterial insecticides and biological pest control** means as well as microbial fertilizers. As a result of long-term screening in **Armenia many thousands of isolates have been obtained from various insects**. Some new bacterial insecticides were developed and introduced in large-scale industrial production in the former SU. Very perspective work in this field is carrying out in Azerbaijan with predatory fungi. At present the Collection of entomopathogenous bacilli in RCDM comprises more than 2000 strains of entomopathogenous bacilli including new bacterial strains against strictly harmful pests.

Biodiversity of the Caucasus gives a unique chance for isolation of many new species and industrially important strains of microorganisms. The creation of the Regional Centers and establishment of appropriate biotechnological Network should be a substantially important background for development of biotechnology and solution of crucially important problems for the South Caucasus Republics.

2.3.2.3. Key research institutions

Armenia

- ✓ State Microbial Depository Centre of the National Academy of Sciences of Armenia
- ✓ Scientific and Production Center "Armbiotechnology" (Armenia)
- ✓ Yerevan State Medical University (Armenia)
- ✓ Armenian State Agrarian University (Armenia)
- ✓ Institute of Biochemistry of NAS & Armenian State Agrarian University (Armenia)
- ✓ Institute of Microbiology, NAS
- ✓ Institute of Biotechnology Scientific and Production Center "Armbiotechnology" (Armenia)

- ✓ Division of Natural Sciences Microbial Depository Center (Armenia)
- ✓ Institute of Microbiology" Scientific and Production Center "Armbiotechnology (Armenia)
- ✓ YEREVAN APPLIED BIOTECHNOLOGY INSTITUTION" LLC (Armenia)

Azerbaijan

- ✓ Institute of Microbiology , National Academy of Science of Azerbaijan
- ✓ Institute of Botany, National Academy of Science of Azerbaijan
- ✓ Baku State University, Biology department
- ✓ Gjanga Institute of Technology.

Georgia

- ✓ Durmishidze Institute of Biochemistry and Biotechnology of Agrarian University of Georgia
- ✓ Georgian Technical University, Durmishidze Center of Biochemistry and Biotechnology;
- ✓ Javakhishvili Tbilisi State University
- ✓ Kurtaisi Polytechnic University
- ✓ Tsereteli Kutaisi State University
- ✓ Eliava Institute of Bacteriophage, Microbiology and Virology (Georgia)

2.3.2.4. Scientific conferences

- ✓ World Food Azerbaijan 2012, 18th Azerbaijan International food industry exihibition 15-17 May, Baku, Azerbaijan, http://www.worldfood.az/2012/?l=ru
  World Food Azerbaijan 2013, 19th Azerbaijan International food industry exihibition 22-24 May, Baku, Azerbaijan http://www.worldfood.az/

2.3.3. *Biotechnology R&D landscape in Georgia*

2.3.4. *1. Key Biotechnology research topics*

Food, Agriculture & Fisheries, and Biotechnology - European Research Priorities (FP7 – Work programme 2011)	**Specific Research Topic of DIBBAUG, and examples of relevant projects on the international level**
Activity 2.1 Sustainable production and management of biological resources from land, forest and aquatic environments	
Enabling research (omics' converging technologies, bioinformatics, biodiversity) for micro-organism, plants and animals	* Mechanism of regulation of tea flavonoids enzymatic oxidation and their antioxidant action. * Genetic diversity of cultivated and wild varieties of Vitis vinifera in the Caucasian area. * Creation of collection of extremophilic mycelial fungi isolated from all ecological niches of the Caucasus, investigation their pathogenicity and elaboration of the technologies based on their degradational, oxidizing and synthesizing potential. * Microbial diversity for novel biotechnology applications (Partner Project. Financed by DOE. Partner LBNL, USA. Technical monitor Dr.Tamas Torok) * Establishment of a Biotechnological Network of Regional Microbial Culture Collections in the Caucasus.
Activity 2.2 "Fork to farm": Food (including sea-food), health and well being	
Innovative food and feed processing	* Biologically active food red colorant of plant origin.
Improved quality and safety of food, beverage and feed	* Prevention of food spoilage by suppression of phenoloxidase, peroxidase and growth of pathogenic microflora by use of natural inhibitors of plant origin.
Activity 2.3 Life sciences, biotechnology and biochemistry for sustainable non-food products and processes	

Environmental biotechnology	* Development of a novel, cost-effective bioprocess for production of fuel ethanol from herbaceous lignocellulosic wastes. * Coordination of Plant Oxidative Enzymes as a Key Factor in Degradation of Organic Xenobiotics. * Biotransformation of Carcinogens. ISTC G-284. * Elaboration of Methods of Bioremediation of Contaminated Soils of Former Military Locations and Proving Grounds in Georgia. * Elaboration of a new strategy of phytoremediation and longterm protection of the environment polluted by hydrocarbons. * Mechanisms to detoxify selected organic contaminants in higher plants and microbes, and their potential use in landscape management (US Army Corps of Engineers. Engineer Research and Developing Center. Environmental Laboratory, Vicksburg, MS, USA.) * Bacteriophage, an effective biological tool against plant diseases caused by pathogenic bacteria. * Novel approach for the improvement of ecological guarantee of oil pipelines. * Creation of a novel complex phytoremediation technology for rehabilitation of soils and waters polluted with explosives.

2.3.3.2. Technological needs

The main technological needs are as follows:

- ✓ **Biofuels** production technologies
- ✓ **Environmental Remediation** technologies
- ✓ **Agricultural biotechnologies** – eco and bioproducts production
- ✓ **Innovative and cost-effective biotechnologies for food industry**: natural colorants, biological functional composites – rich in biologically active compounds food additives.

Georgia is an ancient country with the well developed traditional fermentation industries –bakery, cheese-making, production of acido-lactic products (motherland of yogurt), wine-making (viticulture of the Caucasus exceeds 500 endemic species), beverages.
DIBBAUG has created and maintaining four microbial collections (bacteria, actynomicetes, microscopic and basidial fungi) accounting of more than 4000 strains. These strains have been isolated from the soils and natural substrates of East North part of Georgia. The screening of these cultures exposed existence of individually important producers of enzymes, secondary metabolites (organic acids, carothinoides, amino acids, etc) and polysaccharides.

One of the most important directions of R&D is **the conversion by basidial fungi of food processing and some other wastes into nontoxic an nonpathogenic, rich in protein biomass**.

Due to the transit function of Georgia **including transport of oil and gas** from East to West it is extremely important the selection of microorganisms of different taxonomic groups degrading oil hydrocarbons.

To preserve the ecology along oil pipeline Baku - Tbilisi – Ceyhan and gas pipeline Baku-Erzerum such microorganisms would **participate in degradation of pollutants in ryzosphere.** The experimental results of the project will facilitate the solvation of a problem connected with a danger of the environmental pollution in Georgia with hydrocarbons. Our results in this field will contribute the ecological security of Eurasian Transport Corridor (TRASECA).

Selection of producers of stable enzymes from extremophilic microorganisms for their practical application, became an important step in realization of national biotechnological program.
Collection and study of lactic acid bacteria and yeasts, important for diary industry have been created.

2.3.4.3. Scientific conferences

Consultations from Belgian and Holland 13 companies, December 10-13, 2012, Tbilisi

2.4. Market landscape

2.4.1. *Biotechnology market landscape in the European Union*

Industrial biotech is an industry in which Europe is a world leader. Europe produces about 75% of the world's enzymes.

2.4.1.1.Key industrial players

Following are some key players of the European Union with regards to the biotech industry:

Germany: Germany is one of the leading global biotech players and accommodates maximum number of biotech-based companies when compared to the other EU members. The German biotech industry comprises four important segments including agricultural biotech, industrial biotech, medical biotech and service and suppliers. Germany offers favorable investment options in the biotech sector. Some of the largest and most reputed biotech clusters are located around Rhine-Neckar Triangle (Heidelberg), Cologne/Düsseldorf, Berlin/Brandenburg and Munich.
Germany has a highly innovative R&D, with a research landscape comprising 330 research institutes and 343 universities that work in cooperation with the biotech companies to help them in discovering newer and more effective products.
Besides, Germany boasts of a highly skilled personnel. In fact the number of natural science PhDs in Germany is more than that in the US and Japan.

The UK: It's the research expertise in biotechnology that has made it possible for the UK to emerge as the second largest biotech industry among the EU nations. It has got a well-developed R&D sector. The UK government is also working towards increasing technology transfer facilities and funding to the biotech firms.

France: France has the fourth largest biotech industry in Europe. Over the past couple of decades, France has made incredible progress in the biotech industry. With more than 300 biotech firms and over 600 biotech service and support companies, France offers a favorable investment climate to companies planning to invest in the biotech sector. France boasts of a distinctly diversified industrial base.
The French biotech industry employs approximately 6,000 people, more than 50% of whom are involved in R&D activities. France also provides the foreign investors a favorable environment for partnerships. In addition, France boasts of a broad range of support mechanisms and programs available in the field of biotech. Biotech firms in France are eligible for several innovation support measures, including the innovative new companies' scheme (Jeunes Entreprises Innovantes or JEI) and Research Tax Credit (Credit d'Impot Recherche or CIR).

List of companies involved in FP projects (dealing with sudjects close to DIBBAUG research):

- ✓ BASF (Germany)
- ✓ Novozymes A/S (Danemark)
- ✓ Korres S.A Natural Product (Greece)

- ✓ Plant Advanced Technologies (France)
- ✓ Aton-HT Spolka Akcyjna (Poland)
- ✓ Metabolic Explorer SA (France)
- ✓ Entrechem SL (Spain)
- ✓ LentiKat's a.s (Czech Republic)
- ✓ Biogold Fuels Corporation (US)

2.4.1.2.Collaboration with R&D institutions

In Europe, the collaboration between industries and R&D institutions is mainly possible by becoming a member of either an European Technology Platform (ETP) or a cluster. These kind of structures are especially developed to link companies in the same field with the others important actors of the values chains like research institutions, supplier or end users.

List of ETP that DIBBAUG could integrate:

- ✓ The European Plant Science Organisation (**EPSO**) in order to can integrate the European Technology Platform Plants for the Future (**Plant TP**)
- ✓ European Association for Biotech Industry (**EuropaBio**)
- ✓ European Technology Platform Food for Life (**Food for Life TP**)
- ✓ Sustainable Chemistry Technology Platform (**SusChem TP**) (work in collaboration with EuropaBio for the industrial aspect of biotechnology)
- ✓ European Biofuels Technology Platform (**Biofuels TP**)
- ✓ Agricultural Engineering Technology Platform (**AET**)
- ✓ Plateforme Technologique du Vin d'Espagne (**P.T. Vino**)

List of cluster that could be interesting for DIBBAUG to approach:

Cluster name	Country	Domains	Website
Culminatum Innovation Oy LTD	Finland	Environmental technology	http://www.culminatum.fi/sivu.php
Capbioteck	France	Marine and agrofood	http://www.capbiotek.fr/
CLIB 2021	Germany	Industrial Biotechnology	http://www.clib2021.de
Parco Tecnologico Padano	Italy	Agro-biotech	http://www.tecnoparco.org/
Technapoli Science and Technology park	Italy	Medical and food biotechnologies	http://www.technapoli.it/
Italian Association for the Devlopment of Biotechnology (ASSOBIOTEC)	Italy	Pharmaceuticals, agro-food, fine chemicals, environment, processing industry...	http://assobiotec.federchimica.it/home-eng.aspx

2.4.2. *Biotechnology market landscape in the Caucasian region*

2.4.2.1. Key applications domains

The development of Armenia's scientific capability and laws covering biotechnology are limited. Armenia has adopted the Cartagena protocol and some scientists would like to perform research in this field based on the protocol's parameters. In general, knowledge of biotechnology's benefits is low.

The quantity of imported biotechnology products is not known for certain, because Armenia does not have testing laboratories with expertise in this area, and there are no laws governing biotechnology trade. Commentators note that some biotech events could be entering the country, but the quantity is expected to be very limited. Armenia imports only a small amount of food from the United States, including meat, some high-value processed products, and at times, grains. Armenia does not have any laws directly related to biotechnology production and marketing, but does have a framework for implementing the Cartagena protocol for Living Modified Organisms (LMOs). The Ministry of Agriculture and the Ministry of Nature Protection were the lead entities in developing this framework, and received technical and financial assistance from international organizations.

Armenia is taking a cautious approach to acceptance of LMOs, but one that should allow for entry, testing, and development of these products when monitored by an agency of the Armenian government. Field-testing of biotechnology events is not possible at this time, due to lack of a regulatory framework.

Organic agriculture is growing in popularity, and fits well into Armenia's production system, and growth in this sector may place limits on biotechnology trade and development. Regarding consumption, some commentators have expressed support for labeling, but again there is no base law at this time that requires products with GMOs to be identified.

There is no data on development of biotechnology in Azerbaijan.

2.4.3.Biotechnology market landscape in Georgia

2.4.3.1.Key applications domains

- Agricultural products
- Vine industry
- Dairy products
- Mineral waters

- Canning industry
- Beverages
- Biopharmaceuticals

Traditionally Georgia has been a net exporter of food products and a major supplier of vegetables, fruit, tea, essential oils, citrus, wine, mineral waters, cognac, canned fruits, and vegetables to the rest of the Soviet Union. The country used to contribute more than 10 percent of all inter-republic trade in food and agricultural products, and the value of the Georgian food exports to the rest of the former Soviet Union exceeded by factor of 1.7 the value of food imports from Soviet republics. During recent years, however, the supply of agricultural products from Georgia to the FSU republics and international markets has been substantially reduced. The country has lost its position on export markets and, as a result, Georgia became a net importer of food products.

Georgia is largely an **agriculture-based economy**. More than 50 percent of the population is engaged in this sector. Therefore, agriculture could play a critical role in the recovery of the Georgian economy. It used to be one of the main production sectors and still continue to produce, although at a substantially lower level. Currently, farmers are poorly linked to growing urban and export markets. The sector is depressed and stuck in a low input and low output cycle as access to markets and financial resources are limited. Many food processing operations that made canned fruits and vegetables closed their operations in the past decade.

After the collapse of the Soviet Union, the process of rehabilitation of the Georgian agrosector took almost 10 years. Currently, Georgian food processing industry is reviving.

FOOD PROCESSING

Food processing is a major industry in Georgia's economy. During Soviet times, the size of some branches of the Georgian food processing industry grew in excess of the limits of the domestic market and acquired a significant share of the ex-Soviet market. According to a special characteristic of the food processing industry, the output of some products (wine, tea, canned fruit, citrus juice and mineral water) far exceeds the level needed to sustain domestic consumption. At the same time, however the country is not self-sufficient in other basic agricultural products and foodstuffs, such as wheat, sugar, vegetable oil, and milk.

VEGETABLE AND FRUIT PROCESSING

Vegetable and fruit processing could be easily considered as the most vital sector in Georgia, as well as that with the best export potential. However, in the past several years, the output of this sector of the food industry fell considerably, following the pattern experienced in other sector. The present poor situation could be easily demonstrated by the fact that in year 2000 the total output of vegetable and fruit processing sector dropped from 760 million cans to 1.2 million. According to currently available information (2003-2004), 55 food processing plants out of 58 are not operational.

At the same time during the last several years canning industry showed considerable growth. Recently processing of fruits and vegetables increased by 47 percent. In the canning industry, the bulk of the productive capacities have already been privatized. Enterprises were sold by lease bid, competitive bidding, and transformation into joint-stock companies. According to the official privatization strategy, all shares of every canning factory can be sold and investors may acquire majority ownership of the companies.

In addition, the products of the Georgian canning industry are still in demand in the CIS countries, which represent a large market for distribution. Activity in the field is regulated by the Law of Georgia on Fruit Production. **Ministry of Agriculture and Food was working on harmonization of legislation with European standards and on a legislative base.**

Georgia, bridged between Europe and Asia, is a country of about five million where wine is a cultural heritage rather than just an alcoholic beverage. Georgia has i ve distinct wine producing regions: Kakheti, Kartli, Imereti, Racha-Lechkhumi and the Black Sea Subtropical Zone. Kartli is the region where scientists have found and tested wine residues discovered on the inner surfaces of 8,000-year-old ceramic fermentation and storage jars, known as "Qvevri". Georgian wine is produced using both – traditional methods as well as modern European techniques. These varied production styles contribute to a wide range of of flavor in products produced from the same grape and appellation, resulting in a single variety having a greatly varied taste and quality.
There are about 180 wine companies functioning in the country, and 35 out of these are engaged in export activities. h e key industry players are export-oriented and their export activities reach 80-95% of total production. Russia has been the largest importer of Georgian wines up until its 2006 embargo, believed to be due to political reasons. Nevertheless, Georgia started to diversify its export markets and regardless of war with Russia in 2008 and the world economic crisis, wine exports grew to the pre-embargo quantities.
At present, most of the companies are well equipped with up-to-date production facilities and there are advanced, accredited laboratories for necessary quality control. Georgian wine production (2010): 19,060,000 liters = 74,550,000 GEL (Average 2010 Exchange Rate 1USD=1.8GEL).

Georgia is home to over 2000 mineral water springs and several (Nabeglavi, Sairme, Borjomi, Rachis Tsklebi, etc.) are bottled for domestic consumption and export.
Georgian mineral waters have exceptional and interesting tastes - very different from French and Italian varieties. The most famous Georgian mineral waters - Nabeglavi and Borjomi are protected Geographic Indications, but there are many less known springs worth sampling located in small towns and alongside roads throughout the country.

• Wine exports represent c. 25% of total agriculture exports. Historically, Russia accounted for 90% of total exports but Georgian wine producers have managed to refocus their sales efforts, and the majority of exports are addressed to CIS countries
• The Georgian wine industry has a long tradition – archaeological records suggest Georgia was potentially the first region in the world producing wine, Saperavi and Rkatsiteli are its most well known grape varieties
• An established ability to produce and domestic consumption levels suggest further growth opportunity for this industry

Georgian wine exports, 2009:

- Lithuania 4% USA 4%
- Poland 6%
- Other 19%
- Belarus 11%

- Kazahstan 15%
- Ukraine 42%

(Animal products are not allowed to export in Europe)

2.4.3.2.Key industrial players

JSC Tbilvino

• Leading Georgian wine producer and number one wine exporter

Brief Overview:

GEORGIA FOOD IMPORT

• A global buyer of processed, prepackaged and bulk foods for distribution into Georgia. It buys processed, prepackaged and bulk foods globally, for distribution into Georgia.

AROMA-PRODUCTS

Fruit Processing Company

2.4.3.3.Collaboration with R&D institutions

Within Georgia

- Javakhishvili Tbilisi State University
- Georgian Technical University
- Institute of Plant Protection
- Institute of viticulture.....
- Institute of Food Processing, GTU

Outside Georgia:

- University of Ljubljana
- Institute of Biotechnology, Grazz, Austria
- Institute of Microbiology, Ukraine
- D.K. Zabolotny Institute of Microbiology and Virology of NAS Ukraine.
- Lviv Department of Physical-Chemistry of Institute for Physical-Organic Chemistry and Coal Chemistry, NAS Ukraine of National Academy of Science of Ukraine
- Institute of Microbiology, Chishenau, Moldova
- Cranfield University, UK

2.5. Potential socio-economic impacts

Biotechnology has been used for more than 6,000 years for lots of interesting and practical purposes: making food such as bread and cheese, preserving dairy products and fermenting beer. Although we do not always realise it, biotechnology is a huge part of our everyday lives, from the clothes we wear and how we wash them, the food we eat and the sources it comes from, the medicine we use to keep us healthy and even the fuel we use to take us where we need to go, biotech already plays, and must continue to play, an invaluable role in meeting our needs. No other industry is better placed to enhance quality of life and respond to society's 'Grand Challenges' of tackling an ageing and ever increasing population, healthcare choice and affordability, resource efficiency, food security, climate change and energy shortages.

All of these bold technologies, and those that are still in the pipeline, promise a brighter future for Europe and the world. But for this to happen, the industry requires sounds policy decisions that support innovation and risk–taking as well as a public that is well informed about how biotech is creating a healthier, greener, more productive and more sustainable economy.

2.5.1. *Potential impact on health*

Impact of genetically engineered food on health:
The health effects of foods grown from genetically engineered crop depend on the composition of the food itself. Any new product may have either beneficial or occasional harmful effects on human health. For example, a biotech-derived food with a higher content of digestible iron is likely to have a positive effect if consumed by iron-deficient individuals. Alternatively, the transfer of genes from one species to another may also transfer the risk for exposure to allergens. These risks are systematically evaluated by FDA and identified prior to commercialization. Individuals allergic to certain nuts, for example, need to know if genes conveying this trait are transferred to other foods such as soybeans. Labeling would be required if such crops were available to consumers.

Combat malnutrition

Healthcare biotech

- is already benefiting more than 350 million patients around the world through the use of biotech medicine to treat and prevent every day and chronic illnesses including heart attacks, stroke, multiple sclerosis, breast cancer, cystic fibrosis, leukemia, diabetes, hepatitis and other rare or infectious diseases.
- enables the development of therapies for rare diseases that are often debilitating and life threatening and that effect 20 to 30 million Europeans and their families.
- increases the effectiveness and safety of treatments as well as reducing the use of ineffective treatments and adverse reactions through its approach on Personalised Medicine that works to diagnose what one patient's problems are precisely and then work to better adapt the healthcare solutions to suit their specific needs.

Agricultural biotech produces food containing fewer toxins such as mycotoxins, a toxic fungus that infects plants damaged by pests.

2.5.2. *Potential impact on environment*

Impact of genetically engineered food on environment:
Among the potential ecological risks identified are increased weediness, due to cross- pollination from genetically modified crops spreads to other plants in nearby fields. This may allow the spread of traits such as herbicide-resistance to non-target plants that could potentially develop into weeds. This ecological risk is assessed when deciding if a plant with a given trait should be released into a particular environment, and if so, under what conditions.

Other potential ecological risks stem from the use of genetically modified corn and cotton with insecticidal genes from Bacillus thuringiensis (Bt genes). This may lead to the development of resistance to Bt in insect populations exposed to the biotech-derived crop. There also may be risks to non-target species, such as birds and butterflies, from the plants with Bt genes. The monitoring of these effects of new crops in the environment and implementation of effective risk management approaches is an essential component of further research. It is also important to keep all risks in perspective by comparing the products of biotechnology and conventional agriculture.

The reduction of biodiversity would represent a technology-transcending risk. Reduced biological diversity due to destruction of tropical forests, conversion of land to agriculture, overfishing, and the other practices to feed a growing world population is a significant loss far more than any potential loss of biodiversity due to biotech-derived crop varieties. Improved governance and international support are necessary to limit loss of biodiversity

Industrial biotech

- transforms agricultural products and organic waste into other substances with the aim of substituting the need for crude oil as a starting material to help fight global warming.
- can save energy in production processes and lead to significant reductions in greenhouse gas emissions. WWF estimates a reduction of between 1 billion and 2.5 billion tonnes of C02 equivalent per year by 2030.
- offers an alternative and safer form of global energy instead of diminishing and volatile fossil fuels.

Agricultural biotech

- offers built-in protection against insect damage, resulting in a decrease in pesticide spraying.
- protects soil from erosion and compaction by enabling farmers to reduce the need to plough their fields and the need to travel up and down their fields to manage weeds or pests because the agbiotech plants protect themselves against both. By disturbing soil less, this also increases the efficiency of water usages by keeping the water in the soil.
- helps reduce fuel use and C02 emissions by requiring less tillage and helps farmers grow more food, reliably, in harsher climatic conditions. In 2009, this was equivalent to removing 17.7 billion kg of carbon dioxide from the atmosphere or equal to removing 7.8 million cars from the road for one year.

2.5.3. *Potential impact on economy and society*

2.5.3.1. Potential economic impact

Healthcare biotech is estimated to account for more than 20% of all marketed medicines and it is estimated that by 2015, 50% of all medicines will come from biotech.

Industrial biotech :
In parallel, the economy benefits as biotechnology enables the introduction of more efficient, less energy-intensive processes. Already, fermentation and enzymatic processes are commonly used in the fine chemicals sector, to produce for example vitamins, pharmaceutical intermediates and flavours. They are also making their first inroads into larger volume segments such as polymers, bulk chemicals and bio-fuels, and many other industrial sectors. Some recent reports (such as those by BCC Inc1. and Freedonia2) predict annual growth rates of nearly 5% for fermentation products (compared to 2-3% for overall chemical production) in the coming years, while others (such as the one by McKinsey & Company3) predict much higher growth rates and consequently estimate biotechnology to be applied in the production of up to 10% of all chemicals sold by the year 2010. Although numbers differ, all studies agree that industrial biotechnology will play an increasingly significant role in the chemical and other manufacturing industries in the future.

2.5.3.2. Potential impact on labour force profile and new business growth

Healthcare biotech:
☐ comprises more than 1700 companies and a market worth more than €17 billion in Europe alone.
☐ creates jobs. Between 200 and 2008, employment in all departments of companies working on the development of orphan drugs for rare disease patients in the EU more than doubled, showing an increase of 158% according to the Office of Health Economics, UK.

Industrial biotech is worth nearly €2 trillion and provides approximately 22 million jobs in Europe alone across sectors as diverse as agriculture, forestry, fisheries, food, chemicals and biofuels.

2.5.3.3. Potential impact on life conditions

Industrial biotech uses enzymes and micro-organisms to make products which improve the effectiveness of detergents so that clothes can be washed at lower temperatures and the production of paper and pulp, food, clothing, chemicals and bioenergy is done in a more environmentally efficient way using less energy, less water and producing less waste.

By offering new, improved and adapted agricultural crops such as drought or saline resistant plants, **agricultural biotech** can contribute to meeting the Millennium Development Goals on reducing poverty and can help increase food security for a growing global population.
The overall goal of Industrial Biotechnology (white biotechnology) is to develop new bio-based technologies to convert renewable raw materials into chemicals, materials and bio-energy.

Importance of industrial biotech: A renewed interest in the sustainability of industrial processes has also contributed to biotechnology's attractiveness. All major facets of European society and economic activity, including agriculture, environmental protection and industry are being challenged to demonstrate their sustainability. Industrial Biotechnology can make a major contribution. It can, for example:

• make agriculture (in its broadest sense, including forestry) more competitive and sustainable by creating new non-food markets;
• improve the quality of life of European citizens while reducing environmental impact by developing innovative products at affordable costs; and

• help industry increase its economic and environmental efficiency (eco-efficiency) and sustainability,
while maintaining or improving its competitive advantage and ability to generate growth.

White Biotechnology can make a positive impact across all three dimensions of ainability: Society, the Environment and the Economy. In short, Industrial Biotechnology is a cornerstone of the knowledge-based bio-economy. It adds value to agricultural products and builds new industrial production schemes targeted towards an overall greater degree of sustainability.

3. STRATEGIC DEVELOPMENT PLAN OF DIBBAUG

3.1. Introduction

A strategic development plan for DIBBAUG is presented in the following lines. This plan has been prepared with the assistance of inno and UMU. It is based on the results of two previous activities: SWOT and socio-economic analysis. The aim of this plan is to determine the next steps for future development of DIBBAUG not only in the region, but also at an international level. The plan will include, for example:

- Development of collaborative network, which can directly improve the research abilities of DIBBAUG
- Advancement of young scientists,
- Strategic orientation of personnel development,
- Development of laboratory management skills establishing management quality assurance and bio safety programmes
- Training on and supporting in the development of operating procedures.

Our experience shows the high importance of the consultation and consensus building process around the Strategic Development Plan. This consultation and consensus building process are the two blocks that insure the success of the development plans. Therefore, this task will be implemented in steps:

- 1st Step: A peer review of the Strategic Development Plan by the Scientific Reference Team, and adjustment of the Plan.
- 2nd Step: An internal meeting. It will allow internal validation of the Strategic Development plan of DIBBAUG.
- 3rd Step: A workshop, inviting the external actors and partners, which will allow additional brainstorming, discussion and agreement of the strategy and the next steps of its implementation.

Based on the Strategic Development Plan, the work planning of other Work Packages (including twinning and international cooperation activities) might be adjusted.

3.2. Mission and vision of DIBBAUG

3.2.1. Vision

Vision of DIBBAUG is that only complementarities of efforts on all activities as from creation of new knowledge to its implementation and innovation offer an advance beyond the state of the art.

We will work to bring together leading scientists in the field of biochemistry and biotechnology to create the theoretical database which will enable development of new technologies for safe, functional food and rich in biologically active compounds food ingredients productions. We will maintain and expand the expertise of the DIBBAUG in research, technology development and

innovation to enhance work environment for new knowledge implementation, so important for sustainable development.

3.2.2.Mission

The mission of the Institute is to support the organic balance and the exchange of knowledge between fundamental and applied research for effective implementation of new knowledge, products and technologies at a qualitatively new level.

3.3. The Changing Context

The strategic plan must meet future challenges, dictated by the social and the scientific evolution, in the region of Georgia (Caucasus), as well as internationally.

3.4. Strategic development objectives

In the frame of strengthening cooperation between EU and Georgia and create a solid basis of cooperation in the area of Biotechnology and Biochemistry a Strategic Development Plan (SDP) has been worked out. Since a basic objective of the BIOPARTNERS project is to enhance the DIBBAUG capabilities in the area of Biotechnology and Biochemistry, this SDP is focusing on:

- To enhance the quality of young scientists
- To create, stimulate, and improve research environment in Georgia
- To attract, motivate and retain top quality staff in the area of Biotechnology and Biochemistry.
- To maintain and to develop the potential of DIBBAUG in the field of Biochemistry and Biotechnology

The Strategic Development Objectives have been framed with reference to the analysis of the external and internal environment of DIBBAUG, and they were based on the socio-economic analysis and the SWOT analysis, which in turn has affected our strategic priorities and actions to be taken, as set out in the following Sections.

3.5. Strategic priorities and actions to be taken

3.5.1.Objective 1: To enhance the quality of young scientists

DIBBAUG is going to implement the following steps:

- To facilitate the exchange of researchers and young specialists between Georgia and the European Union. This could help young researches to increase their training in biological sciences using the resources available in Europe which could be of importance from a translational point of view.
- To encourage talented people and young scientists to pursue RDI in collaboration with laboratories, universities, Institutes, industries and professionals. BIOPARTNERS project is a keystone to this pursuit, giving the opportunity to young scientists, to get in touch with researchers at laboratories abroad.
- DIBBAUG will offer young specialists possibility of personal development and career prospects and developing measures for staff appreciation, motivation and encouragement.
- To identify international experts who can help to conduct training workshops for young scientists of DIBBAUG.
- To attractscientists from well-known universities to participate in teaching, research, and training of young scientists
- To encourage and realize postdoctoral research training, in order to advance young scientists.
- To contribute the advancement young scientists by involvement in current project twinning activities, inclusion in exchange program, training at partner European university, etc.

3.5.2. Objective 2: To create, stimulate, and improve the research environment in Georgia

Research, Development, and Innovation (RDI) should be responsive to the industry and business needs, as well as, national priorities and international trends. Knowledge economy and globalization dictate strong RDI programs and initiatives that introduce intelligent technological solutions to solve growing complexities in real life problems, emerging advanced technologies, such as nanotechnology and biotechnology, should be explored as much as they could, to add a positive impact on the economy and society. According to the socio-economic analysis recommended changes, RDI should be stimulated to improve international competitiveness. The SWOT analysis concludes that DIBBAUG should improve technology transfer. The results of the SWOT analysis demonstrate that research and managerial capacities of DIBBAUG in Biotechnology have to be developed in order to become a key player at international level.

According to the socio-economic analysis recommended changes, RDI should be stimulated to improve international competitiveness. The SWOT analysis concludes that JUST should improve the faculty members' research productivities and encourage innovation and technology transfer. Socio-economic and SWOT analysis call for more collaboration with the business and industries. The priorities and actions taken to achieve this objectives will overcome Gaps in research and marketing capabilities.

STRATEGIC PRIORITY 1:

To promote research, development and innovation in Biotechnology, Biochemistry and food fields in step with the social and economic development needs

Planning research development directions should be in step with the needs of the local society. Georgian society and economic environment point to the development of Biotechnology in the region. Therefore actions, promoting research and innovation, that should be taken by DIBBAUG are:

- Choosing research priorities according to the global research trends and covering important national and European related priorities, e.g. new Production Technologies, Security and Healthcare, Nanotechnologies, enzymatic technology, Environment monitoring, Biotechnologies of processing of agrarian, medicinal and municipal wastes, Creation and production of functional food on the base of Georgian Flora, Working out original technologies of biofuel, etc.
- Focusing our effort on those activities which will cause fast development of DIBBAUG and give an advantage to go forward with the innovative technologies which will give Georgia more benefits from research, collaboration and innovation.
- Supporting integrating and networking of researchers and industrial partners through enhance awareness of potential partners about collaboration perspectives, set up of joint projects .
- Building the capacities of DIBBAUG through the retention of the best staff and involvement of undergraduate and graduate students in research, development and management.
- Participating in as many as possible international programs and activities in the field of biotechnology.
- Encouraging , supporting and recognizing individuals and teams that make a positive impact on DIBBAUG and advancing its goals.
- Create capabilities in areas that have high impact on the economic growth and social development and focus on revolutionary areas such as biotechnology and nanotechnology.
- Promote capacity around writing research proposals according to national and international requests for proposal, procedures for submission of external grants, and management of external grants. The experience of BIOPARTNERS project would be the most valuable and effective supply, since it is promoting DIBBAUG's capacity in producing scientific results, by training its research staff in the above mentioned topics. Thus a tradition on research grants is going to be established in the neat lines of DIBBAUG.
- Involve Industry and business in the R&D cycle.
- Provide training on and support in the development of operating procedures.

STRATEGIC PRIORITY 2:

To reinforce international cooperation capacities of DIBBAUG and integrate DIBBAUG in the international networks and research consortia

This should be enhanced by realizing the following steps:

- To increase the visibility of DIBBAUG on the European level and to allow its better integration in the European Research Area. We will achieve this aim by helping European organisations (private and public) to become more knowledgeable of potential collaboration opportunities with the DIBBAUG's scientific work. This will include dissemination actions, improvement and upgrade of DIBBAUG'sWebsite and preparation of promotional materials. The publication of scientific work
  papers, documents and other publications will allow the promotion of the DIBBAUG's
- research.
- To Support integrating and networking of researchers, developers and industrial partners through enhance awareness of potential partners about collaboration perspectives, set up of joint projects and promotion of DIBBAUG's activities, research, know-how and opportunities.
- To enlarge the international network of DIBBAUG and to integrate in the thematic European Technology platforms.
- To expand DIBBAUG's activities on regional (Caucasian) level.

STRATEGIC PRIORITY 3:

To develop strategic partnerships with business and industry

Research results, in the frame of BIOPARTNERS, would give DIBBAUG a great oportunity to participate in future projects concerning Biotechnology and food including FP7 projects . It will also make it visible in Europe both in academic and industrial/business level. Strategic partnerships with industry are necessary for DIBBAUG to improve scientifically. Consequently DIBBAUG should undergo the following *actions:*

- We will open channels of communications with business and industry to exchange ideas about establishing collaborations of mutual interest and benefit.
  Promote technology transfer opportunities and eliminate any of its barriers.
- We will enhance quality and competitiveness of scientific products and technologies developed in DIBBAUG in order to encourage national economic growth
- We will create a pool of science and technical knowledge through building up and exploiting research and innovation potential in selected fields in Ukraine and on the international level.
- We will encourage respect in interactions between S&T staff and managers
- We will involve young business developers within the commercialization process and support the development of their ability and skills to work with researchers, investors and industrials in order to link research and industry.
- We will Increase the number of cooperative agreements with business and industry.
  Undertake jointly sponsored research with industry.
  Support integrating and networking of researchers, developers and industrial partners through enhance awareness of potential partners about collaboration perspectives, set up of joint projects and promotion of DIBBAUG's activities, research, know-how and opportunities.

3.5.3. Objective 3: To attract, motivate and retain top quality staff

To achieve this objective, DIBBAUG will require a renewed commitment to retain, motivate and attract high quality staff, both in terms of teaching and research. DIBBAUG is seeking a continuous improvement of its staff. In this direction, cooperation and twinning actions with UMU, in the

frame of BIOPARTNERS, are very useful and fruitful.Enhancing such collaborations on the basis of mutual benefit and reciprocity would create in DIBBAUG the environment capable not only to retain its stuff but also to attract new one. Likewise, the SWOT analysis calls for more participation in EU events to promote competencies and capacities in Biotech research. The priorities and actions taken to achieve this objective will overcome the human resources gap in the SWOT.

STRATEGIC PRIORITY 1:

To retain highly-skilled researchers through promotion on their career paths and mechanisms for continuous development

Twinning activities with UMU, in the frame of BIOPARTNERS (twinning agreement), are a very important step to the direction of creating an environment, encouraging DIBBAUG staff to promote research in the Biotechnology area.

- Supporting professional development of S& staff by providing continuing education , trainings for maintain proficiency and cutting edge skills and evaluating programs for short term exchange of leading scientists, young researchers and graduate students
- Developing and implement researchers development/training programs based on the needs assessment survey, in addition to current and future issues. BIOPARTNERS project is an example of such actions. DIBBAUG's researchers are sharing data, information and tools with UMU experts. It is strongly recommended to continue with sharing, next to knowledge, research results. On the other hand, in the same project, scientific meetings and workshops have already taken place and are also planned to take place in the near future.
- Establishing orientation programs for new staff.
- We will support professional development of S& staff by providing continuing education, trainings for maintain proficiency and cutting edge skills and evaluating programs for short term exchange of leading scientists, young researchers and graduate students
- Supporting professional development of S& staff by providing continuing education , trainings for maintain proficiency and cutting edge skills and evaluating programs for short term exchange of leading scientists and young researchers and graduate students.
- Strengthening DIBBAUG's authority by ensuring consistent quality for all our researches, projects and activities throughout the world and knowledge dissemination by participation in international programs, events and other activities.
- Attracting top-quality students and staff and fostering their development;

STRATEGIC PRIORITY 2:

To encourage exchange of researchers with world renowned institutions

Short visits to UMU and vice are planned for the near future. This should be enhanced by realizing the following steps:

- Encouraging staff to spend their sabbatical leave in renowned institutions in Europe for example.

- Using collaboration networks including E.U. exchange and collaboration programs. DIBBAUG has already made an important contribution in this step by submitting and implementing, together with UMU, the BIOPARTNERS project.

STRATEGIC PRIORITY 3:

To build and strengthen international collaborative partnership and RDI networks

The Collaborative Research Networks (CRN) program is part of a suite of initiatives to reform higher education teaching, learning, research and research training. These reforms will lead to a system that is focused on quality, excellence, collaboration, and sustainability.

In general, partnership with RDI networks in the region, the E.U. and internationally, is a strategic priority of great importance to DIBBAUG, especially after the successful (up to date) realization of BIOPARTNERS project. As a result DIBBAUG would seek to:

- Promote collaboration and exchange with renowned institutions
- Improve the research abilities and widen knowledge diffusion and channels of interaction.
- Reverse brain drain. This would be a self-evident result if all steps described in the previous two strategic priorities would be implemented.

3.6. Conclusions and recommendations

The Strategic Development Plan of DIBBAUG has been presented. Based on previous activities such as SWOT, socio-economic analysis but mainly the results already obtained by the BIOPARTNERS project implementation, the Strategic Development Plan of DIBBAUG could be regarded as an ambitious one. It is structured around four objectives:

Objective 1: To enhance the quality of young scientists.

Objective 2: To create, stimulate, and improve the research environment of DIBBAUG.

Objective 3: To attract, motivate and retain top quality staff.

It should be mentioned at this point that in order to achieve the two last objectives, but mainly the last one, research on embedded system design should be further reinforced. This means that more people on the research area of embedded should blend with the existing researchers. Only this way a critical mass of researchers, capable to cooperate with the industry, could be created and therefore work on a smarter and greener institution.