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JOINT GENOMIC CENTER – A NEW APPROACH FOR THE ESTABLISHMENT OF AN EFFICIENT PUBLIC/PRIVATE PARTNERSHIP

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Joint Genomic Center is a new initiative for the efficient establishment of public/private partnership. In December 2006 the Sofia University "St. Kliment Ohridski" and the Agricultural Academy agreed to create jointly a Genomic Center on the principles of the Limited liability Company. It is the first initiative of this kind that joins the scientific efforts of such institutions with the aim to meet mostly the needs of the private sector.

Genomics and the Global Challenges

The global bio economy is facing serious challenges that need to be addressed both globally and locally. Over the last fifty years 1/5 of the top soil, 1/5 of the agricultural land and 1/3 of the forests have been lost due to many factors like the intensive and unwise use of the natural bioresources, global warming, the urbanization, the constantly growing population etc. Over the next 50 years the world population will grow to more than 9 billion while 2/10 of the arable land will be lost due to salinity, acidity and soil erosion. In order to face these challenges the world needs to build a sustainable bioeconomy which implements the knowledge based utilization of the natural resources like plants, animals, water, soil etc.

The European agri-food industry alone represents more than €1618 billion annually and employs over 22.1 million people. The European food and drink industry transforms more than 70% of the agricultural raw materials produced in the EU and exports in excess of €45 billion. Forestry and its related industries employ more than 3.5 million Europeans and contribute more than € 200 billion to the EU economy. Until 2005 The Common Agricultural Policy (CAP) used to work by direct payment of a subsidy for crops planted. This led to overproduction and trade distortions in the late 1990s. In 2005 CAP has changed its priority from support to overproduction towards market-oriented, environmentally friendly and sustainable farming.

The advances in the field of life sciences during the last 20 years have been tremendous. Our knowledge for the functioning of the genomes of living organisms has grown to a degree allowing us to use them in a sustainable way. The technology development has allowed the researchers to simultaneously study the function of thousands of genes, metabolites and proteins. As a result new scientific fields have emerged called genomics, metabolomics, proteomics and bioinfor-

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matics. These new scientific fields provide the opportunity to evaluate the biodiversity in order to protect it and to use it properly for the constantly growing demands of the humankind. Via utilizing our knowledge we can create better plants, animals, food, cosmetic and pharmaceutical products while preserving the natural resources and biodiversity.

In December 2000, plant genomics was recognized as a key priority at the millstone EC-supported Versailles Conference - Agricultural research in European Research Area. The EC has the serious concern of lagging behind in this field not only from USA, but also from China, Japan and even Brazil. In 2002 the European Reasearch Area Network (ERA NET) project was launched in order to overcome the fragmentation of EU science and to avoid the duplication of research programmes in the different EU countries. Bulgaria has joined the ERA Plant Genomics (ERA PG) network in 2007.

In 2002 The European Commission adopted a Strategy for Europe on Life Sciences and Biotechnology. This was in response to the importance attached to life sciences by the European Council. It proposes a comprehensive roadmap up to 2010 and puts the sector at the forefront of those frontier technologies which are helping to take the EU towards its long term strategic goal established by the Lisbon European Council in March 2000 of becoming "the most competitive and dynamic, knowledge-based economy in the world, capable of sustainable growth with more and better jobs…" within a decade.

Present State of the Bulgarian Bio economy

Although Bulgaria is small in area it is one of the richest countries of living biodiversity consisting of: 94 species of mammals, 383 birds, 36 reptiles, 16 amphibians, 207 Black Sea and freshwater fish, around 27,000 insects and other invertebrates, between 3,500 and 3,750 higher plant species and more than 6,500 lower plants and fungi. Thus Bulgaria is among the countries having the greatest biological diversity in Europe with a high potential to develop competitive bioeconomy. However, the rich natural resources are in contrast with the current poor situation of the Bulgarian agriculture and bioeconomy as a whole and the lack of effective technology transfer and generation of intellectual property necessary for the production of high quality and high added value products.

The number of employed people in the agriculture and forestry sector in Bulgaria equals to 806 966 for the year 2004 which is 24.9% of the total number of employed people in Bulgaria. If we add the 3.6% for the people employed in the food and tobacco industry it becomes obvious that the agriculture, forestry and food industries create a substantial workload which determines their importance for the Bulgarian economy. At the same time the contribution of Bulgarian agriculture and forestry to the state revenue is diminishing from 18,8% in the year 1998 to 10.9% in 2004. This is mainly due to the slow and unstable growth in the sector which is caused by the slow process of its restructuring.

The Bulgarian foreign trade suffers from the low competitiveness of the created products. The technological product in Bulgaria is some 50 % below the level of the EU-10. Bulgaria lags behind the leaders among the new EU Members States (Hungary, the Czech Republic and (Estonia) five-fold in terms of the share of high-tech Exports. R&D expenditures in Bulgaria are four times lower than the average EU-15 level. Bulgaria is faced with the serious threat of remaining outside the global technological flows and faces the risk of limiting its long-term innovation capacity. The contribution to the national export of agricultural products for 2004 is as follows: cereals-wheat, barley and maize – 14%, tobacco 13.58%, oleaginous seeds, mainly sunflower (11.11%), meat products (8.09%), food and vegetable products (6.13%), milk and milk products (6.05%), vegetables (4.60%), wine (3.9%), fruit (3.5%). The main exported products are raw material and semi-manufactured goods while products with high added value predominate in the national import. This shows the vulnerability of the Bulgarian bioeconomy and the immediate need to make it more competitive via making it able to produce high value added products.

Following the EU priorities the Bulgarian government launched the programme "Genomica" in 2001 as one of the five national priority research programmes. In spite of the achieved results, there is significant delay in the development of scientific and technological capacity, for providing an intensive genome research in this country. Bulgaria lags very much behind the European countries, the USA and a number of developing ones like Brazil, India and China. Bulgaria continues to lose ground with regard to the international recognition of its research product. Neglecting key fields like genomics, proteomics, metabolomics and bioinformatics will have a long-term negative impact on the development of a number of applied science fields. These include the selection of new and more effective plant varieties and animal breeds, characterisation and use of genetic resources for food, pharmaceutical, industrial and environmental purposes, predictive and preventive diagnostics in animal and plant health care.

The main factors which hampered the development of the genome research in Bulgaria are:

- Insufficient budget financing;
- Fragmented research and technological potential;
- Lack of industry interest;
- Lack of modern infrastructure and equipment;
- Lack of international cooperation

Establishment of Joint Genomic Centre (JGC)

The macroeconomic stability in Bulgaria has created the necessary conditions for growth of enterprises and establishment of productive innovation partnerships. The proper functioning of the innovation system would enhance the competitiveness of Bulgarian businesses in the EU. The share of innovative enterprises is gradually rising in Bulgaria. According to the latest official statistical data, they account for some 16 % of all companies but this is still far below the EU average.

The development of high value added products in the field of agriculture, food and feed industry, cosmetics and pharmaceutical industry requires research capacity and modern facilities that are currently not available in Bulgaria. It is expected this products to be natural for Bulgaria and in this way to complement and stimulate the development of the national and European bioeconomy based on knowledge which is of a key priority of its prosperity.

In 2006 the AgroBioInstitute (ABI) (Centre in Excellence in Plant Biotechnoly as acknowledged by the European Commission in 1999) started the initiative for establishment of Joint Genomic Centre (JGC). The Joint Genomic Centre has to give the opportunity of research groups from the universities, research institutes and SMEs to perform research in the field of genomics, metabolomics, proteomics and bioinformatics. Since 2007 Bulgaria is associated member of the European Research Network in Plant Genomics (ERA-NET PG). In 2007 following the initiative of ABI the Joint Genomic Centre was established as a Limited liability company (Ltd) between the National Centre of Agricultural Sciences (NCAS)(today Agricultural Academy) and the Sofia University (SU). NCAS and the SU respectively authorized the AgroBioInstitute and the Biology Faculty to organize the actual establishment of the JGC. The equipment of the JGC is shared among the members. The access to the JGC equipment for non member institutions will be granted on the basis of projects as well as a service. The JGC aims to become a key strategic centre which will provide the Bulgarian universities, research institutes and SMEs access to modern equipment, "know-how", utilization of a multidisciplinary approach, contemporary approaches in the field of genomics, metabolomics, proteomics and bioinformatics and a highly qualified personnel for production of high-value added products, following the principles of the EU for complementation and integration thus avoiding duplication.

The proposed project plans for the establishment of Joint Genomics Centre (JGC) which unites researchers in the field of biotechnology from leading laboratories, institutes, universities and private laboratories from Bulgaria and abroad who perform genomics, metabolomics and other biotechnological

research activities for improvement of agriculture crops, stock-breeding, fish-breeding, lactic acid bacteria, food products, cosmetics and pharmaceutical products and others. The JGC's direct cooperation with laboratories offering high-tech service, as well as with businesses (SMEs in particular) producing and using high-tech products will lead to a new rapid advance and considerable rise in the level of technology transfer, the creation and practical application of technologies and high-throughput methods and high value added products. Moreover it will help the immediate and effective incorporation of the national genomics program into ERA-NET ensuring Bulgaria maintains access to cutting edge science and technology available across the EU.

JGC will play a key role in the innovation of the following sectors:

Agriculture, stock-breeding, fish-breeding, genetic resources and environment

1. Evaluation of the biodiversity in Bulgaria and selection of unique for the country organisms (microorganisms, plants, animals) with the aim of their protection, examination, improvement and utilization in the agriculture, pharmaceutical industry and the food industry

2. Establishment of a genebank for preservation of DNA sequences from the selected unique organisms, rare and endangered species and plants possesing economic and ecological potential

3. Accelerated breeding and development of new cultivars with the help of DNA markers for the important agricultural crops like wheat, barley, maize, sunflower, grapevine, oil rose and others

4. Development of new plant cultivars which are able to survive through extremal environmental conditions and at the first place tollerance against drought

5. Development and implementation of high-throuput molecular genetics methods for assesment and production of certifies seed and planting material

6. Development of technologies and models for high efficiency production of biofuel on the basis of plant material

7. Development of biofertilizers and biopesticides in terms of improving the soil fertility

8. Development and implementation of high-throuput molecular genetics methods for assesment of origin, identity and quality of products made from animals, fish and microorganisms

9. Development of predictive and preventive diagnostic systems in animals and plants

Industry: food industry, cosmetics industry, production of bio-materials, components and energy resources:

1. New foods and drinks: products from lactic acid bacteria (the unique for Bulgaria bacteria strain *Lactobacillus bulgaricus*); products derived after lactic acid fermentation; healthy foods and food additives

2. Nutrition and health: identification and characterization of the food ingredients which play a substantial role over the human health

3. Development and implementation of high-throuput methods for analysis of biological material for assessment of the status and the origin of food products

4. New products from essential oil plants on the basis of their specific and large biodiversity and high added value of the developed products

Healthcare and pharmaceutical industry

Development and production of new pharmaceutical products on the basis of plants with medicinal and pharmaceutical characteristics (e.g. "mursalski" tea *Sideritis scardika* – prevention of cardio-vascular diseases, *Leucojum aestivum* – a source of galantamine for treatment of diseases of the nerve system and Alzheimer disease; oil rose *Rosa damascena* – aromatherapy, antioxidants); table grapevines and wines – (antioxidants) for diseases related to the

Services

1. DNA identification for cultivar identity and purity for the breeding programs

2. Diagnostics and assessment of the plant and seed material's genetic and health status for seed producers and plant nurceries

3. Detection of genetically modified organisms (GMO)

4. DNA protection of the intellectual property of divers bioproducts

5. Assessment of the status and origin of food products

6. Control based on DNA analysis over the import and export of planting material and animal products, their quality and safety

7. DNA sequencing

8. Molecular markers development and genotyping

9. Bioinformatics services and development of bioinformatics software tools (Establishment of Agri Bio Info Service Unit (ABISu) at JGC)

Education and Training

Innovation, research and education are the main drivers of the global knowledge economy. Currently, Bulgaria suffers from the innovation gap which hampers the development of the economy. JGC will contribute to the successful filling of this gap by implementing cutting edge research and creating high value added products but also by education and training of highly motivated young researchers which will ensure the future perspectives of the centre's development. JGC will perform postgraduate education, research and innovation in emerging trans- and interdisciplinary fields.

One of the main reasons for the low participation of Bulgarian scientists as coordinators of EU scientific projects is the lack of management skills. Therefore, JGC will put accent on the scientific education of the young researchers but also on the development of their management skills and ability to run and coordinate projects. The JGC researchers will work in close cooperation with the newly established European Institute of Technology (EIT) in order to ensure the up to date transfer of all new and modern achievements of science, technology, management and education on a national level. JGC will also work in close cooperation with the Universities in Bulgaria and will provide the technology base and know-how for the development and application of the innovative skills thus reinforcing the transfer of research activities from basic to applied research. JGC will help to close and boost the cycle between the education, research, innovation and industry and will offer the private sector a new relationship with education and research beyond what exists today (Figure 1). Education will have the real opportunity to be supported by the private sector and to be involved in the process of developing actual market products. Institutions and companies will be working together in the frame of the JGC consortiums on a daily basis towards common objectives until the projects continue to be supported financially. The JGC should be able to issue diplomas and degrees.

General Goal of the Project

The main goal of the project Joint Genomic Centre (JGC) is to increase the competitiveness of the Bulgarian bioeconomy by establishment of a key strategic centre which will provide the Bulgarian univer-

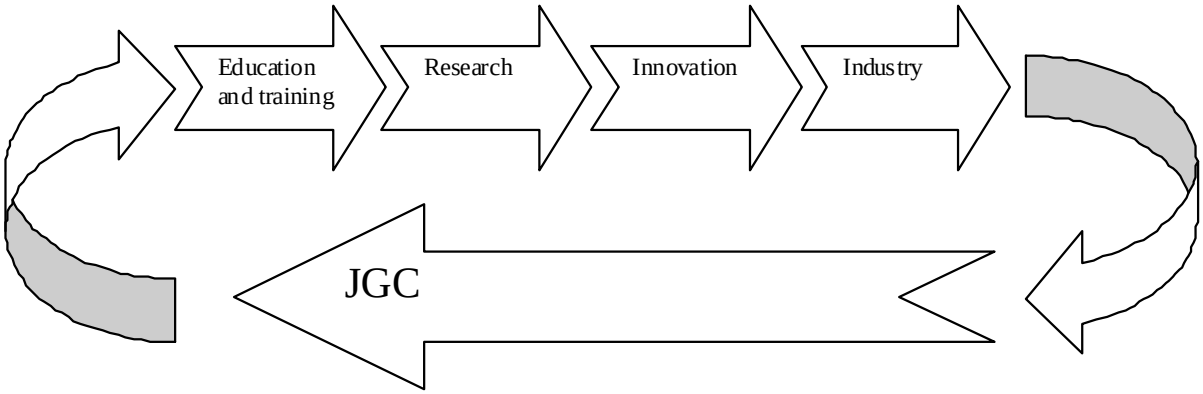


Fig. 1. JGC closing the cycle between education, research, innovation and industry

sity and academic researchers and SMEs an access to modern equipment, "know-how", utilization of the multidisciplinary approach, up-to-date experimental methods and a highly qualified stuff for development of high value added products in the field of agriculture, food industry, cosmetics industry, production of biomaterials, ingredients and energy resources, health and pharmaceutical industry by following the complementary and synergic principles of the EU – complementation, integration and avoidance of duplication on national and European level.

Specific Goals of the Project

· To create conditions for integration of agricultural genomics researchers from advanced laboratories, institutes, universities, and private sector laboratories working on genomics and metabolomics applications in crop improvement, animal welfare and human health and thus to avoid the duplication at the national level thus avoiding duplication of project funding on a national level for production of sustainable bioproducts with high intellectual and competitive value.

· To establish a key centre for "knowledge triangle" – developing social and economically important synergies between research policy, innovation policy and education policy. To be created in order to contribute to the whole Lisbon strategy for economical and knowledge based society;

· To improve the synergies with ERA NET and leading international research centres and programmes, as well as private industry companies working in the field of genomics research thus ensuring access to cutting edge science and technology.

· Generation and implementation of high value added products with nationally important intellectual property. Thus to safeguard the social, economical and cultural models and lifestyle;

· Effective technology transfer and development of collaborative high-tech products. Active cooperation with organizations and companies for the introduction of new competitive products and technologies for the improvement of the national agriculture, industry and health care;

· Transfer, development and effective implementation of high-tech methods for diagnostics, control and assessment of the quality and the origin of the plants, animals food, feed and other products;

· Development of programs for effective preservation of the biodiversity of unique Bulgarian germplasm of plants, animals and microorganisms with economic, environmental and social importance on a cell and DNA level

· Education and career development of young and highly motivated researches

· Effective participation in national and international research, development and applied programs;

· To develop return programmes for some of the best Bulgarian scientists who work abroad

· To develop programmes for social, ethical and moral support for the genomics research and to integrate the society into the development and acceptance of the genomics research

· To realize effective interaction and project cooperation with the other national high-tech centres

JGC Structure

Taking into account the main tasks and objectives, the overall structure of the JGC is planned to include four main specialised units (Figure 2) which will work in close cooperation: genomics laboratory, metabolomics laboratory, proteomics laboratory and bioinformatics laboratory.

Building a knowledge based economy requires direct knowledge based implementation of the science achievements into the economy sectors. JGC model of interaction with the national institutions, SMEs, NGOs and the market shown in the diagram below (Figure 3) is based on successful models found elsewhere in the EU which have secured EU funds previously and therefore meet all the key EU compliance requirements.The principles of work of JGC are outlined in Figure 3:

· Catalyzing role for initial partnership establishment

· Interdisciplinarity and synergism between partners

· Technology transfer

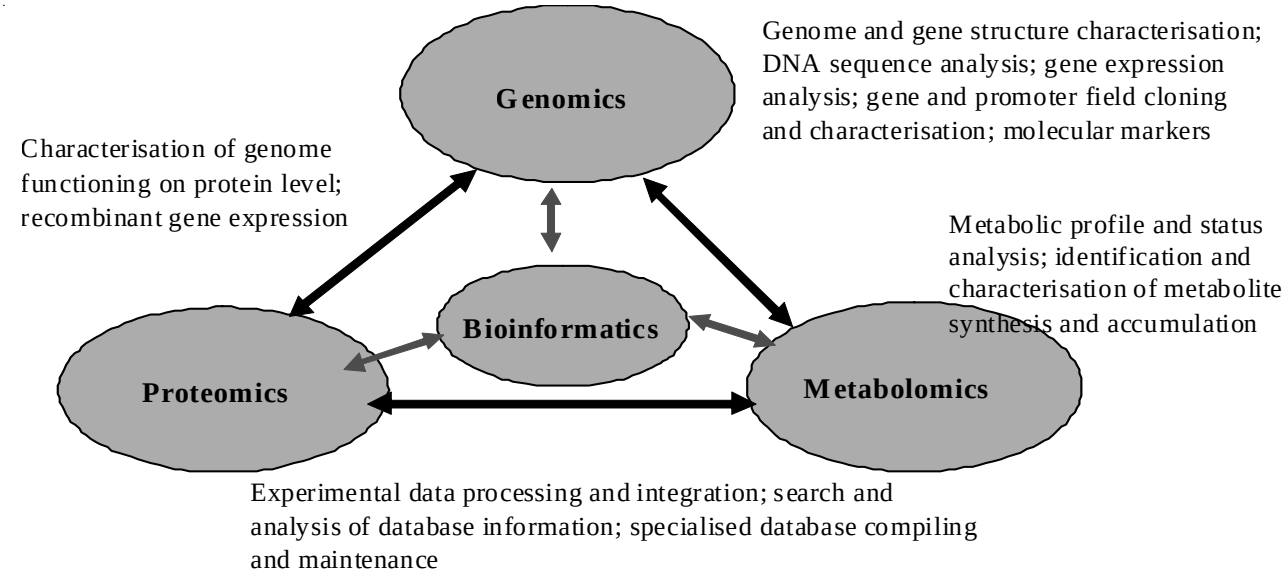


Fig. 2. Overall structure of the JGC including laboratory of genomics, metabolomics, proteomics and bioinformatics

· Intellectual property rights
· Creation of spin-off companies
· Market and marketing
· Minimum working staff, maximum efficiency
· Short term (1-2 years): 6-7 people
· Long term (3-5 years): 10-12 people
· Civil contracts – for payment of nonpermanent staff.

The contribution that plant science can make has already been outlined in studies prepared by scientists in the USA (e.g. Plant/crop-based renewable resources 2020, http://www.oit.doe.gov/agriculture/pdfs/vision2020.pdf; The Multinational Coordinated Arabidopsis 2010 Project, http://www.arabidopsis.org/workshop1.jsp), Japan (The Rice Research Program in Japan, http://rgp.dna.affrc.go.jp/index.html), Australia (The Plant Functional Genomics Centre in Australia, www.arc.gov.au), and Canada (The Canadian Crop Genomics Initiative, www.agr.gc.ca/science). A recent report of the Biotechnology and Biological Sciences Research Council (www.bbsrc.ac.uk/media/pressreleases/04_05_12_csr.html) analyses the problems in the United Kingdom and calls for a national strategy for crop science research.

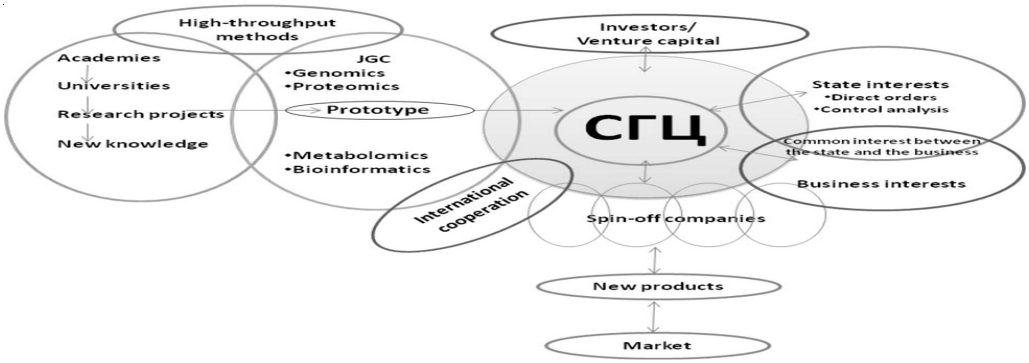
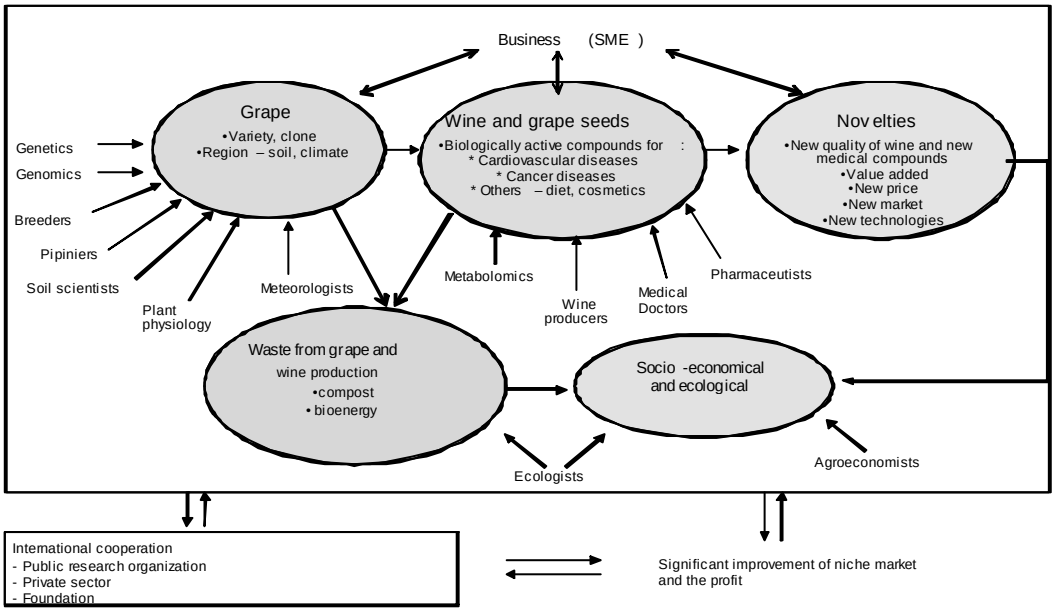


Fig. 3. Schematic presentation of the interactions between JGC, the Government, NGOs, Research institutions, Industry and market



Participants in the Consortiums (Technology platforms) **(Figure 4)**

They will be composed of the principle of the interdisciplinarity and adequate participation from Academies, Universities, NGOs and the private business. Initially a key role is expected to be accomplished by the AgroBioInstitute to Agricultural Academy and Biological Faculty to Sofia University "St. Kliment Ohridski".

Such example for Consortium is for the grape variety Mavrud and the wine "Mavrud". Basically speaking, the same principle will be followed by the rest of the TP for microorganisms, plants and animals.

Sources of JGC's Funding

The financial sources which JGC wil utilize in order to fulfill its goals are:

1.European and international research programmes and funds (European Framework Programs); ERA-NET; IAEA, FAO, NATO etc.

2. National Science Fund MES, Research centres

3. Services

4. Contracts with companies from the private sector

5. Licenses and royalties

6. Membership fees

7. Returns from the JGC's bank account interests

8. Donations, testaments and sponsorships

9. Consultations, accomplishment of research and analysis related to the goals of JGC

10. Education courses, qualification and re-qualification courses, seminars and other forms of activities which help the achievement of the JGC's goals

11. Establishment and participation in trade associations

12. Other business activities which might be related to the achievement of the JGC's goals

Conclusion

The Joint Genomics Centre is a new entity which aims to show how the scientific knowledge and experience can meet the requirements of the industry. JGC will serve as a model for public private partnership which could be a good ground base for the future bio economy development of the country.

It remains to see how this model could be successfully implemented for the development of the Bulgarian bio economy.