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THE APPLICATION OF TRIPLE-HELIX MODEL IN AGRICULTURAL SECTOR OF CROATIA

Nothing new that is really comes without collaboration!
James Watson, Nobel Prize Winner, as a co-discoverer of double-helix DNA molecule

INTRODUCTION

Since 1990s we have witnessed a strengthening awareness that innovation, particularly technological, is a structural element in the current competitive system, contributing to the growth of production and to the material wealth of the countries (OECD, 1991:12). The position of a country in the competitive system should be based upon knowledge, i.e. on the development of some new products and methods, which will bring not only success for the firm that is implementing them but also for the economy of the country as a whole.

Knowledge has been considered as a common good that can be shared without fear of losing its value. It is impossible to prevent its wide spreading and exploitation. Therefore, the firms are increasingly intensifying their research and development activity (R&D)[1], emphasizing the importance of collaboration with other research institutions (OECD, 2001:45). However, so far this collaboration has mainly come down to some indirect contacts between certain firms and research institutions, in the form of either publication of periodical articles or attendance of conferences (Cohen et al., 2002:15). At the same time, many national industries are becoming aware of the lack of such tools that would make the collaboration between the firms and research institutions more successful and productive (Bakkevib, Jakobsen, 2003:2). On the basis of literature, it has been understood that generating and spreading of the knowledge is an interactive and a communicatively intensive process, which requires development of back-up tools to be used by the firms not only for the promotion of knowledge but also for more successful

cooperation with other firms and with R&D environment.[2] The role of the universities should become more distinct and influential as an indirect source of knowledge for development of industrial innovation and entrepreneurship (Klofsten, 2000:23; Etzkowitz, Klofsten, 2002:32; Cohen, 2002:19).

Recently, numerous examples of the most developed countries as well as some developing countries, or the countries in transition, have shown that their government strategy, backed-up by support of the university and R&D institutions, has been encouraging development of regional industry, particularly small and medium enterprises (SMEs).

The convergence of three realities (actors), university, industry and government, has become a transition model of the society based upon knowledge, and it has been articulated as *Triple-Helix Model*. This model was originally derived from the survey of the industrial reconstruction of Boston, Massachusetts, in the 1930s, by commercializing the research results achieved from the collaboration between university, industry and government (Etzkowitz, Klofsten, 2002:5). Today, it is considered to be a useful tool for the research of regional socio-economic systems in Europe (Viale, Ghiglione, 1998:3), in Nordic countries (Ylinenpää, 2001:4), and a back-up tool for the development of innovation centers providing support to small and medium enterprises in Italy (Cariola, 1999:10), in contemporary Russia (Kazakova, 2001:3) and the like.

Triple-Helix model implies the development of a trilateral network of organizational links between university, government and industry (Etzkowitz, 2002:12), in which university (and similar research and educational institutions) should be regarded as the main source where knowledge is being generated and from which it is being spread. In order to be able to commercialize the results of research activities, to link up with industrial processes and to support the growth of new firms, it is necessary to develop an entrepreneurial spirit of the university. Government should provide some strategic guidelines for development of a sectorial and a regional economy of the country, by implementing a number of direct and indirect economic measures and by ensuring financing sources of R&D activities. Government should also be responsible for launching of R&D projects of special importance for the country, particularly when their high financial standards cannot be met without financial help of the government. The role of the firms, the last link of this trefoil, should be to concentrate their resources on the commercial part of R&D activ-

ity, to develop new products or technologies, and, to provide universities and R&D institutions with feedback information on some new potential research areas.

Taking the hypotheses of *Model* as a starting point, two innovative projects of the agricultural sector in Croatia have been analyzed, both implying implementation of *in-vitro* technology for the production of seed potatoes and pyrethrum. The former project is in its implementation stage. In other words, the first ton of virus-free seed material had already been produced in greenhouses, and then planted on the fields of the sub-contractors. The latter is still in its planning stage. Therefore, it will be necessary to define the trilateral links of *triple helix matrix*, as a prerequisite for a successful launching of this considerably complex project.

These two projects are important for the economic growth of Croatia since they are both related to a strategically important agricultural crop. The former crop being seed potato, which has been imported so far, and it is beyond any dispute that the country still depends on its import. The latter crop is pyrethrum, which is essential for development of an ecological agricultural production, and which was being produced to a great extent in the period preceding World War 2.

Our hypotheses emphasize the importance of both crops since the main prerequisite for their successful production is an interface between the knowledge resources, particularly those of applied knowledge (universities, institutes, laboratories) on one hand, and big agricultural producers, who can ensure a production basis for commercialization of knowledge, and a number of small and medium entrepreneurs, on the other. It also presupposes some stimulative policies and economic measures for the implementation of R&D projects, for the provision of financial resources, and for a rise of employment rate etc.

The results (primarily analytical) achieved by such a methodological approach can be exploited (i.e. become applicable) in the following ways: (1) in planning development strategy of the agricultural sector, particularly for certain crops or regions (regions under special government concern, islands etc.); (2) in laying out a challenging development system according to the proposed strategic goals and development projects in certain sectors of the economy, and (3) in specifying the exact role of universities, certain colleges and university departments (e.g. Department of Sociology in Split, which is being founded now), as well as R&D institutions in the processes of generation and application of knowledge. In this way the research re-

sults can be capitalized and other research projects can be initiated.

TRIPLE HELIX MODEL – MAIN PROPOSITIONS

In order to found our economic growth on knowledge and innovations it is necessary to redefine knowledge, a leading development resource in the society, and to develop a suitable infrastructure. In this way the knowledge will be concentrated, interconnected and used for the purpose of economic growth and development. In this sense, we can expect some changes in all interface-segments of the model: in R&D institutions[3], in firms, in corporate sector and in government bodies.

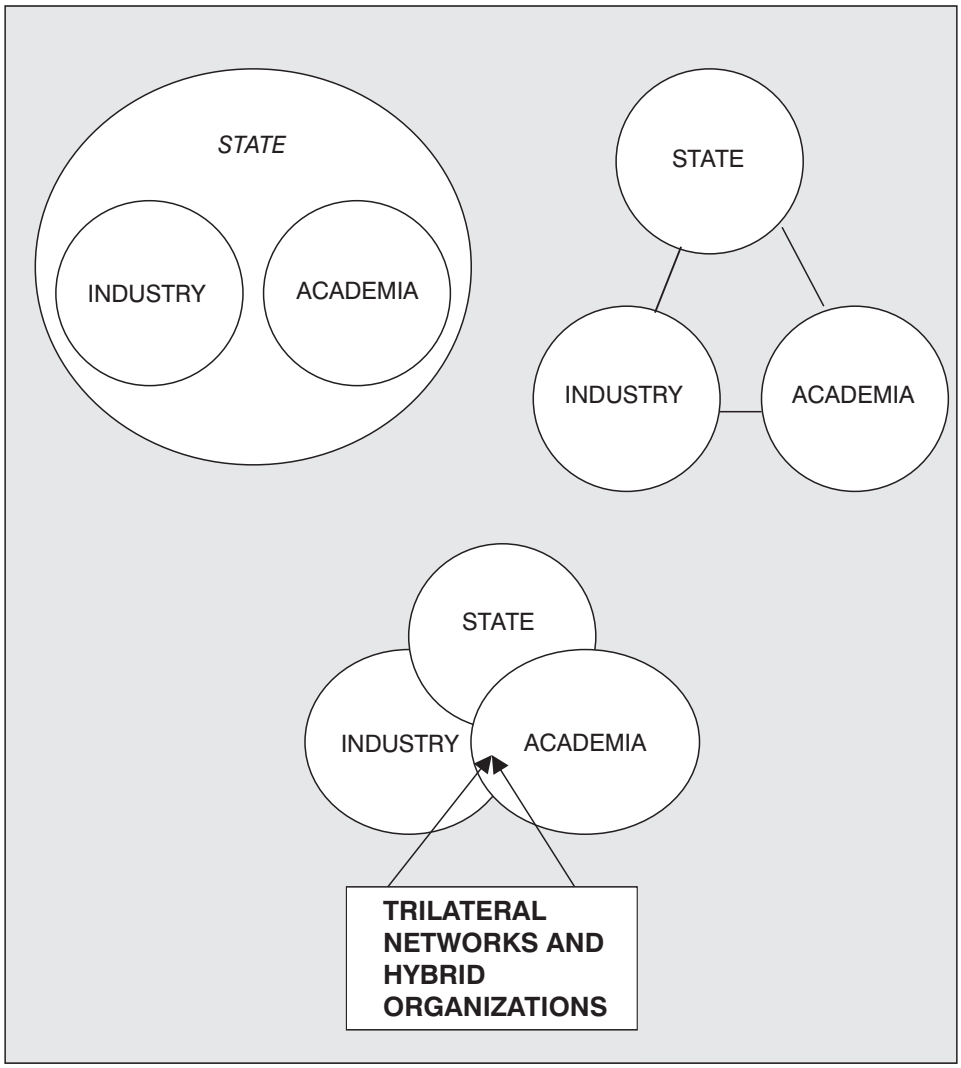
Triple Helix Model, as such, illustrates trilateral links, interfaces and influences of the segments as well as necessary changes of the structure in various stages of knowledge exploitation.

Triple spiral model shows the university-economy-government relationships as relatively equal and interdependent ones, overlapping with each other and changing each other's roles (Etzkowitz, 2002:2).

However, in reality, the relationships between university, economy and government are quite different regarding the institutional frame of the country and an achieved level of strategy transition in the society. There is such a development strategy, which is based upon the prevailing industrial production versus an economic development strategy, which is based upon knowledge and its exploitation.

The roles of economic and political segments are predominantly important in *statist* (or socialistic) *model* of interface between science, economy and government, like in *laissez-faire model*, while the role of knowledge is of minor importance there. On the other hand, the roles of all the segments in *triple helix model* are equalized, assuming the transition of the society based upon knowledge. *Picture 1.* shows different models of interface between knowledge, economy and government.

In the countries (such as U.S.A., W. Europe), in which some prerequisites for integration of knowledge, economy and government have already been provided, triple *helix model* is being recognized as an empirical model. It can be realized as *bottom up*, i.e. by an interaction between some individuals and organizations in various institutional spheres involved in some individual projects, or as *top down*, when it is supported by government incentive policies and measures (Etzkowitz, 2002:4).



Picture 1
From statist model to triple helix model (According to: Etzkowitz, Leydesdorff, 2000:111)

A developing society based upon innovation distinguishes three levels of this model. The first level refers to the interior development structure of each segment of the model. For example, some colleges and universities have been redefining their development strategic goals. Once they used to be mainly scientific-educational institutions, now they are increasingly focusing on R&D activity. The only indicator of their success is their position on the market, while their behavior is characterized by entrepreneurial spirit. Most firms have become aware of the need for mutual integration and for development of strategic alliances in order to be able to concentrate their knowledge resources and to utilize both the synergic effects of integration and the competitive advantages as well.

The second level deals with the impacts of segments on each other. For example, government has been systematically giving support to R&D activity, to innovations and to commercialization of knowledge by ensuring more favorable financing sources for such projects or by granting a tax relief. Some efforts have also been made to develop a standard system of intellectual property protection and various aspects of technology transfer, etc.

The third level refers to trilateral links between the segments of the model, to their overlapping and to development of different organizational forms of their integrated activity. The forms can be structurally adapted in order to be able to generate new ideas or to exploit the knowledge.

However, interrelationships between the segments of the model are not *a priori* coordinated or stable over the long term. During the process of generation and exploitation of knowledge there are constant changes and transformations being carried on in each segment of the triple spiral, in their interactions and in the ways they influence each other. Dynamic aspect of the model implies some communication overlaps between the segments. Therefore, we can expect that discussions and negotiations going on at the level of a trilateral network and a hybrid structure will result in a transformation or a coordination of the institutional framework and will create an innovation-minded environment (Etzkowitz, Leydesdorff, 2000:115).

Redefining of interrelationships between universities, economy and government in order to encourage innovation processes in the society and to commercialize knowledge can be applied at all levels: multinational, national and regional, as well. Yet, in an effort to develop innovation processes, the concentration of resources of the triple spiral model at a regional level will require enhancement of some local conditions by interconnecting R&D with other activities. This can be done only by mutual efforts of all three segments: university, economy and government.

According to Etzkowitz (2002:7) this is the first stage of transformation of the value scale among the promoters of regional economic growth. This stage provides a more favorable *business atmosphere* and some stimulating entrepreneurial tools as prerequisites for an economic growth based upon knowledge. In the following two stages the most innovative ideas and strategies generated from multiple interactions between university, economy and government are being accepted by consensus and there are some attempts to implement them in practice. The key issues of

interactions between the segments of *Triple Helix Model* are: how to formalize the results achieved in an innovation process, how to build up a suitable organizational structure for commercialization of knowledge, how to draw the most favorable financial sources, and how to find the most suitable form in which capital, technology and know-how will be combined.

However, if the interrelationships between university, economy and government are not well defined or poorly defined and therefore it is not possible to generate, implement or commercialize results of innovation processes, it is necessary to ensure a systematic gathering and recording of all the results of both successful and failure projects. In this way the achieved results and the concealed knowledge may be explicitly uncovered and applied on some future projects. It is evident that both the acquisition of techniques needed for memorizing knowledge and the achieved project results are important factors for the process of capitalization of knowledge and for an economic growth based upon this resource especially in a country in which mostly *ab ovo* projects are practiced, in which keeping and sending of documents is regarded as *needless* activity for transfer of knowledge, and in which cooperation or collaboration *happen only by chance*.

APPLICATION OF TRIPLE-HELIX MODEL IN DEVELOPMENT OF PYRETHRUM AND POTATO PRODUCTION

Applicability of the main propositions of *Triple Helix Model*, i.e. of cooperation between institutional knowledge, economy and government in the process of capitalization of knowledge for the purpose of developing national economy, has been analyzed on two projects in agricultural sector of Croatia. The former deals with plantation cultivation of pyrethrum and the latter deals with cultivation of seed – potato.

Both projects are based upon an innovation technique in cultivation of crops – *in vitro technology* and its market applicability, that is, on micro-multiplication of economically important crops, including vegetative multiplication of highly valuable and market-demanded plant genotype, as well as the production of early generations of healthy plants, which can be further cultivated in greenhouses or planted on the fields as an agricultural crop. The application of *in vitro method* of multiplication ensures the following: (1) rapid multiplication of the initial plant, (2) production of healthy plant balm, (3) generation

of a unique genotype or phenotype, and (4) economically profitable production of the plants based upon the above mentioned elements (Jelaska, 1982:42)

1. Case study: Pyrethrum, Dalmatian chrysanthemum (*Chrysanthemum cinerariifolium, Dalmatian pyrethrum*), grows in its natural habitat on the Adriatic coast and on the islands. It is an autochthonous (self-grown) plant with irregular long-shaped olive-green leaves, with a number of tender white flowers with yellow bulrush on a stem. The plant is well known, because its flower contains natural insecticide *pyrethrum*, which, if used correctly, is not toxic for humans and warm-blooded animals. It is also rapidly biodegradable, unlike synthetic insecticides, so it is not harmful for the environment. Due to the complexity of the compound and its instability, it is unlikely that insects become resistant on usage of pyrethrin.

Toxin *pyrethrum* was first recorded in early Chinese history. It is believed that the plant was brought to Europe from China, together with silk, a long time ago. In the 19th century there were big plantations of pyrethrum in Iran and in Dalmatia. In the first decade of the 20th century the plantations of pyrethrum covered some two thousand hectares (5000 acres) of the land in Dalmatia. An average production of pyrethrum was approximately thousand tons of dry bulrushes (Kolak, Šatorić, Rukavina, Filipaj, 1999:432). Throughout the later period the areas planted with pyrethrum, as well as its annual production, have been constantly decreasing. According to a recent survey (1997) the area planted with pyrethrum is minimal and the concentration of pyrethrin is 0.46%.

In view of the world production of pyrethrum, in the period preceding the World War 2., Japan had the largest areas planted with pyrethrum, and the biggest annual production of pyrethrin. During the WW2, and in the period following the war, the production and processing of dry bulrushes, i.e. the extraction of pyrethrin rapidly grew in some East African countries. Since mid 1990s Kenya, which is the second producer of dry bulrushes in the world today, has been developing its own production basis for the selection of the plant clones exactly on the seeds of Dalmatian pyrethrum. During the last 15 years, Australia has developed the most modern industry of pyrethrin in the world, which is located on the island of Tasmania. The annual production of pyrethrin has been constantly growing thanks to innovations in multiplication method and to new techniques for the extraction of the compound from the dry bulrushes of the pyrethrum flower. As a result, a

stable offer of this insecticide on the world market has been guaranteed.

Considering the facts that Croatia has favorable climatic and soil conditions for self-growth of this plant in the coastal area and on the islands, it is obvious that essential prerequisites for re-cultivation of pyrethrum, an important plant culture, already exist. However, in order to be able to design and plan the plantations of pyrethrum, to produce dry bulrushes, to extract pyrethrin and to develop industry of insecticide based upon natural product, it is necessary to connect all the segments of triple helix model. In other words, there must be an interaction between institutionalized knowledge, agricultural sector of the country and government back-up tools and measures.

In innovation segment of the project for re-cultivation of pyrethrum on the plantations it is necessary: (1) to select plants with relatively highest concentration of pyrethrin, in reference to 0.46% concentration found in self-grown plants, which are prevailing in this area today, (2) to produce, by applying *in vitro technology,* healthy plants (virus-free seed material), which guarantees the expected annual crops, and by applying the method of micro multiplication of plants in the greenhouses until they reach the planting stage and get planted on the plantations, (3) to define an adequate system of agrotechnical measures for the protection of growing plants, as well as a protection system on the plantations, (4) to develop a system of picking of the mature flowers, of their drying and storage prior to the processing, (5) to define technology for the processing of pyrethrum flowers, and for the extraction of pyrethrin from the flowers, and (6) to define the ways and procedures of standard production of the final product – a number of various insecticides, which are available on the market today, while their further development will satisfy the expected demand on the market in the future.

Various institutions that generate knowledge including colleges, university departments in the country, laboratories and R&D centers have concentrated necessary resources capable to find the best solutions of the specified R&D areas. While doing so, they must consider the specific qualities of the country and configuration of the region suitable for cultivation of this plant, as well as the existing development level of the processing industry in the country.

The following prerequisites have to be met in the agricultural sector of the country for a successful realization of the project: (1) to identify adequate production re-

Pictures 2, 3 and 4
The flowers of pyrethrum, cultivation of plants in green houses and plantations of pyrethrum

sources for laboratory production of seed material and for cultivation of plants in greenhouses, and to develop cultivation of pyrethrum on the plantations, (2) to define a model of business connections for the production of the plant, i.e. a cooperation between family estates (farms) and big agricultural producers in order to dimension the area with cultivated plants, i.e. to expand the plantation area in proportion to the laboratory and greenhouse capacities, and according to the planned annual production growth, (3) to recognize business interest for starting up industrial production of pyrethrin (insecticide on natural basis) by investing in construction of the plants for extraction and serial production as well as the storage of semi-manufactured and final product, and by developing distribution network.

At the government level, planning and implementation of the project assumes that strategic guidelines for development of agricultural production already exist, that strategic importance and position of each plant has been established (including those plants which do not participate in agricultural sector today, but have been proposed for commercial cultivation in near future). Furthermore, it is necessary: (1) to define the ways and sources of financing of R&D activities in this project, (2) to identify stimulating measures (including tax relief), employment policy, sources of financing etc. for R&D organizations and for agricultural and industrial producers, and (3) to define development strategy as a regional development policy with regard to the most favorable locations for laboratory and greenhouse production, for plantation cultivation and for construction of processing plants.

The feasibility of the project can be assessed from the viewpoint of certainty that agricultural production is organized on crops which are not prevailing in agricultural sector of the country (corn, wheat), or are not included in its agricultural production (pyrethrum is a self-grown plant). An interface of the knowledge, economy and government is a necessary prerequisite for getting involved in such a complex, manifold and an expectedly long-term project, particularly in an environment where an intensive, steady and highly interactive cooperation is not a common practice.

Finally, the feasibility of the project of starting-up industrial production of pyrethrin in Croatia can be considered with regard to the information on implementation of the EU development project for pyrethrin cultivation in Mediterranean area for the purpose of an evaluation of insecticide market and for the sake of health protection in

these countries. The aim of this project is to generate an advanced subtype of *Chrysanthemum cinerariaefolium,* adapted for a possible cultivation in eight Mediterranean countries, which can compete with traditional species of this plant being cultivated in some African countries, or with advanced plant species being cultivated in Australia.[4]

2. Case study: The other project, which deals with the production of seed potato, has already been partly realized, unlike the previous one dealing with the production of pyrethrum, which is still in its planning stage. In the innovation stage of the seed-potato project, the plant genotypes of seed potato, the ones mostly demanded at the market or mostly imported, have already been developed. Almost a ton of virus-free seed material, which will be used as seed basis for starting up the production of seed potato on our own fields, has already been cultivated in laboratories and by micro multiplication in greenhouses.

Tubers of seed potato were planted on a sub-contractor's field in Žumberak last spring. Constant control on the field has shown that the virus-free crop has been retained and this can guarantee a high yield of seed material in the following planting period, the implication being existence of average climatic conditions and implementation of some agrotechnical measures. At the same time, some new virus-free seed material for new sorts of seed potatoes has been produced in laboratories and greenhouses by using method of micro-multiplication. One of the leading producers of seed potato in the country has recognized it as a strategically important crop for the development of his firm.

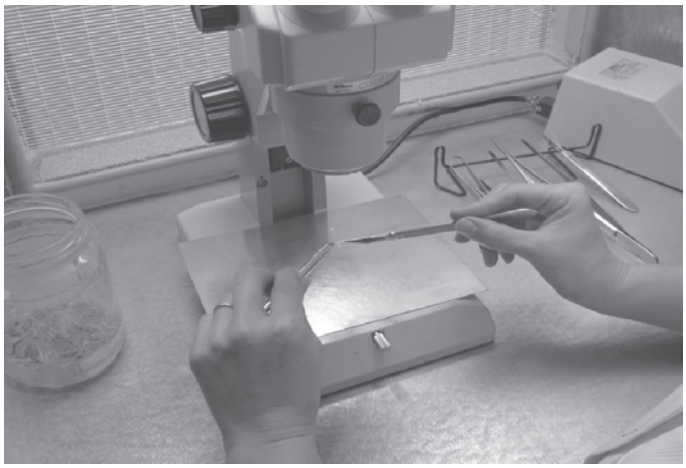
Past experience on the realization of the seed-potato project has shown that cooperation between innovation and production segments of the possible triple model has been successful only because the interests of the researchers of greenhouse plant production and food manufacturers have been mutually recognized. In the laboratory segment of this project, the accrued knowledge and experience have generated virus-free seed material; its micro-multiplication has been provided, including the production of virus-free tubers, which have been prepared for commercial cultivation and for the first planting on the fields.

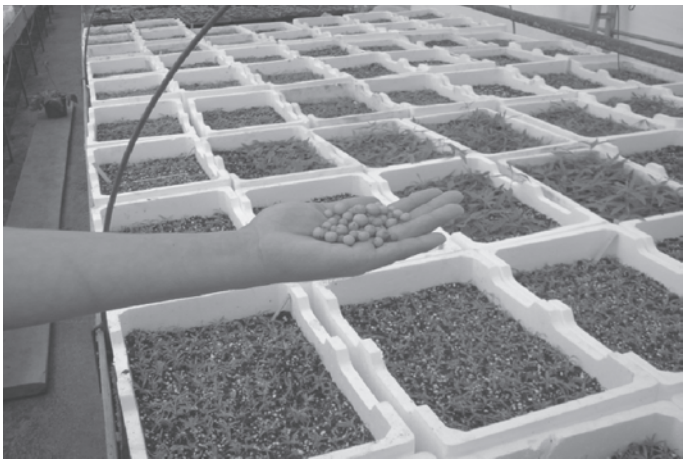
In the production stage of this project the required arable land area for the first and the second multiplied production can be provided (up to 50 ha of the planted area). For further production it is necessary: (1) to connect (formally and on the basis of vested interest) cultivators of seed potato as sub-contractors, who will take over one gen-

eration of virus-free seed material, plant it on their own fields, take necessary agrotechnical measures, including protection measures in order to ensure high degree of virus-free conditions as a main prerequisite for expected above-average yields, and (2) to provide technological support in gathering, storing and keeping of seed potato, including construction of an adequate storage space (capacity and climatic conditions), (3) to invest in extension and/or construction of manufacturing plants in which potato can be further processed for the production of some food products (half-finished, finished, frozen), stock-cattle feed, in industry of alcohol etc., (4) to organize production of mercantile potato on arable fields of the subcontractors, or on the field of big agro-industrial conglomerates, and (5) to provide technological propositions for packing of the final potato product and for placing it on the export market.

The present economic policy in the segment of potato seed production in our country encourages import of seed potato and provides stimulating measures for the cultivators of seed potato, who are subsidized per kilo of produced seed. The main market supplier of potato seed is Netherlands, the leading producer of seed potato in Europe. A complete dependence of our seed potato producers on import has many disadvantages. They are often faced not only with price fluctuations but also with market fluctuations of the offered quantities of suitable sorts. In addition, if it should happen that the imported seed material has failed to be biologically controlled, this carries a risk that the area planted with such seeds develops a virus infection, which will result in a decreased annual yield per acre, below the national average, and even much lower than the world average.[5]

In any case, a complete dependence on the seed potato import may result in the concentration of valuable resources (especially financial resources) in some other sectors e.g. in the commercial one, where the short-term interests are not investments in development of their own seed material, particularly of strategically important crops. Therefore, in order to implement the seed-potato production development project, in accordance with the main propositions of triple helix model, we should at least expect the following: (1) family farms should be encouraged to cooperate with available arable areas where developed virus-free seed material can be cultivated in all the stages from multiplication to the production of the first quantity of seed potato to be offered on the market (in the spring of 2005.); (2) a tax-relief system should be estab-





Pictures 5, 6 and 7
Micro-multiplication, cultivation in green-houses and the first multiplication of virus free seed potato material

lished and favorable investments in expansion of arable area should be provided; (3) processing capacity increase should be encouraged, especially of undeveloped segments (food production, cattle-stock feed, alcohol industry – all based upon potato as a raw material), as well as investments in modern technology, e.g. processing machinery, modern warehouses etc.

As a result of the first multiplication of virus-free seed material, approximately 1 ton of seed material has been produced, and then planted on an area of 2 ha (5 acres). In the following multiplication stage, assuming that the yield per acre at the lower limit is about 15 t/ha, it would be necessary to ensure the area of 14 ha on which about 30 tons of superlative seed material can be planted. In the third multiplication stage, about 200 tons of elite seed material planted on 100 ha (250 acres) could be reasonably expected. After the last multiplication stage, some 1,5 thousand tons of seed potato (which has been imported from Netherlands as *class A*) can be offered on domestic market in the spring of 2006.

According to the available statistic data[6], today Croatia imports about 16 thousand tons of seed potato, and the areas planted with early, late and seed potato covers some 63 thousand hectares (157 500 acres). Due to the lack of a rigid control on import of the seeds in general, additional quantities of seed potatoes are imported through some illegal channels. Assuming that annual yield per acre will be minimal, it is reasonable to expect that the implementation of this seed-potato production development project will ensure about 9% of the registered seed potato import in 2006. Since we are talking here about virus-free seed material, and since we have heard for the seed-potato producers in Croatia, whose annual yield per acre is from 45 even up to 60 t/ha, the economic profitability of this investment seems to be unquestionable.

CONCLUSION

Both development projects significantly encourage a regional economic growth. Pyrethrum was once cultivated in the coastal area and on the islands, and today it grows there as a self-grown plant. Considering the quality of the soil and favorable climatic conditions, the plantations of pyrethrum should be located in the coastal area of the country. In R&D stage, following the experience of Mediterranean countries, Pyrethrum plant clones can be generated by applying *in vitro* technology and by micro-multiplication. The clones are adapted to planting conditions

that exist on certain parts of coastal areas and on the islands, and contain an increased percentage of pyrethrin, which ensures more economical production and processing. Besides, processing and storage capacities can be located in the same region in which all the prerequisites for a planned development of pyrethrin industry have been already met.

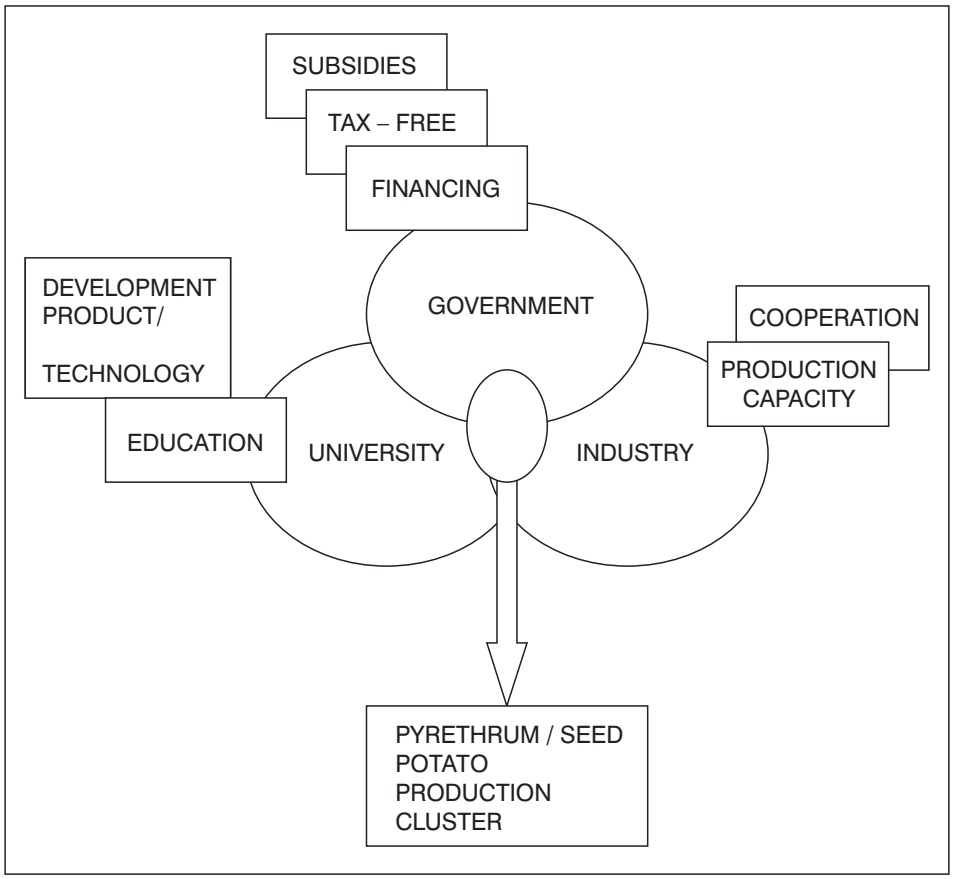
Type of soil, climatic conditions and risk of virus infection are the circumstances that outline and encourage regional concentration of seed potato production in the country. So far there have been successful plantations of seed and mercantile potato on the arable areas of Lika, Zagorje and Međimurje. Some of these regions are considered to be economically undeveloped. Lika, for example, is one of the most undeveloped regions in the country. Therefore, in this case, the seed-potato production development project can encourage economic growth of an undeveloped region, as well.

In the end, realization of both development projects, regardless of the different levels of their present project development, can be successfully implemented if there is an intensive interaction and cooperation between three segments: university, economy and government in all stages of the project realization. Main areas of the project development in each segment and possible manifestations of trilateral organizations and hybrid structures are illustrated on.

Universities and other similar institutions, which generate knowledge, should concentrate all the available resources for the development of the product (and by applying *in vitro* technology they will develop some new species or those species that qualify in view of an expected economically-efficient production). They should also develop new technological solutions to be used in production and crop industry development. They should also provide an efficient educational system and encourage the transition of a concealed knowledge into an explicit one, so that its application value can be generated.

Corporative sector is responsible for the provision of resources, required for commercial exploitation of the knowledge. It should develop production, processing and distribution structures in all the stages of the production cycle, until the final products are placed on the market.

Government should provide development infrastructure and ensure implementation of the project at all possible levels (strategy, policy, measures and activity), taking in consideration an innovative character of the project, strategic interests and some regional characteristics of the economic growth.



Picture 8
Triple Helix configuration in realization of the development project for agricultural production of pyrethrum and seed potato

If the interaction of the three segments in realization of the above described projects is constant and intensive, and provided that all the development activities in each segment are well planned and theoretically organized, so called *cluster* interaction can be formed, i.e. a cooperation and collaboration between existing or newly-formed structures in realization of the development projects as a whole.

In fact, an orientation of the economic growth of the country towards capitalization and commercial application of the knowledge presupposes cooperation, collaboration and integration of the three segments: institutionalized forms of knowledge, economic sector and government. However, innovation segment will be successfully developed only if all other segments have been developed, if their mutual interaction has been achieved and if trilateral structure has been generated.

In the context of main propositions of *Triple Helix Model*, the above analyzed development projects as specific *case studies* of agricultural sector in Croatia, can be assessed as feasible. However, their success as regards the expected

impacts they may have on economic growth of Croatia, will, to a great extent, depend on ability and readiness of the triad to establish a common strategic interest of the analyzed projects. Besides, an intensive coordination, communication and interaction in realization of all aspects of the projects should be provided, and the most adequate forms of trilateral structure and network in project realization and in implementation of the results to the final product and to the full realization of the expected economic impact should be developed.

Theoretical organization, planning and realization of some specific development projects based upon the main propositions of *Triple Helix Model* can be useful in several ways, especially in a country where all the prerequisites for integration of the segments of the model on strategic and political levels have not been created yet. In this way, the proposed strategies can be concretized and the knowledge and experience, also applicable in other development projects, can become accumulated.

In the context of economic growth of Croatia, various structural interactions aiming to commercialize research results, will be exploitable in terms of (1) theoretical organization of the agricultural development strategy by identifying plants/crops of strategic importance for the country and by adequately defining their position in regard to their production capacity, quality of seed material and their dependence on import, (2) planning and realization of regional development by putting an emphasis on enhancement of the agricultural production, (3) building up a development stimulation system pursuant to strategic goals, and (4) concretization of the role of institutional forms of knowledge in R&D activity and in other knowledge-generating processes, or, in other words, commercialization and capitalization of the accrued knowledge.

Actual assessment of omnipresent social crises in our society reminds us of past experience and of numerous social science theories. Main reasons for our referring to the past experience may be a lack of knowledge, inadequate or unavailable knowledge, or, as the case might be, it has been wrongly applied or not applied at all by social forces. Cifrić states that "... the problem with public good is not in the fact that private interests clash with public interests, but in the fact that a number of private interests in modern society have been identified/labeled as public interests, and actual public good has become an abstract category, and not actual social contents." (Cifrić, 2000:15). This is exactly what the authors of this paper have tried to avoid, in an effort to draw public and private notions in a closer

interaction with social and developmental ones. Namely, all sorts of unions between science (theory) and practice seem to be everlasting questions, as old as the society itself. This is where sociology appears too, trying to be a more engaged science in cooperation with economic science. Nevertheless, so far, various dualisms have been prevailing here, but there are some prospects that triple model interactions will take charge, what has been apostrophized in this paper.

However, we should bear in mind that modern society has been defined as a risky society *Risikogesellshaft*, according to Beck, (1986), the risks being the result of human activity. Actually, they are the results of decisions, which get materialized in industrial production. A democratic procedure of decision-making has not been practiced in the domains of entrepreneurship, science and technology so far, although these are the social spheres where actual decisions about (sub) political innovativeness should be made. It is in fact concealed in the term "progress", which, on the other hand, has an undoubtedly magic power, and creates an opportunity for numerous dialogues and discussions and for various social activities. This is the right place for our discussion on *Triple Helix Model*, which presupposes an interactive and integrative activity of various social factors that will all together change the quality of life in the future Croatia. We support the theses on development of a specific type of society, so called a sustainable society, which presupposes an adequate balance between long-term and short-term social objectives. Such a society should be established on the basis of scientific and technological creativity and entrepreneurship. However, this transition into a new millennium society (into 21st century) will be a significant, valuable, technical, political and cultural challenge for Croatia that might be realized only by means of new ideas, new ways of thinking, new methodologies, new methods and new model approaches.

FOOTNOTES

[1] The term "research and development" (R&D), Croatian (I&R), has been extensively used by many countries on the recommendation of OECD.

[2] These concepts are comprised in the following theories: cluster theory (Porter, 1998), innovation systems theory (Lundvall, 1992; Nelson, 1993) and in learning theory (Lundvall, 1992).

[3] They are often called University, although they can also be some other organizations that formally do not belong to the university in narrower sense.

[4] To find more about this project visit the following web site http://www.nf-2000.org; 14. 09. 2002.

[5] According to the data obtained from Institute for Agricultural Zoology at Agricultural Faculty, University of Zagreb, the anylyses of the soil in cadastral districts of Belice and Gardinovac in Međimurje, where potato has been planted on 1,200 ha, have shown that out of 151 samples, 109 (or 38 ha of the planted area) are infected with potato cystlike memathode, a disease which can decrease the yield up to 80% as compared to the average yield crop in this area (according to: http://www.agr.hr/document; 27. 09. 2003).

[6] See data of Bureau of Statistics; http://www.dzs.hr/Hrv/2003/1-1-6h2003.htm; 27. 09. 2003.

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