Adaptation of temperate climate horticultural plants in tropical and subtropical developing countries II. General characteristics, Hungarian experiences and possibilities

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M. Fári[1,2] and **J. Nyéki**[1]

[1]*University of Debrecen, Centre of Agricultural Sciences H-4032, Debrecen, Böszörményi út 138, Hungary*
[2]*Agroinvest Co. Ltd. Budafoki út 78, Budapest, Hungary*

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Summary: The cooperation of Hungarian professionals with Chinese, Thai, South-Korean, Taiwanese and Brazilian colleagues should deserve much more attention than actually done. We refer to the transfer and adaptation of production technologies as well as biotechnological developments in vegetables, fruits, ornamentals and medicinal plants from the Temperate Zone to the tropical and subtropical regions. According to our information Hungarian colleagues involved in extension work are highly esteemed on the same level as Japanese, Chilean, Italian and French colleagues. We could state that immigration of investors, local enterpreneurs as well as those coming from expansive regions of Europe, North America and oversses, representaives of supermakets keeps to be accelerated by the increasing confidence triggered also by the successful management of profitable plantations, vineyards and fruits initiated first about 15 years ago.

For Hungary, the presence and achievements of Hungarian horticultural expertise in tropical and subtropical zones yielded unequivocal advantages. Therefore, the next actual step of development would mean the organisation of a network of the "Units of Horticultural Mission" in the tropic and subtropic countries. We are convinced that those Units will stimulate the traffic of technologies as centers of transfer within and between the regions and contribute to the increasing influence of professionals on the production and trade of horticultural commodities. The introduction and testing of new varieties of vegetables, fruits, medicinal plants (as well as ornamentals), the development of the growing technologies, adaptation and acclimation of Temperate Zone germ plasm representing the general trends of advanced production will be the most important tasks of the Mission with a sufficient oversight upon the whole world. It is taken as a fact that Hungarian horticulture and breeding is competitive on the world market. We are ready to contribute to the development of horticulture on a worldwide scale. The Hungarian R & D will be attentive in the future to manage the accumulated capacities by information and mediating needs and offers to the volonteers of the profession. The reality of the above propositions are amply proved by successes of the Agroinvest Co and of other professionals registered in abroad.

To keep on the top of the world list of the profession we have to follow up the international trends by our permanent presence on the most important centers of administration and production of the world in order to hold on the hot line of the Hungarian administration competent in financing the R & D activities. *We need specialists which are open minded, speak languages, familiar with the tricks of informatics, economics and politics, competent in deals, able to make decisions, etc. The education and training should be strenghtened to be conform with those trends.* That proposal involves also the need to follow up the activities of the transnational companies, the regular, active participation on international conferences, the permanent attention paid to electronic informations available in the worldwide networks as well as the printed periodicals of horticulture. It is also related to the attraction of investors to the developments aimed within the country as well as abroad. At last but not at least we have to keep in mind that the *work performed abroad by the Hungarian professional is a kind of "para-diplomatic mission" which cannot be substituted by any other, sometimes very expensive activity charged on the official diplomatic missions. The benefit of it is, however, valid to the whole country because false stereotypes developed during the last 50 years cannot be abolished otherwise.*

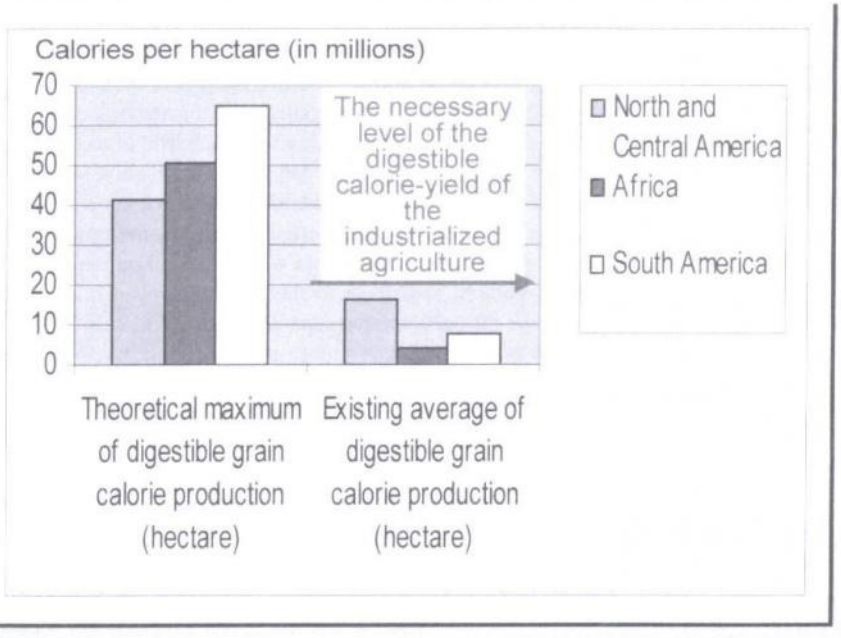
Food production of the XXIst century: challenge of human history

Since the ill-famed study of *Malthus* (1797) the scientists interested in the future of Mankind and ambitious politicians keep to be concerned because of the alleged threatening collapse of the balance between demographic growth and development of food production. In spite of the ominous prognoses, our civilisation found always, up to now, adequate means of to avoid the predicted disaster mainly by exploiting new natural resources owing to the progress to science and technology. In the technically advanced regions of the North, around the turn of the XIX and XX centuries the achievements of technological skill facilitated the change from an extensive agriculture to some kind of industrial food production. That process started about one hundred years ago and showed its Janus-face: on the one hand, it was interpreted as the First Green Revolution, which resulted in a never seen population-explosion of the Third World; on the other hand the leading principles of agricultural technologies did not change adequately. Therefore, the living as well as the anorganic environment became gradually wounded *(Conway,* 2000). Hitherto, the developed countries of the Northern Hemisphere are considered as being incriminated for the global environmental catastrophe having started at the beginning of the 80-es. Actually, they are interested in a kind of hypothetically „sustainable" development or even in the regression of agricultural production on their own areas. The Southern Hemisphere and the huge countries of the Third World unequivocally pledged themselves to increase their food production as the only escape of famine in spite of growing environmental pollution of the densely populated areas (China, India, Brazil, etc.). It is also well known that for the alimentation of the developed countries is increasingly shifted to the Third World countries through the pathways of the globalised world trade, thus the environmental hazards are charged to those countries where the supplies are produced by "advanced" but sometimes utterly polluting technologies (soya, corn, tropical fruits, etc.).

According to actual prognoses the world population will culminate between 2020 and 2050 and will approach some 8–10 billions (*Borlaug,* 1997). It is also expected that the population at least twice as large than the present one will live at 80–90% in the countries of the present Third World. On the search for reassuring solutions we have to deal essetially with the global balance of vegetable and animal proteins, carbohydrates and vitamines, where the painful contradictions of our age are catched in the act. One of the examples is the question of digestible cereal starches as presented in *Figure 1.* In the countries of the Third World

Figure 1

Amount of Digestible Grain Calorie-Yield in Three Continents of the World
(after Conway, 2000[1], modified)



1: Original source: H. Linneman et al., op. Cit; FAO, AGROSTAT.TS, Rome, Italy)

theoretically optimal conditons prevail, in spite of that only 12% of the reasonably calculated maximum has been produced (South-America, Africa). In North-Amerca, on the contrary, more than 40% of the capacitiy has been exploited (*Figure 1*). By means of those large numbers it is easy to prove that first of all in developing countries the production could be increased largely without the extension of the cultivated area, that means the yields of the present 5–8 million cal/ha should be increased to 20 million cal/ha within the 50-year period ahead. To attain that goal we have to develop new principles of food production in consense with the leading politicians, economists, representants of natural sciences and technologists.

The leading principle of the XXIst century: sustainable horticultural food production based on ecological and physiological (biological) considerations

The president of the Rockefeller Fundation, *Gordon Conway*, expressed his view on the future of Mankind, which is to be saved by the "Doubly Green Revolution" (*Conway*, 2000). The connotation of the adverb "doubly" is understood as the most developed biological and scientific knowledge in food production must be coupled with the highest level of environmental protection as a key of success. The two principles should be considered together as indispensable. According to our conviction, in the Doubly Green Revolution horticultural crops will be advanced to the highest positions (*Fári et al.*, 2001). That is the only way to secure the welfare, first of all an adequate, balanced alimentation for the populations of the Third World located mainly in the tropics and subtropics. In the semi-arid regions of the world that problem touches one billiard people. Not regarding the global trends, *in the developing countries of tropical, subtropical climats the development of horticultural production on biological principles is a particularly important, strategic question.* There are different explanations of that, so the most important of them are following:

(1) The provision of the population still in need with healthy food but on a low level of processing ("*in natura*");

(2) It is important to develop in tropical and subtropical regions the horticulture with irrigation to be able to produce commodities offered on the world market at profitable prices, exported mainly to developed countries;

(3) The highly labour intensive horticultural production will absorb the population exposed to the marginalisation due to unempoyment in those over-populated areas.

The leading economists of the Third World started to recognise the importance of that and tend to give exceptional priority in the financement of that branch of production.

Biotechnics in soil tilling, and biotechnological working machines on the fields

The most advanced methods in agricultural production developed in the XXth century are built on a basic, nay, revolutionary recognition: the exhaustive (holistic) knowledge of chemical and biological processes in the soil and in the cultivated plant, as well as the exploitation of that knowledge to the benefit of the technology to be applied in production. *Historical evidence proves the internationally outstanding role of Hungarian scientists in the recognition and formulation of those ideas.* As it is commonsense that the physico-chemical processes alone do not cover the complex processes of the soil as initially postulated by *Justus von Liebig* and his disciples around the middle of XIXth century, but it is rather a biological complex. So one of the forgotten Hungarian professors who used first the concept of "*biotechnics*" in 1918, *Raoul H. Francé*, spoke of "*edaphon*" and opened the way for the new theory of soil cultivation of the XXth century (*Siebeneicher*, 1994). The other idea was the living organism as a "*biotechnological engine*" coined by *Károly Ereky*, who was also a forgotten engineer recalled by *Holló & Kralovánszky* (2000).

Shortly, we will explain where is the idea coming from. As generally recognised, most of the developing countries do not dispose of the capital and the background-industry, thus they are unable to realise the industrialisation of their horticulture and capitalise the protection of soil and environment with the traditional tools at hand, in comparison with the developed countries having introduced those technologies during the XXth century. It is of special relevance for us that in the future all those substances being necessary to realise an environmentally acceptable production of food without (relatively) excessive capital and energy investment should be manufactured by the plant cells themselves. The living organism is the most authentic and efficaceous structure created and verified since billions of years, the prototype of a laboratory. It should be conditioned to do the desired job on the required level. The best solution should be found to exploit the conditions of the growing site (water, sunshine, atmospheric Nitrogene, carbon-dioxide, etc.), and on the other hand, the organism should be armed with resistance to adverse effects, moreover, changed in its composition, becoming more digestible, tolerant to storing conditions, enhanced in biologically precious substances, all together more valuable for the buyer or consumer. The development of more useful organisms to the benefit of Mankind is the job of the breeders, moreover, a challenge to the biotechnologists, a new profession with a very broad perspective. The initial suspicion should be dissolved by reasonable criticism and authentic expertise void of the superficial dilettantism of journalistic campaigns.

As generally accepted for all kind of agricultural production, the technologies of farming are conspuously variable in horticulture too depending on the climatic conditions of the particular region of the Globe. We cannot ignore the technologies developed during the long history of

traditional cultures. Development of any kind is bound to the thorough knowledge of the previous methods and successes. All new ideas must be checked and compared with the precedents and adapted to the local, particular conditions, species and locality. Taking into account the facilities of telecommunication and transport *the transfer and quick adaptation within the framework of international co-operation will be the unprecedented opportunity of agri- and horticulture of the XXIth century*. It is our conviction that a reasonable consideration of soil, precipitation and temperature the application of the most advanced biological principles, inventions, know-hows and tricks are liable to open up immense reserves, which are dormant in the tropical and subtropical regions of the world. Beginning with the first years of the XXIth century the advanced horticultural technologies should be istalled according to the same principles in "developed" as well as in "developing" countries, as a matter of fact, all of them need to be developed continuously. A global, transcontinental program of co-operations should facilitate the spreading of experiences arisen is any part of the world to be adapted anywhere it is reasonable. The new biotechnologies as well the living engines should be applied and their adaptation stimulated by education, research and development (R & D), breeding, trial of varieties, etc. The most efficacious way between the laboratory and the production of the commodities should be shortened to the possible minimum. Hungary is eligible to serve as a bridge in the future between the Europe and the developing Third World. *Our country (Hungary) being still struggling with the lack of capital to be invested but rich in agricultural (farming) experiences and tarditions of innovativeness inspired by excellent geniuses of the near past. Due to dynamically developing foreign relations the professionals are mobile and competitive on the world market by their mental (spiritual) capital. The field of exploiting the qualities accumulated will radiate to the wide world market*. The examples of Netherland, Danemark and Ireland are to be mentioned. In East-Central Europe Hungary's advances in biotechnology are esteemed (*Wagner & Groó*, 1992, *Balázs & Dudits*, 1997) and the successes are performing a beneficial catalisatory effect on the process.

As to underline the above statements we will give some examples on the development of horticultural productione in tropical and subtropical countries during the last 15 years.

Hungarian successes in the acclimatisation of temperate zone horticultural crops

Hungarian expertise was active recently in China, Thailand, Taiwan, South Corea and Brazil, under different organisational, financial and administrative conditions. The co-operation was always started with a thorough study during a travel on the spot in order to elaborate a basic plan of the aimed activities. The realisation of the project was either a continuous presence of the team (Agroinvest Co.), or a supervision of the activities at regular intervals (Pannon Agrar-University, Keszthely; University of Debrecen and others). Among the continuous (permanent) co-operations the so called applied horticultural biotechnology and other units of the mission represented more complex organisational form of activities e.g. which was led by the Agroinvest Co in Brazil. The main fields of activities:

- Table and wine grape production adapted to semi-arid tropical conditions;
- Acclimatisation of vegetables, fruit and medicinal plant species in the tropics and subtropics;
- Adaptation/introduction of alfalfa hay production in large-scale farming of the semi-arid tropics;
- Biotechnology of horticultural crops, micropropagation, virus-free production of transplants for large, industrial plantations under tropical conditions.

Table and wine grape production adapted to semi-arid tropical conditions

In the semi-arid region of North-Eastern Brazil, the valey of São Francisco river Hungarian experts of viticulture and vinification started the job in 1986 (*Lakatos*, 1997; *Lakatos & Balogh*, 2000). The Agroinvest Co is still co-ordinating the activity, but the introduction of remarkable achievements would excede the available space. The most important experiences are condensed in shortly. The millenary traditions of viticulture as well as the excellent education and training of the of the extension service in the enology and management were furnished by the Hungarian team was favourably mached with the equip of the local experts representing the Embrapa, Codevasf. During the joint efforts the viticulture of the area was transfornmed in the spiritual as well as in the physical sense. The 15 years witnessed a change around the towns Petrolina and Juazeiro starting initially with yields of 8–10 tons/ha/harvest to 30–50 tons/ha/harvest. The choice of adequate varieties and rootstocks were supplied with anything they needed on an optimal level. Nutrition, irrigation schedules and treatments of phytosanitation were all reconsidered according to the aims formulated according to an up to date strategy. It could be stated that the abundant yield of excellent quality found its market in the domestic as well as in the foreign trade and caused already a remarkable affluence in the area. In the next wave of development the triumph of tropical enology (wine making) will be expected (*Lakatos*, 1997). Foreign capital is increasingly appearing in the province, which is a vigorous stimulus of the economy. The appreciation of the Brailian administration is honoured by the highest decoration given to the leader of the Hungarian mission, *András Lakatos*. The title of "*Comendador da Ordem Nacional do Crizeiro do Sul*" ("Knight of the National Distinction of the Southern Star") is given as the highest distinction to a foreign citizen. The next projects are the establishment of Stations for phytosanitation, education, agrochemical and soil science based on Hungarian

experiences. Specialised tools needed for the tillage and scientifically developed soil conditioning technologies of the tropical vineyards, then the plant propagation coupled with the careful control (indexing) of virus free stocks will help to maintain and stabilise the high yields. The introduction of biological and integrated phytosanitation is aimed to keep low the level of chemical pollution of the produce offered to the most demanding consumers. The active co-operation with the local R & D institutions, first of all with Codevasf and Embrapa is one of the most fruitful joint enterprises, which guarantee long duration.

Acclimatisation of vegetables, fruit and medicinal plant species in the tropics and subtropics

Hungarian plant breeding is especially interested in the improvement of those crops and plant species. Some of those species are unic regarding the local character of the commodity, thus their importation is impossible. Varieties have been able to withstand the overwhelming flood of the international seed market, moreover many of them gained international reputation and are grown at the moment also in abroad. The Hungarian seed trade furnishes 4% of the world seed supply. Experiences gained during the last 8 year period prove that many of the varieties bred in Hungary are easily adapted to the conditions prevailing in tropical and subtropical countries as well. It is a potent tool to broaden the genetical basis of a given species by acclimatisation and introgression of foreign varieties or even species, moreover, the scale of commodities offered on the local market may be extended favourably creating possibilities of their exportation too. Both aspects are offering advantages to the respective country. The tedious breeding programs to develop resistance or tolerance to local adversities is most efficacious when performed on the spot under continuous presence of the damaging organism (or its race-specific pathogene). That is the most reasonable way to develop highly productive and safely resistant, more or less „intensive" varieties adapted to the needs of particular consumers. Special attention is paid to the vitamins C and A, and mineral salts in vegetables and fruits (pepper, tomato, watermelon and muskmelon, etc.). In several provinces of China, Thailand (the Royal Project), Taiwan and South Corea are references to prove the above statements (*Nyéki*, 2000, *unpublished*).

In the future, the attempts of acclimatisation should be extended to a couple of medicinal plant species in the above mentioned areas. Hungary has relatively abundant resources in plant species as well as in respect of expertise.

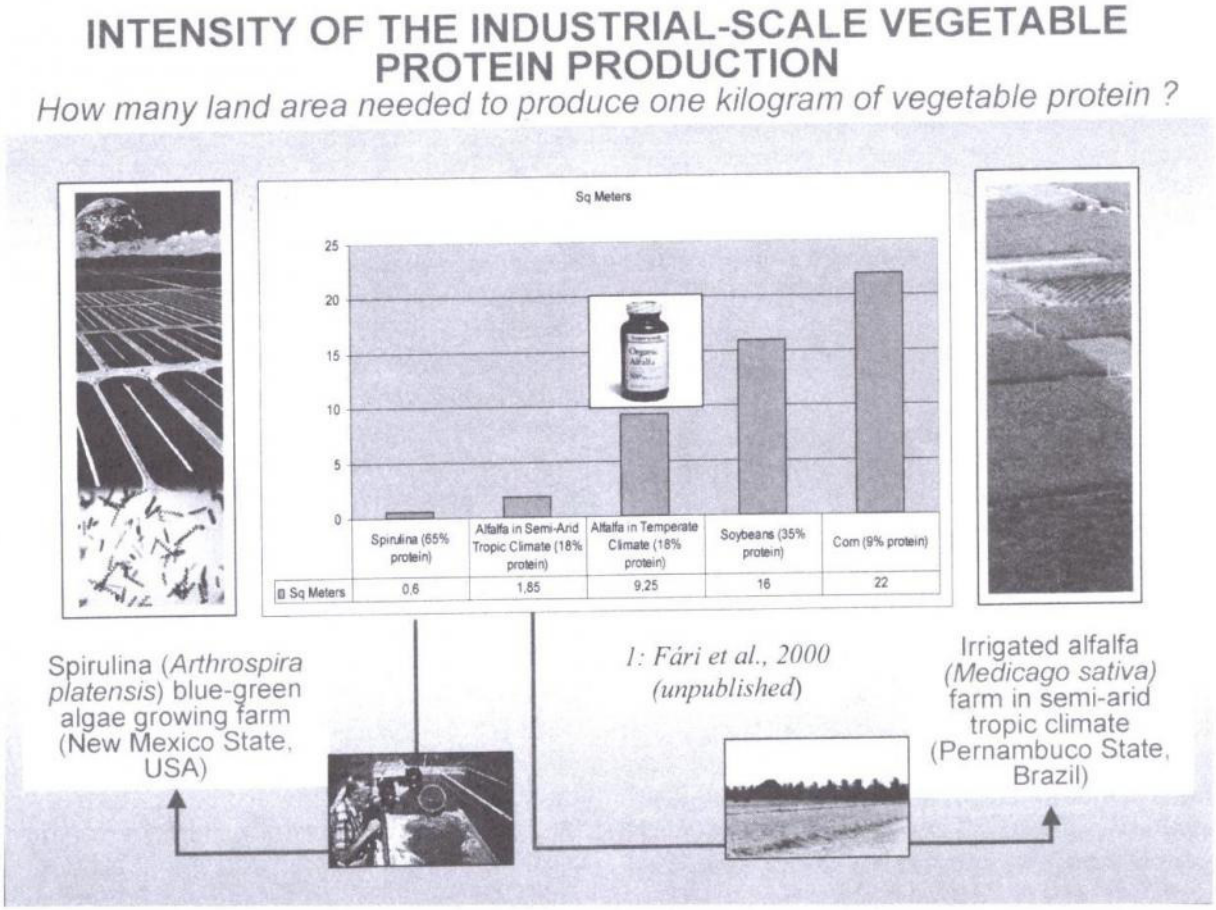
All the three group of crops, vegetables, fruits and medicinal plants are to be grown according to specific technologies developed during a couple generations on a particular spot, therefore the adaptation of the technologies should be put into the perspective of variable conditions experienced by skilled growers. The easiest way should be the presence of Hungarian growers on the particular site of adaptation. Based on the Brazilian experiences the organisation of Units of Hungarian Horticultural Missions in different states will be a promising enterprise.

Adaptation/introduction of alfalfa hay production in large-scale farming of the semi-arid tropics

The production of cheap protein will be a very decisive task in the future. The hegemony of soya protein is well founded at the moment in (industrial) animal husbandry of the developed countries, notwithstanding its importance as human food will grow even further in the Third World. Thus a spectacular rise of th production is expected rather from other sources, especially the leaf proteins. The importance and chances of that, most cheap source of proteins are found in the tropical and subtropical climats of the world, particularly in semi-arid regions because of the favourable "greenhouse effect" of the conditions, which facilitate the development of a high quality of leaf composition. The tender leaves are advantageous sources not only of proteins but also of industrial and pharmacological processing. It is easy to comprehend that the role of leaf proteins will gain much more attention in animal husbandry (and as human food) too. A suggestive example of that tendency is demonstrated by the Brazilian semi-arid region, where the *Hungarian agronomists developed large scale production sytem of alfalfa (Medicago sativa L.) under, tropical conditions.* The expert of Agroinvest Co, *Peter Simics,* engineer of agronomy was involved for a couple of years in this job. He achieved outstanding yields with good reliablility. On the irrigated fields of the tropical climat alfalfa, the "queen of fodder crops" produced at Petrolina 25–30 tons of dry hay per year. *According to the calculated figures, one kg protein is produced on each 1.85 m^2, which is ten fold more than that produced by soybeans (Figure 2) let alone its high content of carotene and xanthophyll.* A good example of the above mentioned „Doubly Green Revolution" as for producing much more values on the same area. The feed of high biological quality improves the health of the livestock and maximises the utilisation of the feed. The local staff of animal husbandry is a convincing witness of that fact: horses and beafs held on alfalfa hay diet are much more resistant to tropical, constitutional as well as to infectious diseases. We feel to be right to say: tropical alfalfa is a true biotechnological engin producing protein and vitamines and exploits all advantages of the tropical climat maximally. The proteins are covering the needs of the lactiferous cow with its composition of amino acids, and facilitates the reduction of environmental pollution by increasing at the same time the health standards of the livestock. Recently, the USA Agricultural Research Service reported upon the development of a transgenic alfalfa variety producing the enzyme phytase at the University of Wisconsin (*McGrawe,* 1998). Thus further possibilities are showing up in the use of transgenic techniques.

On the contrary, we will find plenty of paradoxical cases too. Several regions are maintaining the sub-extensive methods of animal husbandry, often because of the lack of

Figure 2



investment but also because of lack of information or expertise. They do not store hay of adequate quality neither for the dry nor for the humid period of the year. In those regions the animal stock as well as the human population is highly vulnerable by the effects of drought (the Corn of Africa, Northeast of Brazil, Mongolia, etc.). Even the most backward areas of the semi-arid tropics harbour some woody plants more resistant to drought, which may yield valuable leaves for proccessing (e.g. *Leucena* sp., etc.). Those may be combined with other grasses and cactuses as suitable feeds as alternatives for the alfalfa in other regions. That type of development is currently performed in the semi-desert areas of Northeastern Brazil. The CBL (Caatinga /Capim buffel / Leucena) program is supposed to substitute the half-nomadic vaqueiro pasturing husbandry, which did not change since about 5 centuries and is endagering the local endemic flora as explained by personal informations received from *C. Guimarrães* (2000).

The above examples may prove convincingly that the research on adapting crops of the temperate zone as sources of leaf protein is an important tool to increase the productivity of tropical agriculture, which is on the other hand an urgent need of the growing human population, thus deserves much more attention and must be recommended everywhere over the world.

Biotechnology of horticultural crops, micropropagation, virus-free production of transplants for large, industrial plantations under tropical conditions

In the background of utilising the experiences of Hungarian expertise we have the body of the Hungarian horticultural biotechnology as a stable basis, which comprises the industrial micropropagation which is already a result of development over more than twenty years and gained considerable international reputation. The Propamatic system of *Fári* (1987) was honoured by an international award of the Moët-Hennessy group and found successful application in Petrolina at the Brazilian-Hungarian project. The Agroinvest Co established in Petrolina the laboratory of horticultural biotechnology, which exerts influence on the development throughout the whole country. The Unit of Applied Biotechnology Mission (UABM) serves since nearly ten years the Brazilan-Hungarian co-operation of agricultural science and development. In the framework of that co-operation courses of training are held in Hungary at the most important bases of internationally recognised research. The participants returning to their home developed active partnership with the Hungarian colleagues on different fields of the profession. Universities and research stations got involved in

that program. The famous University of Viçosa initiated by the Rockefeller Foudation is a partner in dealing with Hungarian pepper, tomato and eggplant varieties and adapting the techniques of genetic transformation in Brazilian varieties of those species. Those joint projects contribute to the international competitivity of Brazilian science and to the realisation of Doubly Green Revolution building up in the minds the idea of principles to be followed in the future development. For research purposes *Gábor Csilléry* shared his collection of germplasm in the genus of Capsicum with Brazilian coleagues of the University mentioned. The results of joint research activities have been published in Brazilian as well as in international scientic periodicals (*Fári & Melo, 1996; Fontes* et al., 1999; *Fári & Menezes, 1999; Fári* et al., 2000).

At present the perspective which may still be predicted we put the emphasis on the further development of the Hungarian system of micropropagation. The Agroinvest Co and Hungarian universities with the support of the Hungarian gouvernment will perform the installation of special modules of micropropagation working according to the principles of a bio-reactor and bound to serve the markets of tropical developing countries in growing bananas, pineapple and other tropical fruit species. It will be economical in saving energy, labour and costs and will be ready for use in 2002/2003.

At Petrolina, the first large-scale plant of raising transplants in plastic trays was started in 1993 also with the participation of Hungarian experts. That meant an intense new perspective for the local expertise, first of all of the canning industry and the farmers managing larger enterprises. The system is working excellently since its adaptation under the supervision of locally trained employees on a farm of the Codevasf. The volume of the production depends on the order of the growers, but attains many times ten millions of transplants of vegetables, mainly tomatoes and peppers.

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