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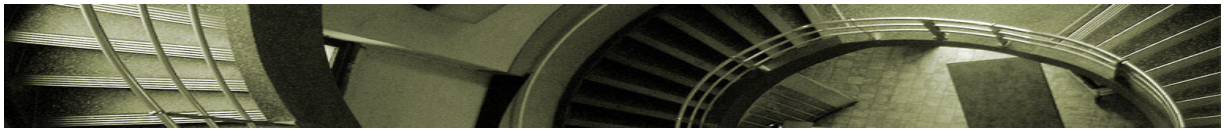


Abstract :

The scientific and technological agriculture development is to allow for the objective to have the agricultural production as the same an industrial production. The nanotechnologies are doing as a new platform became viable new transformation in nature, foods and agri-foods systems. This paper will discuss the potentials applications of nanotechnologies in agriculture, foods, prepared foods. All the potentialities - until now- from nanotechnologies was developed by big transnational companies and partners as research centers, universities and the consequence is to apply a new paradigm of how this companies is playing. This new paradigm has news technical characteristics that determine new forms to produce and consume foods and new economics relation. This process is the real place where the food design happens.

Keywords: Nanotechnology; Agri-foods; Transnational companies; Scientific paradigm

Resumen

El desarrollo científico y tecnológico de la agricultura tiene el objetivo de obtener una producción agrícola similar a la producción industrial. La nanotecnología, como una nueva plataforma, hace viable este perspectiva en la transformación de la naturaleza, de los alimentos y de los sistemas alimentarios. Este trabajo analiza las aplicaciones potenciales de la nanotecnología en la agricultura, la alimentación, los alimentos preparados. Todo el potencial - hasta ahora - de la nanotecnología ha sido desarrollado por las grandes empresas transnacionales y con la asociación a centros de investigación, de universidades y da como resultado la aplicación de un nuevo paradigma en el posicionamiento que estas empresas tienen sobre la sociedad Este nuevo paradigma muestra las características que definen nuevas formas de producción y consumo de productos alimentarios y nuevas relaciones económicas.

Palabras clave: Nanotecnología; Agro-alimentos; Compañías transnacionales; Paradigma científico.

Résumé :

Le développement scientifique et technologique de l'agriculture doit tenir compte de l'objectif d'obtenir une production agricole similaire à la production industrielle. Les nanotechnologies, comme nouvelle plate-forme, rendent viable cette nouvelle perspective

de transformation de la nature, les produits alimentaires et des systèmes agroalimentaires. Cet article discute des applications potentielles des nanotechnologies dans l'agriculture, des produits alimentaires, des produits alimentaires préparés. Toutes les potentialités - jusqu'à présent - des nanotechnologies ont été développées par des grandes entreprises transnationales et leurs associés comme des centres de recherches, des universités et la conséquence est un nouveau paradigme sur l'impact de ces entreprises sur la société. Ce nouveau paradigme démontre de nouvelles caractéristiques techniques qui déterminent les nouvelles formes de production et de consommation des produits alimentaires ainsi que les nouvelles relations économiques.

Mots-clés : Nanotechnologie ; Agroalimentaires ; Compagnies transnationales ; Paradigme scientifique.

Resumo :

O desenvolvimento científico e tecnológico voltado para a agricultura, sempre teve como objetivo tornar a sua produção cada vez mais idêntica a produção industrial. A Nanotecnologia se coloca enquanto uma nova plataforma que viabiliza novas transformações da natureza, alimentos e sistema agro-alimentar nesta direção da industrialização integral da agricultura. Neste trabalho, iremos discutir as aplicações potenciais da nanotecnologia na agricultura, nos alimentos processados, nas embalagens para alimentos. Todas estas potencialidades da nanotecnologia vem sendo desenvolvidas pelas grandes empresas transnacionais, o que implica em termos, um novo paradigma relativo a atuação destas empresas que apresentam determinadas características técnicas, que impõem determinadas formas de produção e consumo e relações econômicas. Ao final, apresenta-se algumas conclusões preliminares e sugestões de temas de pesquisas.

Palavras-Chave : Nanotecnologia; Agroalimentos; Companhias transnacionais; Paradigma científico.

Nanotechnology as a new techno-scientific paradigm of the nature, foods and agri-food systems transformation

Paulo Roberto Martins
Sociologist, Master in Agricultural Development CPDA / URRRJ, Doctor of Social Sciences IFCH / UNICAMP, coordinated the Brazilian Network for Research in Nanotechnology, Society and Environment - RENANOSOMA, Project Coordinator of Public Engagement in Nanotechnology. President of Sociologists Without Borders - Latin America.

Introduction

Although in the world there are no laws, mandatory product labeling or public debates, an inventory of nanotechnology-based consumer products currently on the global market made by a project on emerging nanotechnologies from Woodrow Wilson International Center for Scholars (2010) found more than 1,000 products with nanotechnology.

In the food chain it is possible to find manufactured nanoparticles, nanoemulsions and nanocapsules that are now found in agricultural chemicals, processed foods, food packaging and food contact materials. Friends of the Earth (2009) has identified more than 100 of these products, which are now on sale internationally. However, it is known that many food manufacturers may be unwilling to label the nanomaterial content of their products since that 100 products are just a small fraction of the total number of nanomaterial-containing products now available worldwide.

In general, nanotechnology has been provisionally defined in relation to materials, systems and processes in which it is present or operates at a scale of 100 nanometres (nm)

or less. It involves the handling of materials and the creation of structures and systems at the scale of atoms and molécules- the nanoscale. The properties and effects of nanoscale particles and materials differ significantly from larger particles of the same chemical composition.

It is known that the nanoparticles can be more chemically reactive and more bioactive than larger particles. For the reason that their very small size, nanoparticles also have much greater access to our bodies, so they are more likely than larger particles to enter cells, tissues and organs. These novel properties offer many new opportunities for food industry applications (Pray & Yaktine, 2009). For example, the potent nutritional additives, such as stronger flavourings, colourings and antibacterial ingredients for food packaging. However, these same properties may also result in greater toxicity risks for human health and environment.

There is a rapidly expanding set of scientific studies demonstrating that some of the nanomaterials now being used in foods and agricultural products introduce new risks to human health and environment. For example, nanoparticles of silver, titanium dioxide, zinc and zinc oxide presently used in nutritional supplements, as in food packaging and food contact materials, have been found to be highly toxic to cells in test tube studies. Preliminary environmental studies also suggest that these substances may be toxic to ecologically important species such as water fleas. Yet, there still is no nanotechnology-specific regulation or safety testing required before the manufactured nanomaterials can be used in food, food packaging or agricultural products.

Early studies of public opinion show that given the ongoing scientific uncertainty about the safety of manufactured nanomaterials in food additives, ingredients and packaging people do not want to eat nanofoods. As there are no laws to require labeling of manufactured nano ingredients and additives in food and packaging, there is no way for anyone to choose to eat nano-free.

Nanotechnology also poses broader challenges to the development of more sustainable food and farming systems. At a time when global sales of organic food and farming are experiencing sustained growth, nanotechnology appears likely to establish our reliance on chemical and energy-intensive agricultural technologies. Against the back-drop of dangerous climate change, there is a growing public interest in reducing the distances that food travels between producers and consumers, since nanotechnology appears likely to promote transport of fresh and processed foods over even greater distances.

I. Nanotechnologies

It is always preferable to refer to the term nanotechnology in the plural, namely nanotechnologies, as there are a variety of technologies operating within the dimensions of the basic components (organic and inorganic) which are the atoms and molecules. This means that these technologies operate at the nanoscale.

For now it is accepted that nanotechnology refers to any technology relating to materials, systems and processes that operate at a scale of 100 nanometers or less (one nanometer is equal to billionth of a meter). It should also indicate that there are several suggestions to extend to 300 nm, the interval which classifies the nanotechnology in order to make feasible the better health and environmental assessment of nanoparticles.

1.1. Nanotechnology in food chain

An important part of the agro food chain is the food industry, with an annual turnover around $ 4 billion U.S. There are several publications aiming for the applications of nanotechnology in the food chain (Pray & Yaktine, 2009). Nanofoods might mean "those which were grown, produced, processed or packaged using nanotechnology techniques, tools or those containing nanomaterials." (Centro Ecológico, 2009). In this paper there is no intention to approach this issue deeply, but only to indicate the main fields of application.

According to Mattoso et *al*. (2005), "The importance of nanotechnology in agro-business begins in the first stages of the productive chains, contributing significantly to improve the performance, efficiency and economy of inputs (fertilizers, pesticides, etc.) by means of the development of nanoparticles and nanoencapsulation to controlled release of fertilizers and pesticides in soils and also to drugs for veterinary application." In this same work the authors also associate the nanotechnology to the aspects related to the development: of new uses of agricultural products, replacement of non-renewable raw materials, use of biodegradable natural products, waste transformation to raw materials, increase of the agro-industry competitiveness (for example through separation and/or barrier membranes for several agro-industrial processes), active and intelligent packaging, precision farming, traceability, traceability & certification of agricultural products and food safety.

1.2. About marketing masters

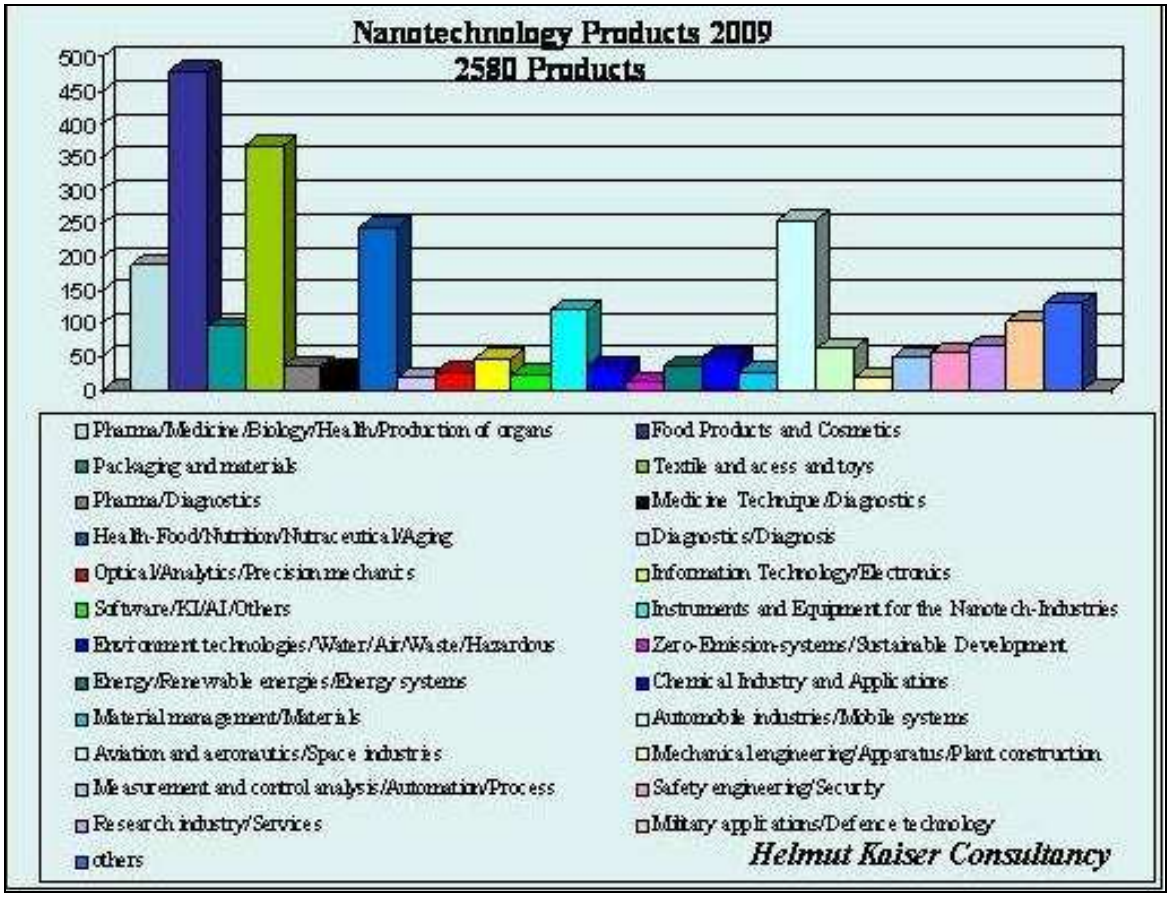
Several international consulting companies have released their figures on the global market of nanofoods and the number of companies working with nanotechnology. Although they do not demonstrate how they have found the figures released, it follows the example of the Helmut Kaiser Consultancy (2008) :

“Tomorrow we will design food by shaping molecules and atoms. Nanoscale biotech and nano-bio-info will have big impacts on the food and food-processing industries. The future belongs to new products, new processes with the goal to customize and personalize the products. Improving the safety and quality of food will be the first step. More than 180 applications are in different developing stages and a few of them are on the market already. The nanofood market is expected to surge from 2.6 bn. US dollars today to 7.0 bn. US dollars in 2006 and to 20.4 bn. US dollars in 2010. More than 200 Companies around the world are today active in research and development. USA is the leader followed by Japan and China. By 2010 Asian with more than 50 percent of the world population will be the biggest market for Nanofood with the leading of China.”

The expectation to this advice is that in 2010 we will have already thousands of companies incorporating nanotechnology activities.

It is clear in this context that all major companies in the food sector such as Heinz, Nestle, Unilever, Kraft, etc., as well as the major agrochemical companies such as BASF, Bayer, Syngenta, Monsanto, etc., are investing in nanotechnology. It is well known that nanotechnology is an object of investment by large companies, active in the agro-food system. So it is in this environment that the great global interest in nanotechnology is materialized, which appears as a new support to make feasible the reproduction of capital invested by these companies.

It follows the several datum related to the nanotechnology products market (Helmut Kaiser Consultancy, 2009):



Source : Helmut Kaiser Consultancy, 2009

By products and applications,

In total we have listed 2580 products and applications for 2009:

188 Listed	- Pharma/Medicine/Biology/Health/Production of organs
480 Listed	- Food Products and Cosmetics
95 Listed	- Packaging and materials
368 Listed	- Textile and acess.....and toys…
36 Listed	- Pharma/Diagnostics
32 Listed	- Medicine Technique/Diagnostics
245 Listed	- Health-Food/Nutrition/Nutraceutical/Aging
18 Listed	- Diagnostics/Diagnosis
28 Listed	- Optical/Analytics/Precision mechanics
47 Listed	- Information Technology/Electronics
22 Listed	- Software/KI/AI/Others
120 Listed	- Instruments and Equipment for the Nanotech-Industries
36 Listed	- Environment technologies/Water/Air/Waste/Hazardous
12 Listed	- Zero-Emission-systems/Sustainable Development
36 ListQed	- Energy/Renewable energies/Energy systems
49 Listed	- Chemical Industry and Applications
28 Listed	- Material management/Materials
256 Listed	- Automobile industries/Mobile systems
61 Listed	- Aviation and aeronautics/Space industries
19 Listed	- Mechanical engineering/Apparatus/Plant construction
49 Listed	- Measurement and control analysis/Automation/Process
56 Listed	- Safety engineering/Security
67 Listed	- Research industry/Services
102 Listed	- Military applications/Defence technology

130 Listed	- others

Source : Helmut Kaiser Consultancy, 2009

By Countries and regions

- USA, JAPAN, CHINA, GERMANY/RUSSIA/UK/F/I/ CN/Singapore/Korea/Australia/Switzerland
- 40 more countries worldwide

By Companies

In the inventory there are currently 2580 products produced by 1200 companies, located in over 40 countries.

By Materials

Products and applications listed by key materials

- Silver
- carbon
- Zinc
- Silicon-Silicea
- Titanium
- Gold
- Others

Worldwide research in nanotechnology health and environmental implications

- Research by projects, countries, materials, products, and implications

Overview of Market analysis from different source worldwide

- Over 10 research companies and institutes published market figures and developments which is shown in comparison by year and developments

Source : Helmut Kaiser Consultancy, 2009

Summary of the study and inventory

- Facts and figures about products in the inventory

research projects and developments

Development of Nanotechnology Markets Worldwide by Applications 2002 –2006-2010- 2015 (bn. US$)

	2002	2006	2010	2015
World	110.6	299.9	516.9	891.1
NAFTA	82.9	179.9	258.4	409.9
Europe	12.1	74.9	155.7	267.3
Asia	11	32.9	77.5	169.4
Others	4.4	11.9	25.8	44.5

Source : Helmut Kaiser Consultancy, 2009

II. Nanotechnologies and changes in food and agro-food systems

This central part of the work is anchored at the reflections of Gyorgy Scrinis and Kristen Lyon (2007) who published a paper entitled "The Emerging Nano-Corporate Paradigm:

nanotecnology and the transformation of nature, food and agri-food systems". For these authors, the investment in nanotechnology by large multinational corporations indicates that nanotechnology has come close to becoming the dominant techno-scientific form that will shape the next stage of development and transformation of the agro-food system.

Therefore, the point of view expressed by them is that the changes indicated above shall be made by the companies and/or corporations according to the decisions taken in the business scope. Here there is a direct connection between the adoption of this technology (nanotechnology), its role as the dominant techno-scientific form and the presence of corporations setting the course of this technology application.

Therefore, according to the authors cited *supra*, the new paradigm to become the hegemonic capitalist production on the transformation of food and agri-food chain is called the Paradigm of Corporate Nanofoods (corporate meaning those produced within the business system). For these authors, such a paradigm will be characterized by the continuation, extension, exacerbation and transformation of dominant socio-economic, technical and ecological relations within and among various sectors of the food chain (Scrinis & Lyons, 2007: 31).

The technical characteristics that come up as a background to consolidate this paradigm are the following:

1. Nanotechnology contains the rebuilding logic at a genetic and cellular level which allows the re-engineering of crops, animals and other living organisms, and agricultural inputs. The atomic and molecular structures are being transformed in "building bricks" and primary inputs of the agricultural and processed food production.

2. Nanotechnology enables the development of more accurate and efficient, intelligent and self-regulated production technologies, the so-called "delivery technologies," technologies designed for the use of raw materials which produce less waste, cybernetic technology designed to meet particular conditions,

3. Nanotechnology allows the development of tools and systems for identification, tracking, monitoring and surveillance of inputs, products and systems that enable the identification, préservation and quality control.

4. Nanotechnology enables the manufacture of new types of materials and also changes the traits of crops and food products. This means that inputs and final products of agriculture and food industry will be increasingly interchangeable. Example: to change the traits of a particular crop to expand its functional properties.

5. Nanotechnology is the technological platform that places the technological basis for the enhancement of the technical and scientific development of actual technologies and for the projected convergence and integration thereof. Example: nano encapsulation for pesticides and nutrients to food processing industry. Thus the nanotechnology can be the unit among the different links of the agro-food system chain.

These technical features have economic implications which should be clarified to assure the understanding of the conditions under which foods are being designed or redesigned. Scrinis and Lyons (2007) indicate the following impacts resulting from the uses of nanotechnologies: the increase of the process of making food even more similar to COMMODITIES (commodification) throughout the agri-food system, comprehending the universe of production and consumption, an extension of the process corporate concentration, control and integration of agro-food system.

The key concept is "techno-commodification" created by the authors (Scrinis & Lyons, 2007:34) which indicates "where tecnologies directly mediate or enable the commodification of social retations, knowledge and material practices. Within the food system, the knowledge, skill and practices of farmers, processors and food consumers

may be further appropriated, commodified and embedded within "smart" and value-added inputs, technological packages and food products."

Within the agricultural production at the farms we have the contribution of nanotechnology in the process of integrating seed and chemical inputs, new tools (nano-sensors) of monitoring and large-scale production micromanagement; new traits in crops and livestock allowing an approach directly the emerging agronomic problems or consumers' demands. These new technologies attract the farmers to a process that is properly subordinated to the universe of the patents and their leonine contracts, as it happens in relation to the genetically modified organisms.

In terms of the treadmill of nanotechnology production (routine production) (1), this may make feasible the linking between the treadmill related to chemicals and genetics. Thus deepening the farmers' dependence process through the creation of new forms of technological dependence also increasing the financial risks and environmental impacts of agricultural activities.

The impacts of nanotechnologies are also present in terms of quantity and quality of rural jobs. Therefore, new mechanical and chemical technology and/or automation technology, which contain nanotechnology, imply an innovation process that eliminates jobs in the agricultural production process.

Regarding the food processing industry, the impacts of techno-commodification by nanotechnology can lead to new forms of technical properties to modify the nutrient profile of foods and introduce new functionalities for packaging which add more value to food. These industries are also interested in producing knowledge and skills to prepare diet, healthy and suitable food to the taste of consumers, based on this techno-commodification process.

[1] For the understanding of theoretical "treadmill of production" framework refer to the works of Allan Schnaiberg and Kenneth Gould.

Of course these nanotechnologies are technologies mostly developed by business corporations. Accordingly, Scrinis and Lyons (2007), state that the "nano-corporate" paradigm aims to emphasize the forms of domination executed by corporations in our contemporary world, as well as the close inter-connection between these technological standards and their respective economic forms. These corporations own these nanotechnologies and perform the control thereon as well as on the patents and products associated therewith. This is the first step to restructure and expand their control over the agro-food system. Therefore, there are large corporations present in agro-food system that determine what nanotechnologies, materials and products will be produced and traded.

It must be clear how the development of the process characteristic of the dominant paradigm to understand where the food is designed and redesigned. It is intended to make clear that it is not done in the laboratories. At these ones it is performed only as a part of this design/redesign, previously defined at other instances. Consequently, it is not the called "freedom of research" or the researcher's decision about what shall be researched that defines the issues related to this paradigmatic case.

We can characterize this dominant paradigm by the concentration (2), integration and coordination within and across food system sectors, oligopolistic markets. Markets characterized as "clusters" of corporations that establish collaboration among several food sectorss. The research & development will no longer be held by the public research systems but will be executed by corporations with the correspondent increase in the use of patents. This implies an integrated and homogeneous food system verticalization.

Some challenges to this paradigm have appeared via the emergence of segmented and competitive production systems fit for "Delivering" a wide variety of quality products, focused on health and on certain niches. Here it is worth noticing the growing power of

[2] For several years, ETCGroup (2004; 2005 ;2009), a Canadian NGO, has produced a report outlining this process of concentration of corporations dedicated to the agro-food system. See URL: www.etcgroup.org

retail/supermarkets that have faced/fought against the dominant control embodied in the agri-food system from the agribusiness until the manufacturing food sectors.

What is in appearance a simple and growing unified system, has emerged a system that is interacting with other systems, with concurrent interests between the dominant "players" and supermarkets.

Nanotechnology enters this paradigm to facilitate the intensification of corporate merger and integration of agro-food system within and among its various sectors. While a technological platform, the nanotechnology makes feasible the convergences and alliances among industries. But nanotechnology also takes the role- due to its ability to modify production systems and end products according to precise specifications– in facilitating the distribution and preserving the identification of different products- enabling the quick adaptation to the consumers' demands as well as the pressure from environmental crises.

III. Preliminary conclusions

Only with the development of this project by studying in-depth the subject is that the proposed conclusions below mentioned won't be so preliminary. If in the future they will be deemed appropriate, they will surely be incorporated into the final conclusions of the proposed study. Otherwise, these findings could be rewritten.

The reflections previously performed lead us to conclude that the "NANO FOOD COORPORATE PARADIGM" does not represent a break with other recent economic or technological paradigms related to agro-food system. Nanotechnology will collaborate so that the biotechnology and information technology will have more importance in various food sectors, managing and coordinating the production and distribution process of an agro-food system.

Therefore, we have indicated that the nanotechnology will be- in this century- the technology platform that will shape the future development in this scope of business, as well as facilitate the integration and convergence of technosciences present therein. The scope of this technology platform will be huge, larger than the actual genetic engineering has already demonstrated.

To understand the whole process that involves agriculture and agro-industry it should be noted that the agricultural activities are under pressure – on one hand- by industries that supply inputs (seeds, pesticides, fertilizers, veterinary medicines, machines and equipment, research, software, information technology and communication, etc.) and– on the other hand– by the industries that process and trade agricultural products.

The dominant economic and technological paradigm is that economic capital will eventually take over the economic surplus produced by agricultural capital. Here, the technical progress has the role to make the production process in agriculture increasingly closer to the industrial production causing that the capital can control more the working time. Technological progress is always developed in order to control natural processes in which there is a time of no work thus making these processes independent of nature. Irrigation (water variable control) and early variety (less production cycle time) are some examples of the interference of this technical progress towards the control of natural variables by decreasing the time of no work in agriculture, making it closer to the industrial production.

Nanotechnology may lead to full achievement of food production as a strictly industrial production to the extent that it reaches the nanofabrication where food will be produced by direct manipulation of atoms and molecules, via "bottom-up" technology. For example, under this way it would be produced the starches, proteins, etc. that would later be processed into various foods that incorporate the starch such as potatoes, breads, etc.

The fact that it can happen in this 21st century, something impossible in the past century, poses now a concern for all societies of this planet, that is, what to do with those

members who are dedicated to traditional farming still practiced today in large scale in this planet, involving billions of people. Nanotechnology, as a platform of this "Nano Corporate Paradigm", will have great influence on this process. To the extent that nanotechnology is focused on agro-food chain and has been developed under the large corporations' dominium, these transnational companies are just the ones which are redesigning the food, in the way of nanofabricated food. Tense day will come!

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