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Public research agenda in face of possibilities for agricultural development

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ABSTRACT

Recent advances in biotechnology have altered the roles performed by public and private sectors in the process of agricultural research. Unlike what occurred during the Green Revolution, the private sector has been the main actor in this "new phase" of agricultural research. On the other hand, the Public Agricultural Research Institutes (PARIs) have made efforts to keep up with such advances and, in certain cases, even anticipate them. Certain PARIs are also working with different types of research. Considering the diversity of technological possibilities, the plurality of strategies has become an interesting option to PARIs.

Key words: Agricultural Research, Public Agricultural Research Institutes, Agriculture.

Introduction

The founding landmark of agricultural research in Brazil was the establishment of Rio de Janeiro's Botanic Garden in 1808. Since then, the country has accumulated success stories in various fields, the most internationally prominent being tropical agriculture research. During the past few years, however, significant advances in the frontier of scientific knowledge have taken place, especially in biotechnology. Such advances have radically changed the way research is carried out. Our Public Institutes of Agricultural Research (Instituições Públicas de Pesquisa Agropecuária, IPPAs) have been working hard to keep pace with this progress, often even attempting at anticipating them. Overall, there is greater participation of transnational firms in biotechnology research on more profitable agricultural crops (soy, corn, cotton, etc). Research on products with a more limited market share and, therefore, lower profitability is carried out almost exclusively by IPPAs.

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In both cases, however, public research is relevant for expanding the potential benefits of new technologies, as not seldom there is enough qualification for developing this kind of research. The Brazilian Agricultural Research Corporation (Embrapa), for instance, takes on a vital role in the national seed market of both conventional and genetically modified soy. This institution also carries out research on plants drawing less interest from private initiative, such as the transgenic bean resistant to the golden mosaic virus.

IPPAs can therefore work both with those crops enticing significant participation from the private sector and with those less attractive to private investment. Furthermore, it is recognized that IPPAs should also work with other modalities of research such as "alternative agriculture". This type of agriculture is promising for smaller scale agriculture, and public research can (and should) assist its development. This article aims at discussing the chief traits of research on both biotechnology and alternative agriculture. These are two different forms of agricultural production, involving diverse ways of conducting the research process.

From the perspective of IPPAs, this article concludes that, characteristic differences notwithstanding, biotechnology and "alternative technologies" are two research modes that can (and should) be seen, whenever possible, as complementary. Strategies of public research need to take both options into account: agricultural research on more diffused and larger scale crops, and on those with smaller markets and better adapted to smallholdings. Even though alternative agriculture includes various styles, there is at least one common ground, namely, the production of foodstuff less reliant on inputs coming from outside the rural property. This underscores the need for research better adapted to the particular characteristics of smallholdings and the needs of their farmers.

The organization of agricultural research

Between 1950 and 1960, the so-called Green Revolution was implemented in various nations. During this period, international institutes of agricultural research were established worldwide with the goal of increasing food production by means of improved seeds and diffusion of agricultural techniques. In 1959, the International Rice Research Institute (IRRI) was created in the Philippines by the Ford and Rockefeller Foundations. In 1963, the International Maize and Wheat Improvement Center (CIMMYT) was established in Mexico. At about the same time, these two institutions participated in the inception of the International Institute for Tropical Agriculture (IITA) in Nigeria, and of the International Center for Tropical Agriculture (CIAT) in Colombia. In 1971, the Consultative Group on International Agricultural Research (CGIAR) was created, including as its sponsors members of the World Bank, the Food and Agriculture Organization (FAO), and the United Nations Development Program (UNDP), besides nine representatives of national governments, two regional banks, and three foundations (MELLO, 1995; HAYAMI and RUTTAN, 1988).

Sponsored by CGIAR, the international research system rapidly expanded, and began to contribute importantly to the growth of agricultural production in developing countries. Throughout Latin America, the adoption of a centralized institutional model in place of the so-called diffuse system led to the creation of National Systems of Agricultural Research (INIAS). The purpose was to build up infrastructure capable of adapting and transferring international technology to those countries.[1]

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[1] It is worthy remarking that Brazil was not part of this process – its research was not centralized until 1973, when Embrapa was created.

In most cases, this was based on an idea of agricultural development of "Schultzian" inspiration, grounded on the offer of abundant and inexpensive (better said, subsidized) technology as the chief means for promoting agricultural development in developing countries (SCHULTZ, 1965). From this perspective, research institutions were supposed to bridge a fundamental gap, that of an economic mechanism for inducing innovation and make possible novel and fundamental "income flows" in agriculture (HAYAMI and RUTTAN, 1988). It should however be highlighted that this model buttressed technology diffusion through adaptive research, therefore generalizing a technological pattern stemming especially from the United States (SALLES FILHO, 1995).

More recently, many events have altered the relations of supply-demand for technologies and the various actors making up the system of research and innovation in agriculture. Castro et al. (2006) highlight the following: new intellectual property and patent laws for living material; biotechnological advances in genetic improvement techniques; economic growth of the cultivars market; and increased participation of transnational conglomerates in the seed business. For the authors, such events changed the relations, performance, and space of public and private agriculture research institutions in the market.

According to FAO (2004), in contrast to Green Revolution research, a significant portion of agricultural biotechnology research, as well as all commercialization activities, are being carried out by private companies based on industrialized countries. This is a radical shift from the Green Revolution, when the public sector performed a crucial role in research and technology diffusion. This change had important consequences for the way research is done, the kinds of technologies being developed, and the way such technologies spread. This prevalence of the private sector in agricultural biotechnology may prevent access to its benefits by (especially poor) farmers in developing countries.

Still according to FAO (2004), it is not clear whether public research systems may benefit from transnational companies' efforts. Moreover, as public research programs are often limited to national borders, the benefits of technological innovation across similar agro-climatic zones but within different countries are reduced.

FAO (2004) itself notes that the countries which mostly benefited from the opportunities provided by the Green Revolution were those that already had, or were fast in creating, considerable national agricultural research capability. At that time, there was interest in the rapid diffusion of technologies, and various international institutes of agricultural research were created around the world with the support of the Ford and Rockefeller Foundations. Today the context is different; transnational companies dominate the offer of new technology, and agricultural research institutes from less developed countries are losing their previous importance.

In the late 1990's, Seiler (1998) and others have warned that unless the way biotechnology was being configured were corrected and IPPAs intervene in order to balance private interests in the research agenda, fears could become true that "the 'bio-revolution' will reenact the Green Revolution's ambivalent results"(IDEM: 62).

Within this framework and given their greater heterogeneity, developing countries may become mere passive consumers of technologies elaborated by transnational companies unless local research institutions are strengthened. On the other hand, these nations could potentially reap greater benefits from biotechnology if their research structures were bolstered through exploring, whenever possible, complementarities between the public and the private sectors (national or not) in order to carve out a larger creative space for technological alternatives (FUCK, 2005).

The global spread of GMO cultivation

The growth of genetically modified organisms (GMOs) cultivation worldwide is significant. According to James (2007), area planted with GM crops exceeded 114 million hectares in 2007 – a 12 percent increase from the previous year. Besides increased planted area in chief producing countries such as the United States and Argentina, more countries are adopting this technology. With the inclusion of Poland and Chile, the number of nations cultivating GM crops rose to 23 altogether, 12 emergent and 11 industrialized. Globally, 12 million farmers make use of GM technology.

Internationally, there are relatively few commercial GM crops, the most significant being soy, corn, cotton and canola.[2] Herbicide-tolerance is the prevalent trait (seventy percent), the remaining comprising resistance to insects, or a combination of both (JAMES, 2007).

Brazil is the third world producer of GM crops. Planted area estimated by James (2007) is 15 million hectares, of which around 14.5 million hectares are taken by herbicide-resistant soy, and the rest by varieties of insect-resistant cotton.[3] Occupied area is likely to grow in the next few years due to the commercial release of some varieties of transgenic corn in early 2008. Brazil had the sharpest absolute increase in area planted with GMOs between 2006 and 2007, by 3.5 million hectares (in relative terms, growth in this period was only inferior to India's). The same study highlights substantial possibilities for 13 million hectares of corn given the commercial release of some GM varieties, in addition to opportunities for rice and sugarcane.

As noted before, the main focus of commercial biotechnology is the transfer of genes conferring resistance to herbicides and protecting plants against some kinds of insects. Castro et al. (2006) argue that the real challenge for biotechnology in developing countries is to improve yields and adapt crops to constraining environmental conditions (i.e., pests, diseases, abiotic stress, and so forth). This would allow for expanding food production to areas already being used, with lower environmental impact due to reduced use of inputs such as fertilizers and agrochemicals. Seiler (1998) has noted that the new biotechniques offer multiple possibilities for alleviating some of developing countries' most pressing problems, be it through the principles of genetic engineering, rapid multiplication of healthy (virus-free) plant material, or improved adaptation of crops to their specific geoclimatic environment.

In order to take advantage of these opportunities, cutting-edge research adapted to the specificities of developing countries is needed. Castor et al. (2006) noted that characteristics such as tolerance-resistance to abiotic-biotic stress are determined by many genes, as well as by complex genotype-environment relations which are not yet sufficiently comprehended. Therefore, these authors suggest that Brazil strengthen programs focused on the knowledge of genomes and gene prospection, "since the understanding of complex biological

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[2] 2007 data for the relative participation of each crop was not available at the time this article was written. In 2006, the figures were: soy accounted for 57% of the global GM-planted area, followed by corn (25%), cotton (13%), and canola (5%) (JAMES, 2006).

[3] Data from the National Company of Food Supply (Conab) shows that in 2006-07 around a million hectares of cotton and 21 million hectares of soy were planted in Brazil (CONAB, 2008).

mechanisms will, in the medium term, open up perspectives for overcoming a great deal of tropical agriculture's most serious problems".

IPPAs such as Embrapa and the Agronomic Institute (IAC) [4] are not the only Brazilian institutions involved in plant biotechnology. There are also others connected to universities. Among these, Fonseca et al. (2004) highlight the Federal University of Rio Grande do Sul's Biotechnology Center (CBiot), the Caxias do Sul University's Biotechnology Institute, and the Campinas State University's Biology Institute.

The private sector has also contributed to research advances. An interesting institutional arrangement is that of spin-offs from genetic sequencing projects financed by venture capital funds. This is the case of Alellyx Applied Genomics and Canavialis, research companies which received financial support from Votorantim Ventures, Votorantim Group's venture capital fund (DIAS, 2006).

Among private organizations ran by rural producers the Sugarcane Technology Center (CTC) stands out for its research on biotechnology, plant health, and production of sugar, ethanol, and energy. Glyphosate-resistant GM soy, on its turn, is offered by the Agricultural Research Cooperative (Coodetec), the Center for Experimentation and Research Foundation (Fundacep), and the Mato Grosso Foundation (Fundação MT) as part of deals with the transnational corporation Monsanto. Other transnational companies also carry out research, notably on GM soy, corn, and cotton seeds.

Embrapa itself takes part in the supply of glyphosate-resistant GM soybeans. These varieties are the result of a deal between Embrapa and Monsanto according to which Monsanto's Roundup Ready technology is licensed to Embrapa soy varieties (as mentioned above, Monsanto has similar deals with other of Brazil's research institutions and companies). The contract signed between Embrapa and Monsanto includes funds for investment in research projects fed by royalties derived from the commercialization of GM soy. In 2006, it amounted to R$800,000, and in 2007, to another R$2.4 million – a total of R$3.2 million to be used in five projects. [5]

Besides Roundup Ready, other varieties of transgenic soy are being researched by Embrapa. One of them stems from a deal struck between Embrapa and the German transnational company Basf. This variety of transgenic soy is being developed in Brazil under Embrapa's coordination. According to this deal, Basf supplied the *ahas* gene which was applied to one of Embrapa's soybean varieties. The new seed is resistant to herbicides of the imidazolinones class, which kills weeds. These seeds are still being tested. Upon commercial release, they are likely to broaden the supply of transgenic soy and therefore intensify market competition, especially against glyphosate-resistant varieties.

Embrapa's transgenic bean is in its latest research stages. This GM variety is resistant to the golden mosaic virus, transmitted by the white-fly and which is considered the most serious bean illness in Brazil. Embrapa plans to request commercial release from the National

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[4] Besides the Agronomic Institute, which is part of the São Paulo Agribusiness Technology Agency (APTA), various State Organizations of Agriculture and Livestock Research (OEPAs) stand out for their plant improvement activities in Brazil. Among these are the Paraná Agronomic Institute (Iapar), the Minas Gerais Agriculture and Livestock Research Company (Epamig), the Pernambuco Agriculture and Livestock Research Company (IPA).

[5] The five projects selected by the Fund's management team will receive funds for research on lettuce, soy, cotton, beans, and rice (COSTA, 2007).

Technical Biosafety Committee (CTNBio) in 2009. The production cost of this GM variety is expected to be lower than its conventional counterpart, which requires the use of insecticide. It could also benefit producers from various Brazilian regions -- only the regions of temperate climate, where the white-fly does not proliferate, are free from the virus.

Along other examples, research on soy resistant to imidazolinone herbicides and on bean resistant to the golden mosaic virus brings Embrapa to the forefront of institutions developing GM plants worldwide. It is thus seen that Embrapa has an active role in advancing research related to the development of GM seeds. This may broaden the technological options offered to rural producers, thus preventing the new technology from remaining limited to a few companies and agricultural crops.

The various forms of "alternative agriculture"

Besides GM crops, other forms of agricultural production are drawing the interest of rural producers. A salient one is the so-called "alternative agriculture', a label which comprises various approaches such as organic, natural, biodynamic, biological, and ecological agriculture, as well as permaculture.

Campanhola and Valarini (2001) identified the following common ground between these: a) recycling natural resources inside the agricultural property; b) composting and transforming plant waste into soil humus; c) preference for using grind, semi-soluble or thermally treated rocks; d) live and dead plant matter covering the soil; e) diversification and integration of plant and animal activities; f) use of animal manure; g) use of biofertilizers; h) crop rotation and intercropping; i) biological control of pests and plant pathogens, without agrochemicals; k) use of traditional mixtures in the control of plant pathogens; l) use of mechanic, physical, vegetative, and plant extract methods in the control of pests and plant pathogens; m) no use of growth regulators and synthetic additives to animal nutrition; n) use of plant and animal germplasm better adapted to each ecological context; and o) use of windbreaks.

On the other hand, the various approaches to alternative agriculture have particularities. For instance, organic agriculture is characterized by the restoration of soil fertility through biological processes, elimination of pests and diseases, and interaction between animal and plant production (PIRES *et al*., 2002). Biodynamic agriculture is distinguished by the application of biodynamic preparations to the soil, plants, and composts. Permanent agriculture is production maximally integrated to the natural environment. Agroecology is based on the idea that crops are ecosystems subject to the same ecological processes found in other types of vegetation; thus its stress on the interaction with man, whose actions are ruled by culture, habits and traditions (CAMPANHOLA and VALARINI, 2001).

For Guzmán (1997), agroecology is defined as the ecological management of natural resources which allows for the design of sustainable development methods through the incorporation of participatory collective social action. Lacey (2000), on his turn, understands agroecology as a significant (if only partial) alternative to agricultural biotechnology which, besides enjoying strong empirical support, also responds to the values of ecologic sustainability and social justice. This author also contends that there is room for a constructive dialogue between agroecology and research on transgenic seeds associated to the CGIAR. According to him, both approaches claim to tackle the needs and problems of poor farmers. There are, however, differences. CGIAR research tends to focus on agrobiotechnology methods, namely, how they may contribute, for instance, to meeting demands in food production and mitigating chronic malnutrition in poor agricultural communities. The agroecological approach insists, on its turn, that the technical solutions proposed should not be abstracted from the ecological and social context of their implementation.

Regarding environmental aspects, Bin (2004) argued that the differences between techniques in environment-oriented intensive agriculture and in "agroecologic" productive systems are subtle, and seem to refer more to the way they are used than to their intrinsic characteristics. This author notes that while conventional systems incorporate components from agroecologic agriculture, the opposite is also true. "A clear example is the use biological control techniques, both in monocultures and in organic production. Or else, the existence of organic monocultures, strongly dependent on external (even if organic and biologic) inputs" (IDEM: 71).

From the demand perspective, differences also seem minimal, since most consumers are not heedful of the various kinds of alternative agriculture, seeing all its products simply as organic. Campanhola and Valarini (2001) have noted five causes for the increase in demand for these products: a) consumers' concerns with health or with the risk of eating food containing agrochemical residue; b) the action of environmental Non-Governmental Organizations (NGOs), some of which act in the certification and opening of spaces for the commercialization of organic products by farmers themselves; c) the influence of religious groups advocating man's spiritual equilibrium through the consumption of healthy food produced in harmony with nature; d) the influence on consumers of organized groups opposed to the prevalence of transnational corporations in modern agriculture; e) the use of marketing tools by large supermarket chains, following the example of developed countries where the demand for organic products was induced in certain consumer groups.

Many consumers prefer to purchase products with such characteristics, even if that means paying more than they would for foods produced by conventional methods. This has opened a significant market share for these products. Greater value makes up for the more intensive use of labor by producers, lower productivity at the early stages of production, and the cost of certification.

Campanhola and Valarini (2001) presented five arguments in favor of organic agriculture as a viable alternative for the market inclusion of smallholders. Firstly, even with greater use of labor and lower productivity than conventional systems, it shows higher economic performance; this translates into reduction of effective costs, higher cost-benefit ratios, and higher effective income. Secondly, organic products are associated with market niches, and supply a restricted and select segment of consumers who are willing to pay more for such products. Thirdly, since small farmers are included in the (Brazilian or international) commercialization chains of organic products, they should organize themselves in associations or co-ops. Fourthly, organics fill a supply gap in specialized products which are not so appealing to large agricultural enterprises such as green vegetables and medicinal plants. The fifth and last argument refers to the diversification of organic production and to the reduced dependence on inputs that are external to the rural property; these conditions become obstacles to the emergence of large organic producers.[6]

Embrapa's diversified agricultural research portfolio

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[6] It is worth remarking that, given its potential profitability, organic products may also attract large producers, especially when there is potential for securing market niches.

Embrapa is Brazil's chief IPPA, and has become an international reference in research on agriculture of tropical and semi-temperate regions. Founded in 1973, Embrapa is today made up of 38 research units, three services and 13 administrative units. Embrapa participates in and coordinates the National Agriculture Research Systems (SNPA), formed by the State Organizations of Agricultural Research (OEPAs), federal and state universities and research institutes, as well as other public and private institutions directly or indirectly linked to agriculture and livestock research.[7]

Mendes and Albuquerque (2007) note that research models adopted by Embrapa refer to four moments: i) Concentrated Research Model; ii) Circular Programming Model; iii) Embrapa Planning System (SEP); and iv) Embrapa Management System (SEG). The first was based on the creation of integrated R&D centers, focused on major national themes, and had the purpose of replacing the former diffused research model. The establishment of priorities and research development were to be carried out by decentralized units subscribing to a National Research Plan. The Circular Programming Model was conceived in the late 1980's in order to foster participation of various segments in the definition of research programs. According to these authors, this commitment by Embrapa became more explicit with the establishment of the Embrapa Planning System (SEP) model, outlined in 1992. In Mendes and Albuquerque's words, "The model in operation today, the Embrapa Management System (SEG), was implanted in 2002 and brought significant change to the scope and focus of research management and organization in place until then" (2007: 14).

SEG is a research planning system concerned with the following aspects of project management: planning, execution, follow-up, assessment, feedback, and timeline for clearing financial resources. Inductive and resource allocation procedures are performed through Macroprograms (MP), and aim at building up and managing one of Embrapa's project and processes portfolios. They should also fulfill the institutional goals, and secure the program's technical and scientific quality as well as strategic merits. Overall, SEG contemplates six MPs.[8] MP1, called "Major National Challenges", is made up of 18 projects.[9]

Of these, it is worth highlighting the agroenvironment, biosafety, organic agriculture, and conservation of genetic resources projects. The agroenvironment network carries out research comprising the entire Brazilian Amazon, involving fifty researchers from six of Embrapa's research centers as well as from partner institutions (producers' organizations, foundations, universities, governmental and non-governmental research institutes). It encompasses from social aspects geared towards conservation of the environment to the

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[7] In <www.embrapa.br/a_embrapa/snpa>, last access May 8, 2008.

[8] The themes are the following: 1) major national challenges; 2) sector sustainability and competitiveness; 3) agribusiness incremental technological development; 4) technology transfer and entrepreneurial communication; 5) institutional development; and 6) support to agricultural development and to sustainability in rural areas.

[9] The projects are the following: 1) precision agriculture; 2) agroenvironment; 3) alternative agroenergy; 4) functional foods; 5) technological bases of aquaculture; 6) biosafety of genetically modified organisms (GMOs); 7) quality beef; 8) science and technology for the development of organic agriculture; 9) conservation of Brazilian genetic resources; 10) creating tools for securing the health of agricultural products; 11) energy forests; 12) environmental, economic, and social impacts of beef cattle farming; 13) nanotechnology; 14) sustainable production of sugarcane for energy; 15) genomic techniques for obtaining more water-efficient plants; 16) biodiesel technologies; 17) genomic technologies for animal genetic improvement and livestock production; 18) climatic risk zoning for family agriculture, crops of energetic potential, and pasture. Information obtained in <http://www.embrapa.br/publicacoes/institucionais/pesquisa-em-rede/>. Last access February 26, 2008.

generation of environmental services. The network also pursues other goals such as definition of agroecologic indexes for productive innovation systems and environmental services provided to rural properties, identification of social representations and environmental perceptions, promotion of the economic variability of production systems, among others.

The biosafety network's studies cover the environmental and food safety of GMOs developed by Embrapa. This network comprises 130 researchers from 14 of Embrapa's units, as well as other research and education institutions, in Brazil and abroad. Research involves biosafety testing of genetically modified soy, potato resistant to the mosaic virus, bean resistant to the golden mosaic virus, papaya resistant to the ring spot virus, and insect-resistant cotton. Besides generating scientific data on these GM plants, these studies also have impact on the training and qualification (in the short, medium, and long run) of personnel now working or who will work on the development and regulation of new transgenic products.

The organic agriculture network is made up of 27 Embrapa units, bringing together 369 researchers and technicians, besides 25 partner institutions such as NGOs, universities and research and extension institutions. Among the network's goals are natural resources management in organic agriculture, development of cultivars appropriate for organic agriculture, participatory knowledge construction, and socio-economics of organic agriculture.

The genetic resources network aims at organizing and protecting the management of genetic resources in order to meet national demands. This network involves 635 scientists from 105 partner institutions (Embrapa research centers, federal and state universities, private sector and other research institutions in Brazil). Moreover, it serves 187 active germplasm banks, in addition to providing continued support for hundreds of private and public genetic improvement programs.

This branching out of research shows that Embrapa's network configuration seeks to broaden and diversify the scope of agricultural research. This option takes into account the qualification of Embrapa and other institutions making up the SNPA for developing research supporting a very complex and diversified agriculture such as Brazil's.

This attitude resonates with what Bin (2004) underscored as the new path for agricultural research, one geared towards enhancing productivity while reducing negative environmental impact, and taking into account the specificities of different agroecosystems as well as their proximity to ecological processes. According to this author, the most salient directions of this new path are: i) genetic improvement and molecular biology; ii) optimization of input use; iii) soil and water use and management; iv) biodiversity use and management; v) agroecologic (or "alternative") practices; vi) surveillance and assessment of environmental impacts; vii) smallholding technologies; and ix) environmental education.

Conclusions

Given Brazilian agriculture's characteristic heterogeneity, IPPAs are expected to pursue a wide range of alternatives, therefore exploring the various options stemming from conventional, alternative, and biotechnological agriculture research. At present, this last modality is globally restricted to a few products developed by transnational corporations. Thus, strengthening IPPAs and the information exchange among them (for instance, via CGIAR for international knowledge exchange, or even in the relations between Embrapa and the other SNPA institutions) may expand the potential benefits of new technologies for agricultural producers, including small farmers. IPPAs are likely to have an important role both in crops unattractive to private investment and in those dominated by the private sector – such is the case of Embrapa's participation in the transgenic soy seed market in Brazil.

On the other hand, it is understood that IPPAs should not be restricted to biotechnology or even conventional agriculture research. There is increasing room for the expansion of "alternative agriculture", especially in countries with a strong agricultural tradition such as Brazil. Growing demand for organic products allows for the development of economically viable "alternative agriculture". It is up to the IPPAs to identify relevant spaces for the development of research capable of contemplating a wide array of social actors. On the production side, alternative technologies have been appealing to smallholdings, and may even aid in the empowerment of rural communities. Scientific research on "alternative agriculture" and the extension of public technical assistance are important ways of leveraging such alternative forms of production, thus providing options for farmers who have hitherto remained at the margins of the productive process.

It thus becomes clear that holding a plurality of strategies is interesting to IPPAs, specially for securing strategic spaces and allowing for the complementarity of their research activities, be they conventional or alternative. However, this does not mean that strengthening IPPAs in developing countries will solve all their agricultural research problems. Neither is it being suggested that IPPAs should a priori carry out research in all areas indiscriminately. What seems certain is that, without such strengthening and plurality of strategies, IPPAs may have their research capacity reduced, therefore jeopardizing rural and agricultural development.

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