Research Article

Reducing Risks and Improving Safe Use of Agricultural Biotechnology Products through Participatory Technology Development.

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Abstract

The emergence of modern biotechnology has invoked a major global controversy over the future of world agriculture. The debates surrounding this controversial issue have often reflected the interests of developed countries and paid little attention to the needs of developing countries, especially those needs related to food requirements of low-income populations. Biotechnology though, can make life better for the poor in developing countries by producing higher than usual yields with less input, better rotations to conserve natural resources and improve resistance to diseases and pest infestations. It clearly can solve agricultural problems that traditional technology either cannot solve or can solve in a finer better costly manner. Although, perceptions of risks associated with the development and use of agricultural biotechnology products exist, these risks and fears could be reduced, allayed and even viewed in a balanced way through participatory, problem solving approach, involving various agricultural development practitioners. This paper thus argues that participatory technology development involving farmers in research and extension could be what is needed to solve the problems associated with biotechnology development. When all stakeholders are involved, all the fears and suspicions would be over as nothing is seen to be hidden from end users. Thus the authors dwell well on the concept of participatory research pointing out its usefulness and importance in agricultural biotechnology development.

Keywords: Risks, biotechnology, participatory, research, farmers, extension.

Introduction

Today, almost a billion people live in absolute poverty and suffer from chronic hunger. Seventy percent of these individuals are farmers- men, women, and children who eke out a living from small plots of poor soils, mainly in tropical environments that are increasingly prone to drought, flood, bushfires, and hurricanes. Crop yields in these areas are stagnant and epidemics of pests and weeds often ruin crops (Persley and Doyle,1999). Livestock suffer from parasitic diseases, some of which also affect humans. Inputs such as chemical fertilizers and pesticides are expensive, and the latter can affect the health of farm families, destroy wildlife, and contaminate water courses when used in excess. The only way families can grow more food and have a surplus for sale seems to be to clear more forest. Older children move to the city, where they, too, find it difficult to earn enough money to buy the food and medicine they need for themselves and their young children.

As these detrimental social and environmental changes are occurring in the developing world, a revolution in biotechnology and associated information technology is improving the health, well-being, and lifestyle of the privileged and creating more wealth in a few rich countries. Can this revolution also be harnessed to serve the food and nutrition needs of the world’s poor? What are the opportunities, problems, and risks involved with the new technologies and can they be managed? The last question is particularly pressing in light of the current controversy over genetically modified foods. The benefits and risks of biotechnology weigh differently for food in areas of food surplus than they do for life-threatening diseases in those same areas (Persley and Doyle,1999).

Biotechnology is any technique that uses living organisms or substances from those organisms to make or modify a product, improve plants or animals, or develop microorganisms for specific uses. The key components of modern biotechnology are:

- Genomics: The molecular characterization of all species;
- Bioinformatics: The assembly of data from genomic analysis into accessible forms.
- Transformation: The introduction of single genes conferring potentially useful traits into plant, livestock, fish, and tree species;

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- Molecular breeding: The identification and evaluation of desirable traits in breeding programs with the use of marker-assisted selection;
- Diagnostics: The use of molecular characterization to provide more accurate and quicker identification of pathogens.
- Vaccine technology: Use of modern immunology to develop recombinant DNA vaccines for improving control of lethal diseases.

Biotechnology can make life better for the poor in developing countries by producing higher than usual yields with less input, higher yields in a wider range of environments, better rotations to conserve natural resources, and more nutritious harvested products that keep much longer in storage and transport. Improved animals can resist diseases more effectively, have carcass structures that carry higher weights safely and healthily, have more efficient weight gains, and offer better quality meat and other products (Flavel, 1999).

Because plants and animals evolve to fit their environment, and not to serve human needs, men and women have practiced breeding and selection since the earliest times to produce more useful strains of plants and animals. The deployment of new genes and combinations of genes, therefore, is and always will be the basis for plant and animal improvement. Logically, the scientific case for using the new gene technology to improve plants and animals is overwhelming. This improvement process needs to continue in order to sustain today’s and tomorrow’s world in ways that achieve greater benefits and cause less harm to the planet’s resources (Flavel, 1999).

Food security remains an unfulfilled dream for more than 800 million people unable to lead healthy and active lives because they lack access to safe and nutritious food. The fight to achieve food security for this growing population has to take place on many fronts. Technology is one such front and genetic engineering and biotechnology one interdependent option within that front (Klaus, 1995). Biotechnology clearly can solve agricultural problems that traditional technology either cannot solve or can solve in a far more costly manner. But confusion surrounds the perception of risk associated with biotechnology. Whether this new technology promises to be the key technological paradigm in the fight for food security depends on how its risks are perceived, disentangled, and addressed.

**Technology-Inherent Risks**

Current public debate about the “gene revolution” often suffers from a failure to differentiate between risks inherent in a technology and those that transcend it. This differentiation is of utmost importance in any attempt to reason out the risks arising from biotechnology (Klaus, 1995).

Although modern biotechnology has demonstrated its utility, concerns exist about the potential risks posed by genetically modified organisms. Most countries with biotechnological industries have sophisticated legislation in place intended to ensure the safe transfer, handling, use, and disposal of such organisms and their products. Risks disallowed in industrial countries should not be exported to developing countries. If biotechnological procedures are used in developing countries, state-of-the-art quality management that takes local ecological conditions into account must be put into effect along with the well-documented principles and practices of proper risk assessment. Such risk assessments allow governments, communities, and businesses to make informed decisions about the benefits and risks inherent in using a particular technology to solve a specific problem.

Unfortunately, discussion of inherent risk has become mixed up as biologists, legal experts, and ethicists poach on each other’s turf. An orderly discussion would keep these voices to their areas of expertise. Decision making and quality management issues should also be kept distinct: The scientific project level (laboratory safety, measurement standards, assessment of technological alternatives, and so on) should remain separate from the national policy level (accountability issues, legal frameworks, and intellectual property rights, for example), which, in turn, should be disentangled from the international level (vulnerability to substitution, international assistance, and so on). The best minds should work on each level and find ways to achieve overall consensus about how to deal with risk.

**Technology-Transcending risks**

Technology-transcending risks emanate from the political and social context in which a technology is used. In developing countries these risks spring from both the course the global economy takes and country-specific political and social circumstances. The most critical risks have to do with three issues: aggravation of the prosperity gap between North and South, growth in the disparity in income and wealth distribution within societies, and loss of biodiversity (Klaus, 1995).
Biotechnology makes it possible to produce tropical agricultural goods in the laboratory at a more competitive price than under traditional developing-country conditions. Vanilla, cocoa, sugar, and tropical vegetable oils are examples of tropical export commodities under the potential threat of being replaced by products produced more cheaply elsewhere. If genetically engineered products do substitute for tropical agricultural exports, the wide gap in prosperity between North and South may well grow. The solution to the problem lies in a concerted international endeavor to diversify the production structure in vulnerable countries and not in interventions against the market. Governments of the countries in danger should improve governance and undertake more appropriate long-term structural planning. The international development community should support diversification efforts.

The prosperity gap may also grow if the North does not adequately compensate the South for exploiting its indigenous genetic resources. Private enterprise and research institutes could gain unremunerated control of the genes of plants native to the developing world, use them to produce superior varieties and then sell the new varieties back to developing countries at high prices. The basic question of whether the owners of biodiversity should be remunerated has been clearly and positively answered by Article 19 of the Rio Convention on Biological Diversity and by the virtually unanimous consensus of institutions engaged in biotechnological development. But the technical details of how compensation should operate for specific nations remains unclear, who should compensate whom for what and for how much needs unequivocal regulation.

The growing disparities in the distribution of income and wealth in poor societies serve to undermine the substantial contribution biotechnology can make to the welfare of farmers and to national agricultural development. Disease-resistant cassava, millet richer in protein, and rice enriched with vitamin A and tolerant to stress can contribute to prosperity and thus enhance food security only if these technologies, along with social advances, come within the reach of the broad mass of the population, male and female. Whether this happens and how long it takes to happen depend on the political will to create the appropriate national development framework (Klaus, 1995).

Contemporary reviews of the effects of the Green Revolution shows that in countries where small farmers has access to agricultural extension services, land, inputs, and credit, they were able to benefit much more and earlier than smallholders producing without the aid of a favorable agricultural development framework. Like the Green Revolution, genetically engineered crop varieties are a land-saving technology. As such they can be of particular importance to those who have little or only marginal land. Whether the potential benefits become reality for small farmers is not a question of technology but of the social quality of development policy. The economic and social impact of biotechnology can only be as good as the sociopolitical soil in which new varieties are planted. Solutions to food insecurity, therefore, ultimately have to be found in the domain of good governance (Gupta, 1999).

But the private sector, which has taken over more and more of biotechnology research, also has to do its share. As important aspects of plant research continue to be patented, they will become too expensive for poor farmers in developing countries. In order to avoid preventing or disturbing research for the poor, the private sector should make the results of its research available for free or on favorable conditions. In this way cutting-edge research can be used to aid those who, for reasons of poverty, do not yet participate in markets.

Loss of Biodiversity

The reduction of biodiversity is the third key technology—transcending risk. Diversity diminishes not because farmers grow genetically modified foods, but because the political will to conserve diversity does not always exist. It is precisely because farmers find new varieties more remunerative that the number of food crop varieties has diminished over the last 100 years. But the fact that farmers replace inferior varieties with superior varieties does not at all have to translate into a loss of biodiversity. Varieties that are under pressure of substitution can be preserved from extinction through in vivo and in vitro strategies. Improved governance and international support can also limit loss of biodiversity.

The immense reduction of biological diversity due to the destruction of tropical forests, conversion of native land to agriculture, replacement of wild lands with monocultures, over fishing, and the other practices used to feed a growing world population is far more significant than the loss of biodiversity due to the adoption of genetically modified crop varieties. To slow down the continuing loss of biodiversity, the main battlefield must be the preservation of land and water resources (Klaus, 1995).

Use of biotechnology in sectors such as agriculture and medicine has produced a growing number of genetically modified organisms (GMOs) and products from them. The rapid diffusion of transgenic crops illustrates the pace at which biotechnology is transforming the commercial landscape. The potential ecological, human health, and socioeconomic effects of such use have become the focus of widespread debate at national and international levels. These debates are rooted in different cultural approaches to risk acceptance and
management, and their outcomes will reshape existing policies and institutions dealing with the safe use of biotechnology.

Capacity Requirements and the Economics of Regulation

Biosafety measures cannot be effectively implemented without adequate institutional and human capacity at the national level. In most countries with regulatory regimes, existing institutional arrangements have been adjusted to accommodate biosafety needs. Many developing countries are now in the process of developing biosafety regulations. In some poorer countries, discussions about the introduction of these regulations have been accompanied by concerns about their expense (Gupta, 1999). As a way to address these concerns, the last decade has seen an increase in the number of formal and informal programs aimed at creating human resource capacity for biosafety regulation. The programs have focused on risk assessment and regulatory oversight. Training, workshops, seminars, and technical meetings have helped to build capacity in biosafety. International organizations have played a key role in supporting such activities. The draft biosafety protocol also identifies capacity building as a key area for international cooperation (Gupta, 1999).

Public Participation and Awareness

Current public debate on the commercialization of agricultural biotechnology products, especially in Europe, has underscored the importance of public participation in risk assessment and decision making pertaining to GMOs. The rapid pace of technological change and the wide-ranging nature of the perceived effects of biotechnology necessitate much greater public participation in policymaking. A number of industrialized countries have launched programs aimed at including the public in technology assessment and decisions involving the use of biotechnology in agriculture. The issue is not simply one of providing scientific information to the public, but rather of building trust between science and society. Intermediary programs and institutions concerned with the social aspects of biotechnology could be established to build such trust. While informed and effective public participation are the main crucial requirements in this arena, the need to maintain confidentiality about proprietary commercial information constrains the nature and extent of this participation. Where the boundary should lie between privately and publicly held information pertaining to GMOs continues to be an area of debate in determining the appropriate level of public participation in decision making (Tzotzos, 1995).

Information Exchange And Experience Sharing

For information without proprietary constraints, national and international agencies are increasingly using modern communication technologies, such as the internet, to disseminate information on regulations and risk assessments of genetically modified organisms. While such communication technologies are important mechanisms for sharing information and experiences, and their use is likely to grow in the future, excessive reliance on them could prevent those countries with the least capacity and the greatest need for risk-related information from having timely access to the latest knowledge about biosafety. Measures adopted to complement information dissemination through the internet include the establishment of biosafety clearing houses within national and international agencies. The use of such intermediary institutions as bridges for sharing information and experience between various sections of society and across countries needs to be enhanced. In particular, intermediary institutions could facilitate the task of monitoring risk assessments and decisions pertaining to biotechnology-products as an important means of accumulating knowledge. While a number of national agencies have begun monitoring activities, the results of these efforts have not been consolidated into global biosafety assessments. Such assessments could be useful in disseminating the lessons learned about different genetically modified organisms and in facilitating experience and information sharing among countries.

Redirection Of Existing Technological Efforts

Efforts to redirect biotechnology to address the needs of low-income families in developing countries should be placed in a large policy framework that addresses other social issues. More important, such strategies should be part of policies designed to use science and technology to achieve sustainable development goals that embody ecological, social, and economic requirements. In addition, biotechnology should be considered one tool in a larger portfolio of technological options, to be applied where it is needed and where it offers the best available option for solving specific problems.

The choice of technology should be driven by the determination of local needs. Many developing countries have already indicated priorities that could be addressed using genetic modification in their agricultural development strategies. Many African countries, for example lie in regions where drought tolerance, disease resistance, and crop-yield increases are priorities. Crops such as cassava, millet, yams, millet, and sorghum are prime candidates for genetic modification. Modification that seeks to prolong the shelf life of foods could help reduce postharvest losses significantly. The use of herbicide tolerance in low-till agriculture is another high

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priority, especially in helping to lessen farm labor and providing farm workers- most of whom are women- with opportunities to engage in other activities.

Another potential area for biotechnology application is the development of livestock that is tolerant to many tropical diseases. Modern methods, such as genomics, could be applied in this area without requiring transgenesis. Also related to agricultural production is the significance of re-vegetation in marginal areas. Investment in fast-growing plants could help facilitate ecological restoration in many denuded regions of the world. Such research could also add to the fodder available in these countries.

Redirecting global research and development efforts to focus on these challenges will entail considerable international cooperation, increases in public sector funding, and incentives for private enterprises. It will also require tolerance for using science and technology for sustainable development in the developed and developing countries.

**Technology management**

Three categories of risk need to be addressed in considering the role of biotechnology for low-income families: health, environment, and socioeconomic considerations. The advent of biotechnology demands that all countries put in place measures that ensure safety to human health and the environment. Such measures involve the judicious use of strategies for assessing, managing, and communicating risk. In addition, equity considerations also call for social policies that address the impact of new technologies on rural populations. Such policies should include ways of creating alternative livelihoods for farm workers displaced by new technological practices.

Many developing countries are currently reluctant to engage in biotechnology development because they fear some developed countries would erect barriers against their products. These concerns are real and have created an atmosphere of distrust that is likely to undermine not only the global trading system, but also the ability of developing countries to meet their basic needs.

A final area of concern is the impact of intellectual property protection on the ability of the developing countries to use biotechnology. This point has two dimensions. First, international agricultural research institutions are increasingly dealing with intellectual property issues. Ways must be found to enable these institutions to have access to technologies needed to meet the needs of low-income families. Second, national research institutes in developing countries face similar challenges. Biotechnology firms should make public pledges to share technologies with developing countries. Realizing such pledges will require considerable institutional innovation to provide the required comfort among the providers and users of technology.

**THE IMPORTANT ROLE OF PARTICIPATORY RESEARCH**

Participatory research has three key elements: people, power and praxis (Finn, 1994). It is people-centered (Brown, 1985) in the sense that the process of critical inquiry is informed by and responds to the experiences and needs of people involved. Participatory research is about power. Power is crucial to the construction of reality, language, meanings and rituals of truth; power functions in all knowledge and in every definition. Power is knowledge and knowledge creates truth and therefore power (Foucault, 1980). Participatory research is also about praxis. It recognizes the inseparability of theory and practice and critical awareness of the personal-political dialectic.

Participatory research makes a participatory approach to learning as a central part of a research process. Research is not done just to generate facts, but to develop understanding of oneself and one’s context. It is about understanding how to learn, which allows people to become self-sufficient learners and evaluate knowledge that others generate. Good participatory research helps develop relationships of solidarity by bringing people together to collectively research, study, learn, and then act. There is no off-the-shelf formula, step-by-step method, or “correct” way to do participatory research. Rather, participatory methodology is best described as a set of principles and a process of engagement in the inquiry.

**Conceptualizing the Research Process**

Participatory research stresses the importance of creating a participatory and democratic learning that provides people (especially the underprivileged) the opportunity to overcome what has been called the “habit of submission-the frame of mind that curtails people from fully and critically engaging with their world and participating in civic life. It is only through participation in learning environments in which open, critical and democratic dialogue is fostered that people can develop greater self-confidence along with greater knowledge (Finn, 1994).

Participatory research challenges practices that separate the researcher from the researched and promotes the forging of a partnership between researchers and the people under study. Both researcher and participant are actors in the investigative process, influencing the flow, interpreting the content, and sharing options for action. Ideally, this collaborative process is empowering because it:
Brings isolated people together around common problems and needs;
Validates their experiences as the foundation for understanding and critical reflection;
Prepresents the knowledge and experiences of the researchers as additional information upon which to critically reflect;
Contextualizes what have previously felt like “personal,” individual problems or weakness;
Links such personal experiences to political realities.

The result of this kind of activity is living knowledge that may get translated into action. A key methodological feature that distinguishes participatory research from other social research is dialogue. Through dialogue, people come together and participate in all crucial aspects of investigation, education and collective action. It is through talking to one another and doing things together that people get connected, and this connectedness leads to shared meaning. Dialogue encourages people to voice their perspectives and experiences, helping them to look at the “whys” of their lives, inviting them to critically examine the sources and implications of their own knowledge. In this context, dialogue allows to awaken participants’ voices and cultivates their participation as critical, active agents of change. This is particularly essential in the light of many social forces of domination at work in the lives of people from socially and culturally disenfranchised groups (Finn, 1994).

The role of the researcher in this process is a facilitator of the learning process. The researcher is not an expert who is assumed to have all the knowledge and gives it to the people who are assumed not to have any knowledge. Rather, it is a facilitator who sets up situations that allow people to discover for themselves what they already know along with gaining for themselves new knowledge. In this process, the researcher not only learns from the participants, but also engages in dialogue by posing questions:

- What are the conditions of participants’ lives?
- What are the determining features of the social structure and social relations that contribute to creating their life patterns?
- What choices do they make, and why do they believe those are good things to do?
- What are the possibilities for their experience and action?

The researcher’s sharing of his or her perceptions, questions in response to the dialogue, and different theories and data invite the participants to critically reflect upon their own experiences and personal theories from a broader context. Ideally, in such a setting, the expert knowledge of the researcher combined with the experiential knowledge of community members, create an entirely new ways of thinking about issues.

This is the meaning of conscientization, which many writers today popularize. Critical consciousness is raised not by analyzing the problematic situation alone, but by engaging in action in order to transform the situation. Dialogue acts as a means for fostering critical consciousness about social reality, an understanding based on knowledge of how people and issues are historically and politically situated (Brown, 1985).

Communication is a key methodological concern in participatory research. It draws upon creative combinations of written, oral and visual communication in the design; implementation and documentation of research. Grassroots community workers, village women, and consciousness raising groups have used photo novella (people’s photographic documentation of their everyday lives) to record and to reflect their needs, promote dialogue, encourage action, and inform policy. Researchers use theater and visual imagery to facilitate collective learning, expression, and action. Other forms of popular communication are utilized such as collectively written songs, cartoons, community meetings, community self-portraits and videotape recordings.

Critical knowledge development calls for a creative blend of traditional methods of inquiry and new approaches. Use of alternative communication methods in participatory research has both pushed researchers to re-examine conventional methods and opened up the possibility of using methods that previously would not have been considered legitimate.

Farmer Participation In Agricultural Research

The rise of farmer participatory research (FPR) was a deliberate effort among agricultural professionals to combine farmers’ indigenous traditional knowledge (ITK) with the more widely recognized expertise of the agricultural research community. The approach aimed to distinguish itself from farming systems research (FSR) in its more deliberate attempt to actively involve farmers in setting the research agenda, implementing trails and analyzing findings and results (Farrington and Martin, 1988). FPR has gone beyond the on-farm trials which became the standard of FSR, and actually called for farmers to design, monitor and evaluate experiments in collaboration with researchers - carried out in their own fields (Okali et al., 1994). Some have argued that while FPR approaches can increase participation among farmers, as a research methodology, it has not brought about impact and output (Bentley, 1994), or may require more than short-term technology development efforts (Humphries et al., 2000). Research from Africa supports this argument by showing that less than 15% of “experiments led by farmers” resulted in the definition of new knowledge or the development of new technologies (i.e., were not already in existence elsewhere). The study concluded that farmers’ experiments are in fact more
"complementary" rather than "synergistic" to formal agricultural research efforts, and that farmers' experiments are more closely linked to agricultural extension activities rather than to agricultural research accomplishments (Sumberg and Okali, 1997).

Some of the trends like the recognition of the importance of farmers' ITK, strengthening of farmers' participation, the emergence of non-government organizations (NGOs) within the agricultural technology development sphere - allowed for the development of one of the more articulate models deriving from the FPR experiences - the multiple source of innovation model (Biggs, 1989). The model states that agricultural innovation (and the systems that carry those innovations between and among farmers) can derive from several sources, rather than from a single formal source (i.e., traditional research institutions). Evidence from Ecuador, Niger and other countries supports the multiple source of innovation model by providing well-documented examples of innovations emerging from farmers' associations and NGOs, and argues that public sector research extension institutions are neither the only nor the main agents of agricultural technology adaptation and dissemination (McCorkle et al., 1988; Bebbington, 1989; Engel, 1990). The multiple source of innovation model has allowed for greater operational space for NGOs within the agricultural technology development system, as it has provided greater legitimacy to their contribution (Farrington and Amanor, 1991).

Farmer Participation in Agricultural Extension

Despite the articulate and increasingly large body of literature on participatory research and extension approaches, much of the work that has been conducted under the farmer-first and FPR frameworks focuses mainly on the research dimension of agricultural technology development and dissemination approaches. Concrete examples of the application of the underlying principles of participation, indigenous knowledge, and the users' (or farmers') perspective to the extension function and a discussion of the implications of these considerations to agricultural extension systems have been somewhat limited.

Roling (1995) outlines the facilitation model of extension that has emerged in recent years. The model also identifies the need to support farmer networking to reinforce individual learning, centered within a process which is facilitated by highly trained outsiders (agricultural professionals - both researchers and extension workers), thus comprising an agricultural knowledge and information system (AKIS). While the move from a linear transfer-of-technology extension model to the facilitation model is a difficult one, it is a trend which is gaining acceptance within donor and public sector institutions, but it also begs the need for further investigation into the characteristics of the approach (Roling and van de Fliert, 1994).

Engel (1991) presents a (general) typology of participation in extension which attempts to qualify levels of intensity of farmer participation as:

- Participation in extension meetings or activities;
- Participatory diagnoses (e.g., participatory rural appraisal, problem-census, etc.)
- Participation through organization;

Using this typology, much of what is called farmer participation in extension falls under the first two levels. However, for extension to become more farmer-led, a greater emphasis must be placed on the third - more substantive - type of farmer participation. One example of this third type of farmer participation in extension can be noted in the experience of the Uganda National Farmer's Association that has established a "demand driven, cost-recovery" extension system as an alternative to public sector extension in a number of districts (Carney, 1998).

Farmer participation in extension will require putting farmers first by placing real ownership and accountability of public extension organizations into the hands of the clients - the farmers, and their communities and organizations. Anholt (1994) suggests that this might be accomplished by developing mechanisms for improving public support (i.e., cost-sharing, local taxes, etc.) that would provide resources to farmers and their organizations, and allow them to choose the types of extension services that are most relevant to their needs. However, he goes on to say that this will also require farmers to assume more responsibility to determine (and pay for) extension services and programs. User-centered approaches to extension - while increasingly fashionable - are not favored by agricultural extension agencies (particularly the public sector) because of the resulting changes in their power relations with farmers (Tendler, 1993).

Drawing upon extension practice and literature, key elements of agricultural extension approaches can be identified and formulated into a comparative typology for three different types of extension approaches. The first two columns represent two distinct extension approaches - extensionists-centered and farmer-led approaches. Using key elements of any extension approach, the table attempts to differentiate between these two distinct approaches, recognizing that these are only models and that no single extension program may neatly fit into either model. The third column represents an emerging typology of extension approach which argues for a synthesis of these two conventional models into the form of an “accompaniment” model for participatory agricultural extension - a “middle path” between the more traditional extensionists-centered approaches and the more dynamic farmer-led approaches (Chikaire, et al., 2012b).
This “accompaniment model” suggests that farmer-led extension approaches cannot solely focus on the farmer promoters involved in the process, as there is, indeed, a critical role for professional extension workers to “accompany” the efforts and to support the achievements of farmer promoters. Experience has shown that it is difficult to achieve quality work from farmer promoters if they are not supported by well-trained professional extension workers sensitive to the new attitudes required of them. However, the professional extension workers must also be committed to and enthusiastic about the changes brought about by farmer-led extension approaches, especially in terms of the change in roles expected of them as professionals, and the communication/capacity-building skills that are required of them in order to work effectively with farmer promoters.

**Why use Participatory Technology Development?**

Generations of scientists and practitioners in rural development are concerned with the serious limitations of conventional research and extension approaches linked to the industrialized agricultural systems of Western societies, known also as top-down transfer of technology (TOT). These limitations include:

- Detrimental impacts on the environment, and contamination of soil, water, air and food due to use of chemicals and declining fertility;
- Decreasing biodiversity due to the impositions of hybrid and genetically modified seeds for cash cropping which are reducing the in situ stock of land races and reduction of natural habitat containing wild ancestral stocks of domesticated species;
- The growing dependency of farmers upon external agro-technologies and agro-technicians, reducing their confidence in their own skills and abilities to manage their resources;
- Reduction of farmers into passive users of solutions who are not consulted over application of technologies to local conditions due to the imperative character of the technology transfer approaches.

In reaction to the top-down approach, several circles of scientists and practitioners who have come to recognize their position as “outsiders” to rural life are assuming the following values:

- Emphasis of creative interactions within rural communities so that traditional, indigenous, local, or popular knowledge and experiences become the driving force of development;
- Acknowledgment that their own knowledge is a product of research centers, universities and development agencies-known as technical, scientific or modern knowledge and experiences-and thus that their knowledge assumes very different contexts, values and conditions from those of farmers;
- Enhancement of dialogue between the two different knowledge systems, those of “outsiders” and locals," in order to find joint solutions to rural issues while taking full advantage of local resources (natural social or cultural) (Finn,1994).

PTD is a long-term interaction between outsiders and local people, with the aim of generating innovations based on indigenous knowledge and cultures to develop sustainable livelihood systems. It involves and links the power and capacities of agricultural research with the interests and knowledge of local communities. More broadly, PTD deals with natural resources management by strengthening the local indigenous specialists and their communities to carry out experiments in becoming more sustainable and self reliant through drawing on their local resources (Sala et al.,2004). Since PTD is closely related to community development, the role of outsiders consists in facilitating self-learning processes and serving as technicians and managers of development institutions together with local people. These outsiders also facilitate the organization of a network of village specialists to intensify communication over local innovations and encourage their persistence through ongoing experimentation in self-sustained agricultural innovations and local resource management (Chikaire, et al., 2012a).

**Characteristics of Participatory Technology Development (PTD)**

PTD is an intercultural dialogue process with multiple levels of complexity:

1) Human interaction to creatively link the knowledge of scientists and farmers in order to overcome the limitations of cultural or technical biases;
2) Skillful application of participatory methods to involve farmers as equally valuable agents in the generation of ideas and new technologies;
3) Technology generation dealing with practical solutions that rely on local resources and indigenous knowledge and practices;
4) A shared vision of development that accomplishes values which are environmentally sound and culturally embedded and sustainable, and which enhance biodiversity.
There are many ways to understand and practice participation of local people (beneficiaries) in development work, but at the same time there is terrible confusion. Too often participation is used manipulatively as a means to get local peoples to work to fulfill goals and quotas of outside organizations rather than taking the time to work with them to understand their situation, values, and the complex character of their needs. Some development practitioners (outsiders) label passive attendance as “people’s participation.” Other practitioners give orders to the farmers to plant trees, with or without payment, and declare it “people’s participation.” There are innumerable examples about how participation is misunderstood, distorted and misused in practice.

Some aspects are fundamental to the participatory processes:

- Consultation and access to information for the local people about the intentions of outsiders in a village or region regarding the exchange of knowledge to foster innovations.
- Freedom of choice for local people to engage in a process of innovation.
- Empowerment through redistribution of power on the basis of equity and compatibility. Outsiders and local farmers interact according to their capacity to experiment and innovate, recognizing various expectations, needs and responsibilities.
- Mutual trust and respect resulting in a process in which both parties feel encouraged to continue a relationship and maintain a long-term process of community development on the basis of self-reliant resource management.
- Distribution of benefits to partners equally. Local people should be able to perceive how this experience will improve and sustain their livelihoods.
- Adaptability and flexibility of outside institutions to changing and sometimes unforeseen circumstances.

Participation at project level is an effective communication and decision-making process for building ongoing partnerships with local people during all phases of a project cycle:

**Participation in Planning**

The best way to plan with the people is to look at situations through their own eyes and perceptions. Through the use of PRA-tools, we can establish not only the starting point but also visions of development based on local criteria. By this process, people are not made into objects of our development ideas. Rather, they take ownership, mobilize their ideas and forces, and decide on the content and method of the project. Thereby they are positioned to determine our action and facilitation tasks.

**Participation in Implementation**

Planned by and with the people, implementation also is in the hands of the people. They control and monitor the activities and request external support as needed.

**Participatory Evaluation**

Evaluation in this context means to know about what progress is being made and the difficulties encountered in the original plan and to decide jointly what to do next. Evaluation includes not only the field actions but also the attitudes and proceedings of the facilitation team.

In all three instances, participation is both a means and an aim. It is a means because the people take ownership of their own development project and activity, and it is an aim because by getting organized the people enhance their capacity to manage their own livelihoods.

Partnership means a mutually agreed arrangement between public, private, or non-government organizations and local people to achieve jointly determined goals or objectives for the benefit of the environment and society.

Development efforts in the last thirty years provide a number of lessons on the significance of participation;

- Involvement of people living in a locality or region in development projects is a major guarantee that the interests and needs of local people will be defined more effectively.
- Local people generate information that will create a common understanding which is no longer “only scientific or only local” but the basis for original, self beneficial solutions.
- The solutions will be socially and culturally acceptable.
- Participation creates a sense of ownership and local people will implement activities on a basis of self reliance.
- Participation creates a collective self-esteem leading to revitalization of local experiences local people will feel empowered to manage their resources with greater awareness of the value of sustainability for future generation.
Conclusion

The use of biotechnology in sectors such as agriculture and medicine has produced a growing number of genetically modified organisms and products. The rapid diffusion of transgenic crops illustrates the pace at which biotechnology is transforming the commercial landscape. It has great potentials for food security and poverty reduction as yield increases over time. Despite the potentials, there are widespread debate, risks, fears, criticisms following the emergence of biotechnology products. To allay the fears, debate and criticisms, participatory approach to agricultural biotechnology development be adopted which will incorporate numerous stakeholders. These stakeholders will be empowered as they become part and parcel of decision, priority setting, implementation, execution and monitoring and evaluation of programme outcome and development.

References

Engel, P. (1990) Two Ears, One Mouth: Participatory Extension or Why People Have Two Ears and Only one Mouth. At Source Vol. 18 (4):2-5.  


