Integrating Biotechnology and Sustainable Agriculture

The workshop participants were charged with the following tasks:

1 To focus on the "new" molecular and cellular biotechnology

2 To develop a workable definition of sustainable agriculture

3 To prioritize the major issues and identify the non-issues that were brought up but which did not have a significant role to play

4 To identify key areas where additional research is needed in order to determine the receptivity and efficacy in the use of biotechnological products

5 To set forth recommendations for use in the formulation of policy alternatives

6 To indicate areas of consensus and non-concensus

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Biopesticides

 This report is a summary of the issues, research needs, and policy alternatives that participants raised and discussed in the conference workshops concerning the relation between biopesticides and sustainable agriculture.

I CHARACTERIZATION OF BIOPESTICIDES AND SUSTAINABLE AGRICULTURE

The workshop participants began their deliberations by formulating working definitions of "sustainable agriculture" and "biopesticides". They agreed to characterize "sustainable agriculture" in terms of its goal: The goal of sustainable agriculture is equilibrium, i.e., viable agriculture production with either regeneration or no net loss in the long term of natural resources and desirable social structures.

Noting that "-cide" means "kill" and that biotechnologists could develop biopesticides that just repel or otherwise inhibit pests in some non-lethal manner, the group agreed to define biopesticides in terms of "control": Biopesticides are genetically engineered or naturally occurring biological agents that can be used to control pests.

Although they agreed on these working definitions of sustainable agriculture and biopesticides, many of the participants indicated that they would feel more comfortable if the report emphasized certain qualifications or elaborations in relation to the two definitions. Some of the more important of these qualifications and elaborations are:

Flexibility is a key aspect of sustainable agriculture, and there is a need for the delineation, implementation, and diversification of practices specific to sustainable agriculture.

Sustainable agriculture implies that the farmers practicing it will usually be the owner-operators of their farms.

Sustainable agriculture involves the tendency to reduce the number of inputs employed in agriculture.

In sustainable agriculture, one focuses on the functioning of the total agri-system and not just on a number of the system's specific features.

Sustainable agriculture is a means of meeting the needs of both farm families and the broader community, including the consumers of farm products and the smaller rural communities that serve farmers.

Short-term profitability is a means of ensuring the long-range viability of sustainable agriculture.

Biopesticides do not amount to a "magic bullet" that can promote sustainable agriculture in separation from other farm practices.

Genetically engineered biopesticides can occur in several forms, including transgenic plants designed to express insect toxins (e.g., Bacillus thuringiensis), plants engineered to contain plant virus coat proteins, and microbial pesticides such as viruses and fungi. One should therefore be careful in generalizing about the impact of biopesticides on sustainable agriculture.

On the basis of these definitions, qualifications and elaborations, the group then discussed how biopesticides might affect and contribute to the goals of sustainable agriculture. The discussion was divided into three parts: issues, research needs, policy alternatives.

II ISSUES

The group identified a variety of issues, needs and questions relating to the role that biopesticides might play in sustainable agriculture.

1 Impact on Desirable Social Structure—Because past agricultural practices and innovations have sometimes undermined the goal of preserving desirable social structures such as family farms and rural communities, workshop participants were concerned how the use of

biopesticides would affect these structures. They agreed that the impact of biopesticides on these structures depends on a variety of factors, including the following:

The use of biopesticides in conjunction with other sustainable agricultural techniques. Reliance on genetically engineered biopesticides in exclusion of other non-conventional practices could violate the ideals of "self-sufficiency" and "diversity" often associated with sustainable agriculture.

Level of agricultural management skill. Biopesticides will probably require a higher level of management skill than do traditional chemicals. This higher level of management skill is desirable if it promotes owner-operator management practices, but is undesirable if the level of skill is so high that it requires outside assistance incompatible with the goals of sustainable agriculture.

Level of financial investment required of farmer. If biopesticides require
16 a high financial investment from farmers, then they will not provide a viable option for the smaller farmer.

2 Economic Viability of Biopesticides—If biopesticides are going to be available as a component of sustainable agriculture, they must be feasible to develop and implement. If only a small group of farmers are interested in using them—for example, only those practicing sustainable agriculture—then biotechnology companies may not be able to receive a sufficient return on their investment to justify the costs of their research and development.

3 Biopesticides in relation to a safe environment—The group felt that biopesticides would contribute to sustainable agriculture only if adopters and policy makers gave adequate attention to a number of environmental issues, including the following:

Agricultural practices involving biopesticides can contribute to resistant pest populations. Related weedy plants could cross-pollinate with the genetically engineered plants and become more resistant to the predators and conditions that previously controlled them.

If biopesticides are used only at the economic threshold to pest damage, that is, in a manner consistent with the practices of Integrated Pest Management, then they will be less likely to contribute to unwanted resistance in other organisms.

Biopesticides can disrupt other aspects of the environmental system. For example, some biopesticides might be harmful to beneficial organisms and prove difficult to monitor in relation to their environmental fate. Some of the participants suggested that such monitoring can never be adequately performed, while others felt that although monitoring is sometimes limited by the present state of technology and knowledge, it is not a major concern in relation to endogenous biopesticides.

If the genetic alterations of biopesticides are well characterized in advance, this could possibly limit unpredicted effects of releasing such organisms in the environment.

The chance of unintended environmental effects could also be limited by using biopesticides in conjunction with a crop rotation system.

We cannot claim that biopesticides as a class are always safer than chemical pesticides, though many biopesticides will be. In general, the goals of sustainable agriculture will be better served if we consider the balance between safety and effectiveness when comparing and deciding between biopesticides and chemical pesticides.

4 Promoting Diversity—Because biotic diversity at all levels promotes long-term stability of agri-systems, it would be more in accord with sustainable agriculture to adopt a strategy of developing diverse types of biopesticides rather than only one or two major varieties.

III RESEARCH NEEDS

The participants listed a number of research endeavors that they felt would advance the goals of sustainable agriculture and address the issues discussed in the previous section. They also emphasized that these endeavors would require integrated, interdisciplinary approaches between molecular biologists, ecologists, and the members of other disciplines. The following types of research were more frequently mentioned as important:

—Development of a consolidated data base in the areas of microbial and agricultural ecology, which would help us learn more about the possible consequences of the environmental release of biopesticides;

—Development of control and containment mechanisms such as conditional lethal genes;

—Consideration of ways to make biopesticides economically more viable;

—Ascertainment of the effect of public versus private research arrangements on diversity, for example, whether the tendency of private research to focus on high yield crops might reduce the diversity of biotechnologically engineered plants;

—Ascertainment of the degree to which public funds are being directed towards sustainable agriculture;

—Documentation of the degree to which current patenting practices inhibit the sharing of information necessary for the development of biopesticides compatible with sustainable agriculture;

—Development of methods by which biopesticide researchers can equitably compensate Third World countries for the (often unacknowledged) use of the genetic material contained in the landraces of many Third World countries;

—Reduction of the level of managerial specialization and expertise required for farmers who might utilize biopesticides;

—Documentation of the methods used by non-conventional farmers to produce their crops, thereby adding to our store of knowledge on sustainable practices;

—Collection of data concerning regional variability in sustainable agriculture practices;

—Promotion of the training of plant breeders, a disappearing art in the U.S. but still needed despite the development of new techniques for breeding plants;

—Elucidation of the differences between the conceptual systems (views of nature and of the relationship between humans and nature) underlying sustainable agriculture and biotechnology, and the practices which these systems tend to sanction or prohibit (the ethical dimension of agriculture).

IV POLICY SUGGESTIONS

The members of the group formulated a variety of specific policy suggestions, listed below:

1 More public input into decisions concerning biopesticides and sustainable agriculture—The workshop participants expressed a need to develop better mechanisms for public input into "major decisions" that have an impact on society and that are made by a variety of groups

that influence the direction of biopesticide development and use. These groups include federal and state regulatory agencies, land grant universities, and private industry. Appropriate mechanisms for delivering these policy inputs vary. Depending on the case, public input might be needed prior to decisions concerning research projects, the release of genetically engineered organisms into the environment, or the commercialization of new products. In particular:

Advisory group's—Public input is needed to help direct research investments towards areas that are consistent with sustainable agriculture. To be useful, these inputs must occur prior to the time such investments are initiated.

Public hearings—Many people feel that the current system by which federal agencies solicit input on regulatory decisions is too passive, usually involving only notification in official publications. A preferred approach would involve public hearings at the regional level, at least on issues that are particularly controversial.

Ombudsperson—In relation to university research concerning biopesticides or sustainable agriculture, an ombudsperson could serve as a liaison with the public.

2 Redirecting Research to promote sustainable agriculture and development of "special" agricultural products—State governments and/or some other funding sources should establish a system of competitive grants to promote sustainable agricultural research. Citizens should have a role in formulating the criteria for awarding them.

Land grant universities should work exclusively on the development of products that promote sustainable agriculture and that are prohibitively costly or otherwise unattractive for private companies to develop. In order to inform farmers about new conventional agricultural products developed by private industry, however, extension specialists should be involved in field testing them. Many members of the group therefore agreed that the original proposal should be modified. Although a much larger proportion of land grant funds should go into areas outside the corporate sphere of interest, this should not be done to the exclusion of involvement with products developed by private companies.

3 Modify environmental and agricultural policies—Some aspects of current environmental and agricultural policies should be modified

in order to prevent unintended side effects that undermine the goal of sustainable agriculture. For example, a land set-aside program apparently contributed to the wheat streak mosaic in Kansas.

4 Integration of biopesticides with other techniques of sustainable agriculture—The group returned repeatedly to the point that if sustainable agriculture farmers are going to utilize biopesticides ,then they must integrate them with other techniques of sustainable agriculture. Furthermore, such integration requires a clear idea of the full meaning of sustainable agriculture.

Does sustainable agriculture signify only environmental equilibrium or regeneration, or is it a "form of life" that suggests a "deeper" and/or more creative relation to the environment, a more equitable relationship among the persons working the land, and a stronger bond between these persons and the broader community of which they are a part? Because the characterization of "sustainable agriculture" will take on different nuances in different situations, it must remain definite enough to allow for an effective contrast with conventional agriculture and yet flexible enough to meet evolving needs and knowledge. In particular, the criteria for sustainable agriculture should be generated at least in part through dialogue among extension agents, farmers, and other concerned members of the community.

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Herbicide Tolerance

The participants of the workshop were asked to address a number of questions concerning herbicide-tolerant plants and sustainable agriculture; for example—what are herbicide-tolerant plants? Who is interested in their development and why? What will be the effects of herbicide-tolerant plants on the amount and the mix of herbicide use? How will this affect the rural population? What are the alternatives? What is the role of public and private research in all of this?

Probably the most important result of the workshop is not a recommendation, but rather the exchange of a wide variety of opinions and ideas among the many participants with a wide spectrum of perspectives and backgrounds represented. Early in the discussions, some participants were surprised that issues they thought to be trivial were seriously contested by others. The discussions were intense at times, and there was an "absorption" of differing opinions as the workshop progressed. This mutual enlightenment was reflected clearly in the evolution of the participants' statements and comments throughout the meeting, and the resulting learning process was valuable.

Though "progress" was made and consensus was reached on some points, the time frame was too short and the original starting points too far apart to come up with strong policy recommendations. This is reflected in the general nature of the recommendations which follow.

I ISSUES

The following contaisn a summary of the discussion on different issues.

1 Herbicide-tolerant plants and sustainable agriculture: a state of the art—The massive "opinion gap" between the participants' viewpoints is reflected in the groups' inability to reach a consensus on a working definition of "sustainable agriculture". It was agreed that although consensus could not be reached on a single definition, the discussion should proceed, but with the understanding that there were a variety of definitions for the term "sustainable agriculture" which reflected low- to high- inputs. If sustainable agriculture was defined in a narrow sense, i.e., without synthetic chemical inputs, herbicide-tolerant plants would not have a role. Furthermore, there was a common concern that safe, high quality foods and feeds be produced without damaging the natural resources for present and future generations.

It was recognized that in the past, selective herbicide weed control and herbicide-tolerant plants have been a natural combination: herbicide-tolerant plants were at the origin of many current chemical weed control practices. Biotechnology provides the possibility of broadening the range of herbicide-tolerant plants beyond those which could be developed through traditional plant breeding methods. A number of herbicide chemicals have been targeted. Certain non-selective herbicides, such as glyphosate, and some of the newer selective herbicides such as the imidazolinones and sulfonylureas are the focus of considerable research in the development of herbicide-tolerant plants.

Both private firms and public institutions have, on their own or in cooperation, heavily invested in research and/or development of herbicide-tolerant crops, even though the motivation for the research may be different

Z The impact of herbicide-tolerant plants—There was no clear answer to the question of whether herbicide-tolerant plants would tend to increase or decrease herbicide use. Some feared that it would increase chemical use and thereby add to the environmental burden, while others insisted that herbicide-tolerant plants could reduce the amount of herbicide use.

Also, skepticism was expressed during the discussion that herbicide-tolerant plants would allow manufacturers to dispense with the older, less selective herbicides. The point was made that weeds tole-

rant to new low-dose herbicides have appeared at "an astonishing" rate and unless multi-resistant crops or multicrop-resistance was developed, the adaptation of weeds to new herbicides would not allow the effective and quick replacement of the "older" pesticides by chemical pesticides.

The discussion about the impact of herbicide-tolerant plants on the rural population focused on the "efficiency effect" of herbicide-tolerant plants. An increase in production efficiency would increase output, thereby lowering prices and reducing the demand for labor in the agricultural sector. A number of people expressed their concern about this effect, and especially about the expected further reduction of the small farms. Others argued that the only way to ensure the profitability of U.S. farms in the long run is to introduce efficiency-improving technologies such as herbicide-tolerant plants in order to improve or sustain the competitiveness of U.S. agriculture in the world markets.

II ALTERNATIVES

A wide range of potential alternatives were proposed and discussed. These included new biological and new chemical approaches as well as alternative farming systems, such as different tillage and crop rotation practices.

There was general agreement that we needed more information on how these alternative technologies compare to one another or to the currently used technology in terms of efficiency and environmental effects. This information was considered essential to provide a common foundation of knowledge needed to come up with policy recommendations.

Some argued that the attitude of the consumer is an increasingly important issue in the comparison of alternative weed control technologies. In the opinion of these participants, some alternative agricultural systems which are less hazardous for the environment may be less efficient and would—if implemented—result in increased production costs and ultimately result in higher food prices. The extent to which the consumer is willing to pay higher prices for such products clearly influences this notion of "efficiency".

III RESEARCH

As stated in the previous section, there was a consensus that we need more information about the alternative practices. In addition, it was

argued that insufficient resources were being appropriated for the study of alternative agricultural systems of weed control. It was proposed that more public sector funds be used to study weed control approaches, such as:

—crop rotation,
— use of weed growth suppression techniques such as allelopathy and cover crops,
—cultivation techniques such as ridge tillage,
— fungal pathogens of weeds,
— development of crop plants with improved competitive properties,
— selective insect pests of weeds,
— determination of weed population thresholds without adverse effects on yields,
— integrated weed-management programs
— intercropping and timing of planting approaches.

There was a fair consensus that it would be good to alternate approaches, but no consensus on how effective these approaches might be. However, there was no agreement about the kind and amount of support this project should receive, or how such a project might impact on other research programs. One participant felt strongly that it was important that not all public research funds go into "the dazzling science of molecular biology."

IV POLICY RECOMMENDATIONS

At the conclusion of the workshop, the following recommendations were made:

•/ Funding should be provided to the public sector to conduct research on the environmental, economic and social impacts of current and alternative systems of weed control. Part of this research should focus on herbicide-tolerant plant/herbicide combinations.

Z Major public and private research should be undertaken on the environmental, economic and social impacts of agricultural systems.

3 A study should be conducted to determine how farm policy affects the adoption of different weed control techniques.

4 If some of these alternative forms of weed control prove to be environmentally, socially and economically superior to conventional methods, public funds should be provided to foster innovation at the producer level for these alternative forms.

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Disease Control in Animals

The biotechnological issues confronting society are those of food availability, cost, quality, and human as well as animal health. The health of farm animals is intimately related to a complex web of causation involving production systems, agents and environments. Diseases appear to be an innate phenomenon related to the interdependent influence of a myriad of factors involving agents, environments, and hosts. The manipulation of these factors affects animal health and disease not only on a local or regional scale, but globally, particularly as the United States imports and exports animals and animal products internationally. It is critical that researchers and the public become sensitized to the influences of current practices of farm animal agriculture as they affect the health of animals and humans as well as the ecosystem. Such an awareness compels us to address those issues that relate to sustainable agriculture, including an emphasis on concerns for long-term food and water resource capacities.

Current biotechnological developments present significant factors in human intervention that can be employed to enhance animal health, improve on disease control techniques and increase the quality and availability of food, fiber, and other products generated from animals. Economic, social, political and other human sectors that play a role in animal health and welfare are affected by evolutionary and revolutionary technological changes.

I RESEARCH AND DEVELOPMENT

The participants in this workshop agreed that adequate consideration and research support must be provided by significant public as well as private sector generated funds. These monies should be allocated to appropriate institutions in order to generate and disseminate knowledge about the benefits as well as the costs of the products of biotechnology. Research and development efforts in biotechnology will affect animal health and welfare and food production on a global scale. As we become cognizant of the concept of an integrated world ecosystem, we accept that these global changes will affect the health and welfare of human beings as well as animals.

It is recommended that the evaluation of disease control products that emerge through research and development of the biotechnological enterprise incorporate a sustainable agriculture orientation with a specific emphasis on resource preservation, maintenance of environmental quality, and awareness of consumer/society/animal welfare, farm and agribusiness structure issues.

II ISSUES

The following are issues for research consideration set forth by participants of this workshop. It is duly noted that there was disagreement on the merits and relationships of some of the issues, and these are noted with an asterisk [*]. Nonetheless, the participants agreed that all issues should be set forth for consideration.

1 Whether an animal disease surveillance mechanism needs to be set in place to identify problems facing the agricultural sector, irrespective of the type of management system that is being used.

— Members of the workshop suggested that it would be prudent to trace disease prevalence in various types of farming systems, the causes of diseases, and the economic costs/effects of these diseases and their effects on product quality.

2 Whether there are certain types of animal diseases for which control and/or eradication is not cost effective for the individual producer, but which may be of much higher value when social and economic concerns are considered.

3 Whether small farming operations yield fewer problems with diseases in animals than large operations, or whether the disease problems are related to the quality of management in each system.

4 Whether animal disease problems relate primarily to the quality of management regardless of size of the operation and/or type of production system. Assuming quality of management to be constant, whether there are different disease patterns that correlate to size and environment of the operation.

5 Whether the effects of alternative technological innovations can be designed to improve on the overall social and economic structure of agriculture.

6 Whether biotechnology will result in products or germplasm that will encourage management practices that are not conducive to overall animal welfare.

*7 Whether the implementation of the products of biotechnology will be size neutral, thus maximizing the opportunities for people to own and operate small to medium-sized farms.

'8 Whether large-scale environmentally controlled farming operations have "pushed" animals too far in their abilities to produce food and fiber products to the detriment of the welfare of those animals.

*9 Whether research is needed into issues related to the physiological and behavioral needs, fear, stress, and frustration of animals raised in environmentally controlled operations or in the alternative, whether there is an overemphasis on anthropomorphism [human beings attributing cognition to animals where none exists].

10 Whether the increase in disease control capabilities caused by biotechnology products might pose a further threat to the humane treatment of those animals due to their ability to sustain production under adverse conditions.

11 To conduct research that leads to an examination of current extension agriculture procedures used to inform the agricultural sector of needed biotechnological information for use by a wide range of educational sources; educators, producers, and consumers.

I11 POLICY RECOMMENDATIONS

1 Biotechnology should be utilized to help assure the safety of animal products for human use and consumption.

Z Biotechnology should be utilized to optimize environmental and management practices and systems for production of healthy livestock

and for development of strategies and products that assure well being and freedom from disease.

3 Disease control should be predicated on the establishment of trusting and unbiased relationships between livestock producers and health service providers in the agricultural sector. The fruits of biotechnology need to reach all types and sizes of producer operations in a cooperative effort that uses public service institutions to supplement efforts made by industry.

4 Those involved in research, development, and implementation of the products of biotechnology must study and encourage efficient and effective dissemination of animal health biotechnology information for use by a wide range of educational sources. An increased level of support should be developed in order to disseminate information delivery systems to foster animal health products for a sustainable agriculture.

5 An increased level of study in the areas of technology must be encouraged in order to identify behaviors and social structures of the animal community. This knowledge base can then be utilized for the purposes of developing management systems and skills for improving livestock production, profitability, and livestock welfare.

6 Products of biotechnology should complement disease control measures obtained by good husbandry practices that should include:

—freedom from hunger and malnutrition
—freedom from thermal/physical distress
—freedom from injury and disease
— freedom to express most normal behavior
— freedom from fear

7 Animal disease control programs supported by public funds should be conducted with a particular consideration for:

—the general welfare of animals
—the preservation of the environment
— the provision of wholesome food products
— social and demographic impacts
—economic impacts on food production
— the preservation of germplasm diversity

8 Disease results in the suffering of animals and major economic loss for producers and consumers. Biotechnology offers a methodology to alleviate much of this suffering and loss. Research development and implementation of the products should be promoted and encouraged, concomitant with a sensitivity to animal welfare, the environment, the size of livestock production operations, and to the public health.

9 Biotechnology research and extension programs should be aimed at maximizing the numbers of opportunities for people to own and operate farms.

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Animal Growth Promotants

Workshop participants focused their discussion on the polypeptide animal growth promotants (somatotropins) which can be produced using biotechnological production processes. Other growth promotants were briefly mentioned (e.g., the steroid-based hormones used in cattle feeding for many years, and the chemical repartitioning agents [beta-adrenergic agonists] likely to become available as feed additives in the near future); however, the public concerns which have been voiced about bovine somatotropin (BST) in the dairy industry led to most discussion centering on BST and the closely related porcine somatotropin (PST), which are likely to become commercially available in the dairy and pork industries in the near future.

I ISSUES

After developing a list of over twenty potential issues associated with animal growth promotants, the group identified several that were the most important for more thorough discussion and debate. These included:

— consumer acceptability and related issues
— social impacts when technology is adopted (who wins? who loses?)
— lack of access to the biotechnology development process
— structure of agriculture and regional development implications
— technology transfer to farmers
— economic implications—price levels, etc.

Other issues of concern covered a broad spectrum, including:

— animal safety and welfare, public health, and environmental implications
— unnecessary delays in approval process, perhaps linked to inadequate governmental organizational structure
— patenting and product labeling issues
— nutrition, management intensity, and genetic base requirements to achieve maximum benefits
— rural community and sustainable agriculture implications
— international competition implications

The first four issues received the most attention by workshop participants and a synopsis of the discussion and conclusions are present below.

1 Consumer acceptability—The consumer acceptability of products emerging from agricultural biotechnology was viewed as critical to the commercial viability of the somatotropins in animal agriculture. Products that cannot be sold because of the technology used will stifle the adoption of that technology. Several points were made that relate to the potential consumer acceptability of these products.

There was fairly broad agreement that consumers should be informed about the product characteristics and the processes used in producing their food. It was argued that consumers should be informed as to the presence or absence of "hormones" in their meat and milk products. Labeling the nutritive characteristics of the product and the technology used (which would be almost unique if applied to biotechnology products) could have either positive or negative purchase implications, depending upon consumer perceptions and connotations. Different types of "hormones" (polypeptides versus estrogenic) have quite different risks and health implications, but poorly informed consumers might tend to lump all products of those technologies in the same category.

Labeling related to production practices could unduly alarm some consumers and cause them to boycott those products. Yet, it was felt product labeling should not be protective of any special interest group, e.g., dairy farmers who could get hurt if milk developed a negative consumer perception. It was pointed out that scientific tests are inadequate to distinguish between products produced with and without growth hormones, so administering any label requirements could be

difficult. Even if government-mandated labeling was not required, it was suggested that product merchandisers may embark on "negative advertising" by promoting the absence of added growth promotants in their products to capitalize on consumer concerns or fears (especially if conclusive evidence on changed product composition is not available to eliminate consumer doubts and perceived safety risks associated with using the product).

Consumer labeling of the nutritive characteristics of pork produced using PST could be advantageous, since fat is sharply reduced, and lean tissue is increased with little change in palatability (though that could be an issue). With BST, milk fat content would change slightly, but little significant change in other milk components would likely occur. These changes might not be viewed as sufficiently positive to offset possible consumer concerns about "hormones" in milk, even when there may be no detectable differences in milk from treated or untreated cows. An additional question was raised about increased animal stress in the production process, and its possible effect on the quality of the consumer end products.

The group concluded that consumer education and information programs are essential, so that consumer choices would be based upon accurate perceptions about the products and the process of production. Some participants felt that televised debates on the pros and cons of these new technologies should be considered as part of the information process. It was noted that Federal and Drug Administration (FDA) restrictions on companies undergoing new animal drug application review and clearance limit what these companies can say regarding safety and other consumer concerns prior to FDA approval. Consequently, these limitations may prohibit companies from providing much scientific data to alleviate public concerns or fears that may arise about new products prior to FDA approval.

2 Social impacts—who wins? who loses?—The social impacts of new animal growth promotants were considered a major concern. Especially important was who will gain or lose as a consequence of these new technologies. The group first identified the "players" in the process who might be affected—consumers, food merchandisers, food processors, farmers, farm input suppliers, government, taxpayers, rural residents, and of course, the biotechnology (often pharmaceutical and animal health) companies developing these products.

In the process of discussing possible impacts, it became clear that the impact of BST in the dairy industry, if PST and beta adrenergic agonists in the pork industry could be significantly different due to, among other factors:

—significant consumer product improvements likely in pork, but not in milk, and
—government price support policies and surpluses in the dairy industry.

At the same time, some issues or concerns are very similar, such as farm size structure implications, and consumer acceptability.

The bulk of the discussion focused on farm-level implications of these new production technologies. It was clear from other speakers that these growth promotants would enhance production efficiency. The workshop members concluded that early adopters of these technologies could benefit most, economically, but they would also be assuming additional risks. Some participants felt that management sophistication would be the critical factor determining who would be an early adopter and benefit most from these new technologies. While management sophistication can be found in all farm size classes to some extent, larger operations would generally have the management skills to rapidly benefit from these new technologies. Also, confinement pork operations would be more adaptable to injection or implantation required in the first generation porcine somatotropin products. Thus, small family farmers in both the dairy and pork industries were considered more likely to be at a competitive disadvantage due to the slow adoption of BST and PST, or failure to use it most effectively.

If the efficiency of input utilization improves in these industries more than consumer markets expand, pinpoint suppliers could be affected in several ways. Input suppliers whose business activity is related directly to animal numbers could have less demand for their products and services—e.g., veterinarians, animal health product suppliers—if animal populations declined. Feed use could decline in the pork industry, especially feed grains. If very large operations benefit the most, and the tend to buy fewer inputs from local suppliers, agribusiness in rural communities could be adversely impacted. Biotechnology/animal health product companies which successfully develop the new growth promotants will share in the economic benefits.

Meat packers and dairy processors may benefit from increased supplies or improved quality products. An improved international compe-

titive position for U.S. dairy and pork industries could be result (if the products are cleared and adopted in the U.S. earlier than in competing countries, and if trade barriers are not raised on products from these technologies). However, other competing industries or countries could lose.

Consumers should benefit from lower prices for dairy products and pork and improved fat/lean composition in pork products. However, the beneficial consumer price impacts in dairy would be dependent upon political actions to reduce price supports as production costs decline, and some persons would question whether that is likely.

Government budget costs could be affected in several ways. If it is socially desirable to provide more information to assist technology transfer for small and medium-sized farmers, extension and education costs could increase. If the number of farmers and farm workers leaving these industries increases, costs associated with adjustment could rise. Dairy price support program costs could decline, while feed grain program costs could increase.

3 Lack of access to development process—Some farmers and other workshop participants objected to the public's lack of participation in determining what projects and products were emphasized in the biotechnology research and development process. The group recognized that private companies involved in biotechnological research and development are driven more by economic considerations than social goals (e.g., small versus large farm considerations), and they may need to maintain secrecy about their research program and product development alternatives until patent applications have been filed. However, the group felt that publicly supported research (and, to some extent, private companies) ought to be more responsible to societal goals rather than large farmers and agribusiness. They encouraged a broader social responsiveness, suggesting more public input in determining research priorities in the areas of biotechnology and sustainable agriculture. The group felt that some good initiatives would include:

—university research administrators discussing research priorities with public interest groups
—more universities developing active bioethics programs similar to one at Iowa State University
—more public funding for bioethics and sustainable agriculture programs

They also felt that farmers need to be more active in:

—discussing their research needs with legislators and university administrators

—supporting expanded state and federal funding for the programs mentioned above

4 Structural and regional implications—The group acknowledged with concern the likely accentuation of growth rates of large scale, sophisticated livestock production operations, in the areas where those large scale operations are currently located (often outside the Midwest). How can we direct biotechnological research to achieve social goals like sustaining small, independent agricultural operations? Or are we demanding a system that consumers are unwilling to pay for? Should our policy be directed toward keeping small farmers operating, or having a social safety net to assist them in adjusting to other work or locations? Does biotechnology and sustainable agriculture research offer solutions, or are they likely to be contributors to the perceived problems?

II POLICY RECOMMENDATIONS

The workshop felt that an economically-sound family farm system and a sustainable rural economy were desirable social goals. They recognized that expanded research on biotechnology or sustainable agriculture was not sufficient to achieve these broad social goals. However, such research could assist in achieving these goals if appropriate research priorities and funding were forthcoming. Several policy recommendations emerged from the workshop.

1 Advisory groups reflecting a broad spectrum of the public ought to be required in determining appropriate directions for university and government publicly supported biotechnology research programs.

The feeling of inadequate public access was strong. Broader participation in discussion of general research directions could improve the social responsiveness of these programs, and also increase public support of the research and end-products of the research.

2 Public education programs regarding products from biotechnology need to be undertaken by public agencies (universities, Extension, U.S. Department of Agriculture [USDA], etc.) and the private companies developing these products.

The workshop felt that consumers have a right to know about the product characteristics and processes used in producing their food. Also,