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GMO-Free Alps: An Alternative Path in Technology Development?

Risk assessment of new technologies such as the use of genetically modified organisms (GMOs) in agricultural production is enormously complex. It cannot be limited to analysis only from the perspective of the natural sciences; socioeconomic factors need to be considered as well. Active promotion of GMO-free areas is discussed here as an alternative means of technological development. Disadvantaged and ecologically sensitive areas such as the European Alps are suitable for territorial application of this concept. The state of the current debate about the impacts of GMOs on regional development in disadvantaged and ecologically sensitive regions is presented. This is followed by the results of a survey on the social acceptance of GMO-free areas conducted in 1999 in Austria. These results suggest that the creation of GMO-free zones in the Alps is an idea worth pursuing.

Keywords: *GMO-free areas; sustainable agriculture; endogenous rural development; Alps; Austria.*

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Introduction

In September 1999, representatives of American farmers' associations recommended that their members stop planting genetically modified (GM) varieties of maize, as customers in Japan and Europe were likely to refuse to buy such maize in the future (Figure 1). Moreover, according to a recent survey in France by Sylvander and Leusie (2000), 75% of French households are worried about GM foods. The number of skeptical consumers is growing worldwide (Figure 2), especially in Europe (Then 1999). Of course, it can be argued that this is an illustration of consumer ignorance or the scientific community's failure to communicate scientific evidence. More important, however, such skepticism clearly reveals an important trend among consumers, and this is undoubtedly a significant socioeconomic factor. But skepticism is increasing not only among consumers; scientists also now acknowledge the difficulty of assessing risks, especially in relation to GMOs (Müller 1998).

There is abundant literature on general aspects pertaining to the release of GMOs. The specific impacts of future commercial use of GMOs on the regional development of disadvantaged and ecologically sensitive areas have not yet been assessed in detail, however. The present article summarizes the current debate on how the use of GMOs influences the regional development of such areas, using the Alps as an example. It argues that establishing GMO-free areas in the Alps could actively help promote endogenous development

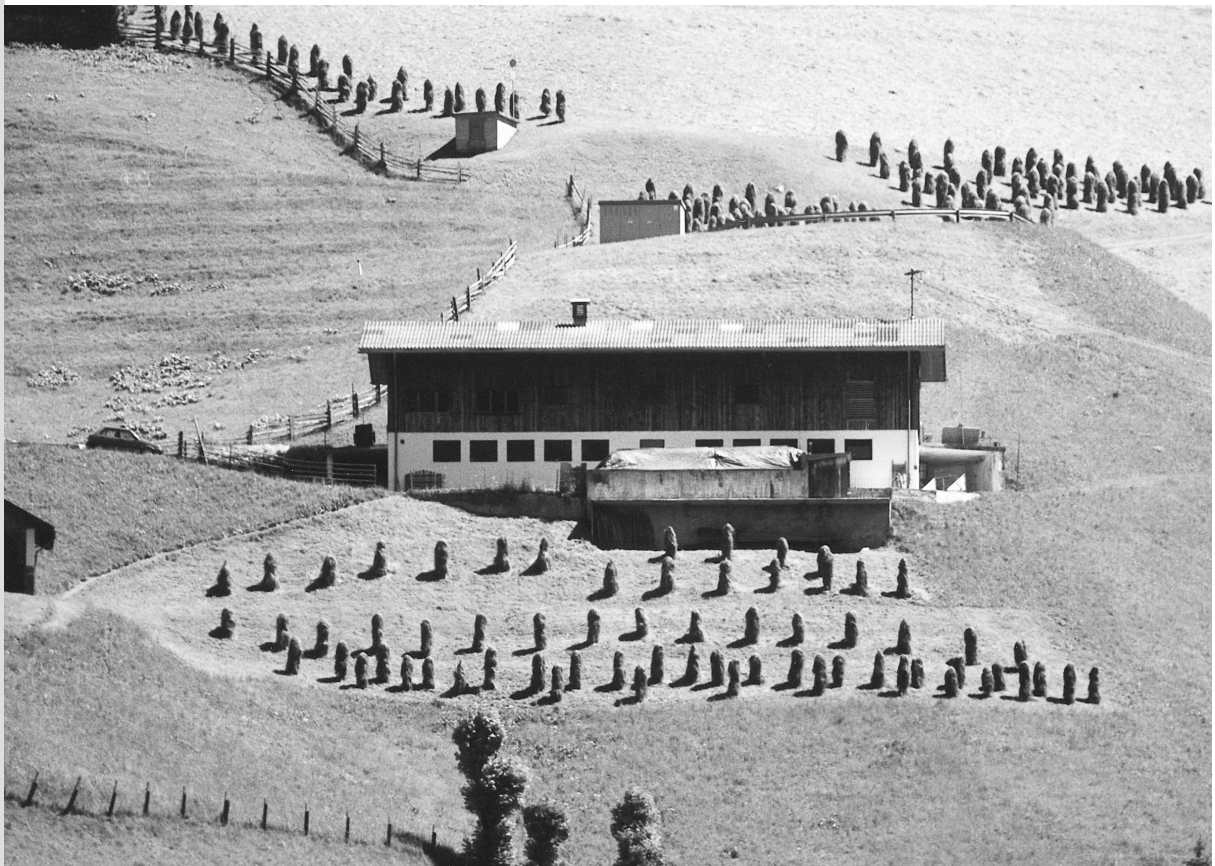

FIGURE 1 Faced with the challenge of modern technology and difficult economic conditions, farmers in the Austrian Alps focus on quality rather than quantity. They combine traditional production methods (here drying rakes for hay, which give the best quality) with a high degree of mechanization. (Photo courtesy of Tiroler Bauernzeitung)

FIGURE 2 Organic farmers and concerned environmentalists from all over Austria gathered in spring 1997 to demonstrate against the use of GMOs in agriculture. This demonstration launched a petition campaign to hold a referendum on the use of GMOs in Austrian agriculture. Over 1 million citizens (ie, over 15% of the population) signed this petition. (Photo by Lois Zibermayer, courtesy of Österreichische Bergbauernvereinigung)

and discusses establishment of GMO-free regions as an alternative option for technology development.

The limitations of scientific risk assessment of GMOs

Given the current status of scientific debate, it seems insufficient to justify the establishment of GMO-free areas by relying only on scientific criteria rooted in the natural sciences—not because evidence is lacking but because predictions made by the natural sciences are limited in scope. The hole in the ozone layer is a case in point: neither its existence nor the relation between cause and effect were scientifically predictable. The problem could only be perceived and analyzed in retrospect. While scientific evaluation of risks is necessary, it is far from sufficient. In addition to the technical dimension, social, political, and economic aspects must also be considered to allow for comprehensive assessment of a given situation.

Skorupinski (1996) argues that the limitations of predictions for complex technologies based exclusively on the natural sciences are impossible to overcome:

> It is particularly problematical to predict possible ecological impacts and side-effects of releasing and commercializing transgenic organisms. On the one hand, there are considerable gaps in knowledge about parameters relevant to ecology and evolutionary biology. On the other hand, predictions have essential limitations due to their inherent potential for indeterminacy. [Author's translation]

Müller (1998) has analyzed the problem of assessing the risks of GMOs from the specific perspective of organic farming and describes the following limitations:

1) Limitations on the ability to gain comprehensive knowledge of cause-and-effect relations because (a) some effects cannot be known at present (similar to the case of DDT); (b) with complex systems, a model cannot give a true picture of reality; therefore, long-term predictions will not be accurate, especially for complex and dynamic systems; (c) knowledge is limited by the current political, economic, and social framework; and (d) the methods applied to assess risks are blind to certain effects.
2) Limitations in the assessment of biological and genetic risks of GMOs (invasiveness, changes in the genetic pool due to cross-pollination, synergistic effects).
3) Limitations in assessing the risks of products containing GMOs (biochemical risks related to allergies, toxicological risks, synergistic impacts).

Müller then evaluates the use of GMOs from the perspective of organic farming, which he defines in terms of 5 principles: necessity, ecology, low persistency, influence on human health, and proximity to natural processes. He concludes that the use of GMOs is not compatible with any of these principles. The principles of organic farming that Müller refers to in his discussion could and should also be applied to agriculture in ecologically sensitive regions; indeed, these regions often have a high percentage of organic farms, as will be shown later in the case of the Austrian Alps.

In general, risk assessment of GMOs in ecologically sensitive regions must include an evaluation of their impacts on the stability and biodiversity of fragile ecosystems and on the regenerative ability of these ecosystems. Moreover, ecologically sensitive areas are very often economically disadvantaged, at least with regard to agricultural development. Impacts on existing

FIGURE 3 These Pinzgauer cattle are one of the few remaining purebred breeds in the Austrian Alps. After many years of decline in the numbers of this breed, Pinzgauers are now internationally sought for freerange cattle production in the Alps. Pinzgauers are good milk and beef producers. Until recently, the Austrian government paid premiums to breeders in accordance with EU regulations on endangered species. (Photo courtesy of Tiroler Bauernzeitung)

social and economic disparities between disadvantaged and more advantaged regions need to be assessed as well. In this respect, discussions about genetic engineering become part of a general discussion about the future development of marginal regions, increasing regional product awareness, and local identity. Present policies in many Alpine regions seem to support contradictory directions in development, for example, intensification of agriculture and preservation of agricultural biodiversity (Figure 3).

In sum, classic methods for assessing the risks of a technology, that is, methods that rely on the argumentative power of the natural sciences and on studies that aim to eliminate uncertainties, cannot be applied as instruments to guide decision making since it is not possible to eliminate uncertainties. Moreover, there appears to be a great need for new strategies of social decision making that explicitly include the interests of all parties involved (Neunteufel 1999).

The need for alternative paths

In view of this situation, it seems irresponsible to gamble on a single direction of development or to encourage new technologies without promoting alternatives at the same time. Genetic engineering is not an isolated case; it is spreading in ways similar to other new technologies. As these technologies become increasingly complex, assessment of their risks also becomes more complex and costly. At the same time, however, the period during which a new technology presents competitive advantages is becoming increasingly shorter due to globally improved and accelerated availability of information. This increases the pressure to reduce the time and effort spent on risk assessment, which necessarily leads to compromises and shortcuts.

Nuclear technology can be taken as an example. During the debate about the Austrian nuclear power plant in Zwentendorf about 20 years ago, the unsolved problem of storing radioactively contaminated waste was repeatedly raised. Supporters of the technology as well as the politicians responsible at the time promised a technical solution to this problem. This was expected about 6 years after the opening of the plant. Today, however, there is still no solution. A further conclusion can be drawn from the example of nuclear power: once it is generally accepted that the possibilities of a technology were overestimated, abandoning this technology becomes even more difficult in cases where it was promoted with one-sided arguments. One-sided promotion of a technology leads to increased direct and indirect dependency on it; this in turn makes the development of alternatives more difficult. Austria, which has never put nuclear power plants into operation, is now regarded as a model for use of decentralized solar energy, developed as a result of its need to find alternatives to nuclear power. In France, by contrast, political and industrial forces still voice support for the nuclear energy program.

The green revolution in agriculture is another example of this problem: it received the backing of the international community while no alternative was given serious consideration. Concepts of sustainable agriculture were only promoted when the green revolution failed to produce the expected results (Lawo 1999).

The idea of supporting alternative technological paths as a strategy to avoid unnecessary and unexpected impacts (due in particular to cumulative effects) has already been advocated by sociologists. The concept of

strategic niche management, for instance, proposes development and establishment of technical alternatives protected from market forces for a certain period of time to allow for proper assessment (Rip 1989; Kemp 1994; Kemp et al 1998; Rennings 2000). These technical alternatives should be tested at the same time as the mainstream technology. Van den Ende et al (1998) argue that this can be validated from a theoretical point of view by the finding that technologies become meaningful when applied and adopted. This concept is part of a process-oriented approach of technology assessment called constructive technology assessment (CTA), developed mainly in The Netherlands and Denmark.

The principle of precaution should always be applied when introducing complex technologies. In other words, the harmlessness of a measure must be proven before the measure is applied. This principle should be observed especially in the case of a technology with high risks of irreversibility.

In the case of biotechnology, the principle of precaution has led to the idea of establishing areas of ecological compensation or protection as an actively supported alternative. Hoppichler (2000) lists the following areas for potential GMO-free demarcation:

- Protected areas for biodiversity preservation (eg, Natura 2000 network) and adjoining areas.
- Organic farming areas, to guarantee at least partially GMO-free agricultural production (as far as possible), to allow for GMO-free organic seed breeding and the propagation of seeds, and to provide an alternative technological option.
- Areas for enhanced in situ (on-farm) preservation of plant-genetic resources under GMO-free conditions.
- Development of transition areas for sustainable agricultural development (see UNESCO's Man and Biosphere [MAB] program) to promote conservation of landscapes, ecosystems, species diversity, and genetic variation, and to foster economic and human development that is socioculturally and ecologically sustainable.
- Mountain areas, whose ecological sensitivity merits special consideration, in accordance with Chapter 13 of Agenda 21 ("Managing Fragile Ecosystems: Sustainable Mountain Development").

GMO-free demarcation in disadvantaged regions also has a positive side effect in that it stimulates an endogenous form of sustainable development.

Strategies for disadvantaged regions: Use versus rejection of GMOs

Some experts think that disadvantaged mountain regions should participate in research and application of GMOs in order to benefit from the economic advantages biotechnology can offer to agriculture. They therefore argue against defining such regions as GMO-free areas. In principle, genetic engineering can help improve agricultural conditions in disadvantaged regions in Europe as well as in many countries of the South. Some countries (eg, Brazil and Indonesia) have shown great interest in the new technology; China has just invested US$ 20 million in genetic engineering applications (Schilde 1999).

Altieri (1998), however, argues against this position, pointing out that innovations in biotechnology are mainly profit-oriented rather than need-oriented and that most of the research being done is paid for and dominated by the producers of GMOs. In 33 of 50 states in the US, 46% of the firms involved in biotechnology support research for the transfer of biotechnology at universities and university-industrial centers. As the main goal of this industrial sector is to maximize shareholder value, the aim of research is to intensify agriculture in areas with favorable environmental conditions, with the result that the needs of marginal regions such as mountains are neglected. Academic institutions supported by the industry therefore not only face the challenge of securing ecologically oriented research (nitrogen-fixing, drought tolerance, etc) but also of making sure that applied nonproprietary knowledge is made public and available for the benefit of all.

Global industrial patterns cannot simply be copied to foster development in disadvantaged areas; there is a need to develop regionally specific models and economic strategies to conserve natural resources such as biodiversity and fresh water. A crucial aspect in regional agricultural use of GMOs is their impact on the reproduction of ecosystems, which depends on a self-sufficient source of ecologically adapted seeds.

Recent patent protection laws and intellectual property rights restrict farmers' freedom of access to seeds and their right to maintain independent seed production through on-farm seed multiplication and seed sharing among farmers. The possibility of preserving traditional unmodified seeds locally can be further limited by unintentional gene transfer. Farmland conservation of old and neglected varieties is vital for the maintenance of genetic diversity. Evidence from the green revolution leaves no doubt that the spread of high-yielding varieties has been an important cause of genetic erosion (Shiva 1999).

Another problem in the regional context is the impact on existing social and economic disparities between disadvantaged and advantaged regions, as progress in genetic breeding techniques can be exploited more profitably in advantaged regions (Lawo 1999; Reimer 1999). Disparities induced by application of such techniques can be observed both in industrial and

developing countries. This is not a specific impact of genetic engineering. But it is important to keep in mind that genetic engineering speeds up such processes and makes it even more difficult to find alternative paths of development.

This brings us back to the problem that genetic engineering research is mainly profit-oriented. Marginal regions normally do not offer much potential for profit. Who will pay for research on problems relevant to communities whose economic potential is limited? If disadvantaged regions cannot participate in and benefit from such research, endogenous regional development without GMOs is an alternative option. To define disadvantaged and ecologically sensitive regions as GMO-free, the following facts must be acknowledged:

- Direct impacts of GMOs, such as unintentional genetic transfer, will prevent the use of different strategies on individual farms, as presently practiced in organic or conventional farming, and therefore require concerted regional action.
- Indirect factors, such as increasing regional disparities, require that GMO-free areas be large enough to include all agroecological zones in order to be considered and accepted as a serious alternative.
- Social acceptance is fundamental for the implementation of GMO-free areas.

The Alps as a potential GMO-free area

Two distinct factors characterize the Alps as an ecologically sensitive area: (1) The negative impacts of flawed agricultural practices are far more rapid and severe in mountainous areas than in plains and require quicker intervention and a higher degree of precaution (CIPRA 1995). (2) Alpine regions are already unable to compete with agriculturally more favored regions in terms of intensification. Consequently, they are threatened by increasing disparity in land use development (Bätzing 1996). Agricultural activity is concentrated on valley floors, thus withdrawing from hillsides, which are often left fallow except in the case of afforestation.

Many inhabitants of the French and Italian Alps have left these mountainous areas because they could not compete with farmers in more advantaged regions, resulting in massive land abandonment. While no general decline in population can be observed in the Austrian Alps, part-time farming is increasing. In these regions, there is a tendency to intensify cultivation on those parts of the farm that are close to the farmstead and can be worked using machinery while marginal land is being abandoned or at least used more extensively than previously. In both cases, the development has a negative impact on biodiversity and the stability of ecosystems. While biodiversity may increase in the case of land abandonment for the first few years, it will decline drastically in the long term. Maximum biodiversity in the Alps has been shown to be closely connected to traditional farming systems (Lughofer et al 1999). The habitats of more than 50% of all animal and plant species are associated with traditionally and extensively cultivated agricultural land (Loziczky and Holler 1999).

Small-scale agriculture can contribute to improving and developing genetic resources (Hammer 1998), but it is under heavy economic pressure. Thus, the economic fragility of agricultural systems in mountain areas adds to their ecological sensitivity. There is increasing recognition that human intervention in Alpine regions must be implemented gradually and much more cautiously than elsewhere; this is reflected in the high proportion of organic farms in Alpine areas. Fifty percent of Austrian organic farms are in Alpine regions (Groier 1998). Most farmers in the Alpine area of Austria have traditionally operated with the necessary precaution and did not have to change much in their farming operations when they converted to organic farming. The Austrian agroenvironmental program conducted an evaluation of the impact of organic farming on biodiversity and concluded that "using organic cultivation methods," "renouncing the use of specific yield-enhancing production techniques," and "maintaining ecologically valuable areas" contributed a great deal to ensuring and enhancing species diversity (BMLF 1996).

By contrast, other human interventions in the Alps such as tourism have been introduced with much less precaution. Current practices have already had many undesirable effects (CIPRA 1995). Consequently, the International Commission for the Protection of the Alps (CIPRA) adopted a resolution on 1 February 1998 to establish and preserve GMO-free Alps. CIPRA is calling for demarcation of a GMO-free area covering all of the Alps, rejecting insular solutions (CIPRA 1998).

While a proposal for the entire Alps is still being discussed, regional solutions have already been implemented. One example is the "großes Walsertal" in the Vorarlberg (Austria), where the establishment of a biosphere park according to UNESCO criteria is actively being pursued. In this project, rejection of GMOs is regarded as an option for increasing market opportunities and halting the decline in prices. In this context, no significant restrictions on traditional agricultural practices are expected. Farmers in this valley are mainly cattle breeders, which means that access to GMO-free concentrated feed needs to be improved. An additional, long-term objective is that the entire region convert to organic farming, which is already quite well represented in the valley and has made it possible to work out the necessary guidelines and control mechanisms.

TABLE 1 Rating of the idea of establishing GMO-free Alps as a biosphere reserve by professional groups or interest groups and the index of the chances for implementation (source: data adapted from the Federal Institute for Less-Favored and Mountainous Areas).

GMO-free Alps as a biosphere reserve		Rating of the idea (1, very good idea; 6, very bad idea)							Chances of implementation
Professional group or interest group	***n***	**1**	**2**	**3**	**4**	**5**	**6**	**Index**	**Index**
Agricultural administration	40	16	9	7	2	2	4	2.42	3.82
Agricultural schools	14	9	3	2	-	-	-	1.50	3.14
Organic farming associations	15	13	1	1	-	-	-	1.20	3.29
Administration of environmental protection	20	15	4	1	-	-	-	1.30	3.35
Environmental NGOs + Green Party	22	19	2	1	-	-	-	1.18	3.14
Politicians (excluding Green Party)	12	7	2	1	-	2	-	2.08	3.50
Consumer affairs, food safety	12	3	3	3	2	-	1	2.58	3.75
Science (excluding biotechnology)	12	7	3	1	-	-	1	1.83	3.91
Biotechnology	4	1	-	1	-	-	2	4.00	4.25
Total	151	90	27	18	4	4	8	1.87	3.52
%		59.6	17.9	11.9	2.6	2.6	5.3		

Survey of experts' opinions on establishing GMO-free areas in Austria

While creation of GMO-free areas seems a desirable goal, it is crucial to find social acceptance for the idea. In Austria, the Federal Institute for Less-Favored and Mountainous Areas conducted a survey among politicians, scientists, administrative personnel, and agricultural and environmental NGOs. The general aim was to assess the opinions of those people who might be professionally confronted with potential environmental impacts from the release of GMOs. The author was involved in this survey in the regions of Tyrol and Vorarlberg.

A questionnaire was distributed to 268 experts throughout Austria, of whom 152 responded (57% return rate). The majority of the experts expressed a critical view of genetic engineering in agriculture. Sixty-seven percent defined themselves as critical to very critical, 19% as slightly critical, while only 14% favored the technology. The experts were classified into 9 groups according to their professional backgrounds.

Main results

The main results are as follows:

- The relationship between protected areas and the application of genetic engineering in agriculture needs to be clarified. Seventy-five percent of the experts who responded thought the use of GMOs caused a significant disturbance in protected areas. They called for a ban on releasing GMOs in such areas and buffer zones.
- The concept of defining "large, GMO-free ecologically sensitive areas"(eg, the size of an Austrian Federal Province) was supported by a majority of the experts (73%), who are relatively convinced that this concept could be advanced within the framework of EU regulations. However, some officials in agricultural administration and certain groups of scientists strongly opposed the idea.
- The idea of defining the entire Alpine region of Austria as a "GMO-free biosphere reserve" was rated as a "good" or "very good" idea by 78% of the respondents. The chances of implementing this concept within the EU framework were generally rated as moderate (Table 1).
- Respondents felt that there are great deficits related to the needs of organic farming: 89% called for GMO-free areas for breeding and propagating organic seeds.
- The experts recommended the following main strategies to assist organic farmers in coping with the problems of genetic engineering: (1) supporting GMO-free production through agricultural environmental programs (60%) and through regional food processing and marketing structures (60%); (2) defining GMO-free areas for seed breeding and multiplication (57%) and demarcation of "large, GMO-free ecologically sensitive areas" (57%). In response to the question of who should bear the additional costs of analyses to ensure the absences of GMOs, 42% of the experts leaned towards the polluter-pays principle and proposed compensation from the seed industry. Only experts in the field of organic farming favor the more realistic scenario of refunds from public revenues (66%).
- The overwhelming majority of experts believe that in situ conservation and on-farm management of plant genetic resources should be GMO-free.

GMO-free Alps as a biosphere reserve

A central aim of the survey was to assess the opinions of experts on the establishment of GMO-free Alps as a biosphere reserve with the following objectives:

- To establish an alternative model of technological development in agriculture.
- To implement sustainable agricultural development combined with nature conservation.
- To protect mountain and water resources through extensive land use.
- To create an area for counterbalancing and regeneration in case of unforeseeable negative impacts from genetic engineering.

As shown in Table 1, most respondents expressed pronounced opinions. Only 22 (14.5%) were somewhat undecided, marking the middle of the scale (ie, 3–4). The proportion of undecided persons was highest among officials in agricultural administration. This reflects the current struggle between two divergent orientations in agricultural policy, that is, protection versus production. Experts in the field of consumer affairs and food safety also had less pronounced opinions. As expected, environmentalists, representatives of organic farming associations, and environmental protection officials made a strong case for GMO-free Alps. Teachers in agricultural schools, who are shaping the values of the future farming generation, also largely supported the idea, followed by politicians. The strongest opponents were scientists dealing with biotechnology, but even some of these were in favor of GMO-free Alps. While 67% of all experts considered themselves critical of agricultural use of GMOs, 78.5% were in favor of GMO-free Alps (Table 2). However, they were more doubtful about the feasibility of implementation than respondents who found agricultural use of GMOs problematic.

In general, the biggest problem concerning implementation appeared to be the administration and control of GMO-free areas. Unintentional genetic transfer ranked second. The experts also expected nonacceptance by farmers and hobby gardeners. Problems related to the efficiency of sanctions and the compatibility of GMO-free areas with EU laws were also expected. Of all groups, scientists in the field of biotechnology, officials in environmental protection and agricultural administration, and teachers in agricultural schools were most concerned about the potential problems of monitoring and administration. Politicians and representatives of organic farmers' associations were more confident: as the use of GMOs is banned in organic farming, control mechanisms already exist.

Conclusion

The proposal for the demarcation of large GMO-free areas found widespread acceptance among relevant stakeholder groups in Austria. GMO-free areas can serve as a starting point for sustainable alternative agricultural development in ecologically sensitive and economically disadvantaged areas such as the Alps. These regions cannot compete with more advantaged regions. Establishing GMO-free areas is certainly not the only alternative form of sustainable development in mountains, but it could trigger a broad discussion of the advantages and disadvantages of certain technologies. The rejection of GMOs in agriculture can be seen as a necessary consensus for redefining the present conflicting directions of agricultural development with respect to sustainability. Once a consensus is reached, GMO-free areas provide an opportunity to create competitive advantages for marketing products and tourism. In the long run, it can be expected that such areas will have a high market potential. The strategy will only work, however, if no universal pattern of development is assumed and if there is a choice with regard to different paths of development. The option of alternative directions in regional development should be actively promoted and

TABLE 2 Rating of the idea of establishing GMO-free Alps as a biosphere reserve and the chances of implementation according to opinions on the use of GMOs in agriculture (source: data adapted from the Federal Institute for Less-Favored and Mountainous Areas).

GMO-free Alps as a biosphere reserve		Rating of the idea (1, very good idea; 6, very bad idea)							Chances of implementation
Opinion on the use of GMOs in agriculture	*n*	1	2	3	4	5	6	Index	Index
Positive	20	4	1	6	-	3	6	3.75	4.42
Slightly critical	29	9	10	5	3	1	1	2.31	3.93
Critical and very critical	100	76	15	7	1	-	1	1.37	3.24
Total	149	89	26	18	4	4	8	1.87	3.52
%		59.7	17.4	12.1	2.7	2.7	5.4		

supported by national governments and transnational institutions as a means of risk reduction. In order to be effective, the demarcated areas must be large. It will take time to build consensus. It is therefore essential that a discussion of both opportunities and implications be launched in the near future.

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