The Gatekeeper Series produced by IIED's Sustainable Agriculture and Rural Livelihoods Programme aims to highlight key topics in the field of sustainable agriculture and resource management. Each paper reviews a selected issue of contemporary importance and draws preliminary conclusions for development that are particularly relevant for policymakers, researchers and planners. References are provided to important sources and background material. The Series is published three times a year – in April, August and December – and is supported by the Swedish International Development Cooperation Agency (Sida).

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Executive Summary

In recent years, the world's largest chemical companies have increasingly been searching for new ways of doing business. As a result, part of the chemical pesticide industry has evolved from making chemicals to the so-called 'Life Science' industry, creating packaged seed-gene and seed-gene-chemical products for a new generation of crop protection and identity-preserved food and nutrition products.

These new ways of doing business have not, however, been accompanied by the "*far-reaching shifts in corporate attitudes*" necessary for making progress towards sustainable development, which the Business Council for Sustainable Development (whose members include many of these companies) called for in the lead-up to the 1992 Rio 'Earth Summit'. Justification for the development of genetic manipulation and the introduction of completely novel genetics into the food chain reveal exactly the same mindset as that which characterised the pesticide era.

This paper analyses, with reference to the 'Life Science' industry, why these shifts have not occurred. Reasons include a self-reinforcing tunnel-vision within the companies themselves, and the unfortunate dichotomy between 'conventional' and 'sustainable' agriculture, which further feeds orthodoxy and division.

Yet it is increasingly clear that it makes good business sense for these companies to make the dramatic shifts called for. An over-simplified reality, uniformity of perspective and inability to innovate will eventually affect a company's value to both shareholders and stakeholders, and can erode the credibility of statements on sustainable development. Already, Life Science companies are reeling from an outpouring of public disquiet and opposition to genetically modified (GM) food crops, especially in Europe.

The paper emphasises that there are business opportunities for such companies in a more regenerative, less extractive agriculture, and an alliance between industry and the sustainable agriculture movement could redefine a company's core competence, from chemistry to agriculture, or even to ecosystem management. It concludes with suggestions for how this alliance could evolve, giving examples of where such approaches are already being tried.

THIRTY CABBAGES: GREENING THE AGRICULTURAL 'LIFE SCIENCE' INDUSTRY

William T. Vorley[1]

The Prism of a Uniform Perspective

In the build-up to the 1992 Rio 'Earth Summit', the Chief Executive Officers of Ciba-Geigy (now Novartis), DuPont and Dow, prepared a global business perspective on sustainable development along with 50 other business leaders on the Business Council for Sustainable Development (BSCD). The resulting declaration states that "*Progress towards sustainable development makes good business sense because it can create competitive advantages and new opportunities. But it requires far-reaching shifts in corporate attitudes and new ways of doing business*" (Schmidheiny and BCSD, 1992).

Finding new ways of doing business was a particularly urgent need for the chemical pesticide divisions of these BCSD member companies. Despite continued growth in the global pesticides market, now valued at around $31 billion, the agri-food chain which links farmers and consumers has been undergoing radical changes in power, affecting the ability of players along that chain to extract value (Koechlin and Wittke, 1998). And the sector of agriculture served by the pesticide companies - farming - is the sector in steepest decline in industrialised countries. Value is being added not on the farm, but by food processors, retailers and restaurants, and these downstream players are increasingly involving themselves in the technical aspects of food production. The voice of the consumer is being heard more distinctly inside the farm gate.

So in the six years since the BCSD declaration, new business areas have rapidly evolved, and part of the chemical pesticide industry has made a dramatic evolution from chemical industry to so-called 'Life Science' industry. Industrial chemical sectors have been shed, and biotechnology research and seed companies acquired, and a wave of mergers have formed research-intensive pharmaceutical and agricultural giants such as Novartis, Monsanto, and most recently Aventis. Companies are betting the family silver on packaged seed-gene and seed-gene-chemical products for a new generation of crop protection and identity-preserved value-added food and nutrition products.

New ways of doing business have not, however, been accompanied by those 'far-reaching shifts in corporate attitudes' which the BCSD declaration called for. Justification for

1 Based on a paper "*Thirty cabbages: Diversity of Perspective to Catalyze Redesign in the Agrochemical Industry*" in *Sustainable Strategies for Industry: The future of corporate practice* (1998) edited by Nigel J. Roome, with permission of Island Press.

the development of genetic manipulation and the introduction of completely novel genetics into the food chain reveal exactly the same mindset as that which characterised the pesticide era.

This tendency to *search for the familiar* in the face of ambiguity and uncertainty stems from a homogeneity in the beliefs and underlying assumptions of an organisation (Johnson and Scholes, 1993). Biotechnology and the emerging rubrics of "sustainable agriculture" and the "greening of industry" have confronted the industry with plenty of ambiguity and uncertainty, and most Life Science companies have indeed responded with a familiar immune reaction: a barrage of information and public relations. Such information presumes that we share industry's perspective, and that we only need to be nursed from our irrational 'unscientific' beliefs, and be reminded of the contribution of pesticides and biotechnology to feeding a growing, hungry world, to see their activities as entirely consistent with a goal of agricultural sustainability (see Tombs, 1993).

As part of these information campaigns, the industry has sought out and sponsored marginal groups to articulate and legitimise its own productionist perspective. Support for Dennis Avery and the Hudson Institute, respectively author and publisher of *Saving the Planet with Pesticides and Plastic*, is a classic example. Seeking out the familiar in this way only expands the contested area between the industry and its critics. It feeds the dangerous orthodoxy of the pesticides and biotechnology debates, consuming much of the political and institutional capital of both industry and environmental groups (Wolcott, 1993). It replaces debate with grand dichotomies and ridiculous choices: Bugs or people? Technology, friend or foe? High input agriculture or starvation? High yield agriculture or wildlife? It locks industry's definitions of 'sustainable agriculture' into defensive endorsements of the status quo. And, central to the theme of this paper, it blocks meaningful discussion of the role of companies, currently in the crop protection business, toward the development of innovative products and services for more sustainable food and fibre production.

It is not only intellectual rigour and civil debate which suffers from a self-reinforcing uniformity of perspective. In an organisational culture dominated by one viewpoint, employees find it nearly impossible to express a different perspective, and company recruitment selects people who support that view or, more typically, can separate their personal and professional values.

Another cost of orthodoxy and gridlock is the massive level of state intervention which it attracts. Most of this intervention takes the form of management and regulation of pesticides rather than research on less chemical-dependent farming systems. Pesticide regulation in the US costs taxpayers and industry more than a billion dollars a year, while the US Department of Agriculture's budget for Integrated Pest Management (IPM) in 1995 was $192 million (Benbrook, 1996).

'Conventional' versus 'sustainable' agriculture is another dichotomy which feeds ortho-

doxy and division. The notion of sustainable agriculture has gained an unfortunate reputation of pointing an accusing finger at the faults of mainstream farming and its suppliers, and it is therefore no surprise that most farmers around the world choose to align themselves more closely with Life Science companies, who are at least producing something of use to them, than with the sustainable agriculture movement.

None of this would have much bearing on the greening of industry, were it not for mounting evidence that an over-simplified reality and uniformity of perspective may leave an organisation vulnerable to unforeseen breakpoints. An inability to *innovate* will eventually affect a company's value to both shareholders and stakeholders, and can erode the credibility of statements on sustainable development. The leaders of large chemical corporations have recognised this point.

This is not the only threat to the sustainability of the industry. Research-intensive companies are realising that the big-selling pesticides are becoming commodity products, and that price competition will increase further as patents expire and as seed-based biotechnological crop protection eats into valuable chunks of traditionally valuable chemical pesticide submarkets. And most dramatically, Life Science companies are reeling from an outpouring of public disquiet and opposition to genetically modified (GM) food crops, especially in Europe. The public are asking what benefit these more 'sustainable' technologies bring to them. The company that has most clearly associated biotechnology with sustainable development, Monsanto, now faces a crisis over its image and with public acceptance of its products in Europe, which is in turn affecting the shareholder value of the company. Even Monsanto's own surveys are revealing substantial opposition to genetic engineering from the public, from the media, and, perhaps of even greater significance, from food retailers.

These societal 'revenge effects' are remarkably similar to the ecological revenge effects which farmers experienced with pesticides - pest resurgences due to the evolution of resistant strains, and the creation of "secondary pests" which were previously regulated by naturally occurring predators and parasites (see Tenner, 1996). Both are symptomatic of approaches which confront the symptoms rather than the cause of problems, whether those problems are crop pests or a low level of public legitimacy.

So the BCSD seems to be right. If Life Science companies are to survive through turning green business opportunities into successful and acceptable products, those far-reaching shifts in corporate attitudes and new ways of doing business are essential. But which attitudes should be shifted, and how are those new perspectives introduced into a myopic corporate culture? What are the high-leverage points that can produce significant, enduring improvements (Senge, 1990)?

Divergent Perspectives and Leverage Points

Divergent perspectives and innovative solutions should, wherever possible, be built

from industry's existing commitments to sustainable development. This was the approach taken by a three-year project co-ordinated from Ames Iowa. The aim was to build those perspectives from the BCSD's statements on *price correction and internalisation of environmental costs*, on an *expanded definition of the role of stakeholders* in corporate policy, and on the need to move *beyond pollution prevention* (Schmidheiny and BCSD, 1992). We therefore selected environmental economists and stakeholder analysts as network partners, and focused on redesign - confronting the causes of unsustainability - rather than eco-efficiency.

Before speculating about the future of an industry, it is vital to explore its present perspectives. The pesticide and biotechnology industry justifies its contribution to sustainability in the language of demographics, hunger, efficiency and human welfare - fewer farmers protecting more crops from the ravages of insects, fungi and weeds in order to provide affordable food for growing populations. But how accurate are those justifications and underlying assumptions?

Pesticides, Biotechnology, Hunger, and Efficiency

In the 36 years since the publication of *Silent Spring* (Carson, 1962), the response of industry and some politicians and scientists to questions about the sustainability of agriculture's reliance on chemical pesticides has remained entrenched in "*the language of loss*" (Bromley, 1994). The debate is framed in terms of the costs of pesticide bans - reduced yields, higher food prices, expansion of cropland into wildlife habitat, and world hunger - in the highly unlikely scenario of deleting pesticides from the existing mix of agricultural practices (Box 1).

Box 1. The Language of Loss

To see how the language of loss remains ingrained in the pesticide debate, we have to look no further than the US Agricultural Retailers Association (1996) *Food for Thought* calendar:

"Without pesticides and fertilisers, U.S. farm exports would fall to zero. Our balance of trade would drop by more than $4 billion, and millions of people around the world would starve."

"An estimated one-third of the world's food supply would be lost each year to weeds, insect pests, and diseases if crop protection chemicals were not used. This is enough to feed about two billion people."

"Without pesticides and fertilisers, U.S. consumers would spend 30 to 40% of their income on food instead of the current 8 to 10%, which is the lowest expenditure in the world."

The bulk of pesticide use has surprisingly little to do with 'feeding the world' or keeping famine at bay (Pretty *et al*., 1998). The largest markets for pesticide manufacturers

weed control with herbicides in North American and EU feedgrain crops - are means to substitute capital for labour and management in the low margin, highly leveraged farming operations which have become the norm of industrialised agriculture. Pesticides have been a factor allowing the revolutions of specialisation and intensification in farming. They are a farmer's tool in securing a market for his food and fibre production in an extremely competitive global market, by meeting the demands of price and quality imposed by the gatekeepers of the agri-food system, the processors, the packers and the retailers. Pesticide use, especially in Europe and Japan, has also been stimulated by artificial price signals from high production subsidies.

Pesticides are feeding the feedlot more than they are feeding the world. A study for the US Farm Bureau (Porterfield *et al.*, 1995) estimated that 61 per cent of pesticides in the US was used in crops primarily for animal feed rather than food or fibre. The global market value for pesticides used to protect national food security in developing countries (rather than to protect export feed, fibre and plantation crops) is rather trivial by global standards. And much of the pesticide market for the most important food crop of the tropics - rice - has been shown to be an unnecessary hangover of the Green Revolution packages of high-yielding varieties, double-cropping, fertilisers and pesticides. It is also worth noting that the first wave of commercialised biotechnology products for agriculture were also crops for animal feed and industrial feedstocks (maize, soybeans, canola) rather than food staples.

Pesticides and the new pesticide-seed combinations prop up other inherently unsustainable but superficially more 'efficient' agricultural practices: simplified crop rotations, the separation of livestock and crop production, and the distancing of food and feed production from consumption. But pesticides are also widely used to prop up more sustainable farming practices, including soil-conserving low tillage systems in which herbicides are substituted for mechanical cultivation.

This perspective, which is absent from most rhetoric on both sides of the pesticide debate, highlights the synergism between pesticides and a raft of economic, technological, political and commercial trends which have set agriculture into a pattern of chemical dependence. Pesticides may be the *cause* of some aspects of agriculture's unsustainability, but they are more likely to be a *consequence* of forces on agriculture that are generating social and environmental outcomes which themselves are seen by many observers to be inherently unsustainable.

Although pesticides initially benefit *farmers*, allowing simplification of management and spread of labour over more acres, they work against the interests of *farming*. Pesticides are among the technologies which have contributed to an inexorable shift in agricultural activities away from the farm. The share of farming in the value added to agriculture has been in steady decline since at least 1920. The shift of agriculture from farm to non-farm reduces returns to labour and requires farmers either to increase production or use their excess management and labour in non-farm employment. Farm

sizes have grown not to achieve greater efficiency, but primarily because expansion has been the only way to maintain income (Wessel, 1983).

Pesticides have also been a major reason for the erosion of the 'social contract' between farming and non-farming populations in industrialised countries, hastening the decline in agriculture's prestige and political bargaining strength. Biotechnology is, to the surprise of many within the industry, further eroding this trust.

These concerns challenge our definition of 'efficiency' and 'sustainability'. We are obliged to question what we are sustaining, for how long, and for whose benefit. If we, as a society, are trying to sustain farmers (as well as agriculture's natural resource base), pesticides and the first wave of GM products would be considered an extremely inappropriate and inefficient technology choice. A growing school of thought believes that, for the health of community and culture, we should have more people rather than less on the land, and a stronger link between the producers and consumers of food, our most basic need (Lewis, 1996).

The concept of 'efficiency' is also challenged from an economic perspective: pesticides have well known environmental and health impacts, which market prices ignore. Prices reflect only those costs borne by the producer, or 'internal' costs. Where the production activity creates costs which are borne by third parties, these 'external' costs are not incorporated in the price, and the market has failed to allocate resources efficiently.

Leaders in the chemical industry, government and environmental groups speak with unusual unanimity about the benefits of correcting prices to internalise external costs. But the pesticide industry has made no systematic attempt to calculate the environmental and social costs of pesticide production, use and disposal, even in their own agrochemical divisions and subsidiaries. The minute fees and taxes on chemical inputs in the US state of Iowa - introduced not as a full 'polluter pays' but to fund research and extension on alternatives - were fiercely resisted by agrochemical interests (John, 1994). Dow's call for a healthy debate among all sectors of society on full-cost approaches (Popoff and Buzelli, 1993) has not even begun.

If a full-cost perspective was applied to pesticides, how would it change the outlook of a pesticide producer toward the development and marketing of pesticides and their alternatives? Two studies (Pearce and Tinch, 1998; Foster *et al.*, 1998) point to both the weaknesses of methodologies applied to date, and also to the potential magnitude of corrections if pesticide prices were adjusted to recognise and reflect the environmental and health costs of their use. A pesticide ecotax weighted to reflect the differences between 'soft' pesticides and products with high external costs would drastically affect the attractiveness of soft products relative to harmful products.

Science, Precaution, and Sustainability

Industry, science and government have viewed sustainability in highly managerial and technocratic terms, defined by experts from the natural sciences or economics (Orr, 1992). The elevation of science as the grand arbiter in deciding what is and what is not sustainable has a long tradition. The answers which science can provide are, of course, only as good as the questions which are asked of it. Regrettably those questions are often confined to the narrowly defined physical hazards of individual technologies or toxics. Science tells us that in 1996 "*A 150-pound adult would have to eat 3,000 heads of lettuce each day for the rest of his or her life to ingest the amount of pesticide that is found to cause health problems in laboratory mice*" (Agricultural Retailers Association, 1996) just as in 1891 it told us that "*A person would have to eat in one sitting 30 cabbages that had been dusted with paris green [copper aceto-arsenite] to get enough poison to hurt him*" (Gillette, 1891, cited in Porter and Fahey, 1952).

A green light from 'expert' knowledge to eat 30 cabbages or 3,000 lettuces per day completely misunderstands a perspective which represents the future-oriented, precautionary movement of what has been labelled "environmentalism". It is more accurately a broad range of concerns around the present and future well-being of people and planet, and encompasses agrarianism and the re-connection of people with the land. This group, which Mayhew and Alessi (1998) label '*sustenance*', questions the use of science amid all the complexity and unknowns of the interactions between chemicals and living things, to serve as primary consultant to those making comprehensive decisions about the future. They feel that the deliberate release of biologically active chemicals into the environment in order to tip the 'pest war' in humans' favour is inherently lacking in precaution. They view the technology of pesticides as flawed, because it is not durable; the more agriculture relies on pesticides, the less effective those chemicals become due to the evolution of resistant pest species and the decimation of natural control agents. They also point to disturbing evidence that the source of funding can dramatically affect the outcome of scientific studies on the safety of pesticides (Fagin *et al.*, 1997). And, citing the 50 years which it took to uncover DDT's impacts on the endocrine system of humans and wildlife, they feel it is only a matter of time before science, retrospectively, finds associations between these chemicals and other symptoms of environmental stress such as the epidemic of malformations in amphibians, or the slow epidemic of breast cancer in humans.

The 'golden age' of modern agri-food systems has been marked by an implicit coalition between agribusiness and science, because the high technology model was in the mutual interests of the scientific community and agro-industrial capital (Goodman and Redclift, 1991). Those arguing from a 'sustenance' viewpoint have not been included in the dialogue, because their precautionary language threatens the stability of that coalition. From the perspective of a therapist, the exclusion of a third party is detrimental to finding innovative ways to unblock the impasse over pesticides and sustainability. If, however, science is positioned as a consultant - a source of information - instead of a

primary arbiter, then new information flows emerge that can serve to stimulate innovative thinking (Figure 1).

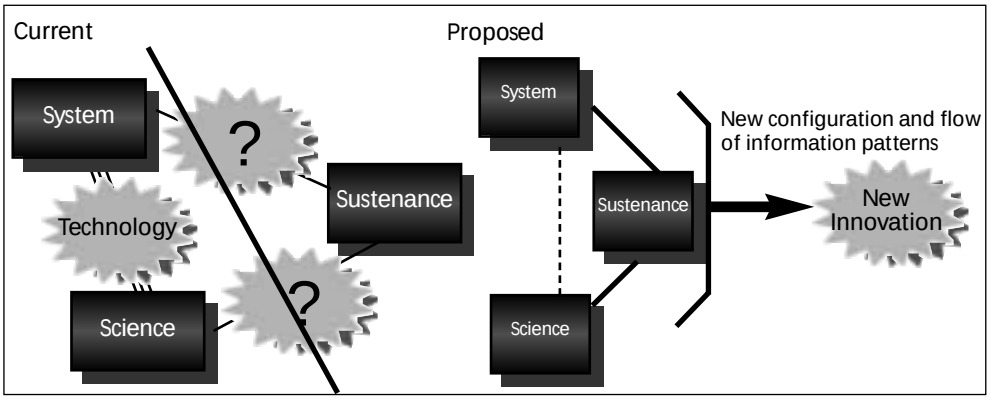

Figure 1. Possible restructuring of the pesticide and biotechnology debates. The solid line between System and Sustenance represents the primary relationship and the dashed line represents a consulting relationship. This new arrangement creates new information flows and creates a potential for new innovations to emerge (Mayhew and Allessi, 1998).

An alliance between the Life Science industry and 'sustenance' is essentially an attempt to *balance interests* in decisions over technology choice and corporate strategy; maximising the value of the company to a *diversity of stakes* (including nature, and including future generations) rather than value only to shareholders.

The prospect of Dow or Bayer bringing deep ecologists into their process of strategic planning may seem ludicrous, considering the chemical industry's tradition of confusing dialogue with *recruitment* to their way of thinking (eg Tombs, 1993), and considering environmentalism's adversarial history and aversion to sleeping with the enemy. But there are business opportunities in a more regenerative, less extractive agriculture, and an alliance between industry and the sustainable agriculture movement could redefine a company's core competence, from chemistry to agriculture, or even to ecosystem management.

But there are two key prerequisites to a successful partnership between industry and 'sustenance': *literacy* and *common vision*.

Industry And Sustainable Agriculture: An Unholy Alliance?

Literacy and Learning

Without literacy, and the organisational learning which nurtures it, everything is viewed through the prism of an organisation's dominant world view, and 'enlightening the public' continues to have precedence over enlightening a company's own personnel.

Organisations must first seek literacy throughout their ranks before claiming the high ground with more 'sustainable' technological and managerial fixes.

But how can corporate literacy be achieved? Companies could take the DuPont route of experiential learning, such as a well-designed series of field trials which compare conventional agricultural systems with the best that reduced-input and organic agriculture can offer. These trials are an open collaboration with specialists in organic farming such as the Rodale Institute, and seem to have avoided successfully the pre-judgmental anti-organic sentiments of agribusiness. The French-based company Rhône Poulenc (now Aventis), has also experimented with organic farming (Maitland, 1994).

Or companies can follow the lead of Monsanto, inviting 'sustenance' groups to their headquarters to set management teams on the right path. Monsanto has seven Sustainability Teams, including the Eco-Efficiency Team, the Water Team and the Global Hunger Team (see Margretta 1997). But note the risk of defining sustainability within the existing technocratic mindset. For instance, without a diversity of internal perspectives, a Global Hunger Team may easily construct world hunger as a technological (rather than a political) challenge, to be overcome by the export of genetically intensified US agriculture. Such an approach has the ingredients of the construction of world hunger in the 1970s—a shortage of protein—which led companies into commercially disastrous ventures in the 1970s with microbial proteins such as BP's 'Torpina' and ICI's 'Pruteen.'

Consultation with representatives of 'sustenance' is no substitute for a more profound and personal challenge to the institution, thereby redefining the problem and the scope of the solution. For this profound rethinking to occur, a significant percentage of managers has to become familiar with the perspectives of the practitioners of an agriculture which, according to existing mindset, is not supposed to exist. These are the farmers, researchers, and advisors in industrial and peasant agriculture who are getting high yields and regenerating their natural resource base with few external inputs, and are shifting from a consuming to a conserving agriculture (Pretty, 1995). These farmers and consultants see folly in the separation of 'pests' from the rest of the farming system. If the pesticide industry is serious about moving from an antagonistic to a complementary role in sustainable agriculture, then companies (as well as regulatory agencies such as the US-EPA) should develop goals for at least five per cent of middle management to spend sabbaticals of up to one year on the farms and research stations of innovators in alternative agriculture.

Uncommon Vision

The development of good solutions requires more than literacy in technological alternatives to controversial products. There is still a profound problem balancing interests across sectors of society when decisions are made in the development process of new technologies and services (Linstone, 1989). Solutions which are seen to benefit only one sector of society are not solutions at all.

Schmidheiny and the BCSD (1992) state that "*Prosperous companies in a sustainable world will be those that are better than their competitors at 'adding value' for all their stakeholders, not just for customers and investors*". But there is still an entrenched tendency, especially in the US pesticide companies, to label non-farming groups as outsiders in the debate over how food is produced and the land is managed, because they are not 'in' farming, and because they are not qualified scientists.

Taking a more systemic view reveals that there are no outsiders; "*you and the cause of your problems are part of a single system*" (Senge, 1990). And one of the best ways to expand perspectives is through Future Searching. Future Search is a structured planning process which "*gets the whole system in the room*" (Weisbord and Janoff, 1995). Fifty to 80 diverse stakeholders come together in retreat setting for two to three days. Rather than planning from the present through compromise and 'agreeing to disagree', the search members agree on a preferred future, and then work backwards to plan the necessary actions of industry, government and other stakeholders for creating that future (Box 2).

Box 2. Future Search in Practice

A Future Search conference took place in Minnesota in 1996 to investigate options for the pesticide industry in sustainable agriculture. Over two days and two nights in the backwaters of rural Minnesota, a group of farmers, agribusiness representatives, scientists, NGO representatives, and members of the public built a dialogue around this controversial subject by, in the words of one participant, asking "*What kind of future do we want*?" rather than "*How are we going to get a sustainable agriculture*?". It is fascinating to note how this conference quickly homed in on leverage points in the pesticides/agricultural sustainability issue, once the discussion had moved beyond the usual string of agricultural woes. Many of those leverage points were not found where the farmer or farmworker uses pesticides, or inside the gates of specific pesticide companies, or in the corridors of policy makers and regulatory agencies. Four involved moving the goal posts at the marketing and consumption end of the agri-food chain through awareness-building or strengthened communities. Two more addressed other areas of public action: a need for greater democratic control over technology choice, and mechanisms for building trust among diverse stakeholders. An opportunity for business to develop a stewardship ethic received so many votes for the final 'tasks/actions' stage of the Search, that two groups were formed to tackle this issue. Only one area identified by the participants - watershed management – was primarily directed at farmers.

Source: *Morley and Franklin* (1998)

This technique has much potential for bringing industry and society together around a subject in which we are all stakeholders - the future of our food system. There is evidence that Future Search conferences of pesticide company employees, company shareholders, environmental groups or the general public would all reach remarkably similar

conclusions about what an ideal food system of the future would look like. This would make explicit the question of what is being sustained, for how long, and for whose benefit, and would explore the potential for agreement on how we get from our present condition to the preferred future. By focusing awareness away from negative stereotypes and barriers of culture, personality, power, status and politics, towards shared goals, Future Search may uncover deep agreements on where our food system should be headed. In this case, Life Science companies would have an excellent reference point for selecting innovations that have a much more social consensus than the current basket of chemical and genetically engineered technologies.

Future searching is a powerful short cut to bringing a wide diversity of perspectives into a company's strategic planning, and forces an organisation to ask: "*If we could reinvent ourselves, what would we look like*?" (Handy, 1994). This approach, when used by an organisation willing to learn, can facilitate a shift "*from reacting to the present to creating the future*" (Senge, 1990). It is a way to build the ownership and unity of purpose necessary for the kind of corporate change which pushes beyond eco-efficiency toward deeper redesign.

This is a marked contrast to the visions foisted on corporations by born-again environmentalist company directors, in which employees are 'trained' in the vision until they 'get it'. A top-down vision in sustainable development is a contradiction in terms.

New Products and Services

Once companies are equipped with literacy and vision to move beyond the status quo, and once disincentives are reversed using green taxes on energy and chemicals, a whole new range of opportunities could open up for the private sector to make money and put their visionary talk into practice developing products and services for sustainable agriculture.

What could be the new role for the Life Science industry? Sustainable agriculture is often described as 'information-intensive' rather than 'input-intensive'. A pesticide company, realising that it sold crop protection rather than chemicals, could therefore move into farm services, crop insurance or performance contracting, and deliver the same end result (healthy crops) with far less material throughput and far less environmental impact.

The possibility that a chemical company could "*extract value from a zero-input farming scenario*" was floated by DowElanco managers at a conference in 1995 (Burnside and Hoefer, 1995). The speakers presented a scenario of a shift from selling crop protection to selling Integrated Crop Management without a 'product' bias.

But again, there are serious limitations to such a transformation:

1. The farm services market is undervalued and distorted by extreme competition between chemical manufacturers and retailers, leading to marketing practices that depress the perceived value of information services (Wolf, 1995). Services such as pest scouting and soil testing are offered free or below cost in order to retain important customers, which makes farmers unwilling to pay independent consultants the full price.

2. There is a danger that companies would package the skills and knowledge of sustainable farming into a 'product' and 'deliver' the technology in the same way that chemical inputs have been sold for the past three decades. Advocates of sustainable agriculture warn of this danger, emphasising that agricultural development is built on participation with farmers and integration of local knowledge. Sustainable agriculture in its broad definition may not be a lucrative market for any purchased inputs, be they chemicals, genetics, or information.

3. The late 1990s, when companies should be implementing their pledges of "*far-reaching shifts in corporate attitudes and new ways of doing business*" have turned out to be a far leaner and meaner era than the years leading up to the Rio Earth Summit. Sustainable development seems to have taken a back seat for many companies, while survival in this maturing industry is top of mind. Such conditions are far from ideal for 'greening' corporate strategy (Walley and Whitehead, 1994).

4. Finally, there may be considerable shareholder resistance to companies diversifying into farm services. Shareholders will not readily accept a decrease in the earning power of a company for a diversification they can effect more cheaply by buying shares of different companies.

Clearly a 'simple' shift from selling chemicals to selling sustainability services is fraught with difficulty, and risks achieving neither the ecological benefits nor farmer acceptance (and hence profitability) that some business commentators have predicted. But literacy in sustainability through a diversity of perspectives, and a shared vision of a future agri-food system, provide the necessary ingredients for sustainable innovations.

Conclusions

Internal learning has a relatively low cost compared to the expensive mistakes of tunnel vision. The failure to understand wider stakeholder perspectives and to balance the development of new technologies has had companies scrambling to relearn and to repair their image around the new technologies of genetically engineered seeds, as they have done with chemical technologies for the past thirty years. An alliance with 'sustenance' stakeholders could radically change a company's perception of what stake it has in the agri-food system. It could be the foundation of a new, more systemic means of technology assessment.

It is not only companies which learn from being brought face-to-face with other ways of knowing. Environmentalists come face-to-face with the constraints on companies, especially their need to protect shareholder value, which in turn tempers the tone of arrogance which environmentalists have used when talking to business. Consumers come face-to-face with the fact that our choices have a direct impact on farmers' practices in terms of technology choice and landscape features. We are confronted with the fact that much of the pesticide use in developing countries is an extension of the North's ecological footprint, in its demands for feed grains for meat production, out-of-season fruits and vegetables, and cotton fibre and clothing. We see that what we do with our savings and pension funds, how we shop, how we eat, and how we vote, all contribute to the issue. All stakeholders learn to appreciate that the pesticide and biotechnology issues are symptomatic of a society "*stuck with ways of knowing, organising, valuing and doing things, with tightly intertwined roots of unsustainability*." (Norgaard, 1992).

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