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NIIF

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# Developing technologies for sustainable resource management: Eating your cake and having it too !

1992

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## The nature of discourse

The sustainable development as a term is much abused and little understood. If the idea is to use resources at a rate and by a technology such that future generations can use them at their preferred rates then sustainability is a non-starting concept. How do we find out `preferred' rates across cultures and generations? Our previous generation did not restrain itself in use of groundwater, land or aquatic resources etc., so that we could use them at our `preferred' rates. They did it partly out of some larger social and ethical concern. But partly, it happened because more destructive alternatives maximising short term returns did not exist then. It is true that today we have higher productivity of practically every natural resources than achieved ever before. Some believe that we can continue to increase the productivity through science and technology without in any way damaging the renewability of resource base. But it is also true that non sustainability of present technological pursuits (comprising chemical intensive agriculture) was never so apparent as now.

I do not want to argue with those who have more confidence in scientific and technological tools but lack courage to confide in human nature. I believe that scientists cannot perform scientific functions honestly and in a professionally rigorous manner without bringing in the ethical and environmental issues on the central agenda. Thus as a scientists, I will be failing my profession if I promised to the politicians or other policy makers that I can deliver more productive alternatives indefinitely as long as I have liberal supply of capital, equipments and scientific manpower. Some exaggeration is inevitable when one prepares grant proposals for funding institutions. Nobody wants to fund someone who does not promise moon. However, science requires taking into account all the evidence available so that consequences of various choices can be faced squarely. I do not imply that there is no scope for innocence or ignorance. Both are noble virtues and I respect them. However, I am suggesting that drawing a very narrow conceptual boundary around a problem so that the negative externality can be ignored is no more acceptable. The boundaries of disciplines and professions are increasing their overlap. This overlap helps us understand a phenomena better. The logic of reductionism as a tool may still be valid. Because maintaining cetaris paribus conditions at the level of large systems would be impossible. No inference howsoever tentative can be derived without drawing a boundary. If everything is related to everything else, causality cannot be attributed.

Therefore, sustainability of resource management depends upon the way we define a causal model of interactions, draw a boundary, attribute responsibility for consequences, organize institutions to correct or contain the negative consequences and maintain the positive ones, generate information and feedback sharing system so that enlightened self interest can become compatible with and lead to collective rationality.

We realize that no one research programme would be able to address all the concerns of sustainability. But each research programme can certainly be modified in such a manner that (a) the causal model is modified to take into account some more interactions in the natural eco system than was the case before and (b) the negative externality of each technology is minimized.

The paper is organised in three parts. First I discuss the concept of sustainability as it applies to conduct of science. Then I discuss specific issues regarding agricultural research. Finally I describe the conundrum of developing and diffusing sustainable technologies through non-sustainable institutions. I try to link personality of a scientist with the research pursuits for sustainability.

## Part One: Sustainability: having your cake and eating it too!

Actually the idea of `having your cake and eating it too' is not so absurd as long as one does not eat all of it and right away. Nature makes it possible for us to have our cake if not of the same size or flavour as we wish, nearly so. But when it comes to eating, it is not necessary that the process of eating should be pursued through same norms, rituals and recipes across different cultures. Thus some people share the cake with not only those who cooked it but also those who could not either because they did not know it, or they had gone out collecting firewood for the kitchen or were sick and sometimes just a little lazy. There are others who argue that cake needs to be shared with only those who are directly responsible for its acquisition. Others can see it but not partake.

In some other societies not only the human beings but also the ants, birds[1] and other living beings are supposed to have a claim on the cake. When number of claimants increase (that is popula-

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1. There is a parable of parrot drawn from a song sung in Southern India which illustrates the eco-ethics referred in paper here:

> In a drought year, the crop has suffered very badly. A women is coming back from the field after pickin up whatever grains she could. On the way she meets a parrot. The parrot starts staring at her. She ask the parrot as to why was he looking at her so intently. The parrot replies that he was actually confuse after looking at the women's necklace. The necklace had a green agate stone. He mistook it to be grain. Only when woman came closer, he realised it was just a stone. Woman asks him had he not go anything for eating.The parrot replies that hadn't she brought all the grains from the field- even the one which had fallen on ground. The women realizes that parrot was hungry, and she also needed the grain very badly for her children. She asks the parrot to come home with her and share whatever she gives her children. But the parrot flies away leaving the woman dumb founded.

It is also possible that parrot realized that if he delayed search for grains other people would also pick up whatever grains were left in the fields. He remembered his young ones who were waiting to be fed.

The song has several messages. It speaks about a cultural system in which the right of birds are being debated vis-a-vis the right of human beings particularly in the period of food crisis in a drought year. Perhaps there was some reasons why the traditional varieties of millets or sorghum had loose set grain which was easy for birds to pick. At the same time there were elaborate designs of birds scaring devices built to reduce the loss due to bird attack. Perhaps people knew that bird would kill insects some of which harmed the crops. How much of the contribution of birds was negative or positive would be reflected in the (a) technology i.e. selection criteria of local varieties, design and efficiency of bird scaring devices, (b) the spirit of co-existence with other parts of nature, and (c) collective consciousness as well as culturally approved behaviours.

How does one interpret this song would also depend upon how one conceptualised the right of different claimants over natural resources. If birds were also considered as legitimate stake holders in the natural resources, then the viability, sustainability and effectiveness of any institution would have to be interpreted very differently. Many times, resource scientists have taken a very limited view of human nature - a view which excludes the rights of other natural beings. The conservation ethic is seldom anchored on such a view. At the same time, giving primacy to any one constituent over the rest may violate the very foundation of eco-sociological knowledge system as argued by the Alaskan leader in part one of this paper.
A knowledge system which generates concern for various parts of eco-system obviously could not have evolved through just the individual innovations. It would have required evolution of cultural norms, folk lores cemented by various kinds of sanctions and rewards for socially approved behaviour.

tion size grows), some rules or norms for prioritization are necessary. The scientists responsible for developing efficient recipes might argue that their job was restricted to the delivery of cake. How could they influence its distribution. That is the subject which social scientists, policy makers and other stake holders must decide. But assume that cake was such that it would produce a particular flavour liked by the consumers only if it was cooked in a particular manner and in a limited size.

The French wine after all is indeed one such product which meets the requirement of small scale site specific (4-S) production with flavour being a function of 4-S. The market forces have not yet found a way of overcoming consumer preference for taste, and resultant biodiversity of grape gardens. The diversity of recipes and methods has also been maintained. Would such norms apply to only products of leisure oriented consumption. What about thousands of local rice, potato and bean varieties which would have disappeared but for the `resistance to change' among the cultivating communities.

Even if the production of cake could not be restricted in size or to site, can it be produced in stages or through semi-processed components so that different consumers can recombine the components or semi-processed recipe according to their taste, resources and preferences[2]. It is quite likely that certain combinations of the cake components will be more tasteful/profitable than others. However, the variance between the combinations may be lesser than the conventional model of having uniform recipe with `take it or leave it' option.

It is difficult to anticipate the preferences although market researches do make an attempt. If they cannot anticipate, they try to mould the preferences through advertising and media planning. Cake can be sold even if it is less nutritious. However, the trade off between long term demand versus short term viability is unlikely to be resolved only by manipulating the quality of cake.

Leaving this metaphor behind, let me illustrate some of the issues which emerge in the discussion on sustainability.

1. Sustainable resource use requires inter-institutional linkages such that interventions in each resource market generate positive externality to the extent possible. Scientists cannot always take institutions as given. The technological choices in such a case may legitimize the given institutions. The linkages have to be forged between crop, livestock, tree, craft related institutions. In addition, linkages between formal and informal knowledge systems, political and technological lobbies, formal and informal sectors etc., would have to be conceptualised. To illustrate, the groundwater may be used through private institutions, power supply may be through public institutions, and the surface irrigation may also be through public institutions. The sustainability of conjunctive water use would not depend just on the agronomic water use efficiency models. It will depend upon the reliability of each system, the extent of costs for generating negative externality and ability to free ride. Linkage between the institutions, therefore, are concomitant aspect of linkage between enterprises, sectors and disciplines. Most of the studies on sustainability have neglected institutional aspect[3].

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2. Dr. Krishnamurthy, Former Director of All India Coordinated Research Project on Dryland Agriculture had coined 1971, a concept of `tiers of technology'. It implied that in dry regions the package approach was unlikely to su ceed and thus farmers should be offered recombinable components. Different combinations may offer vary advantages depending upon intitial endowments of the households.

3. Exceptions are the following studies: Michael M. Cernia,1987, farmer Organizations and Institution Building Sustainable Development, Regional Development Dialogue, 8(2)1-24; and Anil K Gupta, 1987, Organising a Managing Poor Client Oriented Research System: Can Tail Wag the dog?, Presented at the International meet OFCOR projectat International Service For National Agricultural Research, October, The Hague, 1987.

2. The sustainability of a resource use requires development and demonstration of an ethics which guides decisions regarding current versus future consumption of resources. The conception of nature and relationship between human and non-human, animate and in-animate, born and unborn etc., are defined if not determined by this ethics. The bio-ethics can raise following choices:

a) Do I draw natural resources at a rate that the resource renews itself within a short cycle.

b) Do I draw as much as I can till it is available and once exhausted, I shift or change the resource base.

c) Do I draw less than what can be used without impairing the ability of resource to renew itself.

d) Do I draw resources only as much as I need simultaneously ensuring that the genuine needs of others are also met.

e) Do I draw as much as possible, hoard it if feasible and then market it at a very high price to ensure some kind of rationing of its use.

f) Do I develop an institution which through its inefficiency generates a constraint on the maximum sustainable yield.

3. Uncertainty and risks: problem of definition vis-a-vis the phenomena.

I have argued elsewhere (1988) that we may define a problem of risk as uncertainty when we want to absolve our responsibility. On the contrary a problem of uncertainty may be converted into risk when we want to exercise control and justify an investment. Nuclear power plants are an example of technology where hazards are `unexpected' and risk is considered to be too low. The uncertainty about a technology in which we still do not have methods of safe waste disposal is converted into a problem of risk. On the other hand a natural hazard like drought or flood is converted into uncertainty even though over space, these hazards are very well known and probabilities can be easily assigned.

In nature several interactions are still not well understood. For instance, harvesting of a particular specie of say wood from a natural forest changes the ecological succession and consequent biomass supply and productivity. The long term cycles of single specie have shown drastic decline in productivity. Yet the so called scientific forestry continues in the form of monoculture cycles. Selective withdrawal of a resource without knowing enough about its consequence on the remaining biomass is a problem of converting uncertainty into risk. The choice is between appraising a technology in short or long time frame.

4. The time frame in which sustainable options may become feasible may depend upon the tenurial rights available to various resource users. I have discussed two kinds of assurances in the eco-institutional perspective given below.

1. Vertical assurances i.e. future returns from present investments. If I grow a tree today, will I be allowed to cut it tomorrow.

2. Horizontal assurances i.e. others behaviour vis-a-vis one's own. If I don't graze my animals on common land, will others also not graze.

Extending the time frame is a necessary condition for triggering development.

Eco-Institutional Perspective

| | Ecology | Institutions | Technology | Culture |
|---|---|---|---|---|
| Access | ***** | | | |
| Assurances | | ***** | | |
| Ability | | | ***** | |
| Attitudes | | | | ***** |

All the four As i.e. access, assurance, abilities and attitudes, must be satisfied in a system level intervention for it to be sustainable. The advantage of the framework is if we know any two dimensions we can speculate about the third. And if we know three, we can speculate the fourth. Let us take the case of a technology for plant protection. It is useful for me to use biological pest control, if I have some assurance about others behaviour. But if I did not, I might spend more on chemical pesticides, and increase the cost of plant protection of others as well. Further it is not enough to have access to technology and skills or ability to use it, if assurances are not available. Likewise, the culture of collective survival vis-a-vis individual survival would also influence the sustainability of technology as well as institutional arrangement.

3. The right of the unborn.

Given extreme poverty and deprivation in most developing societies, the rights of the unborn are always discounted. It is seldom recognized that what we bequeath may often influence how we survive. The future can occur faster than we think. The hazards expected in the next generation often prepone their arrival. Declining biodiversity, increasing disease and pest hazard and consequent increase in vulnerability is a phenomena which we are witnessing right in our generation. We can relate the technological choices with these rights very precisely. For instance, the rate at which soil nutrients are mined may influence and be influenced by cropping pattern, intensity and partitioning efficiency of a crop plant.

We may not even estimate various consequences of the nutrient imbalance for the elements of which functions are not fully known. The rights of the next generation are thus negotiated through the assumptions made about the present resource use pattern and consequences thereof. The effect of soil mineral properties on disease and pest vulnerability is still being properly assessed. The right of the unborn can be argued not only on ethical grounds but also on efficiency ground. These rights imply a very long time frame and most sustainable technologies fail to prove their effectiveness in shorter time frames. For such technologies to be given a fair trial, invocation of the rights of the unborn thus is a pragmatic political strategy.

4. The sustainability of any technology cannot be assessed at a single enterprise level. The portfolio of enterprises through which a household draws its sustenance offers the first level of analysis. However, sustainability of certain technologies cannot be assessed at the household level also. For example, the watershed based technologies would require appraisal to be made

at catchment level. The upstream and downstream interests may not overlap. The proportion of land which different households have in a catchment may vary. Further, the quality of land and consequent share of surplus it generates for different categories of households may also vary. Generation of collective rationality would be sine qua non for developing sustainable alternatives. The theory of portfolio management at the household and community level remains to be properly articulated.

5. Survival is not just an economic question. The aesthetic, humour, poetry and drama are part of human repertoire which provides syntax for survival. The scientists cannot manipulate this. But they can understand these needs. Once we recognise these needs, we also mentally prepare ourselves for witnessing curious experiments being performed by farmers. And we do not look only for an economic explanation for all the experiments. Sustainability of experimental ethic of the people is very crucial if long term sustainability of resource management has to be assured. The tendency to provide finished product (seed - pesticide - growth hormone complex) tends to undermine this ethic. Studies have shown that problems always not only keep pace with but also move a few steps ahead of the solutions. The experimental ethics thus is subdued but not totally eliminated.

6. Sustainable technologies require a vibrant peer group which does not measure efficiency in only reductionist terms. The peer approval for low external input agriculture or for low or high return, low variance technologies may not always be available. If scientists cannot sustain their motivation, to expect them to develop technologies which are sustainable in nature may be futile.

There are many other dimensions of sustainability which for want of space, I do not intend to discuss. For instance, the problem of younger people out-migrating from rural areas poses a very different kind of challenge than ever faced in past. Likewise, the entrepreneurial adults leave the rural areas for urban markets. The kind of peer group which evolves through the dynamics of resource allocation among those who choose to stay is very different than the peer group in a society having young and old, conformist and non-conformist present together.

In hill areas, drought-prone areas, forest and flood-prone areas, the males have to often emigrate due to limited opportunity for employment available locally. As a consequence the proportion of women headed or managed households are invariably highest in these regions. The women or children or old people inhabiting these regions may not be able to take animals for grazing to the distances that men can. The grazing pressure and resultant implications for choice of technology in land use are obvious. Sustainable technologies for women dominated farming systems would not necessarily require a different kind of plant and animal breeding strategy if institutions could compliment the inadequacy arising out of male emigration. But when institutions always fail to clear the demands of women as a class, the responsibility of the scientists increases. Though I maintain that scientists cannot compensate for all the inadequacies of institutional or public policy domains.

**Part Two: Asking different questions or same questions differently.**

There are obvious questions about the way land use is managed, pest and disease controlled or chemical residues in soil or animal bodies or aquatic systems are treated. I do not intend to spend too much of time on what is obvious. However, the questions which have not been adequately addressed either because of limitations of conceptual framework or method of analysis, will be listed here. If some of these appear obvious to the readers, I will seek forgivance because we shed our naivete not at the same time.

1. The analysis of the post-graduate research provides early signals about the direction future scientists are taking. I did analysis of all the post-graduate thesis in five disciplines (agronomy, genetics and plant breeding, economics, sociology and extension) during 1973 to 1983 drawing upon a journal of abstracts (published by Haryana Agricultural University). In the discipline of agronomy, more than one-third of the theses were on inorganic fertiliser. The problem of salinity, crop rotation had been looked at in less than ten theses. There were only eleven out of 376 theses in which both organic and inorganic fertilizer trials were conducted. And there were only eight theses dealing with problems of organic fertilizer. It is quite possible that the journal has not included large number of other theses which were completed but not reported to the journal. We assume that the limitations of the data are applicable to all the aspects of the research.

Obviously, such pattern of research does not generate much optimism about development of sustainable technologies.

There were about 22 percent theses in rainfed regions of all the subjects. Though only 51 i.e. 4.5 percent were dealing drought prone area problems. On the other hand, the problems of irrigated regions were looked at in 56 percent of theses. For the remaining, the region of the study was not clearly mentioned. If we exclude the studies on cost of cultivation and fertiliser response, inter-cropping and spacing were the two most important aspects of agronomic trials in dry regions.

The problems of livestock and related aspects were studied by hardly 3.29 percent of the students graduating in these five disciplines. So much for the farming system research. The bias against the problems of dry regions was apparent in all the disciplines.

The crop, livestock, trees and craft interactions were never studied together in a study. Such gaps illustrate the point I made earlier about the limitation of the causal models in this area. Likewise, problems of on-farm research received limited attention. I won't be surprised if such is the pattern in most other countries including many developed ones.

The implication for the sustainability is very clear. If future generations have to be made sensitive to the problems of tomorrow (and not yesterdays), then there seems to be no alternative but to take up a global effort to review trends in post-graduate research every year for a few years. Once the professions become sensitive to these questions, the need for external monitoring may not remain. The review of post-graduate research should also enable young students to find out the conceptual niches left uncovered or less covered.

2. On-farm research for risky regions.

The methodology for cropping system research developed at IRRI as well as CIMMYT, I have argued, suffers from the same inadequacy. The theory of niche formation has not been adequately developed. Further, the role of contingency treatments in the trials has not been recognised. The kind of data which is collected often ignores the risk adjustments strategies evolved by the farmers. Much greater emphasis in data collection exist on `what' rather than on `why'.

The protocol for involving farmers including women in design of experiments remain less well developed. The experiments done on station are generally unaffected by the outcome of on-farm research. The inter-disciplinary interpretation of various commodity or disciplinary experiments is the first step towards the search for sustainable technology.

3. Long term experiments.

One of the most tragic and unfortunate aspect of probably all the aided research programmes in developed countries is the near absence of long term longitudinal experiments. It is not realised that rigorous causal and models cannot be developed without data of long term experiments. Given the budget squeeze and declining resources for public research and development, I wonder how would the constituency for longitudinal experiments evolve.

4. Eco-sociological and agro-ecological analysis of research contexts.

In any research on sustainable alternatives, the characterization of environment is a necessary step. Unfortunately, there has been an aggressive thrust of short cut and rapid methods for this purpose in the recent past. I have no hesitation in saying that these methods would die their own natural death in not very distant future despite millions of dollars being pumped by Ford Foundation and other aid agencies. It is very instructive to note that these methods are being used only by large aided NGOs or scientists eager to latch on RRA bandwagon. Since sustainable alternatives require deeper and painstaking understanding of system level interactions, rapid methods often masks the complicated interactions. Celebrations of trivia follows. One of the serious adverse consequence of these methods is the bias for a historical approach to learning. Already there is a declining trend among young people for deeper readings about a subject. These methods legitimize such indifference to prior work in various disciplines. Thus the land use maps prepared by geography departments are never drawn upon. Likewise, the findings are rarely shared in local language with the people. Some of the methods are not even scientifically correct. For instance, transact analysis in a highly variable agro-ecological terrain generates totally imprecise estimates of the resource situation. The age old method of identifying niche characteristics has been given less attention in most of these rapid methods. In any case, I personally reject any short cut in learning. If some surveys have taken far too long to be analyzed or have been done poorly, there are larger number of rapid method oriented results which betray deeper understanding of the society and ecology. The scientific rigour for analyzing local situations has to be increased through better use of ecological concepts and sociological methods. Sustainability in research will become a casualty if the building blocks of knowledge would be poorly designed and defined.

The eco-sociological paradigm (1984) provides a measurable and refutable theory for understanding and describing a research domain. We need more refinements in the methods so long as conditions of internal and external validity are observed.

5. Ethical issues in farmer participatory research.

Much is said about the participation of people in research design and trial implementation though some of the very basic steps are often found missing:

a) The finding of the research are very seldom shared back with the respondents for ethical as well as scientific reasons. The ethical because we have no right use any information given to us interest without clearance from the source. The scientific because only when the findings are fed back, the providers of the data are able to fully appreciate the context of enquiry. It is then that they offer new insights which I have argued are unattainable through any alternative method.

b) A relationship can be sustainable if it involves mutual accountability of highest order. I have not come across many examples where scientists have encouraged people to question assumptions of their own models ruthlessly.

c) The intellectual property rights of the people are still not being protected in most studies. This is particularly true of ethno-biological research. There is no reason why

experimentation by local people be considered an ethnic phenomenon. Innovations are necessary in a dynamic environment with declining resources. Many of these innovations can extend the frontiers of science. Since large number of local innovations draw upon local resources and are generally organic in nature, these provide a very valuable basis for searching sustainable technological alternatives.

6. Research in high risk environments.

In drought and flood prone regions, hill areas and forest regions, natural resources are coming under greater pressure. Before long term solution to these problems can be found, some of the processes through which resource degradation takes place may be understood.

a) Most households have to diversify mix of their economic activities or portfolios to adjust with the risks inherent in the environment. The nature of diversification of course varies within the range defined by the ecological conditions. The portfolios of poor people would obviously be biased in favour of the enterprises which respond more to labour than capital such as small ruminants. On the other hand, better endowed households will either specialize their portfolios or take recourse to diversification in favour of capital intensive enterprises (minor irrigation, mechanization, cross-bred cattle etc.).

b) When access to private resources for dry matter and green fodder goes down, the landless labourers and marginal farmers shift their portfolios towards small ruminants. The less access these farmers have to the financial institutions, higher are the chances of their transferring more and more costs of maintaining their livestock enterprise on to the public or common property resource account. Once the pressure increases, the soil erosion and consequence siltation of canals, river streams become more widespread. It is not surprising to find drought and flood occurring in the same region more often now than before.

c) The mechanization in the lighter soil regions contributes to the elimination of grass cover in the cultivated fields. Even more seriously it makes it well nigh impossible for tree seedlings to grow in the cultivated fields. Agroforestry has been one of the age old methods of managing resources in the sustainable manner. On one hand low rate of interest and easier access to credit among the affluent has spurred the demand for tractors. On the other the seedlings is spontaneously sprouted in the field cannot be by-passed as is the case when ploughing is done by bullocks or camels.

d) The interaction between crop livestock, trees and tools including craft activities is very crucial for survival. While research may still be done on a particular enterprise, the implications for the entire system must, however, be drawn. The causal models based on either energy exchange or capital flows have not been nested into the cultural and social system of reciprocities. For instance, given low rainfall and high coefficient of variation over time and space, it is possible that rain may fall on one side of the village and not the other. Different people may have different size of land holding in a particular micro catchment which may have received drain in a given year. Farmers pool their bullocks in certain parts of semi arid regions and plough these lands together so that crops could be sown before the moisture recedes. The generalize reciprocities dominate in these regions. The book of accounts are settled over long period of time. The analogic means of communication is preferred over the digital one. The proportion of women headed or managed households is much higher in these regions.

e) The lands which are suitable for silvi- pastoral systems are brought under cultivation. And the lands suitable for cultivation are brought under trees. Such distortions of non-sustainable nature are inevitable in a market based systems. Challenge is to devise

institutions which can provide both short and long term assurances to the people so that sustainable land use follows.

f) The organic matter being highly mobile in tropical soils, the institutions for collection of organic matter and enrichment of soil have emerged in many hill and other regions. The kind of technologies which require these institutions may be different from the one which don't.

7. There are very few technologies sustainable in nature which can be entirely managed at individual level. While the entire research focus in the field of extension science has been on individuals, the group based approaches seem to be acquiring more and more importance. The natural and social scientists have to relax the constraint of individual management while developing and diffusing group based technologies (for plant protection, drainage, watershed management etc.).

**Part Three: Areas for future concern**

Given the increasing importance of biotechnology, there is a fear that attention from some of the softer subjects but more crucial for sustainable development, may be distracted. While biotechnology can help in overcoming some of the barriers to gene transfer, it cannot substitute the need for conventional research. The areas where it can help have to be prioritized.

The values and norms for sustainable resource management may get built early in life. The curriculum reform may be most necessary to initiate a large scale change in the way human nature interactions are conceptualised.

Agricultural scientists have delivered very impressive results in the past. It is natural that society expects them to continually deliver results. Since much of the costs paid earlier during the technological transition are unlikely to be absorbed now, it is important for the scientific community to derive the best way possible for sharing the information about these costs. Perhaps the willingness to pay the costs will slowly improve. Some of the ways in which scientists would translate the popular willingness into the technologies would be (a) to breed varieties say of apple with irregular shape but sweet taste and higher flavour, (b) to maintain biodiversity in a manner that communities which do so already do not continue to remain poor, and (c) to develop botanical pesticides and herbal veterinary medicines.

Recognizing that nobody likes a person who warns of a grim future, I want to end this paper on an optimistic note. Once a person was walking across the seashore. There were lot of star fishes being thrown on the shore by the waves. These star fishes were dying very quickly. Another person, a lady observed the first person picking up star fish one by one and throwing it back into the sea. The lady asked this person why was he doing it. There were so many star fishes dying, his action would not make difference to such a large number. This person picked up a star fish and threw it back into the sea and said, "my effort makes difference to at least this star fish which I throw back into the sea".

The research on sustainable alternatives even if does not change the face of the earth would certainly change the person pursing the research. This itself is a good enough reason for modifying one's research agenda. At least one can have one's cake and eat it too this way.