What can we learn from green grassroots innovators:
Blending reductionist and holistic perspectives for sustainability science[1]

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Hitting the target very precisely is a legitimate goal of every scientific pursuit. In the process, if the bullet passes through several other surrounding conditions, which get damaged or require costly repairs or keeping away from the damage costs a great deal, it generally does not matter. Therefore, we get costly accurate solutions affordable by a few leaving a large majority of the people to pursue highly inefficient solutions or no solution at all. The challenge is to find out whether sustainability requires sub-optimality at certain level of targeting in one sector so that inter-sectorally or cross functionally, the outcomes are more sustainable. To put it otherwise, if the negative externality of an accurate hit in the form of a drug or a pest control chemical is very high on the environment, economics and also equity, then will a less accurate hit make sense. Eventually, with better information and more synergistic science, the hit rate and accuracy could be improved. The dominant lesson from the grassroots innovators seems to be precisely this. In addition, the ways in which grassroots innovators achieve solutions may also teach us new heuristics about solving problems and in the process, sometimes, advance the frontiers of science. One must, however, accept that no one system of knowledge can provide all solutions. Blending of formal and informal science is necessary to produce sustainable outcomes. In fact, such blending has taken place implicitly in lot of intuitive discoveries and explorations. Why is it then formal scientific applications make reference to them less often? The trade off between accuracy, affordability, accessibility and local adaptability has to be made in technological portfolios by the households, particularly in disadvantaged regions all the time. Social sustainability, therefore, requires recognition of the challenges that emerge on the scientific frontiers. Let me illustrate.

When a potter, Mansukhbhai, paints an earthen clay hot plate (*thava)* with non-stick *Azo Nobel (*liquid*)* akin to Teflon, he makes a non-stick pan available in a dollar which would cost otherwise at least 5 - 10 dollars (with a metallic base). The scientists in one of the leading chemical technology labs[3] find unique property of this new affordable and accessible clay. Because of the porosity of clay plate, the paint gets embedded much better and does not come off as it happens in the metallic surface. The gas consumption is lesser than the aluminium pane and efficiency is much higher than the available panes. Health hazards are reduced whereas the advantage of low fat cooking are achieved in an extremely low cost manner. Similarly, an aluminium hot plate with ribbed bottom gives advantage in thermal efficiency compared to smooth bottom hot plate. Indian Institute of Petroleum, Dehradun confirmed the claims. If the oil tubes in industrial plants had ribbed surface, so much more thermal efficiency can be achieved. A whole new area of research on the shape and other dimensions of ribs can emerge to improve heat transfer in different kinds of environments.

Most neem based pesticide suffers from the degradation in the light and therefore, scientists have been searching for technologies for making neem compounds storage stable, largely

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through synthetic chemistry or solvent combinations. A farmer, Jadubhai combines few plants along with neem which make multiple compounds from neem completely storage stable even after 20 minutes of ozone exposure. Scientists, in one of the most advanced labs, validate the claim thus developing a new approach to developing storage stability or increased shelf life, and higher effectiveness in the field. This is the first report of a herbal compound achieving what chemists have achieved in the lab through chemicals not all of which are accessible to the farmer or for that matter, are affordable.

A windmill costing about 120 dollars is developed by Mehtar Hussain in Assam for irrigating small field. It is installed in western India, Gujarat for pumping brine solutions for making salt by a cooperative of very poor salt workers. The region where salt is made is a vast arid desert with saline soil and saline ground water, no landmark, no infrastructure without any power line nor any chance of getting power line for next twenty years. It is sanctuary area for one of the wild asses species. Using diesel engine is costly, causes pollution and makes noise disturbing wild animals. An affordable solution emerges to widen the choices of using science in a sustainable manner. A peanut pod collector in arid west is converted into sea-beach cleaner by an entrepreneur in coastal south India.

There are a large number of examples of analogical learning of combining unrelated materials of finding low cost solutions of trying unusual approaches to solve problems. Today with so much focus on climate change, there is very little attention paid to the coping strategies of communities in high-risk environments. The houses build on stilts allowing the water to pass underneath was an extraordinary traditional innovation in a land starved, high flood risk region like Bangladesh. As uncertainty in the environment increases, the need for learning from the minds on margin will increase. The knowledge such communities produce is not marginal any more. But, systematic scientific engagement with such knowledge holders and creative people is yet to take place on a large scale. Indian Council of Medical Research (ICMR) and Council of Scientific and Industrial Research (CSIR) have signed agreements with National Innovation Foundation (NIF) to subject grassroots innovations mobilised by Honey Bee Network to scientific scrutiny and value addition.

A small lab in Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI) is able to develop herbal products by pooling the best practices of different knowledge holders, farmers, pastoralists, etc. The technologies have been licensed to different companies and benefits shared with the communities and individuals. A new model of knowledge-based approach to poverty alleviation is emerging in the process.

The knowledge produced by the institutional science gets opportunity to be critiqued, valorised or transformed through scientific discourse in various fora. Similar opportunities do not exist for informal scientists at the grassroots. Sustainability science requires providing a level plying field to the ideas from the grassroots to be similarly critiqued and valorised across different language barriers and cultural communities around the world. Honey Bee Network is an effort in this direction. The fellows and faculty of the sustainability science programme in their chosen areas of public policy can build upon people's ideas from around the world. Only when the excellence in the formal science will engage with excellence in the informal science, a true blending will take place. No matter which field of science do we take, there are people at the grassroots who can hypothesise or contribute otherwise some ideas which may not emerge in knowledge dense environment. Deviant research has to be legitimised in formal as well as informal environments, otherwise familiar ground will not let unfamiliar solutions to emerge. A kind of insurgent science that questions the very model/s

of thinking solutions has to evolve. Recommendations about giving huge public funds to large corporations so that they could develop answers to the problems of the poor are misplaced. We are trying to rejuvenate a system, which has run its course. In health, we need to explore multi molecule, multi target solutions which will be closer to nature and therefore, to the healing process. Reductionism is necessary for sustainability, just as holism provides the perspective to evaluate the choices. I believe that both reductionist and holistic approaches have to intertwine like a double helical structure of sustainability science.
I will propose an engagement across disciplines in which functional traditional knowledge and contemporary grassroots creativity will provide useful building blocks of sustainability science and technology. If knowledge is conceptualized like "words" in a sentence, then institutions are like "grammar". The culture connotes the "thesaurus" and the ethics is underlying the embedded meanings in certain phrases or usages. We have to analyse the institutional *context* to be able to understand and influence the technological *content* of sustainability science.

I have argued separately[4] that in many cases it is easier to be just than to be fair. I am suggesting the need for developing a theory, which gives privacy to fairness while ensuring justice. Sometimes, intra generational fairness because of the reasons mentioned above is a precondition for ensuring inter-generational justice. If the children of local knowledge experts do not have incentive to keep the knowledge systems alive, then future generations will be deprived of the access to a living laboratory of experimentation and creativity. A grave injustice to future generations will follow because we could not develop norms of fairness in the current generation. We cannot address the issue of fairness knowledge systems without bringing into question the very basis by which justice is defined by institutions regulating and monitoring the interface between formal and informal knowledge systems. Once we do it, we can indeed bring a theory which will give priority to fairness vis-à-vis contemporary justice. It may help in bringing in the issue of inter generational justice requiring intra-generational fairness.

The interface between formal and informal knowledge systems will have to be governed by new ethics which will be fair to the knowledge extractors and providers in a manner that incentives for knowledge production, reproduction and transmission to future generations continue to not only exist but also increase. Never before has so much erosion of community knowledge taken place as is the case currently. The crucible of creativity at the grassroots is fragile. Individual as well as community innovations and traditional knowledge provide a continuing tradition of innovation in most

[4] Gupta, Anil.K., Is a just system also fair? Traversing the domain of knowledge, institutions, culture and ethics. Published in "Who Owns Knowledge? Knowledge and the Law" (Eds. Nico Stehr and Bernd Weiler), London, Transaction Publishers, 2008, p. 87 – 97