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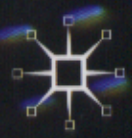
The Innovation for Development Report 2009–2010

Strengthening Innovation for the Prosperity of Nations

Augusto López-Claros



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Augusto López-Claros, Editor
Director, EFD–Global Consulting Network

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European Business School

Augusto López-Claros
Editor

The terms country and nation as used in this report do not in all cases refer to a territorial entity that is a state as understood by international law and practice. The term covers well-defined, geographically self-contained economic areas that may not be states, but for which statistical data are maintained on a separate and independent basis.

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Chapter 2.5

Grassroots Green Innovations for Inclusive, Sustainable Development

Anil K Gupta,[1]
Indian Institute of Management, Ahmedabad and
National Innovation Foundation

Open innovation[2] or user-driven innovation[3] models have been recognized as important tools even by large, traditional companies which have long relied on internal R&D as a major source of innovations. These companies are not only often unable to meet the needs of their existing clients from within, but they are also constrained in their ability to identify and meet the needs of excluded clients.

Despite the capability of these platforms to generate solutions to many problems, the ability of corporations to influence the lives of common people with a variety of products and services has not increased in the recent past. It is now realized that mere reliance on market forces will not work to fill innovation gaps or for disseminating innovative ideas, products, and services among disadvantaged segments of the population. Thus, there seems to be a crisis in a) the sourcing of ideas which can add value to existing knowledge, b) disseminating innovations in a manner that users can adapt to their local context, and c) co-creating solutions for the future that will ensure ecological integrity and social stability by providing opportunities for an improved life for the most disadvantaged. I am not including in this discussion applications of open-source or free software networks, but am confining myself to a discussion of the hard technologies needed by knowledge-rich but economically poor people.

In this paper, I argue that the Honey Bee Network approach, described below, offers new ways of thinking which can help even the formal, organized sector learn from grassroots innovators and traditional knowledge-holders, and enable them to solve problems in an *affordable, accountable, and accessible* manner. I advance three arguments:

- Lack of material resources spurs knowledge-intensive innovation by common people in the informal sector, and thus provides a basis for sustainability by reducing entropy;
- Many grassroots innovations are important, not only be-

[1] Much of the content in this paper has evolved from close interaction with professional colleagues and grassroots innovators in the Honey Bee Network (sristi.org) and friends outside. I must thank Ramesh Patel, Purushottam, Vipin Kumar, Nirmal Sahay, Jayshree, Hiren Prajapati, Riya Sinha, Chinzah Lalmanjuala, Nitin Maurya, Vivek Kumar, Hema Patel, Deepa Tripathi, and Mahesh Patel, for the idea of the distributed supply chain of herbal products; Sivaprasad Chauhan for acknowledging innovators on the package of the products; Mansukh Bhai Jagani for the multi-purpose/functional, motorcycle-powered agricultural machine patented in the U.S.; Amrut Bhai Agrawat for horizontal networking through experimenting farmers workshops, etc. I would like also to acknowledge the support received from many other colleagues in IIMA, SRISTI, GIAN, NIF and SRISTI Innovations.

[2] Chesbrough (2003). Milton Sousa (2009) rightly observes, "It is clear that successful innovation under complexity, uncertainty and change can only be achieved through collaborative approaches that integrate knowledge inside and outside the organization." See also Huston and Sakkab, 2006.

[3] See Allen (1983), quoted by von Hippel (1987). See also numerous papers by von Hippel and his colleagues on user-driven innovations at http://web.mit.edu/evhippel/www/papers/evh-03.htm See in particular von Hippel (2005) and Frank Piller (2008) at: http://www.mass-customization.de/download/piller_2008-pribilla.pdf
Piller reinforces the notion—popular among scholars in this field—that users have incentives other than salaries, monetary compensation or rewards, although many companies do give such awards to the best ideas. The majority do not compensate users, nor do they give them explicit credit on product packaging or brochures. Crowdsourcing, mass sourcing, or distributed strategies for getting ideas

cause they are low in cost and locally sustainable, but also because they offer new problem-solving techniques which can be applied in different contexts;

- Several innovations can be blended by pooling the ideas of different innovators or communities with the scientific and technological knowledge of the formal sector to develop value-added products and services.

If social inclusion is to take place, then many assumptions inherent in the dominant developmental models will have to change, and the role of the state, corporations, and civil society redefined. The classic model of corporate social responsibility will not work in the future, because one cannot first create exclusion and then hope to do something for those who are left out. The strategies for inclusive development will have to build upon the resources in which poor people are especially rich: their knowledge, values, social networks, and institutions. Of course, not all of these factors are equally strong or relevant in every case, but only by recognizing their role will inclusive social development be achieved.

In the first part of this paper, I examine nature as a source of sustainable logic in grassroots innovations. In the second part, I discuss the scope of learning from a variety of green grassroots innovations mobilized by the "Honey Bee Network," an organization developed (on the model of how bees cross-pollinate) for the purpose of learning from the ideas of common people and communities, who are given due credit for their knowledge and ideas.

Learning from nature: A framework for sustainability

In nature, frugality, multi-functionality, simultaneity, and diversity are basic to sustainable resource use. And yet, the institutions that govern the logistics of modern package design, transportation, inventory location, and movement patterns disregard some of these features. In part, this arises because of the way we view markets and their functions in a society in which resources are assumed to be artificially abundant. The recent crisis in the financial markets has highlighted the unrealistic nature of the assumptions underlying commodity markets. This must change.

If 30 percent of goods produced in a rural hinterland are going to be consumed within, say 300 km, or within three months or less, should the storage, packaging, transportation and the entire supply chain not reflect this reality? In the search for optimal solutions for verticals, are we neglecting the horizontals, and, therefore, the connections among communities? Proximal transactions do not have to be analyzed only in terms of remote supply chains. Today most things are packaged for long-term storage, long distance supply, and multiple points of handling. In a mass consumption society, this was imperative for efficiency. But, with changes in energy and other resource constraints, our assumptions about designing logistical solutions must also undergo basic transformation.

It is here that grassroots knowledge, values, and institutions can perhaps come to our rescue. In every culture, the strengthening of vertical markets has weakened the neighborhood economy. Maintaining individual inventories always consumes more resources than community management—privacy of consumption being celebrated in vertical markets. But, in order for social or community-based/graded/ranked/or influenced consumption to generate more optimal solutions, changes in life style will have to be made. We must realize that autonomy, flexibility, unregulated freedom, and excessive resource consumption carry a high price tag.

Can we moderate our need for autonomy in the short run and gain more autonomy in the long run? Such things as carpooling, the collective purchases of household goods, and shared responsibility for goods and services have already begun to be practised in many cultures in response to the challenge of sustainability. From small scale, scattered, and spontaneous steps, we must now make the transition to large scale, systematic, and organized change in designing our future.

Following are some examples of these changes:

Frugality. When I was a child, shopkeepers would often wrap goods in a piece of old newspaper and tie the package with string. There was no plastic then and even paper bags were costly, to be used only to wrap heavy things. Once the package was brought home, my grandfather would spread the newspaper under the bed and hang the string on a nail, for future reuse. Over the years, natural resources have shrunk, but the scale of our consumption and "footprints" has expanded enormously. The design of packaging material, shelves, transportation systems and consumption patterns will only change when different cycles of production and consumption ex-

change are reconsidered. Then we will use sturdy packaging material only for long-term and long-distance consumption. This will have an interesting spillover effect: once we modify the logistical chain, community markets will become more competitive. Face-to-face interaction among consumers and producers will take place more often, altering the entire politics of regional and sectoral development.

Multi-functionality. Higher multi-functionality means less waste and better resource utilization. Most cultures in developing countries are multi-functional in their orientation. When goods and services are well designed, multiple functions are considered. This is evident in the grassroots design of user-driven farm machinery and other tools. The skills, resources, and tools for multi-functional design are quite different from those needed for highly specialized and single-function goods and services, such as a motorcycle or two wheeler used only for transportation. Single-function tools have much greater redundancy and waste energy and resources. Multi-function devices and services—such as the same motorcycle or two-wheel scooter used for ploughing land, removing garden weeds, grinding flour, or washing clothes— have much higher feedback loops and thus reduce waste, ensure higher stability, and justify consumption.

Simultaneity. In nature, there is a constant and simultaneous exchange and flow of services and energy in different directions. Such exchanges require different kinds of logistical chains, which in future will have to integrate the anticipated disposal of recyclable, reusable, renewable resources, and also of those which cannot undergo any of these processes, i.e., true waste. In nature, the species which digest biomass co-evolve with biomass-creating species. This co-evolutionary model can also be applied to humans. Logistical systems will have to mimic ecological exchanges in real time, so that environmental load can be reduced and the "sink and the source"[4] can be redesigned. The simultaneity of exchanges at the community level may give rise not only to disposal, but also to innovations in pooling, sourcing, transportation, storage, and consumption. The negative externality will always be higher when all these transactions have to take place at the level of the consumer, whether firm or individual. In other words, coordination of individual choices in the short run to expand the autonomous choices in the long run has to become the mantra of logistics. For instance, the continuing lack of coordination in purchasing and replacing daily supplies for a household or small enterprise creates excessive individual inventory, waste, more potential energy trapped in immobile resources, and consequently higher cost for internalizing negative externality. This is what is happening today in most "developed," highly urbanized communities worldwide, in which individuals keep much high inventories of such goods to ensure personal comfort and convenience, and do not coordinate their preferences and consumption cycles with their neighbors. Enormous waste of energy and materials results when these goods are not consumed within their safe shelf-life. Although with lower energy prices and higher savings, some societies might manage for the time being, the situation is changing drastically and, some say, irreversibly.

Diversity. On the shelf of any supermarket, small shop, roadside stand, or even home delivery vendor, we invariably find only one or two varieties of a particular vegetable or fruit. Even these few varieties are bred for longer shelf life, more beautiful display, and easier transportation, handling, and storage. If taste and the nutrition suffer, so be it. But that is not necessarily the wish of the majority of people, who would probably appreciate a greater diversity of taste, color, shape, and aroma for both aesthetic and nutritional purposes. But irregularly shaped tomatoes are not considered beautiful. Aesthetics is determined by logistics and the incentive for preserving cultural diversity reduced. Means and ends have become confused, adversely affecting health and nutrition. But the world is beautiful because it is diverse. Agronomy, plant breeding, soil and ecosystem health, human and animal health, and working relationships will undergo complete transformation if diversity in consumption becomes the primary purpose of designing supply chains. There are other implications for logistics: diverse foods or vegetable-dyed textiles would have to be characterized differently and labeled to inform the consumer more accurately about biodiversity and the habitat of raw materials and ingredients. Since vegetable dyes may not always be uniform, consumer preferences will have to accommodate variable coloration. Just as markets created preference for uniformity, the challenge in future will be to do just the opposite. At the same time, packaging and transport logistics

[4] Gupta, 2006.

will have to adapt to new needs. For instance, a whole range of technological innovations will be needed to package diverse fruits, vegetables, and other materials. Human needs and preferences for a sustainable world must guide and trigger technological innovations, supply chains and logistical arrangements, not the other way around.

The famous German ethnologist and Nobel Laureate, Konrad Lorenz, gives a fascinating example of this conceptual framework (Reidl, 198[5]). He suggests that when we examine the feathers of birds, or fish fins, or tree branches, we see the limited range of angles at which these feathers, fins, and branches are set. The entire diversity can, in fact, be covered by a range from 15–90 degrees. Reidl draws upon the work of Lorenz when he says that nature has a few designs which she plays with in a parsimonious and frugal manner over and over again.

Until we discover simple principles and incorporate them in the redesign of logistical systems, the world around us will not become more humane, green, compassionate, and collaborative. Creativity and innovation will inevitably follow in the process of opening up the design and implementation process. If such were not the case, large corporations would not turn towards users and other supply chain members for ideas and innovations. Around the world, corporations are recognizing that it is not correct to confuse the system of R&D with innovation and innovations systems with intra-organizational creativity.

The same simplicity, frugality, multi-functionality, and diversity is witnessed in many grassroots innovations. Where do these innovators get their values?

Learning from grassroots innovators

Learning from common people who are not formally trained in a technical institution, who may be illiterate, and who may not know much about "scaling up" is not common today. Sourcing ideas from the ground up is not the first thing that comes to the minds of public policy makers or heads of corporations when they think about social transformation. Even in areas where such technologies as cell phones do penetrate the non-urban "interior," the applications for bridging knowledge and technology gaps often take much longer to come about, if at all. Despite 400 million cell phones sold in India in the last decade, we do not have even 40 applications for empowering knowledge-rich but economically poor people to improve their lives, for creating markets for their cultural or artisanal skills, or for helping them to disseminate successful local solutions. Without major modification in its image-processing capacity, for example, a camera-phone cannot be used to do a microscopic analysis of water or food. There are countless other examples of technology that has not been adapted to serve a larger social good. Hence, either the designers of technologies or other services in the government or private sector do not learn from the people and understand their needs, or they do not have the commitment to be more inclusive. It is possible that some of them do, in fact, wish to be inclusive, but have not found a way of tapping the creative potential of common people, so that social and knowledge gaps can be bridged.

If learning about developing new applications of existing technologies for social inclusion is so difficult, it would appear to be even more difficult to explore and add value to innovations developed by people at the grassroots without outside help. As mentioned earlier, there are concerted efforts being made by some large corporations[6] to use the open-innovation model to involve users in generating solutions for their problems. One excellent example is Lego,[7] where users can create new designs.[8] This began in 1999, when different users hacked the software and posted it on a website. Lego's response was

[5] Riedl, 1984.

[6] See the "connect-develop" platform of Procter&Gamble, which aims to develop more than half of its products based on ideas sourced from outside the company in the next few years. The company asks its public: "Do you have a game-changing product, technology, business model, method, trademark, package, or design that can help deliver new products and/or services that improve the lives of the world's consumers? Do you have commercial opportunities for existing P&G products/brands? If so, we'd like to consider a partnership." See: http://www.pgconnectdevelop.com/pg-connection-portal/ctx/noauth/PortalHome.do
See also the bibliography of sources on the open innovation model at: http://www.openinnovation.net/Research/Bibliography.html

[7] Eric von Hippel, Professor at the MIT Sloan School of Management (and close collaborator of the Honey Bee Network) observed, "Lego offers a good example of a smooth transition. . . . Within that firm there were maybe about 20 people who were looking at an open model for new product development. Top management protected and encouraged them, and they are managing to build within an old firm a new way of doing things that is gradually making a transition for the entire Lego company. . . . The transition to open can be done without major disruptions, but it's not easy." See: http://www.deloitte.com/view/en_US/us/Insights/Browse-by-Content-Type/deloitte-review/article/7930c99d77ea2210VgnVCM200000bb42f00aRCRD.html

[8] On 25 August 2009, reviewer Anton Olsen wrote about the new possibilities offered by Lego's potential open-source software and hardware, saying: "However, LEGO has a good policy for groups who wish to take the NXT a little farther. They openly support the hacker community with an open-source version of the NXT firmware, provide detailed hardware information including schematics of the NXT and sensors, and give specifications for interfacing third-party and home-built sensors. They even provide a complete Software Developer Kit (SDK)." See: http://www.wired.com/geekdad/2009/08/hacking-the-nxt-with-legos-blessing

to remain neutral, neither encouraging nor discouraging the hacking. Today, it openly invites users to play with various options and share their results with other users. But it would be a quite different matter if solutions were generated by those grassroots users and taken over by a company such as Lego to develop a commercial product, without sharing the benefits or credit with those who provided the innovative solutions.[9] How can we bridge the gap between the formal sector—private corporations, public/R&D institutions and other international developmental organizations—and the creative and innovative capacities at the grassroots? What can be done to replicate the experience of the Honey Bee Network in India in building bridges with the Council of Scientific and Industrial Research (CSIR) and the Indian Council of Medical Research (ICMR)? How can the private sector not only license the technologies developed by farmers, artisans, mechanics, and other lay people, but also share the benefits and credit, and draw more fully on the creative abilities of common people?

The Honey Bee Network experience[10]

More than 20 years ago, the Honey Bee Network was established, based on four principles:

1. When we learn from common people, they should not remain anonymous, but should get due credit for their knowledge, whether developed by individuals or communities;
2. We should try to connect people to people to cross fertilize their ideas, just as bees carry out cross-pollination; this is possible when we communicate in the local language, compare findings with the knowledge gained from the people, and seek their informed consent if the knowledge is unique;
3. Any commercial benefits accruing from the knowledge provided by people (with or without value addition) should be shared in a fair and just manner with those who have provided their ideas;
4. The process of knowledge exchange is kept transparent, with confidentiality being observed when people so desire, and intellectual property rights respected.

These principles were developed even before the appearance of the Convention on Biological Diversity and other debates on individual knowledge rights. In these two decades, the Honey Bee Network has grown from a few hundred ideas, innovations, and traditional knowledge practices to more than 100,000, pooled in a national database on the subject maintained by the National Innovation Foundation set up in 2000. It goes without saying that not all of these ideas are unique or of significant value.

Five years ago formal agreements were signed with the CSIR and three years ago with the ICMR. Outstanding results have been achieved, proving that grassroots innovations and traditional knowledge can not only generate good solutions to local problems, but in some cases also extend the frontiers of science. This blending of formal and informal science, technology, and innovation systems is likely to increase, as the National Innovation Foundation (NIF)—initially funded with only US$400,000 per year—will probably receive five times this sum in funding when it becomes the Institute of the Department of Science and Technology of the Indian government. Although funding may still not be the only critical factor in bringing about significant change, it will, nonetheless, make a substantial difference to the grassroots innovation movement in the country.

The Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI, a voluntary, development organization set up in 1993) soon gave rise, in 1997, to the Grassroots Innovation Augmentation Network (GIAN), a regional incubator for converting innovations to enterprise. The NIF came into being in 2000, with the goal of scaling up the innovation system in the informal sector. With modest, but significant, support from the Sadhbhav Foundation, a private trust, SRISTI also set up a natural product laboratory, to add value to people's knowledge, to take these products to market through SRISTI innovations (a non-profit company), and to pursue innovations in the fields of culture and education. SRISTI has developed many herbal technologies for sustainable resource management. Most of these grassroots innovations are green in nature. There is no alternative but to build on these innovations, while exploring sustainable options in future.

Many of these products are now being manufactured and distributed through an ethical supply chain, such that in sourcing as well as in distribution, local communities are being involved and the benefits shared with the people. In some cases, technologies have been licensed to commercial companies, following a benefit-sharing model developed by SRISTI. The names of the communities and, in a few cases, even the

[9] We need to look at the IP that users are sharing with the corporations and for which not all companies share any reward.

[10] See Gupta, 2006, 2007b, 2007d, and 2008a.

photograph of the innovator, have been included on the packaging by the agricultural growth promoter.

The pattern of "celebrity endorsement" is being replaced by endorsements by ordinary innovators and users. If a company markets a small farmer's innovation, he may then endorse the product. For example, a herbal growth promoter for agricultural applications was developed by SRISTI-Sadhbhav Sanshodhan (a natural product lab of SRISTI) based on knowledge provided by a farmer, Popat Bhai. It was then marketed by the Hyderabad-based company Matrix Bioscience with a photograph of the innovator on the bottle. This was a way of announcing to all farmers that one of their own had invented the product and shared his knowledge, thus making the innovation accessible to other farmers. In this way, one individual's creativity can help thousands of others and stimulate other users to participate in the innovation supply chain. Every package carrying such information provides an incentive to users to write back to the NIF if they have an innovation to share.

SRISTI service centers have been set up in different villages by farmer members of the Honey Bee Network to try, demonstrate, and sell herbal crop enhancers with pesticide properties to other farmers. The profit margin given to wholesalers is then distributed among farmers—at a discount of approximately 40 percent of the retail price—who can demonstrate the technology to others. To ensure that people who cannot afford to buy products are included, solutions are also made public by means of booklets, websites, and training sessions.[11] Those who want to create their own product are encouraged to do so. In this way, we are promoting many more models which combine intellectual property and open-source in a creative manner. Recently, in a workshop of innovators who had developed various modifications around a core technology, it was decided to develop a "technology commons," allowing and encouraging people-to-people copying, but requiring a licensing procedure for people-to-firm use.[12]

Many more models of this kind remain to be developed in coming years, and we foresee many changes, such as the following, in the way markets may be organized:

- ***Modular design.***[13] More and more modular products will be developed, giving users the option to combine these in the manner they want, and sourcing different modules from different suppliers.[13] For example, a modular cellphone, "smart" component can be attached to an electrical appliance (say, a microwave oven) and remotely switched on or off, so food can be ready at a set time when people come home from work. Just such a device has been developed by Prem Singh, a school dropout. But the switching device is costly. When modular technology is readily available, it will be much cheaper for a user to convert any device into a smart remote-operated one.
- ***Collaborative product and service design.*** This is likely to become a dominant way of matching the needs of the people with the distributor supply chain. NIF has recently established a FABLAB for digital fabrication (designed by Neil Gershenfeld and his colleagues at MIT) and connected to similar ones in 12 cities across the globe. A grassroots innovator can seek help from any of them to convert her idea into a product with distributed mentoring and design.[15]
- ***Low-scale markets offered to large-scale distributor networks.*** Today, scale has become the enemy of sustainability. Small-scale needs or demand do not get the attention of leading manufacturers because of the high-cost supply chains they have developed. Niche products can serve niche markets, but they can also serve large modular markets through intermediaries. For example, if people in a particular region enjoy recipes using local, uncultivated but edible, plant ingredients, the foods can be stored, packaged in cheap, biologically safe, materials and made available to local inhabitants by a horizontal supply chain in small scale and at shorter distance. The same products can also be marketed in suitable packaging by global networks, "long tail" fashion,[16] to discerning consumers worldwide.

[11] See the innovation and traditional knowledge base at: www.sristi.org These databases represent the single largest source of such knowledge for more than 20 years, and by now should have multiplied many times over. The fact that they have not is an indication that we still seem to be wary of learning from ordinary people. Development foundations and UN organizations would do well to make this a priority goal.

[12] Sinha (2008), based on her doctoral work supported by SRISTI.

[13] See also Sanchez and Collins (2001) and Lau and Yam (2005).

[14] See Ding-Bang Luh and Chia-Ling Chang, 2008.

[15] See a recent book on this subject by Li et al., 2007.

[16] "Long tail" is a type of frequency distribution in which small volumes of hard-to-find items are inventoried and distributed at a significant profit to many customers, in contrast to selling large volumes of a product to a small number of consumers. The group that purchases a large number of "non-hit" items is the demographic called the "long tail." See Anderson, 2004.

- ***Differentiation through development and inclusion rather than exclusion.*** Many large companies today pride themselves on serving exclusive client groups; however, exclusivity is not only a matter of economic status, but can also be a reward for social and cultural contributions. A teacher distinguished for his or her service to the children in a primary or secondary school is no less important than a client who has sold 50,000 cell phones in a week or a month. The current market system fails to take into account the contributions of people across the spectrum of social, ecological, educational, or cultural groupings, the only models for supporting them being either corporate social responsibility mechanisms or charity—both obsolete.

Simplicity in design will more and more become the rule, such that, in the very near future, an elderly person in India should be able to go to a street corner shop and get a cell phone with only three buttons for contacting three children. If he does not want to call anyone else, he does not need more buttons or a screen. The energy cost will go down, as will the cost of the cell phone. Someone else may want a 6"-screen for educational purposes but not for voice calling. An entire range of applications could emerge, if modular manufacturing were applied.

Grassroots innovation will be taught in every school as a way of becoming an inclusive social person. Developing ideas and solving problems individually and collectively will become an integral part of the education of every child. They will learn to combine the following seven "Es": *ethics, excellence, equity, efficiency, empathy, environment,* and *education,* though in different proportion in different activities.

Innovation as a learning and problem-solving template for social application

Specific innovations may often be less important than the principle behind them. Kanak Das from Assam, North East India, noticed that the condition of the roads in his village was very bad. He was not sure how he could improve the conditions of the road, but asked himself whether it might be possible to make the bumps on the roadwork *for* him by generating energy. So he developed the first cycle to generate energy from bumps in the road, a concept that can be used in practically all automobiles. Until recently, when a few students at MIT, who had seen the video of Kanak Das' cycle, with its shock absorber-based energy-generating system, such a device had never been developed in the formal sector.[17]

The late Ravjibhai Savalia of Bapunagar developed a frying pan with a ribbed bottom to conserve energy. The Indian Institute of Petroleum tested it and found that, because of the increased surface area, the thermal efficiency of the pan went up by more than 1 percent. If the same technique were applied to heating tubes in a large chemical plant, heat-transfer efficiency and cost savings would increase significantly. Here again, a grassroots innovation could influence the productivity of large corporations.

Peanut crops are grown in rain-fed semi-arid regions with light soils. Yusuf Khan, an innovator in Rajasthan, developed an ingenious groundnut pod-collecting device attached to a tractor. The collector scrapes the soil from the pods, leaving it on the ground, while the pods remain on the sieve. A small-scale entrepreneur in Visakhapatnam saw this innovation and licensed the technology for developing a beach cleaner, adapting a technology developed in a dry region for a wet coastal one.

Following are a few more examples of how ideas from one domain may influence technological development in another:

A farmer used three different plants to develop a herbal pesticide. One was *neem*[18] well known for retarding or stopping the growth of insects and helping in plant protection. When scientist Dr. Dhananjay Tiwari took it up for validation in a joint project of NIF-CSIR, he noticed a phenomenon which had not been reported earlier. When neem was exposed to ultraviolet rays for only 2 to 20 minutes, the effectiveness of the chemical compound *azadirachtin* in the *neem* declined steeply. The longer the exposure, the higher was the degradation. When one of the remaining plants was added to the neem, the degradation stopped, forming a herbal stabilizer. There are many reports of chemical stabilization of reactive potential. If this can be made generic, a unique contribution

[17] Although Shakeel Awdhany and others who developed this very sophisticated device acknowledged that they had seen Kanak Das' video, they somehow "forgot" to share the intellectual property rights with the grassroots innovator from India or acknowledge their intellectual debt to him. MIT officials did not respond to my communications on the subject. This is an excellent example of the problem inherent in open-source collaborative product design. The more prominent actors often do not acknowledge the creative contribution of weaker partners, much less share any benefits with them. See http://web.mit.edu/newsoffice/2009/shock-absorbers-0209.html
Kanak Das' innovation was also cited in Gupta (2007c) and was awarded an NIF prize by the by President of India, Honourable Dr. A. P. J. Abdul Kalam in 2002 (see www.nifindia.org/secondaward/press_release.html).

[18] "Azadirachta indica," a tree in the mahogany family, native to India.

will have been made by a grassroots innovator towards the advancement of technology.

The member of a tribe[19] in Orissa had used leaves of a particular plant for ripening bananas. (All fruit ripeners used throughout the world are essentially chemicals known as ethylene inducers.) When the laboratory at the Central Food and Technology Research Institute in Mysore tested this claim, they found that the herbal fruit ripeners not only worked as claimed, but also changed the ratio of reducing to non-reducing sugar. The result was a more nutritious fruit, a botanical development previously unreported in science.[20]

Two brothers in Assam, Mehtar Hussain and Mushtaq Ahmed, developed an inexpensive US$100-windmill to pump water to irrigate a small field. The pump was adapted by the Grassroots Innovation Augmentation Network (GIAN),[21] with the help of NIF for use by salt workers to pump out brine. It was further modified and adapted for use in a desert environment. At a cost of only US$700–US$800, it can be bent 90 degrees to withstand heavy storms, after which it can be raised to its upright position. Recently, an inquiry was received from one of the first nations in the Canadian Arctic, who wanted to use it for generating energy. It is highly unlikely that such an innovation would have emerged in an environment of material abundance.

Such frugal innovations, inspired by "Gandhian engineering," as it is called by Dr. R. A. Mashelkar, Director General of CSIR and President of the Indian National Science Academy, will emerge only in an environment where knowledge is maximized and materials economized.

Lessons for modern organizations and supply chain managers

Following is a selection of concluding recommendations, drawn from the above experience:

Reorganize consumption and production relationships. When technologies are developed by producers who are also users, they better reflect the concerns of both the production and consumption environments. Quality control and frugal design are inevitable consequences.

Invest minimal energy in packaging. A firm will not bother with elaborate packaging if 60 percent of its product is consumed within three months or within 300–500 miles of the point of origin. Products are often over-packaged, as if they were to last a year before consumption and transported more than 1000 miles.

Pay for diversity in taste and appearances. Seldom can one find more than one kind of vegetable or fruit in supermarkets. For supply chain managers, uniform products are easier to pack, transport, and distribute. New ways of sourcing, storing, transporting, and distributing bio-diverse products must be found, as both cultural and bio-diversity are closely linked and mutually reinforcing.

Create frugal design and development processes. A whole range of new platforms will have to be developed to design diverse and affordable products to meet diverse needs. Mass production-based supply chains of uniform design are a thing of the past. Instead, collaborative product design will take place in an environment where the seven "Es" are practiced in an open-sharing platform, and the school curriculum will reflect the importance of building on the ideas of the common people.

Solve unsolved problems. Communities will take ownership of problem solving instead of tolerating such injustices as millions of women carrying water long distances on their heads or manually plucking tea leaves. Time targets and dedicated funds will solve many of these and similar problems which the world now ignores.[22]

Create global markets of grassroots products (g2G).[23] NIF has not only sold products emerging from grassroots innovation on all six continents, but has also received inquiries from all over the world. Grassroots innovation and traditional knowledge-based products must receive adequate attention in global markets. Large-scale changes will have to be implemented in the innovation ecosystem and multimedia, multilanguage, knowledge, and innovation databases much better recognized. Likewise, building on the worldwide emphasis on the positive benefits of microfinance will be an awareness of microventure finance (MVF), a concept currently neglected in the lexicon of social development, to the detriment of innovative potential at the grassroots.

Redesign supply chains. Ethical as well as efficiency criteria will demand that we redesign the supply chains by linking dis-

[19] The patent (No: 295/KOL/2007) for the herbal fruit ripener developed by Sahu Budhadeba was filed by NIF on behalf of the innovator on 26 February 2007.

[20] Sinha (2008) based on her doctoral work supported by SRISTI.

[21] See recent papers on linking traditional knowledge and modern science by McGovern et al (2009) and Gupta (2007).

[22] see Gupta, 2009.

[23] See Gupta, 2008.

tributed, decentralized, and diversified sourcing and distribution systems. It is imperative that we redesign production and consumption relationships so as to reduce the gap between producer and consumer. When more and more people contribute their labor, skills, inventiveness, and other resources, we will be able to develop low-cost procurement and distribution systems. For instance, increased numbers of fabrication labs[24] and a network of tool rooms will lead to user-designed products and services. Vertical supply chains will become horizontal. Lifestyles will change to include purchasing from the neighborhood village and community. There will be greater scope for enhanced international trade in value-added products instead of primary commodities. More and more value addition will take place *in situ*, so that its benefits accrue to both producers and workers.

In other words, the entire development paradigm must be rethought, so that the decision-making options of both rich and poor are enhanced and the time frame in which they occur is lengthened.[25] Some people think in terms of surviving the next day, while others have the luxury of being able to plan for the next century. When these time horizons converge, we will have a society in which the skills, knowledge, and resources in which poor people are rich are validated more fully.

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[24] See the pioneering work of Professor Neil Gershenfeld, Director of MIT's Center for Bits and Atoms, which he is trying to link with the needs of grassroots innovators. (Available at: web.mit.edu/spotlight/mobile-fablab)

[25] See Gupta et al., 1995.

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