Structuring the present for a sustainable future*

Biodiversity is recognized as the key for secure livelihood at all levels of endeavour. It is a paradox, however, that resource-poor people inhabit biodiversity-rich areas. Good examples are the tribal tracts in Orissa, Andhra Pradesh, Madhya Pradesh, Kerala and Tamil Nadu in India. Those poor tribal farmers had all along been maintaining plant genetic diversity, for instance, at their personal cost though their benefits continue to be enjoyed by the well-endowed and rich community. Unpredictable and harsh weather, erratic rainfall, increasing costs of inputs, wide gap between potential and realized benefits from agriculture, continuing pressure to rise to the growing demands of normal living and the lack and non-reach of knowledge and benefits of modern agriculture have made the biodiversity-rich farming community vulnerable to commercial exploitation. Their areas are leased for highly disproportionate compensation. In turn, commercial crop varieties came to replace traditional plant species, landraces and local varieties rapidly. Genetic erosion thus set in and continues.

Varieties evolved by farmers over a long time, known also as landraces carry, for example, valuable genes governing the traits tribal farmers prefer, particularly taste and cooking quality. The expression of such traits is highly site-specific and environment-sensitive. Current traditional practices do not realize optimal yields. There is thus an inadequate food supply with no surplus. Eventually no local or commercial markets evolve. A structural change is therefore needed to reverse this situation.

A first step to economic benefits is to derive more yields from the currently grown landraces or local varieties. This step has to be reinforced with new, cost-effective paradigms of sustainable and profitable use of biodiversity. Resulting rise in economic returns has to catalyse new avenues of genetic enhancement, conservation of gene sources, and evolution and upgradation of local markets for livelihood enhancement. Scientific skill has to prime people's perceptions and synergize science with tradition. Then will emerge new paths of participatory endeavour for ensuring a sustainable and secure livelihood. Sustainable future would depend on such paradigms.

Sustainable future concerns almost every sector in India – be it political, professional, agricultural, industrial, sociological or any other. Concerns may be at varied levels, but all of them converge on sustainable livelihood of the common citizen. In the context of the predominantly agrarian economy of India, secure and sustainable livelihood of the farmers, including the poorest of the poor, would be top priority. To address this need, it is essential to visualize the current status of agriculture in India, recognize the present facts, evaluate paradigms and adapt them as strategies for a sustainable future. This note is an attempt in that direction.

The present

Despite the fact that India has surplus of foodgrains, there are disturbing facts in the current scenario of food production such as

- the fatigue of green revolution,
- retarding productivity increase,
- debility of routine paths of plant improvement,
- anaemic innovations inadequate to enhancing productivity appreciably,
- spectacular achievements only in the two cereals, wheat and rice leaving behind pulses, oilseeds and others relevant for balanced food adequacy, and
- production accounted mainly by a small number of endowed farmers, leaving a large proportion of poor, rural and tribal farmers out of reach.

At the technology level, high-yielding variety (HYV) development in India has been the major area of attention of the research institutes of the Indian Council of Agricultural Research and various state agricultural universities, though a few private sector organizations also take part. Government departments in general are in charge of transfer of HYV technology. Endowed farmers usually adopt the technology of growing input-intensive HYVs, while some 'laggard' farmers follow those progressive farmers. Being adapted only to specific environments, the reach of HYVs is restricted. HYV technology is ill-suited to poor farmers and the fragile and harsh environments governing their farming lands, despite their rich biodiversity. Therefore, it is essential to develop site-specific development options to help such rural and tribal farmers.

About 300 million people, roughly 25% of the world's poor, live in India. With an expected population rise to 1.3 billion by 2020, structural shifts in consumer preference, large gaps in income, wealth and opportunities between the rural and urban population are predicted. The rise in the demand for cereals from 147.1 m metric tonnes in 1993 to 246.1 m metric tonnes in 2020 is within reach. But the almost four times increase in the demand for meat, eggs, milk and milk products would be difficult to meet[1]. The rising population will cause a rapid decrease in water availability both for human and agricultural needs, posing a potential challenge[2]. Nutritional and health deficiency is increasing in urban and rural areas; even Punjab and Haryana, where the green revolution made a mark, are not exceptions. The consequent effects on the social and economic health of the population also need special attention.

The facts

The science of plant breeding played a phenomenal role in bringing in the green revolution, recording quantum jumps in productivity and production of cereals, particularly of wheat and rice. India transcended from a state of want and penury to a state of plenty and prosperity. But the vertical increase in productivity could materialize only in areas where the farmers could provide high inputs, especially irrigation water, chemical fertilizers and pesticides. The reach of HYVs thus was restricted and confined to endowed farmers. HYV technology thus contributed, in a way, to increasing the divide between rich and poor farmers and hence to a lopsided agrarian prosperity.

HYVs are bred under monitored experimental conditions and their adaptability and high yields are tested in farmers'

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fields in various agro-ecological regions. The technology of cultivating HYVs is preferentially propagated in regions where they adapt with high yields. HYVs are thus bred FOR an environment and not IN an environment. But germplasm available *in situ* is potential to breeding IN those environments, specific varieties that can yield high. Further, such areas are not conducive for high inputs to grow HYVs. HYVs bred in a rich environment do not also express their potential in such fragile environments.

Yet rural and tribal population, predominantly agrarian, is more than twice the urban population (Table 1). Tribal farmers are also highly tradition-bound, particularly in their social, cultural and food habits. Their cooking and taste preferences are not met by HYVs. Therefore, they prefer to grow local cultivars and landraces, adopting traditional practices of cultivation. But such practices do not realize potential yields of even the traditional cultivars in harsh environments. Thus such areas are leased for highly disproportionate compensation that is then grown to commercial crop varieties, thus replacing traditional plant species, landraces and local varieties rapidly. The net result is increasing genetic erosion.

Landraces, for example, carry valuable genes governing traits that tribal farmers prefer, particularly taste and cooking quality. Such traits are highly site-specific in their expression and environment-sensitive. The current traditional practices do not realize optimal yields. There is thus an inadequate food supply with no surplus. Eventually no local profitable markets evolve. A structural change is therefore needed to reverse this situation.

India has a vast area under dry (≈70%) and degraded lands (≈58%) with a high population density in such areas[3]. Special attention is called for to ameliorate the poor living under such conditions.

It has been observed that tribals who constitute 8.4% of India's population (according to the 1991 census) conserve 90% of biocultural diversity and protect the polyvalent Indian identity from biocultural pathogens[4]. Among the 9500 wild species of plants, the tribals have identified 7500 of medicinal value[5]. Several species are used in various systems of Indian medicine like Ayurveda, Siddha, Unani and even Tibetan, and some in more than one system[6]. Several medicinal plants have been the base for manufacture of brand medicines; for example, *Trichopus zeylanicus* (arogya pacha) is the base for the medicine, *Jeevani* for removing fatigue and *Bacopa monnieri* (brahmi) in memory plus tablets for improving memory. Some others like *Phyllanthus amarus* (kizhanelli) have been identified for treating Hepatitis B infections. Plants like Karanj, Ipomoea, Mahua and swallow root (*Decalepsis hamiltonii* Wight & Arn.) have been found to work as biopesticides and are effective against insects like brown plant hopper, leaf folder, weevil and flour beetle infesting rice crop and rice flour[7,8]. Thus evidence is abundant and effective that biodiversity in tribal areas has a high potential to provide for sustainable and secure livelihood. The need therefore is to devise location-specific biodiversity-friendly strategies.

The paradigms

Participatory approaches have been recognized as a key option to ensure community development in general. The PEA (participatory extension approach) has five major components: (a) a social mobilization phase in which the needs and problems of target communities are identified in consultation; (b) an action planning phase in which prioritization of problems is done and local institutions are mandated to involve the community in participatory approaches seeking solutions to the problems; (c) experimenting while implementing action in which designed experiments are built into the action plan to test their efficiency; (d) sharing experiences with the community to raise problem awareness and also to enlist continuous community participation, and (e) self-evaluation which is important to boost the spirit of scientist-community participants and also to effect mid-course corrections, as needed[9].

The watershed development programme in Jhabua district, Madhya Pradesh designed and executed on a participatory mode by the people, scientists and the Government was a good example of the PEA. For instance, total gross production at 160 million tonnes in 1995 with a value of Rs 0.32 million rose by three times in 1997 with a value of Rs 0.98 million.

The M.S. Swaminathan Research Foundation (MSSRF), Chennai, aiming to improve the livelihood of tribal farmers of Jeypore tract, Orissa made a pilot survey of farmers' fields in 1998 to learn about their traditional practices of cultivation of rice. It was observed that the major problems were

- poor quality seeds,
- poorly prepared land,
- direct seeding with high seed rates (60–80 kg/acre) to compensate for substandard viability,
- resulting in highly non-uniform plant stand and crowding of plants, making weeding, plant protection and other operations difficult,
- poor benefit–cost ratio dissuading cultivation of genetically rich crops,
- lack of resources to ensure optimal crop growth,
- lack of knowledge on techniques of benefit optimization,
- urgency for increased income to meet increasing cost of living, and
- emerging alternatives like leasing out land to earn easy income.

In consultation with the farming community, as an immediate need, simple scientific modifications to traditional cultivation were suggested. Salient ones were proper application of FYM (if the practice is followed), healthy seed selection, timely transplanting in properly spaced rows, appropriate use of irrigation (where prac-

Table 1. Comparative distribution of Indian population (millions)

Year	Urban	Rural	Tribal	Total
1991	219.9[b]	477.0[b]	64.1[c]	761.0[b]
1993	231.6[a]	574.8[b]	73.9[b]	880.3[a]
2020	465.6[a]	765.1[b]	98.4[b]	1329.1[a]

[a]Bhalla *et al*.[1]; [b]Estimates by V. Arunachalam; [c]1991 census.
Source: Bhalla *et al*.[1].

Table 2. Transfer of Technology (TOT) and Participatory Extension (PEA) (after AGRITEX, 1998)

	TOT	PEA
Main objective	Transfer of technology	Empower farmers
Analysis of needs and priorities	Outsiders	Farmers facilitated by outsiders
Transferred by outsiders to farmers	'Commandments' message, package of practices	Principles, methods, basket of choices
The 'menu'	Fixed	According to choice
Farmers' behaviour	Hear messages; act on commandments; adopt, adapt or reject package	Use methods, apply principles, choose from basket and experiment
Outsiders' desired outcomes emphasis	Adapt or reject package, widespread adoption of package	Wider choices for farmers, farmers' enhanced adaptability
Main mode of extension	Worker to farmer	Farmer to farmer
Roles of extension agent	Teacher trainer	Facilitator, searcher for and provider of choice

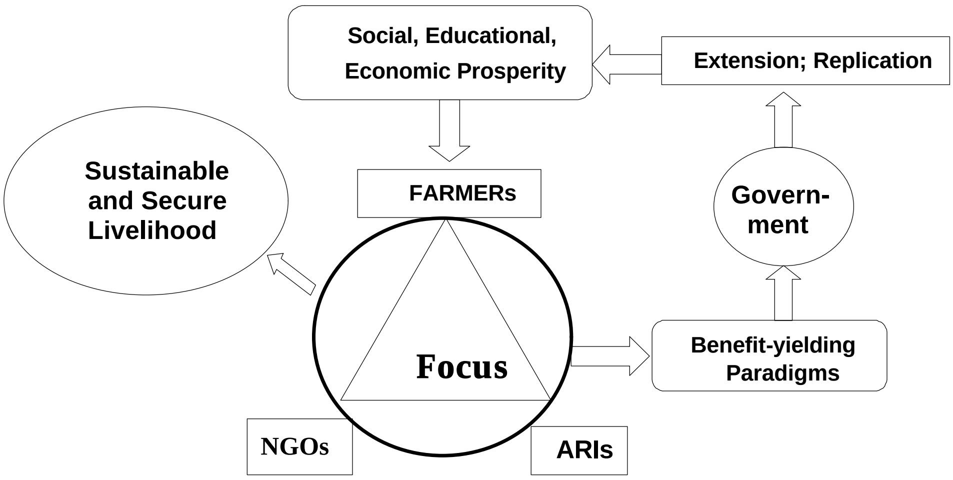

Figure 1. Possible path to a sustainable future (after AGRITEX, 1998).

tised) and timely harvest at physiological maturity. To enable farmers to assess the efficiency of the scientific technology themselves, they were asked to plant a few varieties of their choice both under farmer and modified practices. The results of such experiments carried out in about nine villages were uniformly encouraging. It was clear that yields of rice landraces increased up to 70% under modified practices. Enthused by the results, a large number of farmers, both from villages participating in scientific experiments and from others, planted large plots of rice under modified method during the rainy season of the year 2000. The results confirmed the high yields that were far superior to those that used to be realized earlier. On their own, farmers started extending knowledge of the modified method of cultivation to other farmers. This method proved not only cost-effective but efficient, since a farmer could communicate in a mode and language that the other could effectively understand. The coveting benefits from the modified method were such that some farmers were enthused to pilot-test it even in other crops like pigeonpea and finger millet.

During the participatory improvement programme, farmers themselves identified Kalajeera, as a productive landrace with good aroma and cooking quality. With the husk being black, a colour highly desired by Orissa tribals (with cooked rice becoming white), farmers multiplied this landrace in their fields under the guidance of MSSRF. The price of rice went up to Rs 18–22 a kg compared to Rs 4–6 earlier. Farmers took the initiative to build village seed banks to store seeds. A cooperative mode of marketing and equitable sharing of profit was set in motion. MSSRF as the participatory counterpart in farmers' endeavour helped to structuralize these activities. The speed with which Kalajeera farming has spread to villages far and near provides encouraging expectation.

This participatory experiment has highlighted a few facts: (1) Tribal farmers with strong preference for cultivation traditions handed on by their ancestors are receptive to incorporating scientific modifications in traditional methods, provided they are convinced by field demonstration. (2) When convinced of the efficiency of a scientific intervention, they would take initiatives on their own to extend knowledge on scientific techniques of cultivation to other members of the farming community. (3) In participatory experimentation and extension in which farmers were active and equal partners, there was no place for monetary or other forms of incentives. This was an encouraging and important lesson. Participatory approach is the best option for enabling and ensuring a sustainable livelihood to the tribal poor.

The strategies

The two paradigms summarized above suggest that strategies aiming at sustainable and secure livelihood to the poor should have farmers, NGOs and Agricultural Research Institutions (linked with the Government) as the vertices of a focus triangle from which benefit-yielding paradigms would emanate. They would be extended to the entire farming community and replicated across the state. The resulting social, educational and economic prosperity would continuously be activating the focus triangle to accelerate accrued benefits to the poor (Figure 1).

In this PEA of learning and exchange of knowledge, scientists act more as facilitators than teachers. Farmers function equally as knowledge providers and knowledge absorbers. This activity triangle keeps the morale of farmers high and goads them to achieve further heights. From a number of participatory endeavours across the globe, the salient differences between a formal transfer of technology and PEA can be well recognized (Table 2).

Specific pathways to meet the future demands of India that were thus highlighted were:

- site- and season-specific precision farming,
- absorbing indigenous knowledge (IK) and transferring scientifically-tempered IK,
- high potential rainfed areas (easy option), and
- low potential rainfed areas (harsh environments, natural resource degradation, farmers' aversion to invest in risk agriculture).

The only pathway to address the issues and redress the wants is to resort to participatory endeavours.

If such endeavours help the poor farmers to achieve, at least partially, the five accesses that are hard for them at present, namely physical access, economic access, social access, environmental access and nutritional access, one would believe that a pathway is struck for winning the battle to secure a sustainable future.

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