INFOCHANGE

# agenda

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# New Agriculturist

With roughly 45,000 certified organic farms operating in India, there is finally a rejection of resource-extractive industrial agriculture and a return to traditional, sustainable and ecologically safe farming

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# Towards a new agriculture

All over India rural revivalists are rejecting the corporatised, programmatic, high-input model of agriculture and following agro-ecological approaches in which shared, distributed knowledge systems provide ways to adapt to changing climate and a shrinking natural resource base

*RAHUL GOSWAMI*

THERE ARE TWO SCHOOLS of practice that are used to describe agricultural activity in India. One is the 'industrial', corporate view, developed by a sprawling and overweening bureaucracy that functions through a bewildering range of programmes, missions, campaigns and initiatives. India's agriculture officialdom sees the natural produce of its land and people as distilled into a few powerful equations. At the top of this reductionist, year-on-year corporate view reigns the APY equation — area, production, yield. There are others, some just as old and some new — for example 'logistics' and 'public-private partnership'. In this school of practice, the *kisan* and the cultivating household are treated as human collateral, ultimately incidental to the great task of feeding the nation, useful only to the extent that it obeys instructions.

The other school of practice and method is diffuse and independent. Its practitioners come from a variety of backgrounds and some may even have been a part of the bureaucracy mentioned above. Others have been and are part of social movements whose origins lie in India's freedom struggle. They confound measurement, yet in their intellectual and practical independence lie the answers to many of India's right to food questions.

Generations of our farmers and herders have developed complex, diverse and locally adapted agricultural systems, managed with time-tested, ingenious combinations of techniques and practices that lead to community food security and the conservation of natural resources and biodiversity. These microcosms of agricultural heritage exist all over India, providing ecological and cultural services and preserving traditional forms of farming knowledge, local crop and animal varieties, and socio-cultural organisation. These systems represent the accumulated experiences of peasants interacting with their environment using self-reliance and locally available resources. These agro-ecosystems have allowed our traditional farmers to avert risks and maximise harvest security even in uncertain and marginal environments, using low levels of technology and inputs.

It is a system (taken as a whole but including its many geographical and cultural variations) that has as little to do

with the modern, hermetic understanding of 'food security' as it has to do with the post-1960s, western-dominated definition of organic agriculture and food. Humans, animals, trees (including grasslands) and agricultural fields were inseparable and harmonious components of a single system. The village household looked after the trees on their fields and also contributed to the maintenance of the community grazing land. They looked after animals owned by them, sometimes with the assistance of a grazing hand, and cultivated their fields with or without hired labour or sharecroppers.

Writing in *The Ecologist* 27 years ago, Bharat Dogra sketched out the harmony: "The trees provided fodder for the cattle. They also provided fuel for the villagers. The leaves that fell were put to uses beneficial to the agricultural fields. Meanwhile, their soil and water conservation properties were beneficial for the villagers and contributed to maintaining the fertility of agricultural fields, as well as providing shade during the scorching summer. Certain trees provided edible fruits, medicines, gum, toothpaste and a host of other commodities of everyday use. Cattle provided milk and milk products and contributed to the nutritional content of the villagers' diet. Cattle dung provided organic fertilisers for the fields, while the poultry provided eggs and meat. Not least, bullocks ploughed the fields. The fields produced foodgrain, pulses, oilseeds and vegetables for the villagers. The residues of those crops, of no direct use to man who could not eat them, were fed to the cattle. Poultry birds scavenged the wasted scattered grain."

Alas, India's agricultural bureaucracies of 30 years ago, still fat on a diet of Green Revolution instruction provided by the massive and powerful agricultural colleges of the USA and their agro-industrial partners, chose not to recognise our invaluable agro-ecological heritage. From that time on, those who converted to the corporatist mode of agricultural thought (and the defining APY equation) were India's 'progressive' farmers, and to them partly was the 'Jai Jawan, Jai Kisan' slogan raised. Harmonious agro-ecologies were swept aside by the bureaucracy-research-network combine, and the justification for such steady and deliberate ecocide was held out to Indians in the form of rising yield and production curves. We have many mouths to feed, said the agricultural bureaucracy, and who could argue?

It took the gathering global alarm over climate change — revealed by a new and nervous scientific method — for us to turn back to agriculture and take a long look at what two decades of the reckless pursuit of GDP growth had wrought. Within India, such scrutiny was discouraged, for agricultural research and bureaucracies brook no falling out of line, even in the obvious face of yield plateaus and the growing evidence of widespread ecological damage caused by soil abuse. Within India, it was in those pockets where traditional agro-ecologies had been safeguarded that the answers lay, and the practitioners of such forms of cultivation (whether low-input, zero-chemical fertiliser, *rishi-kheti* and others) organised themselves into thriving sub-cultures. Cut off from official funding sources and still needing to find consumers who valued their produce, some cautiously reached out to the western 'organics' networks whose institutional strengths were superior. Outside India, new forms of rigorous enquiry into the impacts and effects of a globalised economy on climate were steering the focus towards industrial agriculture and its excesses.

For much of the 2000-2009 decade, even grudging official recognition that industrially-organised, centrally-programmed agriculture in India was falling short in delivering 'food security' came slowly. Conceptually ahead by a magnitude were the tradition-oriented sub-cultures — groups such as Deccan Development Society, Centre for Indian Knowledge Systems, Gurukula Botanical Sanctuary, Raitateerpu; and individuals such as G Nammalwar, Subhash Sharma and Suman Sahai — that were strengthening through practice and dialogue the concepts that are easily understood as 'community resilience' and 'food sovereignty'. The foodgrain and food staples price shock of 2008, which had grown from a year earlier and returned in late-2009, forced our government and its agencies to act. They have done so, but their response has been damage containment (as they see it), not a phased rollback of industrial agriculture through a recognition of sub-continental agro-ecologies. They adopt and freely use the common parlance of climate change negotiation, such as 'adaptation' and 'mitigation' and seek to build such laboratory 'solutions' into modified central programmes, all the while refusing to cede control of crop production to those who know it best, and all the while supporting the vast network of businesses and interests surrounding foodgrain at the heart of which throb the chemical fertiliser complexes.

All the while, the evidence at both national and meta-national levels has been growing and becoming compelling. The horrendously long sequence of farmer suicides in Maharashtra, Andhra Pradesh and other states exposed the tragic, needless human cost of India's corporatised agricultural control structures; the discovery that groundwater extraction rates in Punjab and Haryana were amongst the highest in the world exposed the appalling true cost of high-input cultivation techniques; the steady tide of migration to towns and cities by households all over the country revealed the millions forced to abandon their lands in the face of rising input costs and debt burdens. All these pointed directly at the core of the State's approach to agriculture and its utterly misplaced ends.

Outside, systematic study of why industrial agriculture was failing was driven by deep alarm at the staggering human costs, costs that were often unseen and unmarked. "The evidence from various developing countries reveals that sustainable agricultural practices, anchored in local knowledge, are the most effective in developing resilient food production systems," stated the bottom-line conclusion of one of the largest studies to analyse how agro-ecological practices affect productivity in the developing world. It was conducted by researchers at the University of Essex, in Britain, who analysed 286 projects in 57 countries. Among the 12.6 million farmers followed, who were transitioning towards sustainable agriculture, researchers found an average yield increase of 79% across a wide variety of crop types. These farmlands averaged 3 hectares, located in a variety of farming systems — irrigated, rainfed, wetland, humid, highland, mixed and urban. The 2006 study bluntly said: "Sustainable agriculture is driven by local knowledge and resource-conserving techniques, making the best use of nature's goods and services without damaging those assets. Investing in the capacities of small farmers to adopt sustainable practices will help secure higher yields and profits, and will promote local food consumption."

Thereafter came the most comprehensive analysis of world agriculture to date, with a consortium of United Nations, and the World Bank too, engaging more than 400 scientists and development experts from 80 countries over four years to produce the International Assessment of Agricultural Knowledge, Science, and Technology for Development (IAASTD). The boldface conclusion? That our "reliance on resource-extractive industrial agriculture is risky and unsustainable, particularly in the face of worsening climate, energy, and water crises". The IAASTD was ground-breaking in its ability to address agriculture for what it is, an all-inclusive human activity. It also said that achieving a sustainable agro-ecosystem will take some time, especially since we have built up a tremendous debt in our agricultural soils and ecosystem services from the long-standing industrial abuses and historically poor practices in many subsistence agro-ecosystems. Typically, the insights contained in the IAASTD and the import of the study have been ignored by our Ministry of Agriculture, our National Agricultural Research System, and by the many agencies tasked with delivering 'development' to rural cultivators.

What are the reasons for this chronic unwillingness to see?

First, agro-ecological systems cannot be defined in terms of the adoption of any particular technologies or practices — there are no ready blueprints and off-the-shelf templates. Second, sustainable agricultural systems contribute to the delivery and maintenance of a range of public goods such as clean water, carbon sequestration, flood protection, groundwater recharge, and soil conservation. Few of these processes and outcomes — to borrow managerial terminology — have 'market' value quantifiable in terms understood by those advocating public-private partnerships (PPP), for example. Third, the cost benefit of conservation of resources can be determined by the scarcity value of those resources (will urban food consumers be willing to pay for watershed protection in a district they import food from?). But this mechanism can be used only after investing in public education — so that the connections are made in minds — and by building it into public policy at an institutional level, where it immediately runs into political and business interests.

Yet the pressure is mounting. Technological breakthroughs have been neutralised by unfavourable, declining, degrading soil-water ecosystems, by enhanced biotic and abiotic stresses, large post-harvest losses, dwindling national and global funding support to agriculture in general and agricultural research and education in particular, restrictive knowledge-sharing opportunities, stagnating capacity and skills, uncertain policy support, collapsing public service and support systems, and indifferent and inefficient governance. Expanding the area used to cultivate crops is curtailed on the ground directly by urbanisation, on the one hand, and creeping environmental degradation on the other. When climate change impacts are added to this medley of obstacles — extreme weather events that make sowing or harvesting impossible, seasonal shifts in the entire crop calendar — cultivation as an income for rural households becomes less feasible.

"Less immediate, but possibly even more significant impacts are anticipated because of changes in mean temperatures and rainfall and increasing weather variability," said a 2009 Food and Agriculture Organisation (FAO) report entitled 'Agricultural reforms and trade liberalisation in China and selected Asian countries'. "Climate change is thus likely to have significant impact on a wide range of factors essential to human wellbeing, including employment, income, health and prices for water, energy and food. Climate change will affect the extent and nature of agro-ecological zones in Asia and elsewhere, the estimates of areas with potential for crop production and the projections of maximum attainable yields." These projections and estimates have for 50 years been calculated for India by first, a research bureaucracy wedded to the mechanics of a centrally planned economy and, later, a research bureaucracy allied to a merchant network that has grown in power and influence.

Today's biotech-oriented PPP models of industrial agriculture — linked intimately to financial and commodities markets — rely on petroleum-based chemicals for pest and weed control, and rising amounts of synthetic fertiliser in an ultimately futile attempt to compensate for soil degradation. The inputs trap can simply not be disguised by any amount of financial and technological scheming. In stark contrast are the tenets of the agro-ecological system (for which, in this issue of *Agenda*, we shall use 'organic' as a synonym). These practices are defined by much more than just the absence of industrial inputs and the functioning of market mechanics. It is knowledge-intensive farming in which — to borrow a modern term — open source knowledge networks proliferate and thrive.

Organic farmers improve output by tapping a sophisticated understanding of biological systems to build soil fertility and manage pests and weeds through techniques that include intercropping, composting, manures, cover crops, crop sequencing, and natural pest control. The contrast is frightening both because of its crippling weaknesses and because of the disinformation used to disguise those weaknesses: herbicide-resistant weeds and pesticide-resistant pests, both contributing to reduce crop biodiversity. As commercial crop biotechnologies have oversimplified and industrialised simultaneously, they have made agriculture more vulnerable to the next problem. And that problem — climate change — has already stepped over our ecological threshold.

That is why the medium-term future of conventional agriculture (and the massive State- and industrial-sponsored systems which sustain it) seems unsuitable or even implausible. There is, in addition, a major external factor, and that is oil. Conventional industrial agriculture, pursued in the corporate mode, researched as an adjunct to the global seed-pharma MNCs and distributed as a function of the financial markets, is utterly dependent upon oil. The future of fossil fuels is now known, and there again, while the central government pursues its GDP algorithms, it ignores the inevitability of that future. Local organics steps out of that doomed mathematics entirely, and there alone lies the importance of its role in the future of India's myriad agro-ecologies.

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# An evolutionary view of Indian agriculture

Farmers work with knowledge systems that evolve with time and circumstance. They learn and unlearn, choosing the appropriate knowledge in their struggle to earn a livelihood. While scientists rely on averages, the knowledge of local people is dynamic and up-to-date, continually revised as conditions alter. The integration of scientific knowledge systems with indigenous knowledge systems is vital to make agriculture sustainable

*A THIMMAIAH*

TRADITIONAL WISDOM relating to agriculture dates back around 12,000 years when the first plants were domesticated by humans. This wisdom has since been evolving through accumulated experiences in dealing with situations and problems, and has been recorded and channelled down the generations.

Our ancient literature, which was most likely composed between 6,000 BCE and 1,000 ACE, contains a lot of information on agriculture. This includes the four Vedas, the nine Brahmanas, the Aranyakas, Sutra literature, the Sushruta Samhita, the Charaka Samhita, the Upanishads, the epics Ramayana and Mahabharata, the 18 Puranas, and texts such as the Krishi-Parasharas, Kautilya's Arthashastra, the Manusmriti, Varahamihira's Brhat Samhita, the Amarkosha, the Kashyapiya-Krishisukti and Surapala's Vrikshayurveda. Kautilya's Arthashastra deals with the agriculture of his time; Vrikshayurveda provides information on how to combat plant problems through various traditional practices and utilising available resources. Even in the poems of Ghagh (*kahawaten*), one comes across descriptions of agro-management, timing and forecasting of weather, and crop yields.

Traditional farming systems appear to be complex and advanced as they exhibit important elements of sustainability: for instance, they are well adapted to the particular environment, rely on local resources, are decentralised, and, overall, tend to conserve the natural resource base. The ancient texts referred to contain information on farm implements to be used, types of land, monsoon forecasts, manure, irrigation, seeds and sowing, pests and their management, horticulture, etc. The fertile status of the soil in most parts of our country is a result of the wisdom of our forefathers.

Farmers work with dynamic knowledge systems that co-evolve with time as circumstances change. They learn and unlearn, choosing the appropriate knowledge in

Rahul Goswami

their struggle to earn a livelihood. While scientists rely on averages, the knowledge of local people is dynamic and up-to-date, continually revised as conditions alter.

The integration of scientific knowledge systems with indigenous knowledge systems is vital to make agriculture sustainable. We need to maintain the health of the soil in the interest of future generations. Some civilisations view soil as sacred, inviolate, something that must be handed down to coming generations intact, if not improved. Even today, it is proving difficult to find terms equivalent to the ethnic names of soils (with particular or combinations of properties) in many classification systems. The integration of knowledge systems is important because farmers are much more accurate about their nomenclature for identifying soils and their suitability for varied uses.

Indigenous technical knowledge is the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments, and an intimate understanding of the environment. Over the years, the impact of traditional and indigenous knowledge on agriculture has diminished due to the introduction of a synthetic, chemical fertiliser system during the Green Revolution to attain so-called 'self-sufficiency' in food production. But the consequences of dousing the soil with deadly chemicals are being observed in the form of deteriorating soil fertility, contamination of the natural resource base and an increase in crop pest and disease outbreaks. As a result, food producers and consumers are faced with an array of problems on the environment, ecology and health fronts. Eventually, a revival of sustainable, ecologically safe and socially sound practices is being sought by recognising and retrieving traditional wisdom in agriculture.

The indiscriminate use of chemical fertilisers, hybrid seeds and pesticides has resulted in various environmental and health hazards coupled with socio-economic problems. Though agricultural production overall continues to increase, the rate of yield per hectare has begun to decline. The causes of the environmental crisis are, in fact, rooted in the prevalent materialistic paradigm, which promotes high-input technologies and practices in all sectors (domestic, agriculture, industrial, services) leading to soil erosion, salinisation, all types of pollution, desertification, and biodiversity loss.

In the agriculture sector, the Green Revolution selected crops for high yield and palatability. By sacrificing natural resistance for productivity, it made crops more susceptible to pests. Since monoculture has been maintained as the structural base of agricultural systems, pest problems will continue on a negative treadmill that reinforces itself, as more and more vulnerable crops call for increasingly destructive or expensive high-tech protective measures.

Thus, any gain in production is associated with pain of various kinds and magnitudes. The results of the Green Revolution have proved to be a paradox: on the one hand, it offered technology as a substitute both for nature as well as for politics, by the creation of abundance and peace. On the other hand, the technology itself demanded more intensive natural resource use along with intensive external inputs and a restructuring of the way power was distributed in society. While treating nature and politics as dispensable elements in agricultural transformation, the Green Revolution brought about major changes in natural ecosystems and agrarian structures. Sir Albert Howard, who was associated with the Pusa Agriculture Research Centre, made an almost prophetic declaration at the beginning of the 20th century about the emerging practices of modern farming.

He said: "These mushroom ideas of agriculture are failing; mother earth deprived of her manurial rights is in revolt; the land is going on strike; the fertility of the soil is declining… Soil is no longer able to stand the strain. Soil fertility is rapidly diminishing particularly in the US, Canada, Africa, Australia, New Zealand. The loss of fertility all over the world is indicated by the growing menace of soil erosion… Diseases are on the increase… the diseases of crops and animals which feed on them."

Though they may have sounded like an exaggeration at the time, Howard's predictions have all come true, in a magnified way. As history shows, former civilisations were able to overcome economic and cultural decline when the ecosystems which made up their environment remained intact and free from interference. Avoiding detrimental changes in material cycles and energy fluxes, and preventing the loss of biological diversity in our natural environment are of utmost priority among the goals of sustainable development.

Soil is the basis of all human life. Destruction of the soil has contributed to the fall of past civilisations, yet the lessons of history are seldom acknowledged and usually unheeded. The only hope for a healthy world rests on re-establishing harmony in the soil that has been disrupted by modern methods of chemical farming and unplanned rapid industrial growth. These methods bring about serious problems through land degradation. Today's cropland losses impair the wellbeing of the living as well as of generations to come.

The idea of sustainable agriculture is a response to the decline in quality of produce and of the resource base associated with modern farming. It captures a set of concerns about agriculture conceived as a result of the co-evolution of socio-economic and natural systems. Agricultural development resulting from the complex interaction of a multitude of factors, and a wider understanding of the agricultural context, requires the study of relations between farming, the environment and social systems. It is through this deeper understanding of the ecology of farming that doors will open to new technological and management options that are more in tune with the aims of a truly sustainable agriculture. The goal is to develop agro-ecosystems with minimal dependence on high agro-chemical and energy inputs, and in which ecological interactions and synergies between biological components provide the mechanisms for systems to sponsor their own soil fertility, productivity and crop protection. The five objectives of productivity, security, protection, viability and acceptability are called the five pillars of sustainable land management, and they must be achieved simultaneously if true sustainability is to be predicted.

In fact, sustainability is not possible without preserving the cultural diversity that nurtures local agriculture. A closer look at ethno science (the knowledge system of an ethnic group that has originated locally and naturally) will indicate that local people have enormous knowledge about the environment, vegetation, animals and soils. Peasant knowledge about ecosystems usually results in multi-dimensional land use production strategies which generate, within certain ecological and technical limits, the food self-sufficiency of communities in particular regions. Stable production can only take place within the context of a social organisation that protects the integrity of natural resources and nurtures harmonious interactions among humans, the agro-ecosystem and the environment. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

The basic tenets of a sustainable agricultural system are conservation of renewable resources, adaptation of the crop to the environment, and maintenance of a moderate but sustainable level of productivity. And it should be economically viable and socially acceptable.

The production system must:

• Reduce energy and resource use and regulate overall energy inputs so that the output-input ratio is high.

• Reduce plant nutrient losses by effectively controlling leaching, runoff and erosion, and improve nutrient recycling through the promotion of legumes, organic manure and compost, and other effective recycling mechanisms — residue management.

• Encourage local production of feed items adapted to the natural and socio-economic setting.

• Sustain desired net output by preserving natural resources (by minimising soil degradation).

• Reduce costs and increase the efficiency and economic viability of small- and medium-sized farms, thereby promoting a diverse, potentially resilient agricultural system.

From a management point of view, the basic components of a sustainable agro-ecosystem include:

• Vegetative cover as an effective soil- and water-conserving measure, met through the use of no-till practices, mulch farming, cover crops, etc.

• A regular supply of organic matter through regular

addition of manure and compost, and promotion of soil biotic activity.

• Nutrient recycling mechanisms through the use of crop rotation, crop/livestock systems, use of legumes, etc.

• Pest regulation assured through enhanced activity of biological control agents, achieved by conserving and multiplying natural enemies in an eco-friendly way.

The ultimate goal of sustainable agriculture system design is to integrate farm components in a holistic fabric so that overall biological efficiency is improved, biodiversity is preserved, and agro-ecosystem productivity and its self-regulating capacity are maintained. The idea is to design an agro-ecosystem that mimics the structure and function of local natural ecosystems. A major strategy in sustainable agriculture is to restore agricultural diversity in a given time and space through alternative cropping systems, such as crop rotation, cover crops, intercropping, border cropping or crop/livestock mixtures — all of which exhibit several ecological features. Modern agriculture is not sustainable as it is not in consonance with economics, ecology, equity, energy and the socio-cultural dimension. That's why the world over, environmental degradation sourced to agriculture is reaching catastrophic proportions.

Time is running out if we are going to continue with more or less the same strategies in agriculture — high agro-chemical-responsive hybrids, monoculture, *ex-situ* bio-control agents, terminator seeds, and similar technologies. Ironically, the shift from chemical farming to sustainable agriculture is being sought within a very narrow vision, posing severe and irreparable risks to the ecosystem in the long run.

The need of the hour is an alternative sustainable farming system that is ecologically sound, economically feasible and socially just. Sustainable agriculture is a unifying concept, which considers ecological, environmental, philosophical, ethical and social impacts, balanced with cost-effectiveness. Several aspects of traditional systems are relevant, such as their knowledge of farming practices and the physical environment, biological folk taxonomic systems, and use of low-input technologies. By understanding the ecological features of traditional agriculture, such as the ability to bear risk, production efficiencies of symbiotic crop mixtures, recycling of materials, reliance on local resources and germplasm, exploitation of the full range of micro-environments, etc, it is possible to obtain important information that may be used to develop appropriate agricultural strategies tailored to the needs, preferences and resource bases of specific peasant groups and regional agro-ecosystems.

Among the various alternatives, organic farming is gaining acceptance throughout the globe as it has the potential to provide practical solutions to mitigate the maladies afflicting conventional or modern farming. Before India faced the onslaught of chemical farming, its thinkers like Vinoba, Gandhiji and Kumarappa were able to visualise the future of Indian farming through their non-violent approach — aptly suited to the present. Indian culture imbibed a deep sense of oneness with all things natural. Ancient (Vedic) culture taught veneration of the earth as mother, the sky as father, the air as *prana* (soul), the sun as energy, and water streams as life-sustaining veins.

The goal of an alternative agriculture system is to enable peasants to become architects and actors in their own development. From a management perspective, the objective of such a system is to provide a balanced environment, sustained yields, biologically mediated soil fertility, and natural pest regulation through the design of diversified alternative agricultural systems and use of low-input technologies. The strategy is generally based on ecological principles so that management aims at optimal recycling of nutrients, organic matter turnover, closed energy flows, water and soil conservation, and balanced pest/natural enemy populations. By assembling a functional biodiversity, it is possible to provoke a beneficial symbiosis. These, in effect, subsidise alternative agriculture processes by providing ecological services such as the activation of soil biology, recycling of nutrients, and enhancement of beneficial arthropods.

Today there is a whole battery of practices and technologies available that vary in effectiveness as well as in strategic value. Some, which include practices that are already part of conventional farming (genetic improvement, minimum tillage, crop rotation) are of prophylactic value, while others, which are key, are of a preventative nature and act by reinforcing the 'immunity' of the agro-ecosystem. These technologies do not emphasise the boosting of yields under optimal conditions, as Green Revolution technologies do; rather, they assure consistency of production under a whole range of soil and climatic conditions — especially the marginal conditions that usually prevail in small-farm agriculture. The need, however, is not to focus on particular technologies but rather on an agro-ecosystem management approach that emphasises crop diversity, use of manure, green manure, urban and rural waste, legumes in rotation, animal integration, recycling and use of biomass and residue, and incorporates an assemblage of suitable alternative technologies.

The role of an alternative agricultural system is not limited to input substitution alone but ensures that it is economically and ecologically sustainable. Various alternative agricultural systems include traditional and natural farming, organic agriculture, ecological farming, Vedic agriculture, permaculture, biodynamic farming and LEISA (low external input sustainable agriculture). The real success of these systems on an evolutionary timescale demands that the question of the paradigm of development and the technology package be considered together.

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# Tamil Nadu's organic revolution

With chemical farming becoming uneconomical and grain yields declining, more and more farmers are switching to organic agriculture, says natural scientist G Nammalvar in this interview. Nammalvar has been training organic farmers and setting up learning centres in Tamil Nadu for three decades. Trainings sometimes need to be held in marriage halls in order to accommodate up to 1,000 farmers

CLAUDE ALVARES

*Dr G NAMMALVAR IS AN ORGANIC SCIENTIST who has been working on sustainable farming and organic practices. For over four decades he has been educating farmers against large-scale mono-crop farming and against international patents on Indian traditional knowledge. His work in desalinating over 6,000 acres of land after the 2004 tsunami earned him much recognition. Nammalvar works primarily in Tamil Nadu, but also travels in Andhra Pradesh, Karnataka, Kerala and Maharashtra, holding workshops and convincing farming communities to stop using harmful pesticides and fertilisers, and, more recently, GM seeds. He has written extensively (mostly in Tamil) and published books and articles on these practices*

**You are very well known in Tamil Nadu as an organic farmer and natural scientist. How did you get involved with organic farming, considering that you have a college degree, a BSc in agriculture?**

I was not altogether new to farming. Earlier, my brothers and I worked on my father's land in the traditional way of farming. However, after I attended agricultural college where I got a BSc in agriculture, I started using modern methods at the Agricultural Research Station in Koilpatti, which were intended for rainfed crops in black cotton soil. Later, I joined a voluntary organisation called Islands of Peace, Kalakad, founded by 1958 Nobel Peace Prize-winner Rev Father Dominique Pire, and there too I was asked to use Green Revolution practices. But it was under irrigated conditions. We helped farmers dig wells and install pumpsets. After working for 10 years, I realised that only the traders were flourishing and that farmers were either in debt or their condition had remained the same. So I got fed up and left the organisation. I decided to directly help farmers who were suffering. For a long time I searched for methods that would really help farmers.

My colleagues and I started an organisation called Kurumbam in Thanjavur district, in 1981, where we began training villagers in social forestry activities. The word *kurumbam* means 'family'. However, I found that here too the forest department was not prepared to change its attitude. It was only interested in planting eucalyptus on grazing land and thorny *subabool* trees in the lake. In 1983, there was a very big movement in Tamil Nadu regarding the social forestry programme. Around that time, I attended a seminar in Auroville where I was introduced to Bernard Declerq. He took me to see his 3-acre farm and explained things to me. That was good inspiration! He recommended me to Agriculture Man Ecology (AME, a development-oriented, non-government organisation devoted to promoting sustainable agricultural practices). It was then that I realised a systematic approach was necessary for rural farmers to improve their condition, since all their problems were inter-related.

At the end of two or three years there was a suggestion from different groups to attempt certification, as project-holders of NGOs were given only an introductory course which was not sufficient for certification. Three organisations came together to conduct a social forestry programme. Kurumbam and AME conducted Tamil training programmes for field workers on ecological farming. And we started a movement — Low External Input Sustainable Agriculture (LEISA) — in 1990 with farmers and NGOs as its members.

**What is the motivation for farmers to switch to organic farming?**

There are three main reasons. One: farmers have realised that land and the natural environment cannot be sustained through chemical farming. All food is poisoned through modern farming. Second: the farmer finds that the cost and quantum of inputs are increasing day by day and so he cannot pay back his loans. The result is that small and marginal farmers are losing their lands or they are allowing the land to remain fallow and migrating to the river belts for seasonal jobs, or to other states and countries for menial jobs in order to survive. Third: the export market is facing a problem as importers of food materials in European countries and the USA find that our food contains too much pesticide. They insist that these are removed and that the food has to be organic. So the pressure to change is coming from the export market also. Finally, techniques have so improved that a farmer can switch to organic farming without losing too much income. But most of all, farmers are interested in organic farming because chemical farming has become uneconomical, and grain yields have started declining. These are the prime reasons.

**How is it that for the last 30-40 years we got sucked into this chemical way?**

The State wanted more grain production. It started brainwashing the people. People were given fertilisers practically free, or at heavily subsidised rates. Even now in Tamil Nadu, electricity is completely free for farmers so that they can go in for irrigated agriculture. But once the government stops subsidies on chemical inputs, farmers will have to stop using them or change over to some other way of farming. Without water, chemical farming is impossible.

**Do farmers make the switch from chemical to organic farming at one go?**

No. When they start thinking about switching they come for more information. They start by switching first to herbal pest repellents. Then they go in for organic methods of growing crops, and lastly, they will switch to growing indigenous varieties. Thus they are not switching over completely but on a piecemeal basis.

**Are those farmers who are doing organic farming convinced that the yield is comparable to that from chemical farming?**

Oh yes, they are convinced. But right now their concern is at the economic level. In organic farming we are not spending on external inputs. At the same time, it is labour-intensive. I met a landed woman farmer who said that she was prepared to give the land on a contract basis for banana plantation instead of growing crops herself because it was too costly. Basically, in our state there are a lot of industries coming up and agricultural labour wages are high. Often it becomes difficult to get labour.

**What other obstacles do farmers who may wish to convert to organic farming face?**

On the economic plane, many farmers think more about money and not about their home needs and families. On the cultural plane, they are tied up with family pressures. Also, women are not involved. Secondly, companies that manufacture and distribute chemicals, hybrid seeds and machinery, and the so-called scientists in universities, deter farmers from switching over to organic farming. Universities act against organic farming by teaching and encouraging modern hybrid varieties, genetically modified seeds and precision farming. That is a major problem. However, farmers' movements are giving support to the organic farming movement.

**Would you say that there is an organic farming movement underway in Tamil Nadu? How was the movement initiated and how is it being sustained?**

> Farmers have realised that land and the natural environment cannot be sustained through chemical farming. All food is poisoned through modern farming. The farmer finds that the cost and quantum of inputs are increasing day by day and so he cannot pay back his loans. The result is that small and marginal farmers are losing their lands or they are allowing the land to remain fallow and migrating. Also, importers of food materials in European countries and the USA find that our food contains too much pesticide. They insist that these are removed and that the food has to be organic. Farmers are interested in organic farming because chemical farming has become uneconomical, and grain yields have started declining

In every district in Tamil Nadu there are farms cultivating in the organic way. Some of them are fit for training, and about half the 100 farms need to be upgraded to become learning centres. Nowadays, a team of experts conducts training on the farm itself. Thirty to forty participants in each batch are trained for three days; we have conducted many such training sessions. As for organisations, there are always people with initiative and leadership. When the NGO or farmers' forum arranges meetings, sometimes around 1,000 farmers attend. Sometimes they are arranged in marriage halls! MPs and MLAs have also participated in and attended these meetings. In 2008, *Anandha Vigadan*, a well-known Tamil weekly, and our foundation, Nammalvar Ecological Foundation for Farm Research and Global Food Security, together organised seminars and trainings. *Anandha Vigadan* publishes a Tamil fortnightly called *Paumai Vikatan,* and three other monthly magazines that promote organic agriculture. *Kalluppu*, a Tamil monthly published by the Isha Yoga Centre in Coimbatore, carries articles on growing trees, ecology, the environment and natural farming. The popular English daily, *The Hindu*, publishes organic farming case studies every Thursday. All India Radio and TV stations broadcast news and pictures on organic farming. Our connections with NGOs working in other states like Kerala, Karnataka, Andhra Pradesh, Pondicherry, Maharashtra and Orissa help us share experiences and seeds.

**Coming to the different rice varieties, what is the status of the older seeds? How many farmers are using them?**

When I visit remote areas, the old seeds are still available. Some farmers are still growing them, even under dry conditions. Only those strains will remain. Otherwise in the dry belt where tank water is available they have switched to high-yielding varieties. They say that within three months the grain will come up. In some places they have started re-using the old varieties. Biodiversity is imperative to adapt to different ecosystems.

Everywhere in the countryside there are five or six plants which are cattle repellents, and the farmers know this very well. They grow easily, and if you put four or five leaves in a pot mixed with cow urine for 10 days, they start smelling. The farmers add 1 litre of this mixture to 10 litres of water and they spray it on the leaves to prevent insect attacks. Even the most damaging pest — the red hairy caterpillar found in groundnuts — can be controlled if it is sprayed with this mixture. Secondly, most farmers are going in for composting, and quite a good number are going in for vermicomposting (local worms are best suited for vermiculture as they are more adaptable and survive).

**Is organic farming a very complicated business or a very simple business? What are the main principles that farmers should keep in mind when doing organic farming?**

The most important aspect is our health; this is the first principle and the basic reason for doing organic farming. Second, we should allow nature to help us. We should not do anything that will hamper the natural cycle, like disturbing soil microbes that fix atmospheric nitrogen in the soil. Third, we should put agricultural by-products to different use as was being done in the old days. Fourth, no waste either within the farm or outside the farm should be burnt because in organic farming nothing is a waste; the so-called waste is nothing but misplaced resources. Fifth, we should depend on indigenous seeds and indigenous cattle breeds. If farmers are well trained, they can easily opt for pure line selection. It is very important that farmers do not buy seeds from outside. When a farmer buys seeds from outside, he has no information or knowledge about the growth or performance of the plant. That's why he should use seeds only from his own field or get seeds from other farmers and then sow them in his farm. Sixth, the farmer must realise that the plant is a producer and not a consumer. We must enrich the soil; healthy soil will take care of the plant. All this may appear complicated, but farmers are able to pick up these ideas quite easily especially if they are discussed in farmer groups.

**What are the basic practices you would recommend to organic farmers?**

First, take care to select a pure line of seed. Second, collect maximum biomass from the farm and from the neighbourhood for mulching. Third, rear earthworms and release them into the field. Fourth, go in for bio pest repellents that can be used on a large-scale with no ill effects. Fifth, use *panchagavya* made from cattle urine, dung, milk, curd and groundnut cake. In Tamil Nadu, with the help of Dr Natarajan, we have been able to improve on the original formula. We have added four more ingredients to the original five — coconut water, banana, sugarcane juice and toddy. With these nine components we are able to protect plants, improve the health of animals, and reduce diseases of any kind in human beings. We also prepare *panchagavya* from materials sourced from goats.

**What is your vision for the next three years?**

First, very intensive work is needed to continue our campaigns of promoting organic farming, achieving a GMO-free India, making farmers' seeds local, promoting rainwater harvesting and millet crops, converting urban waste to useful products, protecting water sources, establishing seed certification, and protecting the cow. For all these to have an impact, a nationwide NGO-farmer network is essential. Second, to carry out these activities on a wider scale, we need a large number of trainers. So we have to continually conduct training programmes and support trainers who can educate people at the local and grassroots level on all aspects of organic farming — cultivation, marketing, preservation techniques, etc.

(Reprinted from *Organic Farming Source Book 2009*, Other India Press, Mapusa, Goa)

*Dr Claude Alvares is an environmentalist and editor at the Other India Press, an alternative publishing house. He is also director of the Organic Farming Association of India, and is based in Goa*

# Return to the good earth in Sangli

Jayant Barve used to market chemical fertilisers and pesticides and practise chemical agriculture himself. In 1988, he switched to sustainable agriculture, and has never looked back since. In this interview he emphasises that despite much lower input costs, organic farming does give the same yield as chemical agriculture, sometimes even more

CLAUDE ALVARES

*JAYANT BARVE ABANDONED a career at the National Chemical Laboratory to become one of India's most creative and innovative organic farmers. He has been practising sustainable agriculture on his 14-hectare farm in Sangli district since 1988.*

*After teaching at a city college for a few years, he returned to his hometown and began taking an interest in farming. He set up a chemical factory on part of the land and a shop to market chemical fertilisers and pesticides. After following modern farming practices for 12 years, he changed over to sustainable agriculture. He closed down the factory and converted the building into a storeroom for vermicasts released from vermiculture. He also shut the shop marketing chemical fertilisers and pesticides.*

*Barve explains his conversion to sustainable agriculture as follows: "Modern agriculture is based on increasing inputs, machinery and energy. All this brings about soil degradation. The farmer has to take a lot of care in plant protection. He is consequently compelled to resort to costly and hazardous pesticides. These pesticides contaminate the water, soil and environment. The crop cultivated is thus highly poisoned. Tension-free farming with good output, negligible inputs of money and energy, supported by enhancement in soil quality is only possible through organic farming and vermiculture practices."*

*The soil on Barve's farm is mostly black cotton or stony laterite murrum, with a pH of around 7.0. The average annual rainfall is 500 mm, the rainy season being from June to September. There are six male and six female permanent full-time workers on his farm. He has three buffaloes, two cows, four bullocks and heifers and calves. Around two-thirds of the milk produced is sold at the local market, the rest is kept for consumption at home. The bullocks are used for farm cultivation and bullock-cart transport. Barve does not use motorised implements or tractors on his farm.*

*Part of the land is reserved for horticultural crops like grapes, bananas, drumsticks, mangoes and amla; the rest is under seasonal crops such as sorghum, millets, groundnut, chillies, wheat and pulses like horse gram, pigeon pea, etc. Some portion is reserved for fodder for the cattle and forest trees like banyan and acacia. Barve also cultivates ginger every year.*

*Almost all the plots are surrounded by biomass, live fence plantations of giri pushpa* (Glyricidia maculate)*, adulsa* (Adathoda vasaka)*, bahava* (Casia javanica)*, neem* (Azadarichta indica)*, karanj* (Pongamia glabra) *and eranne* (Jatropha curcas)*. Farm waste and cattle dung are used for vermicompost. Irrigation is through drip or sprinkler systems; flood irrigation is avoided everywhere on the farm. The vermiculture pits are kept moist with the help of micro sprinklers. Herbal preparations like* vrikshayurveda *and* krishi parashar *are prepared on the farm and used whenever necessary*

**You have been doing organic farming for 20 years. Could you tell us something about your background?**

I completed my MSc in physics and was working at the National Chemical Laboratory, Pune. I was also a physics lecturer at a reputed college in Pune for five years. Then I was asked by my father to return to my native place because we have property there and I was the only son. So I had to go back.

With some research of my own, we started a unit to manufacture textile dye intermediates. The name of the product that we were manufacturing was paranitro aniline. We brought this product into the market and the small factory that we erected was doing well until 1984.

Then a crisis developed because of the new government policy: import rates for the same product we made dropped, bringing the price lower than ours. So we had to close the factory. I wondered what to do next. I started the business of marketing chemicals, pesticides and fertilisers. We had a small laboratory in our office and we used to give suggestions to farmers about what to spray for which disease, after testing. Our business started growing.

We earned a bit of a name in Sangli district because we were the only consultants at the time (1984-1988) giving proper 'medicines' for particular diseases. We were marketing a NOCIL product. The business grew very nicely.

Then one day I was sitting in our shop and a farmer approached me and asked for a pesticide to repel the crows that were attacking the grapes in his vineyard. He told me that the crows damaged the grapes when they were at the ripening stage. I asked him when he was going to harvest the grapes. He told me he would be packing them the following week. I thought: if he sprays hazardous chemicals to deal with the problem, they will go along with the grapes to the consumer. What would be the impact?

This was the turning point for me into organic farming. Till then I had a farm of my own but I was not looking after it. I decided to do farming myself, and do only organic farming. I met several people and began reading up on organic farming. I met Dr Bhavalkar and Jambekar in Pune, and with their help we planted a grape plot of about 1 acre. We decided not to use any chemical fertiliser, so we started vermiculture. Before planting the grapes and six months after that, because of our laboratory and science mindset, we analysed the soil and observed how its nutrient and organic carbon levels had increased, so also its potash content.

After a year we arrived at the conclusion that this was the only way to grow grapes; that any farming system must practise vermiculture. So we started manufacturing vermicompost. The biomass was not available with us so we approached the Vita Municipal Council and bought vegetable market waste for three years, for our farm. We converted it to vermicompost and got very good results from it. Our grapes were of the best quality. We exported grapes from our particular group — the Vita Village Farmers Group — until 1994.

In my vicinity, wheat farmers irrigate their fields eight to nine times per acre, by flooding. On our farm we irrigate the wheat five times. Hence we are saving a lot of water, electricity and labour. There is no burden of buying pesticides and spraying them, and the anxiety that the people spraying the crops could fall ill. My cattle are in excellent health. I sell one or two buffaloes and am now beginning cow-rearing. Everybody says that my cattle are healthier than those they buy elsewhere

It then struck me that the limitation of organic farming was vermiculture. I had read that if you add organic carbon to the soil, the worms will grow automatically. You need not build a shed and put water on it to develop the worms. Give the soil organic carbon and it will automatically improve and the microbes will develop. And so I realised that vermiculture was not the only solution.

We started thinking about concentrated organic material and collected a number of things like oil cakes, phosphates and silicon oxide, bentomite and rock dust. I read somewhere that composting is not recommended in any of the ancient agricultural systems. Some of the literature I read on the subject came from Dr Rahudkar from Pune and Ashok Joshi, son of Mahadev Shastri Joshi who has translated and published ancient agricultural texts. In ancient times nobody did composting; they would collect dung, put it in a shelter, powder it, and sprinkle it onto the farm. That gave better results because it was not composted and it provided nutrition to the soil and microbes.

This stuck in my mind and I thought of adding 'raw food' to the soil — organic carbon. When we compost it in a pit, all the degradation happens inside the pit. Microbes in the soil do not get food. So we thought of putting organic microbes directly into the soil. We mixed organic carbon materials together and got good results. Again, we did lab tests continuously for two years.

Then my son Jaydev completed his BSc in microbiology. We started a unit to make organic manure at my place, and it's coming up nicely. We have a product called Sanvardhan that we are marketing all over India, mainly in Maharashtra, and also exporting. There's another product called Green Harvest which we are marketing in two districts only. This manure is formulated to replace chemical fertilisers totally.

The second aspect was that although soil quality was improving, we wanted to get rid of pesticides. In 1992, I closed down the chemicals and pesticide business. I also closed down the marketing business. I started reading the ancient books. Then I met Dr Nene from ICRISAT. I purchased a book called *Suraphala's Vrukshayurveda*. Professor Rahudkar was always writing something about herbal preparations. There's another book, *Return to the Good Earth*, a Malaysian publication. I started making some herbal preparations of my own and by 1995 our grapes were absolutely chemical-free.

We enjoyed a separate market; there was no certification. I would market it in my name and earn a good income from it. This continued up to 2000. From 2000-2003, there was a drought and we were unable to manage the grape plantation. I was forced to cut down the grape vines. After 2003, a small dam was built near my farm. I lost around 10 acres of land to the dam, but the rest of the 25 acres became irrigated land.

All the literature on organic farming that I read and the knowledge we gathered on the farm enabled us to do organic farming more consistently. We are producing a number of things including cereals and pulses, chickoo and amla. We have a plantation of around 900 mango trees. We have done grafting of mango trees. When I started farming in 1988, on the 40 acres of land, there were barely 20-25 trees. Today there are 5,000 trees of 54 varieties on the farm. I have maintained this biodiversity.

We are also growing crops like sugarcane, ginger and turmeric. In turmeric we have a black variety that is good for medicinal purposes. We grow jowar and wheat along with beans, red gram and horse gram. This year, we are in contract with a company to supply them specific vegetables for export. We also grow brinjal, tomatoes, onions, garlic and chillies. My farm is now self-sufficient.

**What are your outgoings on the farm? Earlier, you would buy chemicals, etc…**

Today only the final product is going out, not money. My only cost is labour; no inputs are being bought from the market. We buy electricity and concentrates — such as oil cakes, rock dust and rock phosphate — whenever needed. Today, a grape farmer's expenditure on pesticides alone, at current market rates, is Rs 24,000-25,000 per year. Fertiliser expenditure is about Rs 15,000-20,000. I am also looking after a farm for a friend who is cultivating organic grapes. There, our expenditure is like this: the input is our organic manure on which he spends around Rs 8,000-9,000 per year and around Rs 3,000-4,000 for herbal preparations. His expenditure is around Rs 14,000 per year, whereas a chemical farmer spends around Rs 55,000 per year. The only thing is that when a farmer cultivates organic grapes he has to be very alert about weather changes.

**You are one of those people who have come from the other side to this side (organic). Do you think you will ever cross back and use chemicals again?**

No, because our minds have totally changed. Even when we go out, whilst eating outside food, we wonder what pesticides have been sprayed on it. Having run a pesticides business for four years, we know everything about pesticides. Even if somebody gifts us a truckload of urea or chemicals or pesticides, we will not allow him to enter the farm because we are now enjoying the fruits of organic farming.

**What is the message you would like to give to those who say we cannot grow enough food through organic farming?**

This is not the case. Yields in organic farming and chemical farming are the same. In fact, after two or three years, yields start increasing (with organic farming) as is the case with sugarcane in our vicinity which is nearly 50-55 tonnes per acre. With wheat and jowar, yields may vary because of climatic conditions, but with sugarcane it doesn't. In my area, sugarcane yields are nearly 55-60 tonnes per acre with chemical farming while in my case it is 60-65 tonnes per acre. Besides, in contrast to chemical farming, our soil is improving every year, our water requirements are coming down, and input costs are reduced.

For example, for wheat in my vicinity farmers irrigate their fields eight to nine times per acre, by flooding. On our farm we irrigate the wheat five times. Hence we are saving a lot of water, electricity and labour. There is no burden of buying pesticides and spraying them, and the anxiety that the people spraying the crops could fall ill. My cattle are in excellent health. I sell one or two buffaloes and am now beginning cow-rearing. Everybody says that my cattle are healthier than those they buy elsewhere. Albert Howard says in his *Agricultural Testament* that the organic farmer is to be judged by the health of his farm cattle and the health of the plant.

**The problem is with other farmers. They see that you are saving money. They see that your yields are increasing, and they see that you do not have to buy chemicals or fertilisers or spray your crops. They see all this and still there is a mental block about organic farming. Why is that?**

The mental block is of two kinds. Before Independence we were almost slaves, and our minds are set like that. Whenever farmers want to consult about a problem, they go to the doctor or to the shopkeeper. They will not consult their neighbour. Farmers in my area come to my farm; they see how things are done. But they are not ready to swallow what is good because their minds are not set that way. We have been trying for the last 15 years to change this mindset through promotion, canvassing and seminars. But we have not had much success. I have been in the area for the past 15 years and have travelled a lot, at my own expense, advising farmers. But I am still not able to convert even two farmers per year, after meeting 1,000 farmers in a year.

The NCOF has a scheme to train 1,500 farmers. They have offered the scheme to my organisation, and we contacted 1,500 farmers. We went to them in their villages at night — because farmers are free only at that time — and had meetings with them. But whenever we go, their minds are set. They ask us whether we are going to give them subsidies. Secondly, only the women in the villages attend these programmes, the men do not.

(Reprinted from *Organic Farming Source Book 2009*, Other India Press, Mapusa, Goa)

# The new natural economics of agriculture

This farmer watched the decline of his soil and agricultural yields before he let nature be his teacher and understood the agro-economics of agriculture. He abandoned insecticides and chemical fertilisers and relied instead on the cow, trees, birds and vegetation

*SUBHASH SHARMA*

SOIL, WATER AND SEEDS are the strength of farmers. I was able to understand this agro-economics only when I connected with this ground reality. I have been farming since 1975 and, in this time, I have seen two faces of science in agriculture.

In 1975 I began farming like any other farmer, applying plenty of chemical fertiliser and using hybrid seeds. I enjoyed bumper harvests in the initial years, but they could not be sustained for any length of time. Production from my farm started dropping and cultivation costs rose.

This situation continued till 1994, the year I took up natural farming. Nature became my guru and started revealing the reasons for the reduced production on my farm.

In the process of farming with chemicals I had all but destroyed the micro-organism population in the soil, trees, birds, seeds, water. This is what had caused the drop in yields. Nobody should ignore or underestimate the importance of these factors in agriculture. What unfolded on my farm was happening to every farmer like me in India. In pursuit of increased production, we adopted the science of agriculture based on chemicals which resulted in steady low yields and damaged agro-economics.

Of far greater consequence was destruction of the agricultural environment. The labour that was employed on farms was affected by mechanisation, leading to large-scale migration of the rural population to urban areas. The life these people faced in cities and towns turned out to be worse, giving rise to urban crime. Those who could not migrate became Naxalites — tackling them is now costing the nation enormous amounts of public money.

Loss of soil and water is another serious problem. We have already lost our seeds and are being forced to depend on genetically modified seeds that are harmful to human health as well as the environment. Such seeds are referred to as 'terminator' seeds as they barely germinate the following season. Wherever farmers have used genetically modified seeds, soils have deteriorated and new diseases have begun to affect the crops.

Rising temperatures have had their own damaging effect on production patterns. In 2008-09, yields from my farm dropped 25% although my profits doubled thanks to market forces (less produce pushed up prices).

We certainly do not want a situation where farm produce is beyond the purchasing capacity of people. That is why a change in agricultural technique is essential. We need to change in order to protect and preserve our soils, water, seeds, environment, and labour, and to strengthen our economics. And that's possible only if we reduce our costs and yet enhance production.

When I first started natural farming I did not know much about it. Slowly, nature became my teacher and showed me the science and economics of agriculture. From 1994 onwards, I began to understand that this is the only constructive science under which all nature's constituents are conserved, and, at the same time, gradually grows. Under chemical-intensive agriculture, growth results from killing off almost everything else. Natural farming put an end to this violent growth. I was able to visualise a strong economics that served the interests of both farmers and our ecological system. It also made me totally self-reliant.

Rejuvenating the soil has strengthened my agro-economics. I have come to realise the potential strength of the country's agricultural economy. Today, I do not need insecticides or chemical fertiliser, as both problems are managed by nature. The four elements of nature that help this process are: the cow, trees, birds and vegetation. Here is a short elaboration on each of these elements:

*The cow*

In 1994, based on personal observations, I developed a process of utilising fresh cowdung, cow urine, and jaggery. In Indian villages, fresh cowdung diluted with water is traditionally sprayed on open areas around the house (except during the monsoon). When the rains begin, large numbers of earthworms start emerging. This made me think: if fresh cowdung were sprayed onto the fields, wouldn't it multiply earthworm and micro-organism populations? Moreover, if cow urine were used along with the dung, fungus in the soil too could be controlled.

I prepared a 200-litre drum for each acre, using a mixture of 60 kg of fresh cowdung, 5 litres of cow urine, and 250 grams of jaggery, all diluted with water. The mixture gave me better yields in the very first year itself, and after four years the micro-organisms had increased to such an extent that there were 6-10 earthworms in every square foot of field. This called for more feed, which was met by another of the four critical elements — vegetation.

*Trees*

During 1990-92, I realised that the temperature increase brought on by industrial pollution would kill off millions of plant species and living organisms within the next 40-45 years. For me, a farmer, this was a serious warning. To check the rise in temperature, I decided to plant trees. I planted 2,000 wild trees on 1 hectare; on the remaining 11 hectares I planted bird-friendly trees such as jamun, goolar, mango, peepul, bargad, neem, imli and arjun. As these trees grew, yields on my farm increased and I realised how trees help agricultural production.

Trees control increase in ambient temperature, which is a great help in the growth of bacteria and friendly insects. Leaf litter is converted into manure. As the number of trees increases, birds multiply and a new economics of agriculture is revealed.

*Birds*

The tree growth increased the number of micro-organisms and good manure, as bird populations in and around the farm increased. I noticed that each bird ate at least 50 destructive insects, contributing its excreta to the soil as manure. Where there is good vegetation, this process goes on the whole year round. When bird populations swell to several thousands (it took 8-10 years) their 'management' of insects increases proportionately, and, of course, more manure is added to the soil.

*Vegetation*

I started returning crop residue and grass to the farm in 1994. Each hectare of the farm received around 25 tonnes of this wet biomass, encouraging the growth of micro-organisms which, in turn, converted the biomass into manure and simultaneously controlled soil fungi. The increase in micro-organisms and earthworms made our soil

*Organic farmer Sharma: Learning from nature* porous, helping plant roots get oxygen and rain water. Tens of millions of micro-organisms help improve soil fertility during their short lifespan, and, after their demise, they become the best possible natural manure. Studying these organisms and creatures made me realise that every living being on earth plays an important role in the wellbeing of the human race.

India is faced with a deepening water crisis despite it being blessed by nature with abundant water. Changes in agricultural technologies in the 1960s resulted in large amounts of water being used for farming, along with chemical fertilisers and other poisonous compounds. These destroyed and killed insects and small creatures that make the soil porous, thereby capable of absorbing water and recharging the water table. Chemical-based farming caused a rapid drop in groundwater levels. At the same time, rainwater was allowed to flow away through drains and canals, carrying with it useful top soil. Worse, the washed-away soil collected as silt in dams and irrigation reservoirs, adding to the water shortage.

Even as more hydro-electricity was being generated, greater quantities of groundwater were exploited for irrigation and drinking purposes. The result was that, in several states, the groundwater dropped to dangerous levels, affecting ground temperatures as well.

This situation is alarming because it directly affects crop productivity as well as human health. Many irrigation projects were built to develop agriculture, but rising urban populations and industrial growth forced the diversion of enormous quantities of water away from farmers and agriculture. Even within the water crisis spiral, the water that is available is polluted thanks to chemical-intensive agriculture and the discharge of poisonous effluents from industries. Today, management of such harmful, unhealthy water consumes ever more resources.

Yet there is a ray of hope. I am sure that if we change our agricultural policies even now we can solve the water crisis forever. I say this because of my personal experiences with natural farming over destructive science. Since I took to natural farming I have come to realise the importance of water. Now, as a result of retaining all the water that falls onto my farm and diverting it underground, the soil is automatically saved from erosion, enhancing its productivity.

This is self-reliance in water. To verify it, I studied the passage of water onto and through my farm in 2003-04.

The sequence is as follows: when 1 hectare of land receives 1 cm (10 mm) of rain, the total precipitation is 100,000 litres; if rainfall during a particular year in that area is 100 cm, the total precipitation per hectare is 10 million litres; a 12-hectare farm like mine receives a total of 120 million litres of rainwater; adjusting for an average evaporation rate of 30% from the surface leaves behind 84 million litres to be diverted to groundwater; thus, if we draw more water than this for irrigation we will not be self-reliant in water.

How much water do I draw? I have two borewells on my farm, each fitted with a 5 hp pump that draws about 36,000 litres of water per hour. Normally, my pumps run for 800 hours a year. That means each pump draws 28.8 million litres per year; together, they extract 57.6 million litres. Since I have recharged 84 million litres in the year, I have a net gain of 26.4 million litres, which reassures me that my farm is fully self-reliant in water and is recharging the water table.

The farm methods that I adopted in 1994, after realising the importance of the new natural economics, took my produce up to an average of 450 tonnes by 2000, after a low 50 tonnes at the end of the 1975-1994 period. This shows how false the claims of scientists are that chemical fertilisers, poisons and hybrid seeds contribute to higher production.

The increase in production through chemical farming was essentially a result of making more water available and bringing energy to the farm, which was not the case before 1960. From 1975 onwards, chemical-intensive farming was taken up on a large scale. In the first three decades following this dramatic change in method, foodgrain production rose, only to stabilise and then steadily decline from 2002.

In my own case, production dropped steeply during the period 1986-1994: cotton from 30 quintals to 10 quintals, jowar from 50 quintals to 15 quintals, tomatoes from 350 quintals to barely 5 quintals because of mosaic infestation. This happened despite application of the same number of units of electricity, the same amount of water, and increasing doses of chemical fertiliser and pesticides. Contrast this annual disappointment with 1994, the first year of my natural farming, in which I received only 50 tonnes but saved because of lower costs.

Today, with a yield of around 450 tonnes I continue to use electricity and water but chemicals and pesticides have been banished. The day more farmers understand the agro-economics of natural farming is the day they will become strong. Their villages will have abundant water, groundwater levels will rise, and their hard work will genuinely benefit their families, society, and our country.

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*Subhash Sharma is an organic farmer in Yavatmal, Maharashtra. He has lectured on the economics of organic farming all over India*

# Climate change and food security

Rice production in India could decrease by almost a tonne/hectare if the temperature goes up 2$^0$C, while each 1$^0$C rise in mean temperature could cause wheat yield losses of 7 million tonnes per year. A recent national conference on food security and agriculture deliberated strategies to protect agriculture, food and nutrition security in the time of climate change

*SUMAN SAHAI*

*A TWO-DAY NATIONAL CONFERENCE was organised by Gene Campaign and ActionAid on 'Ensuring Food Security in a Changing Climate' to generate greater awareness about this crucial issue and to develop recommendations for future action. The conference, held on April 23 and 24, in New Delhi, brought together over 200 participants from 22 states. Scientific and technical experts from government and non-government organisations, grassroots-level community organisations, civil society groups, members of government departments, scientists, farmer organisations, officials of state governments, diplomats, international organisations and concerned citizens discussed the impact of climate change on agriculture and deliberated the strategies needed to help protect agriculture, food and nutrition security, as well as rural livelihoods*

According to climate estimates, developing countries in the tropics are more susceptible to climate change damage than temperate countries. Agriculture in the productive areas of Africa and South Asia will be amongst the worst-affected. According to some estimates, almost 40% of the production potential in certain developing countries could be lost.

Changes in rainfall patterns and temperature regimes will influence the local water balance and disturb the optimal cultivation period available for particular crops, thus throwing food and agricultural production out of gear. The worst brunt of climate change will be borne by farmers in dryland regions where agriculture is rainfed, conditions are marginal and only one crop is grown per year.

In South Asia, the biggest blow to food production is expected to come from the loss of multiple cropping zones. The worst-affected areas are predicted to be the double- and triple-cropping zones. To offset most of this loss, an effort must be made to convert today's single-cropping areas into two-crop zones. This can first and foremost be done by efficient water harvesting and equitable management.

Coping with the impact of climate change on agriculture will require careful management of resources like soil, water and biodiversity. Making agriculture sustainable is key, and is possible only through production systems that make the most efficient use of environmental goods and services without damaging these assets. If climate change impacts can be incorporated in the design and implementation of development programmes right away, it will help to reduce vulnerability, stabilise food production and secure livelihoods. A large-scale climate literacy programme is necessary to prepare farmers, who are today bewildered by the rapid fluctuations in weather conditions that affect their agriculture. Their traditional knowledge does not help them manage these recent anthropogenic changes.

Developing countries face a substantial decrease in cereal production potential. In India, rice production is slated to decrease by almost a tonne/hectare if the temperature goes up 2$^0$C. By 2050, about half of India's prime wheat production area could get heat-stressed, with the cultivation window becoming smaller, affecting productivity. For each 1$^0$C rise in mean temperature, wheat yield losses in India are likely to be around 7 million tonnes per year, or around $ 1.5 billion at current prices.

To cope with the impact of climate change on agriculture and food production, India will need to act at the global, regional, national and local levels.

**Recommendations for action**

***Global***

India must negotiate hard against the post-Copenhagen 'pledge and review' framework for emissions and try to get global temperature rise capped at 2$^0$C. If this is not done, the impact on agriculture and food security in developing countries will be devastating. Rising temperatures will be beneficial for agriculture in cold temperate regions since warmer conditions will allow their single-crop zones to become two-, even three-crop zones. Given that agriculture is the lifeline of the developing world and will bear the worst brunt of climate change, India must insist that developed countries reduce their own agriculture emissions while at the same time paying for adaptation, especially in the agriculture sector, consistent with the 'polluter pays' principle.

***Regional***

Regional cooperation at the SAARC level is necessary to protect the Himalayan ecosystems and minimise glacial melt. Negotiations on river waters emanating from the

Tibetan plateau are urgent so that flows in our major rivers like the Ganga and Brahmaputra are maintained to support agriculture. Regional strategies for mitigation and adaptation across similar agro-ecologies will help all countries of the region to protect their agriculture and food production.

***National***

Adaptation strategies have long lead times and need to be started *now*. Appropriate policy and budgetary support for mitigation and adaptation actions is needed. Multiple food and livelihood strategies are required in rural areas to minimise risk. Food inflation must be contained at all costs. It will worsen with climate change, as more frequent and unpredictable drought and floods will result in shortfalls in food production. Just one bad monsoon in 2009 led to a reduction of 15 million tonnes of rice and 4 million tonnes of pulse production, causing prices to go through the roof. A carefully planned programme for strategic research, along with dedicated funding, is needed to develop solutions to cope with the impact of global warming on crops, livestock, fish, soil, etc.

***Local***

The real action for both mitigation and adaptation will have to be at the local level. The pursuit of sustainable agricultural development at the local level is integral to climate change mitigation, and combating the effects of climate change is vital for sustainable agriculture. Location-specific technologies will need to be developed at the level of the agro-ecological unit, to make agriculture sustainable and minimise losses to food and nutrition.

Mitigating emissions from agriculture will reduce the farmer's input costs and make the production system more sustainable. The real challenge to the agricultural future of the country, however, will have to be met by rapid and targeted adaptation strategies. Adaptation will require strategies to reduce vulnerabilities, strengthen resilience and build the adaptive capacity of rural and farming communities. Industrial agro ecosystems damage environmental goods and services and so have weak resilience.

Developing sustainability in agriculture production systems rather than seeking to maximise crop, aquacultural and livestock outputs, will help farming communities cope with the uncertainties of climate change. The ecosystem approach with crop rotations, bio-organic fertilisers and biological pest control, improves soil health and water retention, increases fertile top soil, reduces soil erosion and maintains productivity over the long term. The more diverse the agro ecosystem, the more efficient the network of insects and micro-organisms that control pests and disease. Building resilience in agro ecosystems and farming communities, improving adaptive capacity and mitigating greenhouse gas emissions is the way to cope.

Agricultural biodiversity is central to an agro ecosystem approach to food production. Such an approach promotes soil fertility, fosters high productivity and protects crop, livestock, fish and soil resources. Diversity in livestock and fish species and breeds is as important as in crop varieties. Genetic diversity gives species the ability to adapt to changing environments and combat biotic and abiotic stress like pests and disease, drought and salinity.

**Specific recommendations**

Apart from the obvious focus needed on soil health, water conservation and management, and pest management,

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agriculture and food production *per se* will need to become sustainable and ecologically sound to adapt to climate change turbulence.

• A special package for adaptation should be developed for rainfed areas based on minimising risk. The production model should be diversified to include crops, livestock, fisheries, poultry and agro forestry; homestead gardens supported by nurseries should be promoted to make up deficits in food and nutrition from climate-related yield losses; farm ponds, fertiliser trees and biogas plants must be promoted in all semi-arid rainfed areas which constitute 60% of our cultivated area.

• A knowledge-intensive rather than input-intensive approach should be adopted to develop adaptation strategies. Traditional knowledge about the community's coping strategies should be documented and used in training programmes to help find solutions to address the uncertainties of climate change, build resilience, adapt agriculture, and reduce emissions.

• Conserving the genetic diversity of crops and animal breeds, and its associated knowledge, in partnership with local communities, must receive the highest priority.

• Breed improvement of indigenous cattle must be undertaken to improve their performance since they are much better adapted to adverse weather than high-performance hybrids. Balancing feed mixtures, which research shows has the potential to increase milk yields and reduce methane emissions, must be promoted widely.

• An early warning system should be put in place to monitor changes in pest and disease profiles and predict new pest and disease outbreaks. The overall pest control strategy should be based on integrated pest management because it takes care of multiple pests in a given climatic scenario.

• A national grid of grain storages, ranging from pusa bins and grain golas at the household/community level to ultra-modern silos at the district level, must be established to ensure local food security and stabilise prices.

• Agricultural credit and insurance systems must be made more comprehensive and responsive to the needs of small farmers. For instance, pigs are not covered by livestock insurance despite their potential for income enhancement of poor households.

The following adaptation and mitigation support structures should be established at each of the 128 agro ecological zones in the country:

• A centre for climate risk research, management and extension should prepare computer simulation models of different weather probabilities and develop and promote farming system approaches which can help minimise the adverse impacts of unfavourable weather, and maximise the benefits of a good monsoon.

• A farmer field school to house dynamic research and training programmes on building soil health, integrated pest management, water conservation and its equitable and efficient use. The school should engage in participatory plant and animal breeding; there should be a focused research programme to identify valuable genetic traits like drought-, heat- and salinity-tolerance and disease resistance available in the agro biodiversity of the region.

• Gyan chaupals and village resource centres with satellite connectivity from where value-added weather data from the government's Agromet service should be made available to farmers through mobile telephony, giving them information on rainfall and weather in real-time.

• A network of community-level seed banks with the capacity to implement contingency plans and alternative cropping strategies depending on the behaviour of the monsoon.

• Decentralised seed production programmes involving local communities, to address the crisis of seed availability. Seeds of the main crops and contingency crops (for a delayed/failed monsoon, or floods) as well as seeds of fodder and green manure plants specific to the agro ecological unit must be produced and stocked.

Technical and financial investments must be made in climate adaptation and mitigation research. Some priority areas identified by the conference are:

• Evaluation of traditional varieties and animal breeds for valuable traits like tolerance to higher temperatures, drought and salinity, feed conversion efficiency and disease resistance, for use in breeding new varieties and breeds.

• Developing balanced ration and feed-and-fodder regimes that will increase milk yields of indigenous cattle and reduce methane emissions.

• Participatory and formal plant breeding to develop climate-resilient crop varieties that can tolerate higher temperatures, drought and salinity.

• Developing short-duration crop varieties (especially wheat) that can mature before the peak heat phase sets in.

• Selecting genotypes in crops that have a higher per day yield potential to counter yield loss from heat-induced reduction in growing periods.

• Developing (the more heat-tolerant) durum wheat varieties for rabi cultivation in north India, to supplement diminishing wheat yields from existing wheat cultivars, and for durum wheat's *chapatti*-making qualities.

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# Local solutions to climate change

In developing countries, 11% of arable land could be affected by climate change. Indeed, farmers are already facing the impact of climate change. The need of the hour is not to wait for global agreements on mitigating climate change but to act locally, intelligently and consistently, as is being done with water harvesting solutions for rainfed agriculture in Andhra Pradesh

*SREENATH DIXIT*
*B VENKATESWARLU*

AROUND 2200 BCE, there was a shift in the Mediterranean westerly winds. This far-off change had an effect on the Indian monsoon, leading to three centuries of reduced rainfall and colder temperatures. The phenomenon hit agriculture from the Aegean Sea to the Indus; it's said the change in climate brought down Egypt's pyramid-building Old Kingdom and Sargon the Great's empire in Mesopotamia.

After only a few decades of reduced rainfall, cities lining the northern reaches of the Euphrates — a region that was the bread basket for the Akkadians — emptied out as populations migrated. Even intensively irrigated southern Mesopotamia, which boasted one of the most sophisticated bureaucracies of its time, could not react fast enough to the new conditions. With no supplies of rainfed grain from the north, irrigation canals running dry, and waves of migrants from the northern cities, the empire simply collapsed.

Societies have always depended on climate, but are only now coming to grips with the fact that the climate depends on their actions. Left unmanaged, climate change could reverse developmental progress and compromise the wellbeing of current and future generations. As the earth warms, the impacts will be felt everywhere. But much of the damage will occur in developing countries. Millions of people from Bangladesh to Florida will suffer as sea levels rise, inundating settlements and contaminating freshwater. Greater rainfall variability and more severe droughts in semi-arid Asia and Africa will hinder efforts to enhance food security and combat malnourishment. Shrinking Himalayan and Andean glaciers — which regulate river flow and supply water to over a billion people on farms and in cities — will threaten rural livelihoods and major food markets.

Croplands, pastures and forests that occupy 60% of the earth's surface are progressively being exposed to threats from increased climatic variability and, in the longer run, to climate change. Abnormal changes in air temperature and rainfall, and resultant increases in the frequency and intensity of drought and flood events, have long-term implications for the viability of these ecosystems. As climatic patterns alter, so too do the spatial distribution of agro-ecological zones, habitats, distribution patterns of plant diseases and pests, fish populations and ocean circulation patterns which could have significant impacts on agriculture and food production.

Those least able to cope will likely bear additional adverse impacts. The estimate for Africa is that 25-42% of habitats could be lost, affecting both food and non-food crops. Habitat change is already underway in some areas, leading to species range shifts, changes in plant diversity, including indigenous foods and plant-based medicines. In developing countries, 11% of arable land could be affected by climate change, including a reduction of cereal production in up to 65 countries, about 16% of agricultural GDP. Changes in ocean circulation patterns may affect fish populations and the aquatic food web as species seek conditions suitable for their lifecycle. Higher ocean acidity (resulting from carbon dioxide absorption from the atmosphere) could affect the marine environment through deficiency in calcium carbonate, affecting shelled organisms and coral reefs.

Climate change impacts are both biophysical and socio-economic. Biophysical impacts include physiological effects on crops, pasture, forests and livestock; changes in land, soil and water resources; increased weed and pest challenges; shifts in spatial and temporal distribution of impacts; sea level rise, changes in ocean salinity; and sea temperature rise causing fish to inhabit different ranges. These will, in turn, bring socio-economic stresses with decline in yields and production; reduced marginal GDP from agriculture; fluctuations in world market prices; changes in geographical distribution of trade regimes; increased number of people at risk of hunger and food insecurity; migration; and civil unrest.

The failure of the recent Copenhagen climate change summit is only a symptom of the deep divide in the international community. No path-breaking outcome can be expected from a world so polarised. The need of the hour is not to wait for miracles to happen but to act locally, intelligently and consistently. For, small consistent efforts bring about big and lasting change.

The most important primary industry that sustains the world is agriculture and its allied sectors. It is this sector that has the potential to decide the future of human civilisation. There are plenty opportunities here. We elaborate on one such opportunity in rainfed agriculture, where water is going to be a serious limiting factor as an impact of climate change.

In arid and semi-arid ecosystems, rain is the only source of water for agriculture and human and livestock consumption. One of the prominent impacts of climate change has been frequent heavy rainfall interspersed with long spells of drought; many such events have been recorded by our meteorological department in the last decade. In 2008, for instance, parts of Andhra Pradesh's dry Anantapur district experienced 114 mm of rain (more than a fifth of its average annual rainfall of 500 mm!) in less than three hours, after a prolonged drought of over 25 days. This event devastated groundnut, the only profitable commercial crop in the region, resulting in heavy economic losses. Such events are being increasingly reported across rainfed regions in recent years, causing loss of livelihood, agrarian unrest, even farmer suicides.

The sustainability of rainfed agriculture therefore depends on managing drastic changes in weather patterns through local adaptations that require consistent policy and institutional support.

The National Agricultural Innovation Project (NAIP) stresses rainwater management in eight drought-prone districts of Andhra Pradesh. Implemented by the Central Research Institute for Dryland Agriculture (CRIDA, an institute of the Natural Resource Management Division, Indian Council of Agricultural Research), rainwater management is being practised in a cluster of villages in each of these districts, a cluster being selected as an action research field laboratory. Each cluster represents a unique agro-ecology with opportunities for rainwater harvesting and its efficient use. The annual rainfall in these clusters ranges from a mere 500 mm (in Pampanur cluster of Anantapur) to over 1,100 mm (in Thummalacheruvu cluster of Khammam).

Soil type varies too, from deep black soils (Seethagondi, Adilabad) to medium and shallow red soils (Pampanur, Anantapur). Hence, the runoff and infiltration rate, therefore rainwater harvesting potential, also vary. The Seethagondi cluster of villages in tribal Adilabad district is blessed with fairly good rainfall (above 1,000 mm) and a deep black soil. Besides these, the undulating topography offers an ideal opportunity to harvest runoff, storing and reusing the same to tide over brief spells of drought during the cropping season. The technical and economic feasibility of runoff harvesting through farm ponds for profitable crop production and diversification was amply proved over two years (2007-2009). Emphasis is also being laid on scaling up farm ponds through convergence with the National Rural Employment Guarantee Scheme (NREGS) as an option for enhancing productivity (see box).

The Pampanur cluster of Anantapur is extremely arid, hence rainwater harvesting through percolation ponds and recharge of groundwater is preferred as it is not feasible to store water in the porous red soil of the region. Groundwater is judiciously used through sprinklers and drip irrigation systems

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which have been deployed across the cluster by converging with development programmes such as the Andhra Pradesh Micro Irrigation Project (APMIP) and National Horticulture Mission (NHM). Custom hiring centres at Pampanur and Y Kothapalli are equipped with sprinkler sets and pipelines that are in great demand among farmers. Farmers hire sprinkler sets and pay user fees to a committee of fellow farmers (called 'salaha samiti', meaning 'advisory committee'), which maintains records and accounts. The money collected is used to maintain and repair the equipment.

In the B Yerragudi cluster of Kadapa district, in the dry Rayalaseema area, attempts are on to augment water availability through de-silting of the Gajulakunta tank near Konampeta village. The effort began after villagers said they wanted to increase the volume of the silted-up tank. The work was undertaken under the NREGS, thereby ensuring the participation of households in the cluster. The community now feels empowered to employ the NREGS to create assets for the village. Says Veeranna, a small farmer: "We knew that the government was spending a lot of money to help us. But we were unable to use it to create good facilities for our villages."

The Jamisthapur cluster in Mahboobnagar is extremely drought-prone, with an average annual rainfall of just around 600 mm. The soil is shallow, with poor water-holding capacity. The rainwater harvesting strategy here comprised digging a series of percolation ponds, trench-cum-bunds and repairing old check-dams and other water harvesting structures. Promotion of nursery and plantation activities to green up barren hillocks in the ridge area was also encouraged. An old check-dam that was leaking and unable to arrest runoff (and store it to recharge groundwater) was repaired at a cost of Rs 38,000, with people contributing their labour towards the repair. A trench-cum-bund over 5.2 km long was dug in the ridge area, and trees planted along bunds. Two percolation tanks were dug in the cluster to enhance groundwater resources; local youth have been trained to monitor groundwater levels periodically so that the community is aware of the relation between rainfall, conservation measures and groundwater exploitation. The custom hiring centre here too is equipped with efficient groundwater using systems like sprinklers. The farmers of Jamisthapur are being motivated to choose irrigated dry crops in place of paddy during the rabi season, and zero-till maize is being promoted in paddy fallows through careful training and capacity-building activities.

Dupahad cluster of Nalgonda is one of the most drought-prone areas in the state of Andhra Pradesh. Groundwater resources are meagre and the soil porous and shallow. For ages, agriculture here has depended on water harvesting structures like tanks and open wells. However, tanks chronically silt up while open wells remain dry as a result of the collapse of people's institutions and the indiscriminate digging of borewells.

## Farm ponds: scaling up and converging with the NREGS

Farm ponds as an option for harvesting and recycling rainwater have been recommended for over two decades. Such ponds are meant mainly to provide life-saving irrigation to small patches of crop when they are exposed to mid-term drought that is very common in rainfed agriculture.

However, this simple technology has not really taken off, the main reason being that by the time the need for life-saving irrigation arises, water in the pond has dried up. This is either because the soil is so porous it does not retain water for long, or the pond is too small to meet water needs during an intense period of climatic stress.

Keeping these shortcomings in mind, several options like lining the pond with various materials have been tried, especially in shallow, porous red soil regions. But they have proven too expensive for farmers to invest in without assistance.

In black soil regions, water remains impounded for a longer period as fine clay particles in the soil act as natural sealants. Despite this, farm ponds do not find wide acceptance even in these regions. In fact, black soil regions with a rainfall of around 800 mm are ideal for rainwater harvesting and reuse. With this in mind, an attempt was made in Adilabad district's Seethagondi cluster to impound a large volume of rainwater by digging farm ponds whose volume was nine times the recommended size. Initially, it took a lot of persuasion to convince farmers to part with some of their land to dig a pond. Finally, a farmer called Namdev reluctantly agreed. The farm pond was not only a huge success, it managed to pull Namdev out of a debt trap.

This success generated a lot of interest among farmers and within line departments in Adilabad. Namdev became a household name in the surrounding villages. Several farmers who had earlier resisted the idea of a farm pond began to approach project staff to pledge their willingness to surrender part of their field for a pond.

Namdev's experiences were widely shared at discussions, meetings and seminars with the media; they were also highlighted on the project's and ICAR's websites. Taking advantage of the changed attitude of farmers towards farm ponds, a detailed ground survey was carried out in all villages in the Seethagondi cluster and a proposal was prepared identifying 30 suitable sites for farm ponds. The proposal was later submitted to the nodal agency (the District Water Management Agency) that processes NREGS works through gram panchayats. It was closely monitored by project staff and the community. Finally, the agency approved 30 farm ponds at a cost of Rs 20 lakh.

## Social regulation for efficient groundwater usage

This project in the Ibrahimpur cluster of Rangareddy district is committed to judicious use of scarce resources such as groundwater by investing in technology as well as community capacity. It involved a series of consultations with borewell-owning farmers and their neighbours who did not have water sources to irrigate their lands. Initially, the two farmers who owned borewells were opposed to the idea. Project staff decided to repair a defunct borewell as a goodwill gesture, and approached the farmers again. By then, the farmers had begun seeing the benefits and agreed to share water, provided the project assisted the community in digging a few more borewells so that there was enough water to share across a large area.

This time, the project contacted NABARD for assistance. The bank responded by financing the digging of two borewells in the area, under its comprehensive land development programme. This raised the hopes of several farmers, including those who owned borewells, because with the pooling of water they could now irrigate patches of their dry fields that were currently beyond reach. Thus, year-long negotiations with the community to implement social regulations on groundwater usage finally bore fruit. Over 60 acres of land belonging to 18 households were brought under protective irrigation by laying a network of pipelines and borewells. The entire group of farmers has now agreed not to cultivate rabi paddy, and to share borewell water among themselves.

Two strategies were adopted to augment water resources in this cluster. The Jalamalakunta (*kunta* means 'tank') was de-silted by mobilising people under the NREGS. Project staff carried out a detailed survey and estimate of the work, and the village community was encouraged to submit this for inclusion under the NREGS.

They were sanctioned Rs 2.5 lakh (translating to 2,500 person-days at Rs 100 per day per person) for the job. Work began during the summer of 2009. Although there was a severe drought during kharif 2009, rainfall at the end of the season provided some runoff that could be harvested, pushing the water table up in this land of parched fields and dry wells.

Around 50 open wells had been abandoned. After a detailed topological survey, five were selected for recharging using low-cost techniques. This involved diverting runoff from a nearby waterway into a silt trap (a pit filled with loose pebbles) and then leading clear water into the open well through a PVC duct; the whole system costs no more than Rs 1,500. Initial results have been encouraging as farmers were able to grow short-duration vegetables by lifting harvested water from the open wells.

An entirely different approach was adopted in the Ibrahimpur cluster of Rangareddy district, adjacent to the peri-urban areas around Hyderabad city. The objective here was more efficient use of available groundwater by networking six borewells belonging to different farmers and distributing the water to around 18 farmers (their combined land being 45 acres) with the help of sprinklers. The process of linking and networking the wells required greater social skills than irrigation engineering (see box)!

The Jaffergudem cluster of Warangal has proved progressive in terms of the agricultural practices adopted by farmers. However, the shallow and gravelly soil has poor water-holding capacity and needs protective irrigation support for better productivity. Farmers therefore use groundwater for irrigation support. The strategy for rainwater harvesting and use in this cluster is mainly through farm ponds and percolation ponds, and appropriate cropping options. All the soil conservation and rainwater harvesting measures in this cluster are being carried out in conjunction with the NABARD-funded watershed project.

Farmers who own borewells generally cultivate paddy in both the kharif and rabi seasons, upsetting the water balance. While technical support for the watershed activities here was provided to the NABARD project, simultaneous training and capacity-building was launched to educate farmers on the importance of maintaining a water balance. Farmers growing two crops of paddy were convinced to change their methods, at least for the rabi crop. Of the group of five farmers who initially agreed to take up zero-till maize in paddy fallows during the rabi season, one was able to finally sow zero-till maize in rabi 2007. A sustained campaign and farmer-to-farmer training and interactions facilitated by the project team resulted in this practice spreading to 20 farmers during rabi 2008. Now, zero-till maize has been accepted not only as a viable water conservation option but also a remunerative alternative.

The success of 'proofing' rainfed agriculture against climate change lies in judicious use of scarce resources like water, nutrients and biomass, facilitating a support system, and developing people's capacity. The changes brought about by farmers in these eight drought-prone districts show that technologies need a favourable environment in which to work and produce results. The catalyst to making technologies work is community capacity and supportive institutions that are able to sustain the change beyond the project period. CRIDA's work here shows how synergies between different development schemes can be employed to influence sustainable development. These need-based, site-specific innovations and methods reveal how local solutions are more suited to climate change than technology-intensive prescriptions pushed through a top-down approach.

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# Tackling climate change in Gorakhpur

The people of Gorakhpur district, UP, have come to expect heavy rains followed by long dry spells as a consequence of climate change. But they are no longer allowing climate change to affect their crops. At shared learning dialogues, they are learning about the benefits of multi-cropping, alternative farming, soil management and seed autonomy

*SUREKHA SULE*

"EARLIER THERE USED TO BE continuous low-intensity rain, with the river Rohini swelling two or three times due to heavy rains in Nepal. But now it rains incessantly here, bringing flash floods every now and then, followed by a long dry spell which is very bad for our crops," says Ramdeen. He is a farmer from Makhanaha village (Campierganj block, Gorakhpur district) in eastern Uttar Pradesh.

"Earlier the monsoon season would start in June and end in September; our village used to get flooded twice or thrice in July and August. But in 2009 the rain arrived on May 24, and in June itself we had floods," says Rajendra, who also lives in Makhanaha. Villagers speak of odd weather patterns with floods becoming more frequent due to heavier rainfall over fewer days. Earlier, the floodwaters would recede within a week; now the land remains waterlogged for a month, destroying the kharif crop. Excessive rain, floods, waterlogging, drought — all in one season!

In contrast to earlier years, when 70% of the average annual precipitation fell over an 80-day period, the same amount now falls in just 50 days. The indications are that climate change has increased the intensity and frequency of extreme weather events, complicating weather predictions, according to the Gorakhpur Environmental Action Group (GEAG).

Shakuntala Devi, another villager, says: "Earlier it used to get cold during Dassehra (October) and we needed sweaters and *rajais* (quilts). But now even after Diwali there is no sign of winter." Bhanamati Devi agrees: "We used to wait for the arrival of *kadakul* birds (sparrow) to sow wheat after Diwali. These birds flock here at the onset of winter, and that is the right time for us to sow wheat. This year there has been no sign of the birds."

Indeed, farmers were worried about the wheat crop. A late winter means late sowing of wheat. The winter (rabi) wheat grain is aided in the ripening process by warm winds following peak winter. This time around, however, because of the late sowing the fear was that the winds may blow in before the ripening stage, destroying or badly affecting the crop. Gorakhpur's potato crop was affected too because of late winter fog, and then the onion crop was in danger of rotting thanks to a long hot spell. The essential foodgrain, arhar (a pulse), that requires cold weather during its flowering phase has also been affected by a delayed winter. In short, traditional cropping patterns have been seriously disturbed by the extreme weather.

The Himalaya in Nepal descends steeply towards Uttar Pradesh with rivers running into the flat plains (the terai) of eastern Uttar Pradesh, flooding them during the monsoon. River embankments, built to control the water, are often breached by the swirling waters.

Analysing the agro-climatic situation in eastern Uttar Pradesh, Dr Shiraz Wajih (who formed GEAG in 1975) says that Nepal is usually blamed for releasing water and causing flash floods. Instead, he explains, it is a simple relationship between the plains and the hills; with floods comes the problem of heavy siltation (the 1998 flood deposited silt to a depth of six feet, in places). Rivers sometimes change course, forming new lakes. Embankments that are designed to mitigate the effects of flooding are often breached by flash floods. Floodwaters enter villages and fields and then cannot return to the river channel. Various works — such as roads and canals, or projects under the National Rural Employment Guarantee Scheme (NREGS) — act as barriers to the natural flow of water. Drainage should in fact be a priority in the handling of flood-related problems. These may seem like localised issues, says Dr Wajih, but their impact adds up at the macro level making the entire region vulnerable.

**Shared learning dialogue**

Most villages in the terai region of eastern Uttar Pradesh find themselves in a similar situation. With a view to identifying effective mitigation measures, the Gorakhpur Environmental Action Group organised shared learning dialogues (SLDs) at the village, district and state level. "During these SLDs, focus group discussions on local issues were supplemented with recent information drawn from scientific journals and regional research on the implications of climate change on regional flood dynamics," says a policy brief from the group. "Much of the information available on the impact of climate change was very general. Despite this generality, when used to support discussions with regional stakeholders, it was extremely useful for identifying a potential course of action to mitigate the impacts of climate change." SLDs also highlighted the risk of continuing reliance on conventional strategies such as embankments, where existing technical problems like breaching or blocking of drainage are likely to become worse with climate change.

The GEAG dialogues have shown that while strategies designed for the micro level seem to be working, much more is needed for a particular region. A few strategies suggested by GEAG are: better access to climate and weather information and early warnings (the creation of village information centres has been discussed, also SMS-based text services as mobile phone usage in the villages is high); development of points of refuge (raised grain banks and raised houses) in which people and their assets can shelter during a flood; diversification of livelihood and cropping systems; improved drainage; development of insurance systems; and new sources of groundwater for irrigation in drought-prone areas.

The strategies identified through SLDs were implemented by farmers in the village of Sarekhurd (Mehdawal block). Farmers were accustomed to growing foodgrain both during the kharif and rabi seasons. The kharif crop was uncertain and depended on the length of waterlogging — when the entire area was inundated, no farming was possible. When that happened, farmers looked to rabi crops like wheat, gram, peas, lentils and chickpea to sustain them and their families. In a year of excessive flooding, the wheat was sown late and productivity declined. Most of the time the village experienced food insecurity; migration to cities was extremely common.

The Gorakhpur group discussed with the villagers of Sarekhurd how to form a common strategy that would ensure food security whilst guarding against the effects of climate change. With this objective, three committees — agriculture and livelihood, disaster management, and health — were set up. Farmers who joined the agriculture and livelihood committee were given training in alternative farming methods, composting, vegetable production, cash crops, nursery, etc. As a result, they started earning more by growing four to five crops in a year. Multi-cropping instead of mono-cropping has helped stabilise incomes so that farming households that found it difficult to get two square meals a day are now able to run their households comfortably. Children who were earlier taken out of school have returned. Women's and children's health issues are being tackled, and more work in the village has helped stem migration.

Thirty-five-year-old Chulhai owns 1 acre of land in the low-lying area adjacent to the river Rapti. Frequent floods

Rahul Goswami

and waterlogging made the going extremely tough for him and his family of 14. Today, Chulhai considers himself empowered enough to tackle any disaster. "Floods, waterlogging or drought, any situation can be turned to our advantage through right management of time and place," he says. During waterlogging, Chulhai prepares the nursery on a raised platform and replants the saplings when the water recedes. This strategy saves him sowing time; had he waited for the water to recede he would have lost precious time in the plants' growth cycle. During waterlogging, vegetables like bottle gourd and beans are made to grow upwards on a raised platform or *machaan*.

Chulhai sowed Narendra, an early variety of rice, on a fifth of an acre during the kharif season. His efforts yielded six quintals of rice. After keeping some for consumption at home, he sold the remaining two quintals for Rs 2,000. During the rabi season, Chulhai grows vegetables and spices on half his land. He has divided it thus: chillies and mustard on 20% of the land; mustard and lentils on 10%; garlic, onions, radish on 5%; peas on 5%; turmeric on 2%; and gram on 2%. This diverse crop portfolio spreads his risk. The radish will be harvested first and sold, giving him a cash income. If it gets too cold and the potato crop is affected, there are pulses to fall back on. Once it gets colder, Chulhai will sow wheat on half his land. Importantly, he does not use chemical pesticides on his crops. To control pests he has sown *saunf*, coriander and marigolds along the border of his land; this also discourages stray animals from grazing on his crops. Chulhai's farm earned him a cash income of Rs 35,000 in 2008, after factoring in the household's food requirements.

**Government linkage**

During a learning session at Meerpur Phoolwaria village in Gorakhpur's Jungal Kauria block, GEAG found that farmers were aware of the various government agriculture and disaster management schemes and wanted to benefit from these. The problem was scarce information on them, partly a result of poor outreach by the concerned departments. The farmers of Meerpur Phoolwaria decided to take GEAG's help. Meetings were organised where they discussed farm-related problems and how these could be overcome with the help of government schemes; the process was made easier thanks to the attendance of officials from the departments of agriculture, horticulture, animal husbandry, etc. A shortlist of achievements shows the importance of these community meetings:

• Sessions and meetings with horticulture officials helped Rambahal plant banana on part of his 3-acre farm.

• Jitendrakumar learnt about green manure from the agriculture department and now practises organic farming.

• The farmers of Meerpur Phoolwaria have begun collective farming of chickpea. Individual farming had almost ceased because of repeated crop infestations. With inputs from the government, 15 farmer groups put 5 hectares under chickpea and got 32 quintals per hectare in 2008, as against an earlier yield of 12-15 quintals per hectare.

• The soil department helped farmers protect their farms against soil erosion by placing bunds at strategic locations; the bunds totalled a length of around 3 km.

• Animal husbandry officials now come to the village regularly to vaccinate cattle instead of farmers having to drive their cattle to the department office, at the block level.

• Farmers use the 90% subsidy on zinc and gypsum fertiliser and the 50% subsidy on pesticide-spraying machines and seed storage. Even so, their use of chemical pesticides and fertiliser is dropping, to be replaced by traditional remedies such as neem oil.

• The agriculture department held three demonstrations on compost preparation.

These sessions have been successful at the individual level. Rambahal says his farming costs have dropped and his income increased thanks to the knowledge and support he received at the dialogue sessions. His wheat cultivation costs in 2006 were around Rs 8,000; his earnings totalled Rs 25,000. In 2008, his cultivation costs came down to Rs 5,000 as he used his own seeds and organic manure; his income shot up to Rs 100,000 thanks to a productivity boost from 15 quintals per hectare to 22 quintals.

Rambahal's neighbour Ram Pratap Singh complained that farmers had to wait in long queues for seeds at the block office in Jungal Kauria. And it took more than one trip to get the seeds — a single office distributes seeds to farmers in all 170 villages in the block. Farmers say even if they are called one or two villages at a time, seed distribution takes several months. But farmers need seeds during a particular week in the sowing season. That's why GEAC insists on self-reliance as regards seeds.

Finally, the community dialogues threw up an unlikely hero in Meerpur Phoolwaria village. Farmer Mohit Prasad is famous for having gone to Brussels, Belgium, in October 2009. Prasad's visit came about through a mixture of circumstances. The effects of climate change were impacting his livelihood in agriculture, so, close to desperation, Prasad decided to migrate to Dubai in search of work. He even had his passport ready. Then the aid advocacy group Oxfam put out word that it wanted to take a farmer from India to Brussels to speak about the impact of climate change at a conference. Prasad fit the bill, made the trip, delivered his speech to an international audience, and returned to Meerpur Phoolwaria. He's now back in farming after finding that there was enough work to be done on the land. He has put the idea of migrating behind him.

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# Agriculture at nature’s mercy

In recent decades, market forces have prompted farmers in the Sunderbans to choose modern, high-yielding varieties of paddy, oblivious to their sensitivity to salt. Cyclone Aila, which caused a huge inundation of salt in the fields, proved that this was a costly mistake: every farmer who sowed the modern seed ended up with no produce, while those who planted traditional salt-tolerant varieties managed to harvest a little rice

*SUKANTA DAS GUPTA*

CULTIVATORS IN THE REMOTE islands of the Sunderbans have had more than their fair share of struggles against nature since the islands were cleared and made cultivable more than a century ago. They cleared the forest, made protective earthen embankments all around the islands to keep out the surrounding salt water, and waited through several monsoons so that surface salinity of the soil reduced. Soon agriculture became possible, and with agriculture a dense population sprang up on the islands.

The people of the Sunderbans maintained their determination to overcome nature’s unending challenges. It was a constant battle as the fragile embankments suffered continuous erosion, their upper surfaces from the onslaught of the waves and their foundations by powerful river currents. Indeed, the people here are accustomed to crumbling embankments, to cultivated plots being submerged, and to perpetual rebuilding.

On May 25, 2009, however, Cyclone Aila caused such widespread havoc that the brave islanders could do nothing but surrender to nature’s fury. The region was simply not equipped to deal with a calamity on this scale; nothing in living or recorded memory could have prepared them for Aila. The islands have weathered cyclones with greater wind velocity and some peripheral effects of the 2004 tsunami. But all this happened when water in the rivers was at a low ebb. In this inter-tidal zone, daily fluctuations in water level are at least 3-3.6 metres. On a full-moon or no-moon day, the amplitude increases to 5.4-6 metres. That fateful day, a no-moon day, Aila’s landfall coincided with the highest water level. The only reason the death toll (less than 100) was not greater is that Aila made landfall during the day.

Although the toll is tragic for the victims’ families, it is relatively low compared to the history of cyclones in the region. That’s why it masks the true impact, for it broke the backbone of agriculture on these islands. With experts predicting more frequent storms and cyclones as a result of climate change, Aila has shown us the vulnerability of coastal populations in the Sunderbans (both in India and in Bangladesh), a vulnerability that is shared by all coastal habitations in South Asia and threatens other such deltaic regions in the world.

**Agriculture before Aila**

There are 54 populated islands in the Indian Sunderbans, apart from 48 others that constitute reserve forests. On the inhabited islands, around 90% of households depend on agriculture directly or indirectly. Agriculture here is synonymous with paddy cultivation, in a region that is mono-crop due to the shortage of fresh water. On these islands, rain is the only source of water for agriculture because the groundwater in most places is salty. And it’s deep (as has been found by borewells on some islands), making lifting of water for irrigation economically unviable. So, the single crop that is raised is a product of the monsoon.

It was only natural therefore that the first settlers on the islands preferred rice which is salt-tolerant. Usually, soil salinity of 1-2 decisemens per metre (dsm) is ideal for raising crops. But if the salinity exceeds 3 dsm, it harms agriculture. The rice family comprises many varieties that have evolved through the ages in different soil conditions; there are some that can tolerate salinity above this margin.

Soil salinity in the Sunderbans during the initial years of settlement must have been quite high; we hear of rice varieties like Hamilton and Matla being grown here. These varieties were not known to exist outside the Sunderbans, suggesting that they were extremely salt-tolerant. As agriculture on the islands progressed, the salinity of the soil decreased and other varieties of rice began to be planted, like Dudheswar, Nona Bokhra, Nona Shal, and Nona Kheetish. These were imported to the Sunderbans from the adjoining regions of southern West Bengal.

In recent decades, market forces have begun driving decisions, and productivity has become the yardstick by which farmers’ choices are determined. With a perverse sense of assurance against the possibility of salt water intrusion, farmers began choosing modern high-yielding varieties, oblivious to their sensitivity and vulnerability to salt. Under normal conditions, there were indeed demonstrations of significantly increased returns from the new varieties. This led farmers to ignore annual warnings of embankments being breached. And so, modern agriculture in the Sunderbans came to be dominated by rice varieties engineered for the mainland, with high productivity but little salt-tolerance.

**Soil conditions after Aila**

When the embankments crumbled under the force of Cyclone Aila, they could not be restored for over a month in many parts of the islands. This meant the flow of salt water into low-lying lands with the twice-daily turn of the tide. Every incoming tide contributed to fresh salt deposits on the exposed land. In other areas, where the destruction of embankments was not total, residents were able to carry out patchwork repairs more quickly to keep out the seawater. Cultivable land on the islands received varied levels of salt deposits on them, depending on the duration of their exposure to the surrounding rivers.

When, at last, the salt water receded, layers of salt still coated the upper surfaces. After Aila, land salinity in the Sunderbans, measured at various places on the islands, showed a range of 9-15 dsm! No expert on agriculture would recommend any variety of paddy for such land.

Farmers are experts in their field — they waited and prayed for heavy showers to reduce the salinity. The cyclone hit shortly before the scheduled onset of the monsoon. The hope was that a long and heavy monsoon in 2009 would quickly wash away the salt. But the monsoon was late, irregular and deficient compared to the average.

**Tanks and ponds**

The Sunderban islands are dotted with tanks and ponds of various sizes. Almost every landed household has at least one tank. These tanks are the sole reservoirs of fresh water for domestic and agricultural work throughout the year. Not large enough to allow for another major crop during the dry season, the tanks help islanders store water required for ripening of the monsoon paddy in the last stage, well after the rains are over. They also help people grow vegetables like tomatoes and chillies, which do well in these parts. Further, the tanks hold freshwater fish stocks that provide the islanders essential protein. The monsoon is crucial therefore both for the paddy crop and for freshwater fish.

Towards the end of summer 2009, the tanks and ponds had only a minimum level of water, which is not unusual for this time of year. When the cyclone struck, salt water surged into the tanks and ponds, destroying the freshwater fish. A day after the event, the islands were filled with the stench of rotting fish. This also meant the end of tank and pond water to supplement agricultural needs after the monsoons.

The people of the Sunderbans and the administration understood the threat quickly. Together with rebuilding embankments, one of the early livelihood support programmes was to rid the ponds of saline water. Once the embankments were repaired, the Sunderbans Development

> With climate change and the daunting prospect of further disruptions to weather patterns, agriculture here will become increasingly fragile. As the latest experience shows, salt tolerance alone is not the solution; every aspect of the residents' livelihoods must also change

Board (an apex state body to promote development in the area) gave the tank owners money to hire pump sets to lift the salt water out of their inundated ponds and make them ready to receive fresh monsoon water.

With NGOs aiding efforts, the recovery process in many islands appeared to be successful. Tanks and ponds were emptied to make way for rainwater from the months of August to October. Sadly, the result has not been what was hoped for. Although the ponds did receive fresh water directly from the rain, it had flowed across the land carrying with it salt that had accumulated on the land surface. After the monsoon, therefore, water that had collected in the tanks and ponds was saline — unusable either for agriculture or for freshwater fish.

Even after the 2009 monsoon, soil salinity continued to be high. The state had to do something. The West Bengal Department of Agriculture tried to induce farmers in less saline pockets to attempt cultivation. It provided whatever salt-tolerant seed varieties were available in its reserve. Lunishree, Jarava, Sabita and Swarna seeds were distributed to a large number of farmers, many of whom, driven to desperation, were ready to take a chance with the adverse conditions. They had no other means to sustain their households and themselves. They built their seed beds on higher land where soil salinity was relatively low. They began late, well after the first monsoon showers. Some of the seeds failed to germinate; others that did were weak and died in the seed bed itself. Those that survived the initial phase were transplanted to the field when there was a reasonable level of standing rainwater.

After transplantation, the paddy did indeed grow, albeit not as vigorously as usual. The standing water had forced the salt to subside beneath the surface soil. At last the plants flowered and, in many places, showed initial signs of being an adequate crop. But then another problem cropped up.

The monsoon began abating before the rice ripened, and the standing water in the fields evaporated. The salt from under the soil surface was sucked back up by the plants' roots, crippling the plants and destroying the rice grain.

**Mixed outcome**

What was the outcome of the long, tiring struggle to return to normalcy in the Sunderbans? Almost every farmer who sowed the modern seed variety ended up with no produce. Those who were able to collect traditional salt-tolerant varieties, and were lucky to have lower salt deposits on their land, harvested a little rice. But their output was greatly reduced. Compared with the usual rice output in the Sunderbans — 3.5-4 tonnes per hectare — this harvest yielded only 1.5-2 tonnes per hectare.

The difference between local varieties and high-yielding varieties became glaringly clear. Local rice strains such as Dudheswar, Marichsal and Nona Bokhra performed the best, followed by HYV varieties like Lunishree, Jarava and Sabita. MTU7029, the most popular paddy variety in West Bengal, proved totally unsatisfactory in the area this year.

Apart from rice, the croplands produce some post-monsoon grain in normal years. One example is khesari, a pulse that requires little or no irrigation. Other commercial crops like sunflower, tomatoes and chillies are also cultivated in places where transportation is accessible and where ample water reserves (tanks and ponds) are available. Almost every household grows small quantities of winter vegetables, using pond and tank water, for their own consumption which is important for poor households. In 2009, however, after the monsoon, these crops failed entirely or had only marginal success.

The cycle of construction and destruction in the Sunderbans has gone on for years according to nature's diktat. Historians agree that the islands have been depopulated and repopulated over and over again, and at all times the sustenance for people who chose to make the islands their home has been dictated by natural laws and events. This helps us understand that what is happening today is the rule, not the exception. And that the struggle for existence against all odds will continue. Compared with a generation ago, the effects of the 2009 cyclone were mitigated to the extent possible thanks to instant communications and the vast information network that was able to quickly mobilise aid and assistance. Yet the longer-term struggle continues, for after the failed crops of 2009 many of the islands' men have temporarily migrated to find work. With climate change and the daunting prospect of further disruptions in weather patterns and cyclonic events, agriculture here will become increasingly fragile. As the latest experience shows, salt tolerance alone is not the solution; every aspect of the residents' livelihoods must also change.

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# Resilience of man and nature

Cyclone Aila seemed to have broken the back of agriculture in the Sunderbans. But three months later, salinity notwithstanding, seeds were sprouting

*SANTADAS GHOSH*

CYCLONE AILA devastated the economy of the low-lying but densely populated Sunderbans islands, just before the 2009 monsoon. These islands — the official figure is 54 islands, none of which has any freshwater source — are mudflats in the maze of rivers in the Indian part of the Sunderbans. They are surrounded by the Bay of Bengal, whose waters travel with the tide north through numerous channels from the southern tip of West Bengal.

On a no-moon day, with unusual high-tide levels, the islands' earthen embankments gave way to nature's fury, drowning almost every part of the islands in saline water. The destruction was not massive in terms of loss of life. But it ensured little or no agriculture for the inhabitants during the all-important monsoon season. With most islanders relying on agriculture — and the single monsoon crop — many outsiders like me sensed the gravity of the calamity that would unfold with time.

Climate change predictions establish that events like these are likely to occur more frequently in future.

**After Aila**

I was able to embark on a proper exploratory visit to the islands only three months after the event, when the chaotic situation on the ground had limped back to something resembling normalcy. But the veil of routine life in the Sunderbans hid the effects on agriculture. With memories of the aftermath of the cyclone — lands submerged by saline water, standing crops turned brown with salt — I expected to see empty, discoloured lands. But there were patches of green fields, newly planted with rice! It was a pleasant surprise to see attempts at cultivation in the year immediately following Aila. Although the plants looked weak and yellowish, the very fact that seeds had sprouted and taken root in the damaged fields showed their resilience.

Further into the maze of islands that make up the Sunderbans, I saw a mixed scenario. There were vast stretches of fields, as I had expected. These fields had remained submerged in a mixture of trapped salt water and monsoon rains. Where embankments could not be quickly

Even in the most devastated areas, homestead lands were generally higher than the surrounding paddy fields and so the river water didn't stay for too long, even with exposed embankments nearby. Here, people maintained kitchen gardens and grew fruit trees like banana. I saw many tall rotten brown stems of dead banana trees, but there were little green leaves peeping out from below!

repaired and tidal inundations regularly occurred, the land was too saline for seeds to sprout. But where salinity was reduced thanks to rainwater, desperate farmers were rewarded with some rice yields.

Even in the most devastated areas, homestead lands were generally higher than the surrounding paddy fields and so the river water didn't stay for too long, even with exposed embankments nearby. Here, people maintained kitchen gardens and grew fruit trees like banana. I saw many tall rotten brown stems of dead banana trees, but there were little green leaves peeping out from below!

There were more surprises in store. The first was a snake (non-venomous) that I spotted in a field. Did this mean the freshwater ecosystem on the islands had revived? I had discussed the impact of salt water on freshwater snakes, frogs and earthworms with the inhabitants. If there was a drastic decline in their population, the entire ecosystem would be crippled. But people confidently told me that even on the most damaged islands, these species had survived, although in fewer numbers. Earthworms too had survived (salt water is deadly to them); they must have buried themselves deep in the earth to stay away from the salty surface water, coming back up only on higher ground.

For the population of these islands, surviving the post-Aila months on insufficient relief provisions, very little drinking water and an outbreak of diarrhoea has been a dreadful trial. But right through the hardships, their natural instinct was to try and grow crops.

Not everyone with land risked everything on cultivation. Even on islands where land salinity was uniform, some farmers attempted agriculture while others did not. I wanted to know who had tried and who hadn't. My theory was that some families were able to survive despite a very poor harvest because the 'costs' of growing crops differed across households, even in the same village.

My discussions with several villagers yielded the following: everything depends on family labour and hired labour. Monsoon paddy cultivation is possible at a minimal cost if the family doesn't need to hire labour against cash. For such farmer families, the combined cost of fertilisers, pesticides and the processing of rice from paddy totals around Rs 1,000 per hectare in the Sunderbans, against which a normal crop would yield a value of Rs 10,000, at local prices. Therefore, farmers estimated a profit in attempting cultivation if the post-Aila yield was more than 10% of the usual output. For larger farmers who needed hired labour for cultivation, the cost was estimated at Rs 3,500 per hectare; it would require more than 35% of normal output to make the effort remunerative. Therefore, even where the saline water didn't stay long, and the land received less salt deposits, big farmers were afraid to take a risk with agriculture. It was mostly small farmers who tried their luck, using family labour.

This pattern seems perfectly rational, as those who attempted agriculture reported yields varying between 25% and 40% of their normal production.

In many places, soil salinity had risen to such an extent that no one even considered putting any effort into agriculture. In some cases, this is true for the whole island. In other places, parts of islands face different situations. In a few pockets, the land survived the high-salinity wash and normal agriculture was reported during the post-Aila monsoon. As I have recently begun new research on the dynamics of post-Aila livelihood adjustments on the islands, the findings of firsthand data collection on 323 villages spread over 19 islands in the Sunderbans are useful.

Although all the evidence indicates destruction to agriculture following Aila, there is also evidence of resilience, refuting the perception that no agriculture in the Sunderbans would be possible in 2009, a view that I too initially subscribed to (see previous issue of *Infochange Agenda* on coastal communities).

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# Animal farms

The Green Revolution impacted livestock-rearing as well as agriculture. Farmers were encouraged to shift from low-input backyard systems to corporatised capital-intensive systems. As a result, there was an artificial divide between livestock-rearing and agriculture, leading to the further crumbling of fragile livelihoods of small and landless farmers. Organisations such as Anthra are now working with communities to revitalise and re-integrate livestock and agriculture.

*NITYA S GHOTGE*
*SAGARI R RAMDAS*

THE CONVENTIONAL GROWTH pathways recommended for globalisation are in direct contrast to what is needed to cope with global warming and climate change. For the livestock sector, several international agencies predict that global demand for livestock will double during the first half of this century, as a result of growing human populations and their increasing affluence, especially in developing countries like China and India. Global trade in livestock products is already high. India is not yet a significant exporter, but sees itself as having the potential to grow in this direction.

This demands a pattern of livestock-rearing that includes vertical integration of commodities into competitive markets, and international transport of agricultural and livestock produce from areas of cheap and surplus production to centres of demand. These patterns will be disrupted in a world of diminishing fossil fuels. On the other hand, climate change will impose fresh problems such as prolonged and more frequent drought, changes in rainfall distribution, extreme weather events, rising sea levels, increased and changing pest loads, and greater risk of heat stress in livestock farming.

Livestock-rearing along with other allied activities today accounts for around 10% of India’s total emissions as opposed to a world average of approximately 6%. While this is partly because India’s emissions from industry are low, the country will nonetheless have to embark on a policy of livestock development that is mindful of the effects of the sector on climate.

The poor are already disproportionately vulnerable to the effects of climate change because of their greater dependence on agriculture. Food security is becoming a major issue in many developing countries including India, with food prices spiralling upwards. According to the finance ministry’s Mid-Year Review 2009-10, consumer price inflation reached 11.6% in September 2009 thanks mainly to rising food prices. Industrialised systems of livestock-rearing will also be affected as the benefits they enjoyed because of cheap energy costs and subsidies will no longer be available. The plans and polices of the past will thus no more be valid for the future.

**India’s livestock, by numbers**

India has some of the largest livestock populations in the world. It has 57% of the world’s buffalo population and 16% of cattle population. It ranks first in cattle and buffalo populations together, third in sheep, and second in goat populations in the world. Total export earnings from livestock, poultry and related products was Rs 5,120 crore in 2004-05, of which leather accounted for Rs 2,660 crore, with meat and meat products accounting for Rs 1,720 crore. The livestock sector produced 90.7 million tonnes (mt) of milk, 45.2 billion eggs, 2.12 million tonnes of meat, and 44.5 million kg of wool in 2004-05 (India is among the largest producers of milk and eggs in the world).

The development path selected 50 years ago for India drove our agriculture and livestock production systems through two predominant models: the Green and White Revolutions. The Green Revolution focused on improved seeds, irrigation, mechanisation and chemical fertilisers, and began in those areas of the country rich in natural resources. One of the results of the Green Revolution in India was displacement of the work-bullock from farming systems in these initial areas and replacing it with the dairy buffalo. What followed was the White Revolution that based its model on exotic dairy breeds, and buffalo-rearing which was based on improved fodder, increased feed, artificial insemination to upgrade our genetic material, improved health, and improved marketing. This was repeated in species after species, with mixed results.

While our cattle was replaced with the Jersey and Holstein breeds, our sheep were sought to be replaced with exotic merinos from Russia and Australia, our goats with Swiss breeds, our pigs with Yorkshires and Berkshires and our poultry with breeds that had proved successful in countries where livestock industrialisation was already under way.

Subsequently, the poultry industry took off and the dairy cooperative movement boasted a number of success stories. But there are many instances of failure too. The dismal truth in a large part of the country is the breakdown of traditional systems, loss of breeds, inadequacy of new technologies and research to address problems that challenge the poorest farmers of the country, and ultimately, the crumbling of fragile livelihoods dependent on livestock resources. One of the most devastating results was the artificial separation of livestock-rearing from agriculture, with both becoming more and more dependent on external resources and inputs.

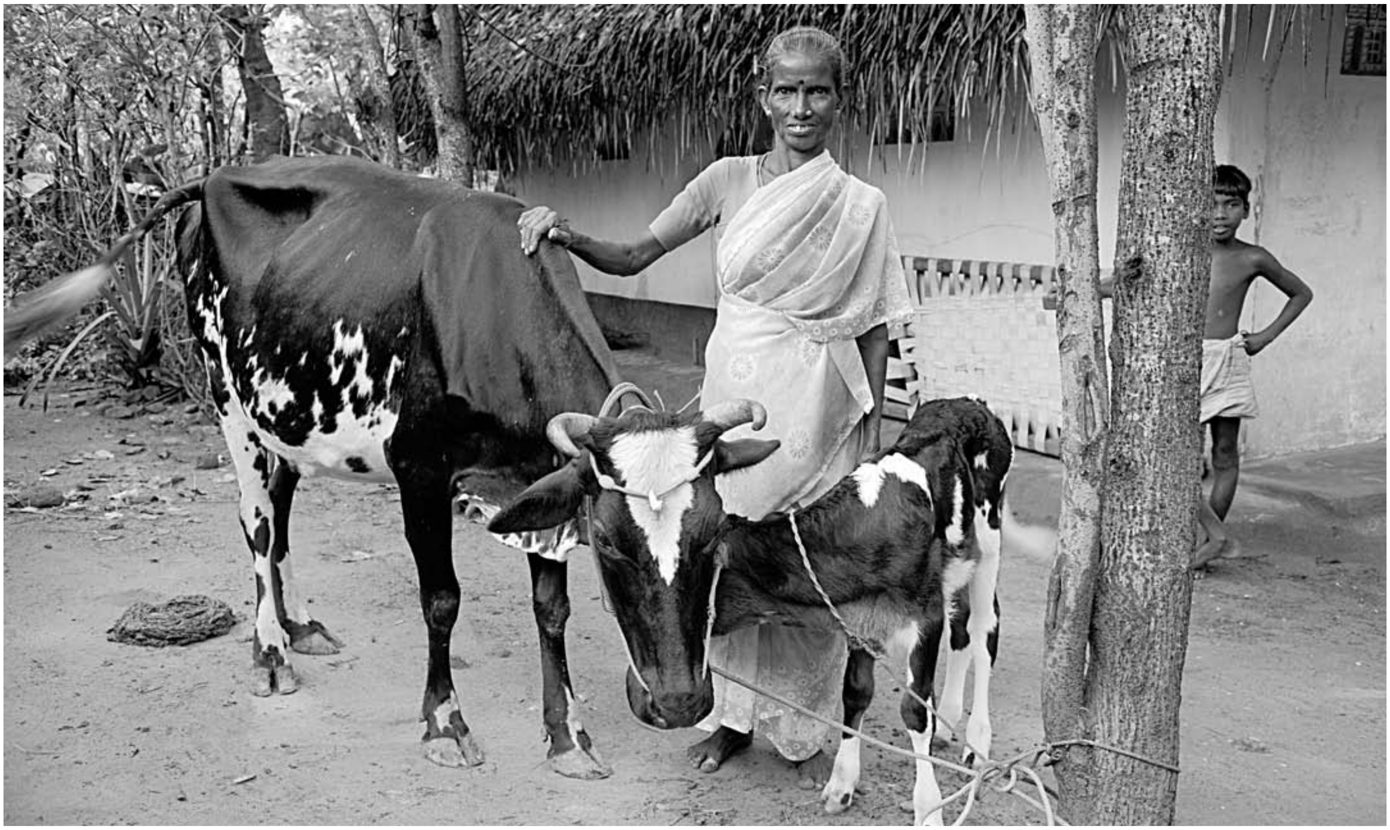
The expansion of these programmes to drier, more marginal areas of India has been a disaster. By the Eleventh Five-Year Plan (2007-12), the Union government began to recognise that the earlier path was not sustainable. According to a report of the Planning Commission's working group on animal husbandry and dairying, there were a number of shortcomings. For instance, the efforts made during the Tenth Five-Year Plan (2002-07) in raising feed and fodder resources for livestock were not very successful. The recommendation was to target at least 10% of cultivable land for fodder crops; however, if fodder crops compete with foodgrain (and crops for biofuel) we will face many more problems.

**The push to go private**

India's farming strength has been the farmer's ability to recycle crop residue to feed animals. This unfortunately has not been encouraged, with farmers being forced to grow cash crops with no edible crop residue. There are many imbalances, illustrated in the ignoring of the unorganised sector in the policy space. There have been no measures to develop the unorganised sector producing dairy products, which otherwise enjoy tremendous demand in the domestic market as well as potential for export, even though the working group stated that in the first four years of the Tenth Plan the growth rate of milk production was less than 3% per annum.

Although India's cooperative milk marketing successes are well-known, global market regimes today pose new challenges for Indian livestock products. Competition from international players, multinational corporations and large private agri-business units threaten to wipe out small producers. India's inability to meet global standards of production — especially in terms of health of livestock and quality of livestock products — could prove extremely detrimental to small producers. Already, poultry contract farmers are crumbling under the stress of having to produce and compete with large international poultry companies.

More worrisome is whether our livestock products are safe for consumption. Along with chemical agriculture, we also ushered in the age of chemical livestock-rearing. Antibiotics, growth boosters and hormones, anti-parasiticals, urea and other chemicals have been extensively advocated in the past to boost livestock production as well as supposedly get rid of infectious disease and infestations. Anti-parasiticals and toxic chemicals like ivermectin, butox and even DDT have been recommended to keep ticks and fleas at bay.



Sudharak Olwe

They are often used in places where animal feed is stored, to control rodents and other pests. They enter the animal's body through multiple routes and ultimately collect in the livestock products we consume — milk, meat and eggs.

While the government may claim that rinderpest has been eradicated, new and emerging diseases continue to pose a major threat to the animal production programme. Emerging diseases like peste des petitis ruminants (PPR), blue tongue, sheep pox and goat pox, swine fever, contagious bovine pleuropneumonia, and New Castle disease (Ranikhet disease) cause substantial economic losses. Regarding diseases among small ruminants and backyard poultry, the loss is borne entirely by the owner. In most states, departments of animal husbandry and dairying are not well-equipped with infrastructure and technical manpower to carry out programmes on animal health.

The official argument is that declining budgetary allocations to animal husbandry and dairying — Plan outlay has decreased over the past 10 Five-Year Plans from about 1.2% to 0.2% — can be solved through privatisation. This is the position taken despite animal husbandry and dairying contributing over 5% of national GDP.

**Change in livestock production systems**

Farmers are being encouraged to shift from low-input systems to capital-intensive, high-input systems. Backyard poultry farmers are being encouraged to shift to commercial poultry farming or contract farming. Small ruminant holders are being encouraged to shift to dairy breeds. Most poor farmers cannot cope with these changes; they either do not shift or step out of livestock-rearing altogether. Efforts and policy directives have tried to upgrade local stock to 'high-producing' varieties or replace indigenous breeds altogether. This has had two effects. One, 'high-producing' breeds make greater demands on our resources, fodder, water, labour, capital, and healthcare. Poor families often find that between repaying loans, feeding and watering the animals, and increased healthcare, they are unable to make ends meet. The more marginalised among them soon end up selling the animals and losing their livestock assets. The second effect, which has far-reaching consequences, is the rapid disappearance of indigenous breeds and the associated genetic material. Should farmers wish to restock with indigenous breeds, quality animals will simply not be available.

There was a drastic decline of bullocks after the 1980s, with the share of farm animals as draught power declining from 71% in 1961 to less than 23% in 1991. The 59th round of the National Sample Survey Organisation (NSSO) reports that working cattle in rural areas declined by 25% between 1991-92 and 2002-03. There has been a corresponding shift in the composition of bovine populations from cattle to buffaloes. According to the 54th NSSO round, a mere 56% of households reported ownership of at least one livestock in 1998-99. Changes in livestock populations and composition vary across different landholding categories, with the decline in livestock holding being sharpest among landless households.

The 59th round of the National Sample Survey reports of 2002-03 show that the average in-milk bovine stock owned per 100 rural landless households fell from 16 in 1971-72 to just 1 in 2002-03. During the same period there was an overall decrease in in-milk bovine stock per 100 rural households; it fell from 54 to 36. This decline was observed in all major Indian states. NSS reports 402 (48th round), and 493 (59th round) reveal that the average number of sheep and goat stock per 100 households has decreased amongst landless, marginal and small farmers over the past three decades. The average number has increased only in the large landholding category (over 10 hectares of land). Micro-level studies carried out in Gujarat, Andhra Pradesh and Orissa confirm the broad trends that obtain in the NSSO studies. The data indicates that it is becoming increasingly difficult for poor rural farmers to keep animals.

**A false shift away from livestock**

There is now a decline in livestock assets amongst poor, marginal and small farmers. While the livestock economy penetrates sections of rural society both vertically and laterally, and does so more equitably than landholdings, a matter of growing concern is that despite 70% of India's livestock being owned by landless, marginal and small farmers, recent studies across India indicate that over half of all these households are now 'non-livestock owners'. While the total population and density of livestock has increased over time, the number per rural household has dropped.

Indeed, the report of the working group on animal husbandry and dairying reaffirms this decline; it records that the employment rate in the livestock sector has gone down from 4.5% to 2.52%. The report treats this decline as an "inevitable shift" out of rural areas, agriculture and allied sectors and a move towards urban areas and the services sector. The reality is that the so-called shift has been forcibly imposed on peasant/farming communities as a result of neo-liberal economic reforms and policies brought in by the Indian government over the past two decades, encouraging and nurturing corporatisation of the agriculture and livestock sectors, and making it increasingly unviable for farmers to farm and rear livestock, resulting in the collapse of these rural livelihoods and the displacement of people from rural to urban areas. It is not, as is implied, some kind of "voluntary" decision; nor is there any "evolutionary" economic and market logic therein.

For several years now, farmer organisations, scientists and civil society groups have been questioning the validity of such development and growth models of food production and food security. These models, which are capital- and energy-intensive, promote exotic hybrids and crossbreds, chemical fertilisers, pesticides and chemotherapy. They have driven farmers to despair and suicide. At the same time, experiences from different areas show that there are many alternatives to this global model of development, which posit the politics of food sovereignty: the right of people to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agricultural systems.

**Rebuilding food sovereignty, coping with climate change**

It is within this framework that organisations like Anthra have been working closely with farming and pastoralist communities. Anthra aims to transform the current situation with a view to addressing issues of food sovereignty and environmental justice and also the emerging challenges posed by climate change. We have worked with communities in efforts to revitalise and re-integrate livestock and agriculture. These include demonstrating concrete community strategies to conserve and rear local indigenous livestock and poultry breeds, enhancing fodder and water needs of livestock, promoting ethno-veterinary medicines, accessing preventive healthcare services from the government veterinary department, integrating livestock into ongoing ecological agriculture initiatives to improve energy efficiency (draught power), and recycling animal waste into the soil thereby returning valuable carbon to the soil and closing the carbon cycle. These experiences have formed the basis of ongoing learning as also for a proactive outreach programme to sensitise and empower communities that are involved in rebuilding autonomous food production systems. They also constitute the core of critical policy research campaigns to challenge policies that are detrimental to farming communities and offer concrete alternative strategies.

A major effort aims at enabling dialogue and conversations between farmers and scientists, and across disciplines, as many challenges lie at the interface of agriculture, forestry, commodities and trade, and health. Scientists within research institutions and animal husbandry departments have begun to unquestioningly accept certain paradigms and processes evolving in the research, development and extension fields as ‘givens’ — not to be questioned — and end up conducting research within preset boundaries that have been drawn up by the State. For instance, the acceptance that there is no way forward but to privatise veterinary services due to lack of resources persuades scientists to carry out research within the framework of a privatised veterinary healthcare delivery system. Biotechnology as a quick-fix technology for all problems — from increasing production yields, coping with climate change stresses, and disease resistance — has begun to be accepted unquestioningly by the larger scientific community that thus abdicates its central role of critical enquiry.

In contrast, ecological agricultural practices prevent the build-up of animal waste, thereby reducing the chances of greenhouse gas emissions entering the atmosphere. Returning valuable biomass to the soil ensures water retention, reducing the risks posed by sudden periods of drought. Encouraging local crop varieties which require less water reduces the need for expensive, energy-dependent irrigated systems. Local crops that also yield crop residue provide vital feed for livestock without the need to divert land from food to fodder. Encouraging local livestock breeds promotes draught animal power, thereby reducing our dependence on fossil fuels.

Managing manure is an important piece of the whole. Manure reduces demand for fossil fuel, which is the main raw material required to produce chemical fertilisers. Finally, strengthening local markets by connecting local farming communities to local consumers reduces transportation costs, thus the food market’s carbon footprint. Bio-energy generated from animal waste not only provides domestic energy to rural households, it has other multiple benefits. Methane, which is 22 times more potent as a greenhouse gas than carbon dioxide, is efficiently transformed into useful domestic energy. This, in turn, implies that rural households make fewer demands on fossil fuel energy as their energy needs are taken care of at the local level. The slurry from biogas plants is recycled into local agriculture, thereby aiding both agriculture and reducing demand for chemical fertilisers.

While the food sovereignty paradigm is the only sustainable way ahead, it has to be matched by political interventions that will force the rich to reduce their consumption, thereby freeing up vital fossil fuel resources that can be redirected towards meeting the basic needs of the poor.

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# Women farmers: From seed to kitchen

Women contribute 50-60% of labour in farm production in India. There is evidence to suggest that if agriculture were focused on women, outputs could increase by as much as 10-20%, the ecological balance could be restored, and food security of communities improved

*KAVYA DASHORA*

IN INDIA, there are distinct male and female roles in the rural economy. Women and girls engage in a number of agro-oriented activities ranging from seedbed preparation, weeding, horticulture and fruit cultivation to a series of post-harvest crop processing activities like cleaning and drying vegetables, fruits and nuts for domestic use and for market. A disproportionate number of those dependent on land are women: 58% of all male workers and 78% of all female workers, and 86% of all rural female workers are in agriculture. Female-headed households range from 20% to 35% of rural households (widows, deserted women as well as women who manage farming when their men migrate). Although the time devoted by both women and men in agricultural activities may, in several communities and agricultural situations, be taken to be almost equal, women are dominant within the domestic tasks. Rural Indian women are extensively involved in agricultural activities, but the nature and extent of their involvement differs with variations in agro-production systems.

There are community-based differences regarding women's participation in agriculture, therefore location, cropping patterns, ethnic affiliation and economic and educational background also have implications for the specific division of labour within a given family unit. Usually, women's representation is greater in allied agriculture than in grain production, and poor households require the greater involvement of women in income-generating activities than financially stable ones.

Women play an important role in all dimensions of agricultural production — in certain regions, women's time input equals men's, while in other regions traditions restrict their work to the household where they are involved in crop processing and are in charge of household maintenance. In most cases, women's efforts are non-monetised although they make large labour contributions to a range of marketed products such as dried fruits, fuelwood, dairy products and handicrafts.

The problems of women in agriculture resemble the 'progressive set of problems' that other marginalised communities face in the general population, but in a more acute and distressing manner. These problems relate to land ownership, security of tenure, land quality issues in cases where land ownership is assured, and land management issues in terms of agriculture and the support systems it requires. Any changes in land ownership and agricultural patterns affect women far more than men (positive or negative), given the existing gender roles that women are expected to fulfil, mainly related to management of the household in their reproductive roles — fuelwood collection, fodder collection, livestock tending in general, food security needs and so on. Their dependence on agriculture on common lands, on forests and water is that much greater and more acute.

The mode of female participation in agricultural production varies with the land-owning status of the farm household. Women's roles range from managers to landless labourers. In all farm production, the average contribution of women is estimated at 50% to 60% of total labour, much higher in certain regions. Girls are preferred in cottonseed production because their wages are lower than those of adults (see table for wage differentials in agricultural labour). Moreover, they work longer hours and more intensively, and are generally easier to administer. Gathering of fuelwood is the

Sudharak Olwe

exclusive responsibility of women and girls. In general, male activities such as land preparation, planting, sowing, and fertiliser application are one-time jobs, usually accomplished within a stipulated time. Female activities, however, such as weeding, are recurrent daily activities, lasting from the time the seed is planted until it is harvested.

Rural women are often dependent on the natural environment for their livelihood. Maintenance of households and women's livelihoods are, therefore, directly impacted by climate-related damage to or scarcity of natural resources. Limited rights or access to arable land further limits livelihood options and exacerbates financial strain on women, especially in women-headed households. Poor women are less able to purchase technology to adapt to climate change due to limited access to credit and agricultural services (for example, watering technology, farm implements, climate-appropriate seed varieties and fertilisers). Damage to infrastructure that limits clean water, hygienic care, and health services can be especially detrimental to pregnant or nursing women (10-15% of all women, at any given point) as they have unique nutritional and health needs. Public and familial distribution of food may be influenced by gender and make women and girls more susceptible to poor nutrition, disease and famine, especially when communities are under environmental stress. Increased time to collect water (due to drought, desertification or increased salinity) and fuel (due to deforestation or extensive forest kill from disease infestations) decreases the time that women are able to spend on education or other economic and political enterprises, and increases their risk of gender-based violence.

The role of women in agricultural production is largely determined by the lifecycle of the household, location of household fields and other tasks that women undertake during the agricultural year. Their traditional role as primary seed-keepers and seed-processors is well known in our society. They have conventionally been both experts and producers of food from seed to kitchen, and as globalisation shifts agriculture into capital-intensive mode, women bear the disproportionate costs of both displacement and health hazards. They carry the heavier work burden in food production and, because of gender discrimination, get lower returns for their work. However, when addressed in a woman-centric manner, the potential for increased productivity, restoration of ecological balance, for high positive social impacts like increased status, self-confidence and food security for communities, all increase much more tangibly than working in a gender-neutral manner. It has been reported that output could be increased by as much as 10-20% if inputs were reallocated from plots controlled by men to those controlled by women. Women also put land to more sustainable use. The arguments for land fragmentation do not hold much ground given the outweighing advantages of land ownership vesting with women.

Organic farming needs promotion to increase women's productive role in agriculture, decrease health hazards from chemicals, and avoid a drain on scarce family income to pay for unnecessary agricultural inputs. There is a wage disparity based on gender which must be addressed. One solution is for minimum support prices to be fixed for the plantation sector (such as tea, coffee, rubber, arecanut and cardamom) in which a large number of women are directly and actively involved. Empowering women farmers with landholding rights and joint bank accounts with their husbands would go a long way towards achieving gender equity in Indian agriculture. Therefore, effective land rights for women — not just in law, but in practice — seems to be the crux of the matter. As researcher and writer Bina Aggarwal has argued, this is not just for the welfare, equality and empowerment of women but also for efficiency in land use. There is empirical evidence to suggest that women can give increased outputs with secure land rights.

**All-India average daily wage rates in agricultural occupations (Rs) — 2007-08**

| | Ploughing | | | Sowing | | | Weeding | | |
|---|---|---|---|---|---|---|---|---|---|
| | Men | Women | Children | Men | Women | Children | Men | Women | Children |
| Jul-07 | 86.72 | 52.14 | | 74.80 | 53.57 | 41.77 | 68.45 | 55.82 | 40.06 |
| Aug-07 | 86.96 | 46.88 | | 75.10 | 55.00 | 43.91 | 67.53 | 55.32 | 41.25 |
| Sep-07 | 88.43 | 46.43 | | 76.26 | 56.18 | 45.25 | 66.82 | 55.14 | 41.46 |
| Oct-07 | 89.68 | 48.13 | | 77.74 | 56.53 | 45.01 | 68.69 | 56.35 | 43.24 |
| Nov-07 | 89.46 | 46.50 | | 77.54 | 55.79 | 44.00 | 68.71 | 57.04 | 42.15 |
| Dec-07 | 89.84 | 47.14 | | 77.79 | 56.13 | 43.91 | 69.23 | 57.56 | 42.28 |
| Jan-08 | 92.56 | 46.00 | | 79.60 | 58.26 | 48.80 | 70.30 | 58.67 | 43.01 |
| Feb-08 | 92.62 | 64.38 | | 79.64 | 58.45 | 44.44 | 71.21 | 59.61 | 43.91 |
| Mar-08 | 94.72 | 52.00 | | 81.92 | 59.04 | 44.44 | 70.95 | 59.35 | 42.23 |
| Apr-08 | 95.16 | | | 82.86 | 59.17 | 45.00 | 72.00 | 60.05 | 41.67 |
| May-08 | 94.91 | 50.00 | | 84.06 | 59.46 | 45.56 | 72.49 | 61.80 | 43.00 |
| Jun-08 | 95.47 | | | 84.03 | 58.54 | 44.50 | 74.41 | 62.49 | 43.89 |

| | Transplanting | | | Harvesting | | | Winnowing | | |
|---|---|---|---|---|---|---|---|---|---|
| | Men | Women | Children | Men | Women | Children | Men | Women | Children |
| Jul-07 | 71.78 | 58.96 | 44.00 | 73.27 | 60.62 | 38.44 | 68.88 | 53.70 | |
| Aug-07 | 71.38 | 58.63 | 44.71 | 73.66 | 61.83 | 39.60 | 69.93 | 54.89 | |
| Sep-07 | 71.96 | 59.95 | 46.24 | 75.08 | 61.98 | 40.18 | 71.46 | 54.79 | |
| Oct-07 | 73.12 | 61.41 | 44.67 | 74.45 | 61.12 | 41.48 | 70.30 | 54.30 | |
| Nov-07 | 72.59 | 61.31 | 45.14 | 73.37 | 60.83 | 41.40 | 68.38 | 55.13 | 38.53 |
| Dec-07 | 72.96 | 61.63 | 45.14 | 74.21 | 60.73 | 43.14 | 69.75 | 55.15 | |
| Jan-08 | 74.76 | 62.85 | 46.19 | 74.78 | 61.87 | 44.02 | 71.34 | 56.70 | 43.45 |
| Feb-08 | 74.10 | 63.05 | 45.79 | 74.19 | 61.36 | 44.10 | 71.74 | 57.22 | 40.53 |
| Mar-08 | 74.97 | 63.31 | 45.79 | 75.13 | 62.94 | 45.11 | 71.99 | 57.22 | 40.53 |
| Apr-08 | 75.67 | 63.74 | 45.79 | 76.95 | 63.82 | 44.54 | 72.12 | 57.83 | 39.53 |
| May-08 | 75.51 | 63.95 | 46.67 | 78.23 | 64.50 | 43.83 | 73.03 | 58.39 | 40.45 |
| Jun-08 | 76.71 | 64.38 | 48.24 | 79.58 | 66.11 | 44.68 | 73.76 | 57.80 | 42.53 |

| | Threshing | | | Picking | | | Herding livestock | | |
|---|---|---|---|---|---|---|---|---|---|
| | Men | Women | Children | Men | Women | Children | Men | Women | Children |
| Jul-07 | 72.40 | 61.27 | | 70.26 | 57.95 | 40.02 | 46.07 | 36.89 | 30.55 |
| Aug-07 | 72.21 | 61.14 | | 72.01 | 57.63 | 36.68 | 46.41 | 36.92 | 30.62 |
| Sep-07 | 72.94 | 60.38 | 40.53 | 71.07 | 56.98 | 38.56 | 46.57 | 36.50 | 30.80 |
| Oct-07 | 73.47 | 58.00 | 38.78 | 74.57 | 57.37 | 39.77 | 46.88 | 37.46 | 30.45 |
| Nov-07 | 72.91 | 58.32 | 38.07 | 74.88 | 57.14 | 40.82 | 47.47 | 37.46 | 30.81 |
| Dec-07 | 71.96 | 58.45 | 38.24 | 71.55 | 56.16 | 41.24 | 47.30 | 37.39 | 30.75 |
| Jan-08 | 72.56 | 58.15 | 41.10 | 69.40 | 57.17 | 46.74 | 48.07 | 37.53 | 31.32 |
| Feb-08 | 73.32 | 58.08 | 39.08 | 70.75 | 56.51 | 42.40 | 48.26 | 38.06 | 31.47 |
| Mar-08 | 72.77 | 57.62 | 41.27 | 72.88 | 59.97 | 45.27 | 48.53 | 38.23 | 32.05 |
| Apr-08 | 74.44 | 58.34 | 40.27 | 72.20 | 60.19 | 43.20 | 48.49 | 38.78 | 32.16 |
| May-08 | 75.33 | 61.06 | 41.96 | 74.59 | 60.07 | 38.16 | 48.29 | 38.81 | 32.36 |
| Jun-08 | 77.66 | 62.13 | 42.53 | 75.29 | 60.65 | 37.89 | 49.38 | 39.29 | 33.45 |

*Source: 'Wage Rates in Rural India 2007-08', Ministry of Labour, Government of India*

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## Feminisation of agricultural labour

Women constitute approximately 70% of the agricultural labour force, and perform more than 70% of farm labour in less industrialised Asia. In India, women constitute approximately 50% of agricultural and livestock workers. A general pattern in India and throughout Asia is that the poorer the area, the higher the contribution of women, largely as subsistence farmers who work small pieces of land of less than 0.2 hectares. While the rate of feminisation of agricultural labour differs across regions, it reflects common circumstances — increased employment of women on a casual basis in small unregulated workplaces — and common causes for distress migration of men for better paid work in agriculture and non-agriculture sectors. These factors are often combined with the relegation of less profitable crop production to women.

Indigenous communities are not immune to this feminisation of agricultural work. As is seen worldwide, women are the chief producers in jhum fields and in home gardens, bearing responsibility for choosing seeds and locations, weeding, fertilising, processing produce, and so on. It is the reliance of adivasi and indigenous women on natural resources and agriculture that makes them exceedingly vulnerable to climate change, especially as they often live among the world's most poor, with limited access to resources. In Nepal, for example, large-scale migration of men has led women to become *de facto* farm managers. Yet, effective management by women is constrained by women's inability to secure credit when they need it, if at all they get it, since most land titles remain in the men's names and men's signatures are required before credit can be provided. This causes significant delays in procurement of credit and agricultural inputs.

In the consultation on the impact of macro-economic policies on women, held by the Human Development Resource Centre of the United Nations Development Programme (UNDP) in India in 2004, valuable perspectives and insights emerged from a study conducted in Maharashtra and Gujarat, both states pursuing industrial capital and whose rural agricultural land use is under growing pressure from urbanisation.

In their study 'Impact of Maharashtra's Agriculture Policies on Women Farmers: A Gender Budgeting Analysis', Alka Parikh and Sarthi Acharya say that the proportion of female workers in agriculture to total female main workers in Maharashtra was 76.72% in 2001. Thus, women seem to be more confined to agriculture than men. More than half of women farmers were engaged in the capacity of labourers in agriculture. In contrast, this proportion was lower by over 10% in the case of male workers.

"Real wages have increased, leading to a decline in the percentage of people living below the poverty line," they note. "The growth in agricultural wages was faster in the case of female (104%) compared to male workers (71%), in the 1990s. Just 6% of the budget funds allocated to agriculture (less than 1% of the total budget) is devoted to schemes explicitly addressing the needs of women farmers.

After trying to maintain irrigation expenditure levels for four years (1998-2002), allocations were slashed in 2003-4. Irrigation would benefit women, but they might find jobs only in the lowest rungs; their workload would increase if men migrate due to increased irrigation outside. Budgetary allocations to animal husbandry and the fisheries sector have been declining in the four years under this study, 1998-2002. But it is open to further investigation as to whether animal husbandry programmes substantially raise women's status or whether they only increase their workload as unpaid family workers.

In Gujarat, the study 'Impact of Agricultural Policies and Programmes on Women of Small and Marginal and Agriculture Labour Households in Gujarat', by Darshini Mahadevia and Vimal Khawas, found that an overall budget analysis showed that the approach to women's development and gender equity is too fragmented. "There are a large number of schemes and programmes, all getting meagre funds," say the authors, "thus each of the programmes have very meagre coverage. A few women here and a few women there benefit. There is no reflection of the achievements of any of the programmes on the overall development of women and improvement of their status. Impact is also not observed at the taluka level, though in a few individual villages some positive impacts of some programmes are observed. This thin spread of few resources is not a new observation in government programmes. Adequate budgetary allocations for women's development and gender equity, and their appropriate utilisation can take place only in a policy environment that is congenial, that is, one which is human/women-centric."

The study says that Gujarat state's policy environment has always given primacy to industrial development and economic growth. In the decade of the 1980s, the policy environment reached a situation of pursuing economic growth at any cost. Serious deterioration on the environmental front started taking place, leading to stagnancy in agricultural growth and a decline in per capita incomes in agriculture, which still continues to occupy half the working population. Water, fuelwood and fodder scarcities followed and, as a consequence, women's work increased.

# Empty claims of financial inclusion

Government has been broadcasting its success in doubling institutional credit to the agricultural sector. But these numbers have little meaning: 85% of accounts opened were inoperative, 72% had zero or minimum balance, and only 15% had a balance over Rs 100. It is paradoxical to talk about 'inclusive growth' when our policies and practices tread the path of exclusion

*P S M RAO*

THE GOVERNMENT has good reason to be happy with institutional agricultural credit. The aggregate data shows that it has not only achieved its targets, but surpassed them. In 2004, the government wanted credit flow to the sector to be doubled in three years. That, claimed P Chidambaram, then Union finance minister, in his 2007-08 budget speech, happened in just two years. He went on to set bigger credit targets for the following year.

Judging by the targets set and the achievements, the agricultural sector is well supplied with credit. The target for 2007-08, of Rs 225,000 crore, was exceeded by Rs 348 crore. A higher target was set for 2008-09 — Rs 280,000 crore. This too was exceeded by around Rs 7,000 crore. For 2009-10, the target is Rs 325,000 crore which, from all available reports, looks unlikely to be missed.

Yet the experiences of farmers do not match this 'all is well' version of agricultural credit and the numbers that make up the official data. There is enough proof for us to conclude that small farmers — who constitute the bulk of the farming community — did not get their fair share of credit. Before reviewing the farm credit scenario, it would be useful to summarise landholding sizes in India.

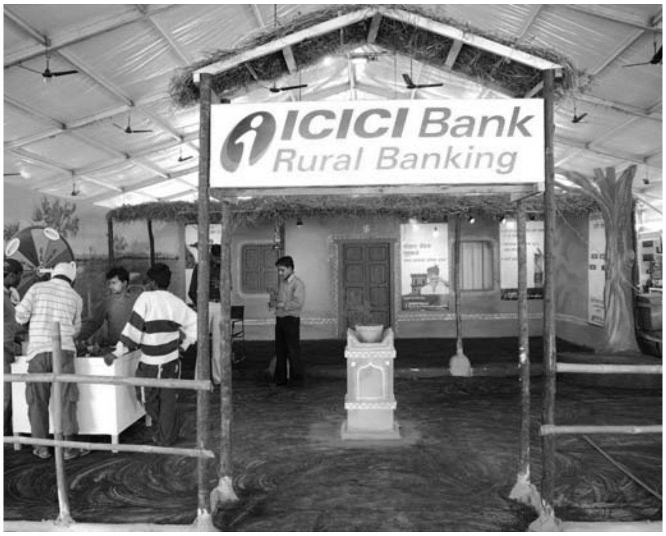
**Farm size**

According to the Ministry of Agriculture's Agricultural Census Division data, 63% of the total 159.9 million hectares of operational holdings in 2001 was held by marginal farmers with less than 1 hectare of land. Small farmers with plot sizes totalling 1-2 hectares made up 18.9% of the holdings, which means that small and marginal farmers together account for a high 81.9% of operational holdings.

Further, it is difficult to ignore those who are classified as semi-medium farmers with holding sizes of 2-4 hectares of land, and constituting about 11.7% of total holdings, since most farmers who committed suicide in Vidarbha were in this category. The extent of land held by them did not yield enough produce to meet their minimum needs, let alone deliver a surplus to repay their debts. This is because land productivity is low; although these farmers are categorised as being above small-farmer level, they cannot be expected to be much above the poverty line. (This is why policymakers must recognise that 'semi-medium' farmers have to be included in schemes with even limited benefit, such as waiver of institutional loans.)

These three classes of farmer — marginal, small and semi-medium — account for 93.6% of holdings. Together, they operate in 100.6 million hectares, which works out to 62.96% of the total operational area. For that matter, 159.9 million hectares of total operational area in the country is distributed over 120.8 million holdings, big and small. That means the average size of holding in India is 1.32 hectares (the average holdings of marginal, small and semi-medium farmers are 0.40, 1.41 and 2.72 hectares respectively). No agriculture policy that ignores these facts will be effective.

While total credit has, according to the official data, increased every year for the last three years, how much of it reaches small and marginal farmers? Many studies point to the gap between credit and those whom it is supposed to reach. According to a World Bank report, as much as 87% of marginal and 70% of small farmers do not get credit through institutions. In fact, 51% of all farmers, big and small, enjoy no banking services at all, let alone credit. The Committee on Financial Inclusion's observation (the C Rangarajan



Committee, 2008) on farmers not getting enough credit is: "National Sample Survey Organisation (NSSO) data reveals that 45.9 million farmer households in the country (51.4%), out of a total of 89.3 million households, do not access credit, either from institutional or non-institutional sources. Further, despite the vast network of bank branches, only 27% of total farm households are indebted to formal sources (of which one-third also borrow from informal sources). Farm households not accessing credit from formal sources as a proportion of total farm households is especially high at 95.91%, 81.26% and 77.59% in the northeastern, eastern and central regions respectively. Thus, apart from the fact that exclusion in general is large, it also varies widely across regions, social groups and asset holdings. The poorer the group, the greater is the exclusion."

This suggests that the bulk of farmers do not get institutional credit. Moreover, those who do cannot meet all their requirements; this means most farmers have to depend on informal sources of credit and then bear the high cost of interest and harsh terms. The rate of interest from non-institutional sources, according to the government's own admission, ranges between 24% and 48% per annum. Interest rates in backward areas are higher than in developed centres, and the rate charged to poor people who have no collateral is more than the rate charged to rich farmers. Thus, poor farmers lose whatever small assets they have in the process of debt redemption.

This is not to say that the cost of borrowing from institutions is reasonable. A study I recently concluded in rainfed areas of Andhra Pradesh confirms that these costs too are burdensome. They included high interest rates ranging from 7% to 16%, with the low end of the interest scale coming into play only in case of loans for which the government interest subvention is eligible, and up to the time that loans do not become overdue. Then there are other charges levied by banks such as process fee, inspection charge, penal interest, equitable mortgage charge, service charge, no-dues certificate fee, gold loan process and appraisal charge and ledger folio charge. Not all banks impose these uniformly, yet every bank has its own way of collecting extra fees. In addition, crop insurance is compulsory for bank borrowers, adding another premium to the farmer's burden. A paddy grower who takes loans for two crops in a year has to pay 4.5% of his/her loan amount as insurance premium (2.5% on rabi and 2% on kharif). This cost alone often cancels out whatever benefit the farmer may get on account of interest subsidy.

Worse, a sizeable number of farmers studied in the three sample villages — one each in Mahboobnagar, Anantapur and Vizianagaram districts — reported paying a bribe in order to get loans and subsidies. That, apart from having to visit banks and government offices a number of times to complete the paperwork demanded of them; in extreme cases, workers lost 90 days' wages.

All this suggests that agricultural loans are difficult to come by, regardless of claims made by the central government.

There is the related issue of agricultural credit as a percentage of total bank credit declining over the years, although 72% of the population lives in rural areas, most of them dependent on agriculture and allied activities for their livelihood. The norm of earmarking 18% net bank credit to agriculture is rarely followed. According to Reserve Bank of India data, the share of agricultural advances to net bank credit ranged between 14.5% and 17.2% of the net bank credit between 2003 and 2009, in the case of public sector banks; it was 10.9% to 15.9% in the case of private banks. The share of agricultural and allied activities in the gross bank credit was in the region of 12% during the last five years, as shown in the accompanying table.

**Table 1**

**Share of agriculture in gross bank credit in India (2005-09) (Amount in Rs crore)**

| Outstanding up to | Agriculture and allied activities | Percentage in total | Total bank credit |
|---|---|---|---|
| Mar-05 | 124,269 | 11.88 | 10,45,954 |
| Mar-06 | 173,875 | 12.04 | 14,43,920 |
| Mar-07 | 230,180 | 12.49 | 18,41,878 |
| Mar-08 | 275,343 | 12.25 | 22,47,289 |
| Mar-09 | 338,656 | 12.78 | 26,48,501 |

*Source: RBI's Annual Report 2006-07 and 2008-09*

Another worrisome trend is that specialised institutions set up to meet the credit needs of farmers and weaker sections are moving away from that role, at a time when the government is talking about strengthening the credit delivery system and financial inclusion. The share of cooperatives — which were once synonymous with agricultural institutional credit — in total agricultural credit has dropped to a mere 12.8% in 2006-07, from 33.9% in 2002-03 and over 50% about a decade ago. The wide network of cooperatives — there are over 100,000 outlets all over India — would have led them to occupy a dominant position in agricultural credit had reforms been aimed at helping the farm sector.

While cooperatives have been losing ground, commercial banks have increased their share from 33% in 1992-93, the year from which banking reforms started taking root, to nearly 78% in 2008-09. Earlier, they were not considered suitable for rural lending owing to their commercial approach and high cost of operation. This shows how the viability concerns of lending agencies are taking precedence over the social approach of protecting agriculture. Commercial principles are now widely applied to lending to a sector that's responsible for providing livelihoods and food to the nation.

Similarly, regional rural banks (RRBs), which are exclusively set up to provide credit to weaker sections in rural areas, have changed character after the reforms introduced in 1992-93. Their responsibility of priority sector lending has been brought down to the level of other commercial banks, the focus being on the financial viability of RRBs rather than

| Table 2 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Share of different institutions in formal agricultural credit, in India (Amount in Rs crore) | | | | | | | | |
| Institution/Year | 1992-93 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 |
| Cooperatives | 9,378 (62.00) | 23,636 (33.97) | 26,875 (30.89) | 31,425 (25.07) | 39,404 (21.83) | 42,480 (20.00) | 48,258 (18.95) | 36,762 (12.80) |
| Regional rural banks | 831 (5.00) | 6,070 (8.72) | 7,581 (8.71) | 12,404 (9.89) | 15,223 (8.43) | 20,434 (10.00) | 25,312 (9.93) | 26,724 (9.30) |
| Commercial banks | 4,960 (33.00) | 39,774 (57.17) | 52,441 (60.29) | 81,481 (65.02) | 125,859 (69.73) | 140,382 (69.05) | 181,088 (71.11) | 223,663 (77.89) |
| Other agencies | - | 80 | 84 | - | - | - | - | - |
| Total | 15,169 | 69,560 | 86,981 | 125,309 | 180,486 | 203,296 | 254,658 | 287,149 |

*Source: Economic Survey 2006-07, GOI and annual reports of different years of NABARD*
*Note: Figures in parentheses indicate relative share in total*

financial aid to farmers. As a result, RRBs are now mandated to earmark only 10% of their lending to weaker sections, from the original 100% — a complete U-turn. If RRBs are to function as commercial banks there is no need for them to exist as separate entities.

Regional rural banks — originally conceived as 'social banks' and defined as 'region-based, rural-oriented, low-cost tiny commercial banks with a social approach' — have 73 metropolitan and 751 urban branches among a combined total of 15,029 branches, as of March 2008. What business did these banks have in urban and metropolitan areas? While their outstanding credit, as of September 2007, is Rs 52,449 crore, their rural credit is only Rs 35,003 crore. Similarly, their deposit portfolio of Rs 85,311 crore contains urban deposits of Rs 32,866 crore.

**Closure of rural branches**

Commercial banks as a bloc are showing an urban bias. They are either closing rural branches or shifting them to urban centres. According to RBI data, the number of rural branches of scheduled commercial banks (including RRBs) has come down by 4,313, from 35,389 branches in 1993 to 31,076 by March 2008. In contrast, the number of new urban and metropolitan branches has increased by 5,829 and 7,155 respectively. The change is seen — both in the reduction of rural and increase in urban branches — not only in relative share but in absolute numbers also (see Table 2).

Overall, even with a total of 76,050 bank branches the population-to-branch ratio has gone up to 15,000 from around 12,500, which was the ratio in the early-1990s. The focus being on profitability, the social objective of providing banking services to the people is taking a back seat although we hear a great deal about 'inclusive growth'. While there are more than 600,000 settlements in India, only 30,000 have bank branches — RBI Governor Dr D Subba Rao himself pointed this out recently.

It is well documented that the current agricultural crisis is the result of a host of factors including declining public investment in agriculture, rising input prices, an unresponsive institutional mechanism, non-remunerative product prices, and the absence of extension services. Farmer suicides are seen to be the consequence of farmers unable to clear their debts, mainly to private sources. This itself indicates the failure of institutional credit to meet the needs of farmers, particularly small and marginal ones.

It is paradoxical to talk about 'inclusive growth' whilst our policies and practices tread the path of exclusion. The reforms have not only resulted in reduced access to credit by farmers, particularly small and marginal farmers, they have also hiked banking and credit costs for this section. Measures like no-frills accounts and kisan credit cards have proved useless to farmers. In November 2005, the RBI asked banks to open accounts with small or no deposits, covering all households, as part of financial inclusion. By November 2008, tremendous progress was reported: 155 out of 355 campaign districts were said to have achieved 'financial inclusion'. But the opening of bank accounts did not bring any tangible benefits to the poor. A study, jointly conducted by the College of Agricultural Banking of the RBI and the Chennai-based Centre for Microfinance of the Institute of Financial Management and Research, found that 85% of accounts opened were inoperative; 72% of accounts had zero or minimum balance, and only 15% of accounts studied had a balance of over Rs 100. The experience with kisan credit cards is the same. Although an impressive number of cards were issued — 86,359,000 by 2009, according to data compiled by the National Bank for Agriculture and Rural Development (NABARD) — most of the cards are not used as credit cards. Instead, agricultural cash credit (ACC) borrowers are converted to KCC holders without changing the lending procedure.

These examples show that recent trends are going against rural areas in general and agriculture in particular. Small and marginal farmers are hard done by; any assertions to the contrary neither hide the truth nor reduce the sufferings of India's rural poor. Results that reflect true 'inclusion' will emerge only when sincere efforts are made to put in place policies that genuinely have the interests of agriculture and farmers at their heart.

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# Natural farming, tribal farming

In major parts of India, agriculture is in crisis, with very low returns and large-scale destruction of cropped lands. Conservation agriculture can help small and middle farmers escape the downward spiral that impoverishes them even as it destroys the soil and ecosystem. Tribal farmers in particular have an intuitive understanding of natural farming techniques, Agragamee discovered during its nascent initiatives in organic conservation agriculture with tribal farmers in Orissa

*VIDHYA DAS*

IT'S A LONG, ARDUOUS STRUGGLE getting something out of the red-brown soil that covers most of Kashipur in Orissa. And a quirky, lateral approach does little to help, as most people, including my colleagues, view anything unusual in cultivation practice with deep suspicion. Sumani is my strongest critic, and a follower. I impressed her with vermiculture and she took a pot of worms to start her own. She even took a bottle of *panchakavya* from me and tried it with great enthusiasm, and, I hope, success on her vegetable patch.

Vermicompost is all very well under ideal conditions — a dairy with stall-fed cattle, a largish campus that did not need to grow food for the family and so could afford a fair portion of area for trees that produce leaf mould and mulch, sufficient water and other resources. But what about small farming families with less than 2 acres of non-irrigated uplands? These families find it hard to keep vermicomposting going, and the risks are high: they can be attacked by pests; suffer too much or too little watering; the organic matter has to decompose just right; you have to have the right mix of cowdung and partially decomposed matter for the worms to thrive… Sumani herself found it difficult to get her culture right; she managed only after replenishing her supplies several times from our carefully monitored stock of 'local' non-exotic worms.

We had been experimenting with organic farming, permaculture, double digging, and other techniques for some years. The red inorganic soil of Kashipur gives a little, grudgingly, and then holds back. Just making compost requires a great deal of effort in terms of time and labour. You have to water it regularly to keep the moisture levels right, and water is at a premium in the rolling uplands. We had made several compost heaps, and they just grew; they did not decompose until the rains came. I wondered how one family could do all this and manage the huge cost in terms of labour. How would they maintain moisture levels for good compost? And in the quantities required?

Very often, farmers do not factor labour costs into their production systems, especially small and marginal farmers. But the whole family works on the farm — children, women, even the elderly. Then, because returns are too low to sustain them, they work on the farms of large farmers; here too, the real labour costs are not factored in.

At the first opportunity, farmers give in and take to chemicals, starting up the cycle of dependence and debt. Or, they opt out of their traditional cropping patterns and move to eucalyptus plantations, which hold even more risks and limitations.

When the great Masanobu-*san* (Fukuoka) died, I felt compelled to re-examine his practical philosophy. Natural farming, farming in nature's image, seemed good in the pages of the exciting book *One Straw Revolution.* But I wasn't a rice farmer, and we did not have rice lands. Moreover, even the concepts of organic farming with input substitution were difficult for my colleagues to swallow. How then would they react to his major tenets of no tilling, no weeding, no fertilisers (not even organic ones), and no pesticides?

I had chosen an unused patch of the Agragamee campus land. We had just cut the grass. Just sow the paddy, I told Ratha, at the same time and the same way, just before the rains, as you do in your fields. He wanted to dig. This was upland paddy that did not require standing water. We compromised. We raised beds 4-5 feet in width, threw soil from the furrows in between on to the beds on either side, sowed our paddy, and mulched all the beds with leaves. This successful first step emboldened me and we made similar beds with finger millet and foxtail millet.

The paddy did indeed sprout! When I peered at the neighbouring fields, my no-till methods compared very well. Sumani made special trips to monitor my fields, and congratulated me on my success. But her scepticism returned when we found that the millets had done poorly. Perhaps we had sown them late…

I had cut and mulched weeds on an unused bed. In some of the beds, the weeds had grown enough. In others, we added some to provide soil cover, spread EWM, threw soil from the furrows on either side on to the beds, and transplanted cabbage, brinjal and chilli seedlings. The cauliflowers died, but the chillies and brinjal did well. Long after other beds of chilli and brinjal, planted at the same time, had exhausted, mine survived and continued to yield. No-till needs understanding and patience. Gradually, the whole campus turned into a zero-tillage zone; even my colleagues grudgingly began showing a little acceptance of the approach.

Disaster struck in the form of expert advice. A group of experts saw our fields and were shocked by the overgrowth and apparent disarray. The beds were dug up, weeds pulled out and put into compost bins, and soon there were perfectly straight rows of cabbage and onions, watered in neat little furrows. They got good results from the soil that had retained its humus and organic matter. But this was an exception that only proved the value of conservation agriculture, as yields dropped again the next season.

After returning from a farmers' fair, a member of the visiting team wrote me about Raju Titus who had a 'natural farm' in Hoshangabad, Madhya Pradesh, which Masanobu Fukuoka had visited and helped design. Some of us went to see the farm. That was the turning point. Raju's fields of golden wheat put the neighbouring fields to shame. He produced enough for his family even though half his land was covered with *subabul* and other fruit trees. The leaf fall enriched his land; the fuelwood he gave away to people from neighbouring villages. His wife and just one helper managed almost the entire agricultural operation. While Raju explained the theoretical aspects, his wife gave us all the practical insights.

We returned convinced that this was the future of farming, and gradually we began to turn all the cultivated land on campus into zero-tillage, natural farms. We also felt we should help the local community benefit from this method, and, seeking to reach out to the tribal farmers we worked with, we invited Raju for a workshop. Raju is a man of few words. He briefly explained his methods and their value to farmers, and then demonstrated the techniques in practice. The farmer-to-farmer communication worked wonders. During the course of the workshop, 15 farmers declared that they would like to turn their farms into zero-tillage natural farms. This was success beyond all expectations; we eagerly began the process of expanding our experiments beyond the campus.

But it was not an easy task. Tribal regions in south Orissa, where Agragamee works, are hilly upland areas where shifting cultivation has been practised to the point of disaster. Heavy rains a few years ago had caused huge landslides, destroying both upland and lowland crops. The lowlands, where the best paddy in the region used to be cultivated, were now quite useless.

Land is divided into four zones in this region: irrigated lowlands, backyards, non-irrigated croplands, and dongar or hilly uplands. With the entire terrain in undulating relief, the first category of land is at a premium. It is painfully carved out of hill slopes and narrow stream beds through years and years of backbreaking work with bullocks and plough. When the uplands are denuded, a single day of heavy rains can destroy the crops so lovingly nurtured on them, throwing the farmer into deep despair.

Governments have also been very unkind in compensating farmers for their losses. Although an official compensation is declared for farmers who have lost their crops, it is much too little to be of any significant help, and is often badly handled.

Even so, there is opportunity too. '*Podu chaso*', as slash-and-burn cultivation is called in tribal regions of Orissa, is significant for the diversity of crops it has traditionally helped sustain, as also the diversity of cultivation practices it has generated. Crop rotations, intercropping, and other sustainable agricultural practices are a part of the inherited knowledge system of the Podu farmer. The rice varieties that have been preserved by tribal farmers in Orissa's undivided Koraput region are amazing. There are several varieties of short-duration and long-duration upland paddy that grow on the middle region slopes. Some of the most exquisite varieties of scented rice are grown here, the most famous being 'kala jeera', so called because the paddy is black in colour before it is de-husked. Apart from this, there are short- and long-duration varieties of ragi and the less common millets including foxtail millet, pearl millet and sorghum. Amongst pulses, they grow several varieties of broad bean, arhar, cow pea, rice bean, urad, and a local variety commonly called 'baeil'.

Not all of this is grown on hill or mountain slopes, the typical shifting cultivation or swidden land. For example, most scented varieties of paddy are lowland varieties. Not all of the land under shifting cultivation is mountain land either. But, it is the entire system of agriculture practised by the tribal communities that has helped preserve this rich diversity of crops, as also diversity of cultivation, as different systems are practised on different types of land and different types of soil. This knowledge system is of great value today, when the genetic wealth of plant resources is being usurped by multinational corporations and their aggressive market strategies.

The Podu system has developed in tune with the climatic conditions of the southern Orissa districts. Here, monsoon is the main agricultural season. It is characterised by a thin continuous drizzle for four to five months in the year. This provides the moisture necessary for hill slope cultivation, without the soil being washed away to any significant extent. Shifting cultivation crops are completely attuned to this sort of rain. Their shallow root zones thrive on the thin soil layers, while their moisture tolerance enables them to survive and produce a bountiful harvest. The burning enriches the potassium content of the soil, whilst also controlling pests and weeds.

Tribal knowledge systems also have a deep understanding of the crop rotation practices required to maintain shifting cultivation cycles at optimal level. In lowland paddy areas, tribal communities have developed indigenous systems of water management and crop optimisation, combining long-duration and short-duration varieties that enable crops to withstand the water currents of the monsoon in the valley, while optimising land use.

The typical shifting cultivation of tribal communities in southern Orissa is practised on primarily two categories of land:

**Medium land:** This land has a slope ranging from 3-10 degree gradient. Here, rice and millet, followed by a last niger crop, are cultivated annually under rainfed conditions. The land is cultivated in three- to four-year cycles, with equal fallow periods. This land is highly eroded, with rills and gullies steadily eating into the cropped area. Most of the medium lands are under private ownership.

**Upland:** These are hilly regions with slopes ranging from 10-45 degree gradient. With sufficient fallow periods, this land has good regenerating capacity and productivity. But due to various reasons, the length of the fallow period has been decreasing, leading to landslides during the monsoons which inundate lowlands and result in huge crop losses. Most of the uplands are referred to as "uncultivable wastes". These are government lands on which nobody is allowed ownership except under special consideration. This special consideration can take different forms.

In 1993, the government passed an order for upland slopes to be recorded in the name of landless tribals as a special provision under the International Fund For Agriculture Development (IFAD)-funded Orissa Tribal Development Project (OTDP) in Kashipur block. The project had several forward-looking and pro-poor provisions, the major objective being to improve tribal livelihoods through agricultural and market development. This was a landmark legislation, in which title deeds were sanctioned to landless tribal families on slopes between 10-30 degree gradient. The revenue department was required to record the names of both husband and wife on the title deed, providing economic security to women as well. Under the Land Acquisition Act, special provisions also facilitate acquisition of these lands by industrial and mining companies.

A major thrust of the OTDP programme was agro-forestry, wherein hill slopes under shifting cultivation were divided into three zones based on gradient. The 0-10-degree slope was marked for annual cropping, with soil and water conservation measures being undertaken; the 10-30-degree slope was marked for agro-forestry; slopes above 30 degrees were marked for plantation. Hill slopes were divided into strips of 1 hectare and distributed to tribal families with priority being given to the landless. The zone of 0-10-degree slopes was surveyed and settled with ownership rights given to the tillers.

Soil conservation measures were undertaken, like constructing contour stone and vegetative bunds on the hill slopes, checking gully and ravine formation through appropriate drainage treatment and other erosion control measures. Fruit-bearing trees like mango, litchi, guava and cashew were introduced as part of agro-forestry. Miscellaneous plantations were taken up on slopes above 30 degrees. Using sophisticated equipment, land survey and settlement processes were completed in 400 villages in Kashipur, and *pattas* distributed in over 150 villages. Local NGOs and tribal leadership were engaged in the decision-making process, to minimise conflict.

Initially, the tribals adopted this model enthusiastically. The land was settled and *pattas* were issued after the state government passed an order that this form of agriculture should be applicable to all tribal areas. However, on the ground the programme was poorly planned and implemented, and the initial impact was not sustained. The barren hill slopes, where a lot was spent on agro-forestry and soil conservation, now bear testimony to the inadequacy of measures aimed at reclaiming wastelands in high-relief shifting cultivation areas. Admitting its failures, the IFAD evaluation report states that the OTDP is a classic example of a development intervention in which the 'hardware' side of development was given far more importance than the 'software' side, both during design and implementation.

Although initially the settled lands and soil conservation measures seemed to have worked, very soon the tribal practice of slash-and-burn cultivation negated much of the gains. Even though ownership is now recognised, the soil loss and degradation of land resources continues. This also shows that the technology selected to provide viable and eco-friendly alternatives to shifting cultivation was inappropriate.

Several watershed projects have also been taken up under various government programmes in tribal regions. These projects, which saw substantial investments in earthworks, water resource development, manpower, etc, have had hardly any impact; nor have they done much to establish the viability of the soil conservation and erosion treatment model for environmentally degraded upland tribal areas. A few watersheds have helped a fraction of the tribal community improve their livelihoods. But by and large, this fraction does not include the poorer sections. Furthermore, the land development measures have done little to improve soil fertility, decrease topsoil loss or help establish a healthy vegetative cover.

Several reports indicate the multi-level failure of the watershed programme, and many of the causes of this failure are attributed to poor levels of participation. However, there has been little review of the techniques and technology used for the treatment of watersheds, and

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linking the interventions to the livelihood needs of poorer sections of the community. Thus, while NGOs fare better thanks to their increased sensitivity towards the needs of more marginalised sections, the cost-benefit ratios for watersheds still raise many questions.

According to a Planning Commission report, the 16.5 million hectares treated under the micro-watershed approach are not reflected in the net sown area which has stagnated at around 142 million hectares over the last 20 years. According to the Planning Commission: "Although the ministries of agriculture and rural development have implemented watershed projects for more than a decade, evaluation reports have shown that most projects have failed to generate sustainability because of the failure of government agencies to involve the people. Most government watershed development investments have yielded disappointing results given the vast resources allocated."

This is especially unfortunate in upland tribal areas where the pace of environmental degradation is accelerating, with accompanying impoverishment and distress among local communities. The poor outcomes of the watershed approach do little to build the faith of tribal people who respond in a superficial manner in anticipation of wage payments as some succour in their poverty-stricken lives. Watersheds also fail to recognise traditional knowledge systems and do little to promote indigenous crop varieties. There is an urgent need to address all these problems for any level of people's involvement and sustainability.

What could the options in such a scenario be? Was it the technology or the 'software' (as the IFAD report mentions) that failed these poor communities? There is no dearth of government expenditure on natural resource management programmes, and yet poverty increases. Could there be a way where current know-how can be combined with tribal knowledge systems and practices to reverse the ecological destruction, whilst helping improve the livelihood opportunities of tribal communities?

Not just tribal regions but in major parts of India, agriculture is in crisis with very low returns and large-scale destruction of cropped lands. An approach such as conservation agriculture needs to be taken up extensively with small and middle farmers to help them escape the downward spiral that impoverishes them even as it destroys the soil and the ecosystem.

Acceptance of conservation agriculture is much greater among farmers in rainfed regions. This could give rainfed agriculture the boost it needs, as a major portion of arable land in India is cropped primarily under rainfed conditions. Conservation agro-ecology systems could also be designed combining agriculture and plantation crops to bring about an overall surge in ecological gains. When integrated with local experience and wisdom, this approach can be adapted to improve agricultural production in rainfed agricultural uplands, irrigated backyard gardens, and commons, under the management of women's groups and the village community.

As the farm sector goes into a downward spin, the government's actions to bail out farmers takes the form of corporatisation, which allows agri-business companies, retailers and food-processing companies to enter into agreements directly with farmers. This, it is presumed, will help farmers find ready and reliable markets for their produce. However, failed experiments in states like Andhra Pradesh indicate that, with such 'solutions', farmers bear the final costs and receive very little benefit.

On the other hand, support for ecologically sound measures that help increase the production of food commodities that are in short supply such as lentils, oilseeds and millet, through approaches like conservation agriculture, will help rural communities address impoverishment. Agragamee's nascent initiatives in organic conservation agriculture with tribal farmers highlighted the farmer's interest and intuitive understanding of such an approach. Our early mistakes have only boosted enthusiasm amongst them to try again with deeper understanding, the next monsoon. This is where the support and partnership of government is required, for that will enable the positives from our experience to be of use in other parts of the country.

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# The home gardens of Wayanad

Wayanad, which has been in the news for the high number of farmer suicides, is also known for widespread homestead farming. A typical home garden integrates trees with field crops, livestock, poultry and fish. Home gardens form a dominant and promising land use system and maintain high levels of productivity, stability and sustainability

*A V SANTHOSHKUMAR*
*KAORU ICHIKAWA*

WAYANAD DISTRICT IN KERALA lies on the edge of the Deccan plateau and is unique because of its elevation (700-2,100 metres above mean sea level) compared to the rest of the plains in the state. This district has a purely agriculture-dependent economy and is among the most underdeveloped regions in India. The social fabric of the district is distinctly different from the rest of Kerala, with the highest proportion of aboriginal tribes, a low sex ratio, and an environmentally fragile ecosystem. The district covers an area of 212,560 hectares and is home to 780,619 inhabitants (2001 census). Aboriginal tribes form 17.4% of the total district population.

The gross cropped area of Wayanad covers 97.82% of the geographical area and is dominated by cash crops. The major plantation crops (tea, coffee, pepper and arecanut) together constitute 38% of cropped area. Coffee, which covers a total area of 67,429 hectares, is grown as under-crop in the homesteads of over 80% of small and marginal farmers in Wayanad district. Pepper, the second most important crop in the district, is also grown in home gardens. Of the total estimated 155,855 landholdings in the district of Wayanad, 83% belong to either small or marginal farmers.

Since Wayanad is a largely montane area that receives high annual rainfall within a short span of three to four months, land performs important hydrological and watershed functions. A large number of people living in the adjoining areas receive most of their water supply from rivers originating in the area. Thus, the soils and waters of this region sustain the livelihoods of many people. The geographic setting of Wayanad makes it highly sensitive to environmental stresses.

The area falls entirely within the Western Ghats of India, one of the 18 biodiversity hotspots. It is characterised by high levels of species endemism. The forests here are globally important as they house endemic flora and fauna, including 229 species of plants, 31 species of mammals, 15 species of birds, 52 species of amphibians. Among these, 55 species are critically endangered, 148 species are endangered, and 129 species are vulnerable, according to IUCN classification. A number of cultivated food plants have their wild relatives in these wet evergreen forests, including the spices black pepper, cardamom, cinnamon and curcuma.

The forests of Wayanad are unique and important because they represent a transition zone from the moist forests of the southwestern ghats to the northern drier forests. However, a large proportion of the Wayanad landscape comprises tea and coffee plantations that have resulted in severe fragmentation of the forests. Conserving these forests from fragmentation and overexploitation is a huge challenge.

In addition to rich biodiversity, Wayanad is home to diverse social, religious, and linguistic groups. The cultural diversity of rituals, customs and lifestyles has led to the establishment of several religious institutions. The six main tribal communities living in Wayanad are the Paniyan, Adiyan, Kattunaickan, Mullu Kuruman, Urali Kuruman and Kurichian. Each of these tribal groups has its own unique social and cultural characteristics.

**Sustainable use of biological diversity in socio-ecological production landscapes**

The district of Wayanad is characterised by homestead farming at the subsistence level and smallholder plantations. Paddy, the staple food of the region, is cultivated on 11,331 hectares. Paddy-based cropping systems involve paddy, vegetables and banana. The uplands adjoining the wetlands are characterised by homestead farming with coffee and pepper. Coffee-based cropping systems involving coffee, pepper and ginger, along with many trees, are the most prevalent land use patterns. In traditional agro-forestry systems composed mainly of home gardens, the native tree composition of farmlands was largely left intact; only the under-storey plants were replaced by crops. This system lies contiguous with the natural forests and provides an unhindered habitat for wildlife in the area due to plant diversity and shade.

Most farmers in Wayanad are small, marginal, and tend to grow multiple sets of crop on their farmlands. Traditionally, the inhabitants of the area have not depended on forests or community-owned lands for their biomass requirements.

One of the reasons was the absence of community-held lands, unlike in many other places in the world. Farmers maintain a spectacular variety of plants in their home gardens to meet their varied needs.

A typical home garden represents an operational farm unit that integrates trees with field crops, livestock, poultry and/or fish, with the basic objective of ensuring sustained availability of multiple products such as food, vegetables, fruits, fodder, fuel, timber, medicines and/or ornamentals, besides generating employment and cash income. Home gardens constitute a dominant and promising land use system, maintaining high levels of productivity, stability, sustainability and equitability.

Home gardens with a multi-storey canopy structure are deliberately planned to mimic a natural forest and thereby lack a discernible planting pattern. Physiognomically, home gardens exhibit a multi-tiered canopy structure somewhat similar to that of a tropical evergreen forest. The mean density of trees in a home garden is estimated to be as high as 116 trees per hectare.

The high degree of biodiversity present in a home garden is unique and totally distinct from the biodiversity present in a natural forest. The biodiversity of a home garden is the result of generations of conscious selection by farmers, and bears the imprint of their choices. Moreover, these components are, in most cases, the last refuge for species that are useful but not commercially viable for cultivation

Home gardens play an important role in the food security of the region as they supply varied products throughout the seasons. Tubers, vegetables, fruits and spices from home gardens make up a significant part of the nutritional requirements of the household. Crop diversity in homesteads results in a range of output from a given area, increasing self-sufficiency and reducing the economic risks associated with adverse climatic, biological and market impacts on particular crops. In densely populated or heavily degraded areas without sufficient staple crop fields, as in Wayanad, home gardens also provide large portions of staple foods.

Another important function of home gardens is the generation of a cash income. Most of the income from a home garden is from marketable surplus derived from perennials such as fruit trees. Income from a home garden could account for more than 50% of the total income of a household.

The high degree of biodiversity present in a home garden is unique and totally distinct from the biodiversity present in a natural forest. The biodiversity of a home garden is the result of generations of conscious selection by farmers, and bears the imprint of their choices. Moreover, these components are, in most cases, the last refuge for species that are useful but not commercially viable for cultivation. Various studies have indicated that home gardens usually contain high volumes of commercial timber and fuelwood which satisfy a substantial proportion of society's demands.

Home gardens also meet a significant portion of the household's energy requirements. Most cooking fuel requirements are met through twigs and other forms of litter collected from the home garden. Oils extracted from varied sources, like coconut and sesame, used to serve as the source of lighting fuel in traditional homesteads before the advent of electricity. The green leaves and cowdung from home gardens used to be a major source of chemical energy in the household, and the fodder from home gardens fed to the cows would serve as the major mechanical energy source used in farming.

In addition to their production value, home gardens have an important social and cultural function. At times, they serve as a status symbol and the aesthetic value partly outweighs the productive function. The exchange of home garden products and planting material is common in many traditional societies. Some plant species in home gardens are necessary for religious ceremonies; not being commercially viable, they are not cultivated. Most traditional medicinal plants are encountered in home gardens. Home gardens also fulfil ecological functions, particularly in landscapes where large, monotonous and mono-functional agricultural fields dominate.

The multi-layered vegetation structure of home gardens, which resemble natural forests, offers a habitat to a diverse community of wild plants and animals. This structure appears to contribute substantially to the sustainability of home garden systems.

Home gardens save agricultural lands from the degradation resulting from intensive agriculture, and maintain or increase site productivity through nutrient recycling and soil protection. Farmers derive a variety of services and products from home gardens; they increase the value of output per unit of land through spatial or inter-temporal inter-cropping of trees and other species. Home gardens also help farmers by supplying raw materials (such as leaf compost) for agriculture. And they spread the need for labour inputs more evenly seasonally, thus reducing the effects of sharp peaks and troughs characteristic of tropical agriculture. Farmers are able to utilise family labour as a part-time activity without requiring a change in occupation for the landholder.

The technology involved in home gardens is simple, labour-intensive and requires little outside technical or financial support. Tree components of home gardens offer many useful 'assets' to the poor such as low investment cost, rapid appreciation, divisibility, flexible harvesting time and the ability to meet unforeseen contingencies.

Despite these advantages, home gardens rank low in economic calculations as the marketable surplus produced by them is quite low. Lower economic returns force many farmers to shrink their home gardens to make space for more remunerative mono-crops. The process of modernisation includes a decrease in tree/shrub diversity, gradual concentration on a limited number of cash crop species, increase in ornamental plants, gradual homogenisation of the home garden structure, and an increase in the use of external inputs. Traditional home gardens are subject to different conversion processes linked to socio-economic changes, to the point of them becoming irrelevant or even extinct. This change is principally attributed to an increase in the importance of socio-economic factors (such as commercialisation) over time, with a decrease in the importance of agro-ecological characteristics. For example, many agro-ecological characteristics, such as low fertility, can be altered with technologies like the application of fertiliser. Scientists have voiced concerns that socio-economic changes and the related adoption of modern managerial systems bring about a negative conversion process of home gardens in this region. Studies reinforce the general fear of loss of traditional characteristics of home gardens and their gradual demise into cash crop production systems.

A large proportion of the poor depend on ecosystem services from forests and agricultural lands for their survival. In Wayanad, biodiversity and ecosystems contribute to food security and nutrition, providing the raw materials that underpin health, both formal (ayurveda system) and informal (tribal systems). For many families, agriculture (mostly subsistence) is the main occupation and these families have limited access to alternative sources of income. They inhabit marginal, less agriculturally productive land where harvests are more vulnerable to deterioration of soil and water quality. Though the nature and mode of extractive dependence have changed over time, people's dependence on forests continues. Tribal populations are almost entirely dependent on these natural resources for their survival, and any deterioration of these resources will have a telling impact on their livelihood.

The landscape of Wayanad is a mosaic of forested lands managed by the state as reserve forests or wildlife sanctuaries and agricultural lands adjoining forested areas. The favourable role of these landscapes and production systems has been receiving a lot of attention recently. It is now recognised that traditional farmers have not only conserved biodiversity of great economic, cultural, and social value, they have also enhanced it through selection and value-addition. For example, the potential of traditional land use systems to serve as sinks (soil and biomass) of atmospheric $CO_2$ is being recognised of late.

However, agriculture in Wayanad is facing many problems today. Agricultural production and productivity have decreased drastically over the years due to various reasons. The area was in the news for the high number of suicides by farmers, attributed to losses in farming. Many micro- and macro-level factors have been cited as reasons for failure on the agricultural front in this area, including policy changes, institutional factors, socio-economic factors, geographical peculiarities, climate change effects, poor investment in agriculture, and poor infrastructural facilities.

There is potential to strengthen formal and informal institutions to save farming and traditional land use systems in the area. There exist a large number of informal institutions in the form of tribal clans that strongly influence public opinion and the political decision-making process. However, integrating these institutions with the newly-crafted formal institutions remains a challenge. The People's Biodiversity Register (PBR) is an example of one such attempt under local self-government institutions (panchayats) to document and conserve biodiversity. More efforts like these are needed to document and understand the dynamics of these landscapes for their conservation and continued maintenance.

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# Small farmer zindabad

More than 80% of India's farmers are small and marginal farmers. It has been empirically established that small farms produce more per hectare than their larger counterparts. It is therefore imperative to protect the interests of small farmers through measures that help promote and stabilise incomes, reduce risks, and increase profitability, and at the same time improve availability and access to inputs, markets and credit

*This extract is from the report of the National Commission for Enterprises in the Unorganised Sector (NCEUS), 'The Challenge of Employment in India: An Informal Economy Perspective' (2009). It provides an insight into the character of farming, and reveals the nature and potential of the smallholding character of Indian agriculture, which NCEUS has said is "much more prominent and pertinent today than ever before". The predominance of marginal farmers is significant because farming then becomes only one of the sources of livelihood for these households, often much more than that of small farmer households. The NCEUS analysis of smallholder agriculture has shown that the per hectare value of output from small farms is, in general, still not less than that from large farms. "With appropriate institutional support including credit, it has been possible for small farms to catch up and in some cases even surpass large farms in use of HYV and other land-augmenting technologies."*

THE TOTAL NUMBER of agricultural workers in India has been estimated at 258 million, as of 2004-05. About 248 million of the total rural workforce of 341 million are in rural areas. Agricultural production takes place largely on individual or joint holdings. Except for the segment of agriculture that comes under plantations and those covered by corporations and large cooperatives in the organised sector, the Commission has categorised the remaining parts as the unorganised agriculture sector.

The share of unorganised sector agricultural workers in total agricultural workers was 98% during 2004-05. Nearly two-thirds of agricultural workers (64%) are self-employed, or 'farmers' as we call them, and the remaining, a little over one-third (36%), wage workers. Almost all wage workers (98%) are casual labourers. Farmers are a group which can be differentiated by size of landholding as a good proxy. Given the overwhelming dominance of the unorganised sector in agricultural employment, we have dealt with the sector as a whole.

The overall structural change in employment has occurred as a result of slower growth of employment in the agricultural sector vis-à-vis total employment. Over the last two decades, the agricultural workforce grew at 1.04% per annum while the total workforce grew at 1.94% per annum. During 1983-2004/05, female agricultural employment grew at a rate faster than male agricultural employment. A comparison of employment growth rates between 1983/1993-94 and 1993-94/2004-05 shows that the growth rate of agricultural employment decelerated sharply in the last decade, from 1.38% to 0.72%. Although the growth in total employment also declined from 2.03% during 1983/1993-94 to 1.85% during 1993-94/2004-05, the deceleration was clearly not as sharp as in the case of agricultural employment. It is obvious from these results that there is a gradual decline in the potential of the agricultural sector to absorb the incremental workforce. Further, structural constraints appear to be restricting the scope of women's employment outside agriculture, confining them primarily to this sector.

The fact that agriculture continues to absorb more workers can be of little consolation unless it can also be shown that such increased employment is accompanied by higher incomes and productivity per worker. Since agricultural GDP grew at a rate faster than the growth in employment, agricultural GDP per worker (a measure of labour productivity) also increased at an annual rate of 1.52% for the entire period, and 1.24% and 1.79% in the two sub-periods respectively. Thus, agricultural productivity has not remained entirely stagnant but has grown slowly with a decline in growth rate in the second period (1993-94 to 2004-05). These results also hold for the two major sub-sectors, viz crop and livestock. While the livestock sector shows a higher growth rate in labour productivity over the entire period, both the sectors show lower rates of productivity increase in the second period. This rate of improvement is certainly far from adequate to bring about a sustained and rapid improvement in the living conditions of agricultural workers. The result of this has been a steady widening of the disparity in the income generated per worker in agriculture and in the other sectors.

**Growth, grain and livelihoods**

It is widely recognised that in the past decades (1960s to 1980s), agricultural employment increased primarily as a result of land-augmenting technological changes, propelled by enhanced investments in irrigation and supporting institutions and policies. These changes made possible increases in both sown area, through higher cropping intensity, as well as greater labour use per sown hectare, although this increase took place at different time periods, in different regions and across different size classes of farmers. Simultaneously, there has also been a fairly dramatic growth in employment in non-crop agricultural sub-sectors such as dairy farming and livestock. Recent studies have shown a decline in the public support available to agriculture and a petering out of the impetus of such technological changes. Moreover, agricultural growth has been acquiring a more labour saving character. The relatively fast growth of the (unorganised) non-farm sector has also provided some scope for the limited occupational diversification that has occurred. At the same time, one must recognise that if the non-farm sector does not provide adequate remunerative employment opportunities, and if the agricultural sector does not grow fast enough, parts of this sector may show features of agricultural involution, with the sector retaining a growing part of the workforce through fragmentation and sharing of work, with little improvement in productivity or agricultural incomes. These issues need to be examined in some depth as they determine the contours of an agricultural employment strategy.

There is clear evidence that in recent years, agricultural growth — particularly in foodgrain — has declined. This has had an adverse effect on the growth in agricultural wages that have shown signs of deceleration in the 1990s making the situation even more unfavourable for agricultural labourers. On the other hand, farmers, particularly marginal and small farmers, are also facing a crisis due to increasing input costs and uncertain output markets. In these conditions, government support in the form of policy initiatives and schemes to protect the interests of agricultural workers becomes even more pertinent. However, in the post-1990s period, there has been a decline in government support in the form of declining investments in agriculture; subsidies to the sector are also being rationalised.

The withdrawal of the State has led to much greater dependence on private sources for inputs, extension, markets and credit. Farmer suicides have been widespread in the last several years, and the victims have largely been marginal and small farmers. Increasing costs of cultivation, leading to higher indebtedness, crop failures and incapacity to face price shocks with greater liberalisation of the agricultural sector have driven farmers to the extreme. This has prompted the central and state governments to set up several commissions including the National Commission on Farmers and the Committee on Agricultural Indebtedness to suggest remedial steps.

In the liberalised scenario and with increased integration with global markets it has become even more imperative to protect the interests of marginal and small farmers through measures that help promote and stabilise incomes, reduce risks, and increase profitability, and at the same time improve availability and access to inputs, markets and credit. However, we have observed that the dependence on private sources for inputs, irrigation and, most importantly, for credit among small and marginal farmers has increased in recent years reversing earlier trends towards expansion in access.

As pointed out by this Commission, at the all-India level, more than 80% of farmers belong to marginal and small farm size groups, owning or operating less than 2 hectares of land. The percentage of marginal and small farmers in the total, and also the land operated by them, has steadily increased over time. The percentage of marginal farmers has gone up from nearly 38% in 1953-54 to about 70% in 2002-03. The share of marginal and small farmers in owned land went up from 16.3% in 1953-54 to 43.5% in 2002-03. A similar pattern in land distribution is discernible in the case of operational holdings also. By 2002-03, marginal and small farmers accounted for nearly 80% of operational holdings as compared to about 61% in 1960-61. The smallholding character of Indian agriculture is much more prominent and pertinent today than ever before. Nonetheless, we still need to reckon with considerable inequality in land ownership and operation. Medium and large farmers (6% of farmer households) operate more than one-third of total operated area, while large farmers (0.9% of the total) still operate 13.1% of land.

Inter-state analysis indicates that marginal and small farmers as a group outnumber the rest of the farmers in all the states. In 12 out of 27 states, marginal and small farmers constitute the overwhelming majority of farmers, accounting for 90% or above. While marginal and small farmers outnumber medium and large farmers in all states, in 17 out of 27 states they also account for more than 50% of land possessed for cultivation. Within the group of marginal and small farmers, marginal farmers outnumber small farmers, ranging from 2:l in states with low incidence of marginal and small farmers, to as high as 18:l in Tripura, 12:l in Uttarakhand, 10:l in West Bengal and Kerala, and close to 8:l in Bihar. The predominance of marginal farmers is significant because farming then becomes only one of the sources of livelihood for these households, often much more than that of small farmer households. A foothold in land cultivation is seen to be crucial by these households for the security it provides in terms of food, some collateral, and a source of employment when alternative opportunities become far and few. The importance of a livelihood approach to marginal and small farmers can hardly be underrated.

Only 10 states show the contribution of marginal and small farmers at less than 50% of output. It varies widely across states, ranging from about 19% in Punjab to 86% in West Bengal. It is less than half the total output in only a handful of states in the northwest (Punjab, Haryana and

Uttarakhand), centre-west (Rajasthan, Gujarat, Maharashtra and Madhya Pradesh) and south (Andhra Pradesh and Karnataka). But their share in production is often higher in proportion to their share in operational crop land.

**Approach of the Commission, analysis and recommendations**

We have shown that the per hectare value of output from small farms is, in general, still not less than that from large farms. The NSSO 59th round Farmers' Survey has empirically established that small farms continue to produce more (in value terms) per hectare than their larger counterparts in the country as a whole as well as in most parts of the country. Small farms are characterised by applications of smaller capital but higher labour and other inputs, especially owned ones, and are generally characterised by a higher index of cropping intensity and diversification. With appropriate institutional support, including credit, it has been possible for small farms to catch up and, in some cases, even surpass large farms in use of HYV and other land-augmenting technologies.

Our analysis has also shown that gender issues in farming need to be moved to centrestage in agricultural policies and programmes. Till recently, little attention was paid to the role of women in the farming community. Women's work in farm households was seen as mainly supplementing the work of males, who also took all the major decisions. This perception has changed principally because it is recognised that due to the movement of men out of agriculture, women farmers are often the principal (and sole) decision-makers in the household. The Situation Assessment Survey of Farmers 2003 shows that nearly 40% of farmers in India are from among the women. This holds for all size categories. In animal husbandry, more than three-fifths of workers are women. In forestry/plantation activities too, a majority of workers are women.

Input use to enhance productivity has greatly increased since the Green Revolution, which is also one of the reasons for increased cost of cultivation. Timely availability of HYV seeds and usage of fertilisers and pesticides is also important to ensure a good crop. Farmers in general, and marginal and small farmers in particular, often face problems regarding easy and timely availability and quality of these inputs, as also costs and knowledge of use of these inputs in the right quantities. Among the various inputs (pesticides, fertilisers, HYV seeds, organic manure and veterinary services), the Situation Assessment of Farmers Survey shows that only organic manure is most readily available within the village. In most cases, inputs are available in the nearest large village which is more than 2-5 km away. Farmer households have to travel more than 10 km for seeds and pesticides. Access to public extension services has become very weak, which often resulted in inappropriate choice of crops and inputs.

Collective organisation for farmers may be said to be a *sine qua non* for demanding and securing public services and assistance especially in the context of economic reforms that are, by and large, urban-oriented. Farmers groups and cooperatives help to overcome diseconomies of small size and access to credit, inputs and markets. Cooperative forms of organisation have a long history in rural India, especially among farmers. Yet membership of cooperatives, SHGs and other groups is very low among farmers, except in some regions, and is particularly low among marginal and small farmers.

The present constraints on Indian agriculture stem from systemic issues, which include the macro-policy environment. These constraints have seriously affected the degree of public support received by agriculture in investment, credit, extension services, R&D, and so on. This neglect has been most prominent in the case of marginal and small farmers. In the Commission's view, marginal and small farms are the backbone of Indian agriculture. These farmers face various disadvantages while dealing with the markets. At the same time, the Commission's analysis clearly brings out that government interventions also tend to be less effective with respect to these categories of farmers. The Commission feels that there is need for a focused strategy with respect to marginal and small farmers.

Organisationally, such a strategy must focus on group approaches so that the required transaction costs can be reduced and farmers can benefit from economies of scale. The Commission has therefore advocated the setting up of a special programme for marginal and small farmers in order to incentivise the formation of farmers groups and apex organisations, and facilitate finding solutions to the problems of irrigation, inputs, markets, procurement and risk. Also, the risk factor has to be mitigated through appropriate farming strategies as well as adequate insurance. There is the need for insurance instruments that cover production and also market risks for all crops, to reduce the financial risks and increase viability.

# The tired mirage of top-down technology

India’s large and complex public agricultural research and extension system, obsessed with the area-production-yield mantra, is geared towards harnessing technology to close the yield gap, while overlooking ago-ecological approaches entirely. This has been an error of staggering proportions

*RAHUL GOSWAMI*

HOW DOES A TECHNOLOGY CORPORATION that makes farm inputs its business see agriculture? This entity, which does its best to convince developing country governments about the need for technology-intensive agricultural research, works hard to influence policy, programmes and eventually the channels that provide farmers with seeds, fertiliser and pesticides. How does this corporation see the farm?

Quite simply, as a consumer for which a consuming system must be sustained. Such a corporation’s work and view requires a few alliances — with central and state government, with new and potentially lucrative bio-technology labs (private sector), with individual politicians and legislators who can smooth the path for business-friendly acts and regulations, with retail chains that will stifle locally-based competition. While that web is taking shape, this is the reasoning the corporation will dispense for public consumption:

• First, there have been impressive gains in yields over the past 50 years in most of the world, but large and economically exploitable “yield gaps” remain in many places.

• Second, there are many technologies that are at “an early stage of adoption” which “promise a win-win combination of enhancing productivity and sustainably managing natural resources”. These include conservation farming approaches based on no-tillage and the genetically modified (GM) technology revolution, used on less than 10% of the world’s cultivated land. This promise is backed by the even younger adoption phase of information and communication technology (ICT).

• Third, for technology to work best at pushing up yields further, complementary changes in policy and institutions are needed. In much of the developing world, policies are now more favourable towards rapid productivity growth, while a range of innovations in risk management, market development, rural finance, organising farmers, and provision of advisory services can make markets work better.

• Fourth, plant breeders are making steady gains in potential yields for the big three cereals: wheat and rice (slower than before), and maize. “There is no physiological reason why these gains cannot be maintained, but progress is becoming more difficult with conventional breeding.” The answer is genomics and molecular techniques which are now being regularly applied to speed breeding in the leading multinational seed companies and elsewhere, and their costs are falling rapidly. Moreover, “transgenic technology has a proven record of over a decade of safe and environmentally sound use” and its potential is “to address critical biotic and abiotic stresses of the developing world”.

With the dominance of the area, production and yield (APY) model of measuring and addressing agriculture in India, central and state planners, riding the juggernaut of the national agricultural research system, have reached automatically for industrial models and paper economies of scale. The saddest and most pervasive indicator of what the pursuit of this model has cost India can be seen in the historical trend of fertiliser use (see box). Developing countries now account for 68% of total global fertiliser use. Fertiliser use per hectare is also now higher in developing countries than in industrially advanced countries (in the South vs the North).

Such chemical dependence is especially tragic in India. Albert Howard, considered by many to be the father of organic agriculture, was one of the first to articulate an alternative to chemical agriculture, as usual on the basis of his work in India in the early part of the 20th century. Over his lifetime, he published several books describing composting techniques (practice, experimentation and insights gained through closely working with Yeshwant Wad), underlining the importance of humus and the re-use of agricultural waste on the farm, and urging the elimination of chemical inputs because of their effects on soil fertility. Here was the means to close the yield gap.

For the global agbiotech-seed corporations and their clients and partners in government and the local private sector, the problem is that “closing the yield gap” on the large scale needed requires, as they say, “massive investments in rural infrastructure and institutions, plus technology transfer”. Public sector agencies have, in reaching the billion small farmers in Asia, helped lessen the yield gap but these efforts have been socially and politically driven, in the main. That civic imperative is steadily changing, for in India as in

## India's fertiliser addiction

The Economic Survey 2009-10 has attempted to conceal the true impact of chemical fertiliser abuse in India. Chapter 2 of the survey deals with agriculture, and states: "The per hectare consumption of fertilisers in nutrient terms increased from 105.5 kg in 2005-06 to 128.6 kg in 2008-09." This is false. Here is why.

In 1950-51, average fertiliser use in India was only 0.58 kg per hectare. The net sown area was 118.75 million hectares upon which 69,000 tonnes of fertiliser were used. Of course, this is a notional average use only, as 60 years ago, fertiliser was an agricultural input in only a few districts that were being primed for what was to become the Green Revolution. Still, that was the 'national average'. It took 16 years before that average crossed 10 kg of fertiliser per hectare, and that happened in 1967-68 when the net sown area was 139.88 million hectares and total fertiliser use was 1.53 million tonnes. Thereafter, it took only five years to reach 20 kg/ha. The period 1971-72 to 1975-76 saw little change — the only such period in the last 60 years — in intensity of fertiliser use. Those were the years of the global oil crisis, the so-called 'first oil shock' of the '70s. For that time, the 'national average' remained between 18 and 20 kg/ha, while the total net sown area varied little from 140 million hectares and total fertiliser use stayed between 2.65 and 2.89 million tonnes.

Per hectare application of fertiliser continued its upward trend in 1975-76; it took less than eight years to cross 50 kg/ha and another six years to cross 80 kg/ha — in 1989-90 India's total fertiliser use was 11.56 million tonnes. In the decade of the 1990s, total fertiliser use in India rose by 44% (from 12.54 mt to 18.06 mt) and per hectare application went up by 46% as the available agricultural land plateaued at around 140 million hectares. Both total use and per hectare application remained at those levels until 2004-05. In the last four years there has been an astonishingly steep increase in total use and per hectare use. For 2008-09, total fertiliser use at 24.9 mt is more than 6.5 mt more than the figure for 2004-05, and per hectare use has shot up to over 174 kg/ha from 130 kg/ha in 2004-05 — a jump of 33% in just four years.

The Economic Survey 2009-10 states: "Chemical fertilisers have played a significant role in the development of the agricultural sector. The per hectare consumption of fertilisers in nutrient terms increased from 105.5 kg in 2005-06 to 128.6 kg in 2008-09. However, improving the marginal productivity of soil still remains a challenge. This requires increased NPK application and application of proper nutrients, based on soil analysis."

The survey is wrong. The per hectare use crossed 105 kg in 1997 — nine years before the survey says it did — and crossed 130 kg in 2004-05. In 2008-09, the rude equation is: 143 million hectares of net sown area; 24.9 mt of total fertiliser consumption. The survey has concealed true per hectare consumption of fertiliser by swapping net sown area with gross sown area. Net sown area is the land surface on which crops are grown. To assess output and productivity, when cultivated land is used to grow more than one crop per year, that area on which the second crop is grown is counted again, which gives us gross sown area. Counting cultivated land more than once raises the sown area from 143 million hectares (net) to 190 million hectares (gross). And that is how the per hectare consumption of fertiliser is portrayed as much lower than it truly is. Chemical fertiliser, however, affects the parcel of land, and is not divisible by the number of crops the land is employed for. The resulting difference is enormous: 45.4 kg/hectare!

*Data sources: Reserve Bank of India Handbook of Statistics on Indian Economy 2008-09. For 2007-08 and 2008-09, total NPK consumption figures are from the Economic Survey 2009-10*

South Asia, the agricultural extension system is unable to respond to new challenges, hampered as it is institutionally. The new "solution" is most likely to come from the well-stocked public-private partnership stable, now strengthened by a combination that brings together ICT and 'AR4D' (agricultural research for development).

India's national agricultural research system has treated agro-ecological approaches to cultivation as a clumsy proto-technical holdout from a bygone era. In doing so, it has made an error of staggering proportions which is only now being recognised. The Indian Council of Agricultural Research (ICAR) may make appropriate noises now and then to quell criticism, but the organic tradition in India's farming systems cannot find favour with the core of our public agricultural research system, very simply because it is not designed to.

The evidence has been accumulating. A survey conducted by a group of researchers from the Indian Institute of Soil Science, Bhopal, and the Directorate of Oilseeds Research, Hyderabad, has, in rupee terms, compared the costs and benefits of organic farming versus conventional high-input farming. Reporting their findings in the journal *Current Science* (May 10, 2010), the group's work shows that organic farming, in spite of the reduction in crop productivity by 9.2%, provided higher net profit to farmers by 22.0%, compared to conventional farming. This is mainly due to the availability of premium price (20-40%) for certified organic produce combined with a reduction in the cost of cultivation by 11.7%. Moreover, there was an overall improvement in soil quality — physical, chemical, biological properties, availability of macro- and micro-nutrients — that point to enhanced soil health through the adoption of organic farming methods.

The group surveyed certified organic farms to find and list the real benefits and feasibility of organic farming in terms of the production potential, economics, and soil health compared with conventional farms. The survey was conducted during 2008-09 in Maharashtra, Karnataka, Tamil Nadu (including Pondicherry), Kerala and Uttarakhand involving 50 certified organic farms and 50 comparable conventional farms.

Today, an area of more than 528,000 hectares is estimated to be under organic farming in India, with about 45,000 certified organic farms. Economically, the Indian organic farming industry is estimated to produce fruit, vegetables, grain and herbs worth about US$ 78 million and is almost entirely export-oriented. According to the Agricultural and Processed Food Products Export Development Authority (APEDA, the nodal agency that promotes Indian organic agriculture), about 586,000 tonnes' worth of organic products are being exported annually.

There are biological and energy benefits of organic and agro-ecological farming which, under the growing shadow of climate change and energy scarcity, become even more compelling for our farming households and communities. The density of soil is less in organic farms, which indicates better soil aggregation and soil physical conditions. In India, studies have found up to a 30% increase in the organic carbon of soil in organic farms compared to conventional farms. Next, conservation farming using zero-tillage reduces fuel use for farm power in agriculture by 66-75% — in irrigated South Asian systems there has been wide adoption by small-scale farmers of zero-tillage in rice-wheat systems (with recorded increases in wheat yields of 11%). As the Intergovernmental Panel on Climate Change (IPCC) has also pointed out, conservation tillage is also a potentially important source of carbon sequestration in tropical soils.

"With less than 10% of the world's crop land under conservation tillage, wider adoption of the practice represents a major opportunity to improve the sustainability, energy efficiency and yield of cropping," was an observation made during the 'Expert Meeting on How to Feed the World in 2050', organised by the Food and Agriculture Organisation (FAO) in June 2009. Conservation agriculture is seen as knowledge-intensive and location-specific and requiring sharply increased investment in research on suitable varieties, management practices adapted to specific sites, appropriate machinery, and advisory services and farmer networks.

Is that taking place in India? The short answer is 'no'. Seven years ago, an ICAR policy briefing said: "Competitive agricultural technology funds focus mainly on short-term research issues. This means that there will always be a need to fund long-term basic research through block grant systems. However, it remains important to improve the competitiveness and accountability of research systems through enhancing the overall share of competitive funding. India has all the necessary preconditions for making competitive funding effective and efficient."

What has it done with these available and favourable conditions? To answer that requires first a précis on the Indian national agricultural research system.

Currently, the public agricultural research and extension system consists of ICAR and its various institutes, and the State Agricultural Institutes (SAUs) and their various campuses and regional institutes. ICAR funds and manages a vast network of research institutes, including national institutes for basic and strategic research and post-graduate education; central research institutes for commodity-specific research; national bureaus for conservation and exchange of germplasm and soil-survey work; and national research centres for applied, commodity-specific strategic research in what it calls "mission mode".

In addition, ICAR manages a large number of All-India Coordinated Research Projects (AICRPs), which draw scientists from both ICAR institutions and SAUs. Most AICRP centres are located on SAU campuses under the administrative control of the respective SAUs. However, for the most important AICRPs (rice, wheat, maize, cattle, oilseeds, water, cropping systems, and biological control of pests), ICAR has established special project directorates with their own research infrastructure, under ICAR administrative control, that consist of teams of multi-disciplinary scientists. In addition to the traditional National Agricultural Research System (NARS) — that is, the ICAR/SAU system — there are non-agricultural universities and organisations that support or conduct agricultural research either directly or indirectly. For example, the central government Departments of Biotechnology (DBT), Science and Technology (DST), and Scientific and Industrial Research (DSIR) under the Ministry of Science and Technology, support and conduct agricultural research at their institutes and may also fund research in the ICAR/SAU system.

Forty years ago, there were benefits to the farmer that arose from technological innovations provided by this sprawling, complex system densely populated by an uneasy mix of crop scientists and administrators. However, what this network failed to realise is that the farmer is also often an innovator, and that the national agricultural research system exists primarily to assist the farmer rather than seek direct financial reward through commercialising or licensing their intellectual properties. If at all there is an advocacy for biotechnologies it must demand that farmers can continue to improve and adapt to their circumstances, rather than be forced to consume black-box imports from large patent holders. India's NARS still shrinks from the recognition that the kind of biotechnology that works best for poor and subsistence farmers so far has not been the kind that concentrates the ownership of plant germplasm in the hands of a few patent holders high up in the agbiotech-seed industry chain.

# The gap between field and lab

In India, publicly-funded research shapes the choices available to farmers, food workers and consumers. But farmers and consumers are only at the receiving end of agricultural research, never involved in it. Raitateerpu, a farmers' jury in Karnataka, wants to ensure that citizens are involved in decisions around science, technology and policymaking

*ANITHA PAILOOR*

"GIVEN A CHOICE BETWEEN protecting nature and making a profit, I would opt for nature," said Sadashivaiah, and his statement was greeted with applause from other members of the farmers' jury. Sadashivaiah and his fellow participants were speaking at the Raitateerpu event, organised in January 2010, in Bangalore. The event heard the views and insights of 28 small farmers from Karnataka. The audience included researchers, farmer leaders, a director of the State Agriculture Department, representatives of civil society organisations and consumer activists. Underlining the inclusive nature of the event, private seed company representatives too presented their case in front of jury members during the three-day event. Farmers collected evidence from these experts on different dimensions of farming with a focus on agricultural research.

The process, which followed a 'citizen's jury' model, allowed farmers to review the present status of agricultural research and conclude with a verdict. The entire exercise reflected the current tendency among farmers in Karnataka — although participants included both chemical and non-chemical farmers — to categorically support environment-friendly agricultural practices.

It has become very important to stake farmers' claims over agricultural research. For a long time, agricultural research was thought of as an expert domain and hence farmers were only at the receiving end of research outputs. Every time something failed, farmers were blamed for their 'ignorance and inability' to handle their agriculture. Never was the question asked: Was there something wrong with the research itself? As people say, the research had all the right answers, but did it have the right questions?

The last two decades have seen the organic movement becoming popular among farmers. "After retirement, I wanted to get into farming. When I started agriculture in 2002, the organic movement had reached its peak. I have converted 9 acres of fallow land into a fertile farm, and all organic," said S M Patil, who finds agriculture more satisfying both monetarily and work-wise than his earlier job as village accountant.

Though a new entrant to agriculture, Patil has touched on the heart of the matter. Value-addition and direct marketing form the base of his successful venture. His main farm produce is sapota which gets processed into powder and dry fruit. He also processes herbs into soap, mouth freshener and tooth powder; tomato jam and turmeric pickle are some of his unique products. "We haven't put much effort into promoting our products. We have always maintained the quality of our products. Consumers approach us at the doorstep, and place their orders either personally or through the post," said Pushpa Patil, wrapping a liquid jaggery bottle to be sent to a customer by courier. The Patil couple has customers all over the state, even in neighbouring Maharashtra. They proudly say that they have never suffered from a market that does not know or value their produce. On the contrary, people travel 5 km from Athani in Belgaum district to buy the Patils' fruit in bulk.

Value-addition and direct marketing are offshoots of the organic movement in Karnataka. Organic farmers have explored economic ways that lead out of market-related exploitation. Tree-based farming with horticulture crops is one such way, and was common among those who started agriculture after the 1980s. Such farming means lower dependence on labour and good market opportunities. Growers add value to their produce at various stages depending on the crop, whether sun-dried fruit or pickles and jams. When the mix works optimally, farmers get the entire benefit. "Reaching that stage is not easy, for such experiments are always prone to risk," said Shankaranna, a small farmer in Khanapur, Belgaum district. "I shifted to organic farming five years ago, influenced by a civil society organisation. The period of transformation was not easy. Organic farming requires more attention and hard work, but now I am content with agriculture." Having learnt traditional preservation techniques, he is able to offer his produce to consumers throughout the year.

Native paddy and pulses are the major crops in Shankaranna's fields, while vegetables and fruits are grown mainly for home use. Marketing was not easy for him as he avoided selling his produce in the general market which doesn't recognise the value of non-chemical grain. In the long term, his decision paid off and he now has regular customers. "After people started asking for grain flour, I decided to go for this second-level processing. I also sell vegetable seeds to those who want to take up kitchen gardening," he said. On Thursday afternoons he opens a temporary stall at the Gandhi Shanti Pratishthana, in Dharwar.

Weekly organic markets are increasing in number, helping farmers by (1) bringing them closer to consumer needs, which helps them plan their crop, (2) giving them the incentive to raise the value of their produce by processing it, and (3) removing from the equation middlemen who have exploited farmers extensively. There is the additional benefit of networking, wherein farmers exchange their products and produce. B N Nandeesh, a farmer in Shikaripur, sends rare varieties of native paddy grown on his farm to G M Hosamani in Dharwar, 200 km away. Hosamani procures dry grapes from Belgaum, turmeric and kokum from Sirsi, and honey from Ankola for sale at the weekly market. "Such networking helps us display diverse products," he said. "We cannot hold onto our consumers with just one or two items. Procuring from other farmers can be risky as we have to be careful that they are chemical-free and are of good quality. So we usually prefer to buy from certified organic growers or from those whom we know properly."

The bottom line is that non-chemical food is getting greater public attention, although organic certification is costly for small subsistence farmers, which is why some have opted for group certification, which is affordable.

A P Chandrashekhar is a pioneering organic farmer who dared to add value to his produce 25 years ago. "Organic agriculture requires intelligence. We have to understand the intricacies of nature. The first generation that shifted back to organic had a clear understanding of the situation. As marketing produce was always a problem — we have small quantities due to our mixed cropping system — we were compelled to process the produce. Now, the major task is to match demand and supply." It was not an easy job for Chandrashekhar, who lives on his 13-acre farm in Kalalavadi village, 17 km from Mysore. Although the city is nearby, it took time for consumers to accept farmers' products that entered the market without attractive packaging and marketing.

Home-made products are usually of excellent quality, as they are natural and do not include artificial preservatives. The movement has crossed over to the consumer side in Mysore, with the setting up of an outlet for organic produce called Nesara: the shop offers a range of products from grain to fruit and soap powder.

The media has played an important role in strengthening the organic movement in Karnataka. Translation of Masanobu Fukuoka's *One Straw Revolution* by farmer-writer Santosh Koulagi created a new wave and influenced many. A range of events from native seed festivals, mango fairs, paddy field days, and tender coconut expositions have attracted growers and consumers to the concept of healthy food. Bengali Venkatesha, a farmer in Uttara Kannada, refused chemical inputs even at the peak of the Green Revolution. "Classifying farming methods is not important. It is important to be non-chemical and nature-friendly. If we understand nature and work accordingly, we always succeed. Farming should be need-based, and a harmony should be developed between humans, their cattle and the land," said Venkatesha.

Each of these farms is a university for biodiverse agriculture. When farmers have so much to offer, why is it that they are denied participation in agricultural research? It is this realisation that has driven many civil society groups to take steps to dialogue, debate and discuss farmer-led research as well as to initiate well-grounded actions involving research where communities and farmers are involved directly in designing, data-collection and analysis of agricultural research.

Venkatesha added: "Any new technology which is applicable in farmers' fields, helps them get a good yield, and is sustainable is welcome. Agricultural universities should also recognise farmers' expertise and adopt them in their package of practices." As a farmer who has been successfully selling his produce and value-added products, Venkatesha feels that good quality and a proper approach towards the market are what work. His own examples are white kokum (*Garcinia indica*), which has valuable medicinal properties; his wife Ganga extracts fruit essences, mixes them with sugar or jaggery, depending on the demand, and prepares squash; fragrant and pure turmeric powder also has increasing demand. Their steadfast insistence on quality has brought them customers from as far away as Bangalore (400 km away). Venkatesha's coconut plants are also popular. He prepares 200 plants every year and sells them for Rs 20 each. "The prices are fixed to compensate for our work and material costs," said Venkatesha's mother. "Even if demand is more, we do not increase the price. Profit should be reasonable."

Every Saturday, Vankatesha takes his products to a vegetable shop in the nearby town of Sirsi, where the vendor displays his produce separately. Regular customers visit the shop — vegetables, value-added products and fruit each have their own set of customers. Manorama Joshi, another small farmer in Sirsi, also works on her produce. She sun-dries bananas and jackfruit which are inter-crops in her areca plot. She began after learning that there was good demand for dried fruit. These efforts are sustainable, and appeal to farmers when they are initiated by their peers. At times there is a mismatch between demand and supply but, as farmer and consumer get to know one another, the ability to adjust improves. K B Virupakshar, a farmer in Hubli, grows sapota, bananas, mangoes and drumsticks. "In the last few years, I used to sell the produce at home only," he said. "This time, HOPCOMS offered me Rs 15 a kg for sapota. I thought that my produce should not get lost in a market dominated

Rahul Goswami

by chemically-dependent produce. Now my wife and I visit different direct market outlets and sell. We pass on organic awareness wherever we go." He sells his sapota at Rs 20 per kg.

These are the experiences of farmers who have made the transformation to organic successfully. Although there is a great interest in organic farming, the changeover is not easy. Organic awareness has not reached the larger farming fraternity both in rainfed and irrigated lands. For the majority, agriculture still means 'packet seeds, chemical fertiliser and pesticides'. Along with traditional practices, they have lost their self-reliance and are heavily dependent on outside inputs for farming. "Agriculture department officials were the ones who introduced chemical inputs to us," said Hemavva Lamani, a small farmer in Haveri. "Now they ask us to avoid using them. Is it that easy? For each and every crisis, we farmers are blamed. What about agricultural universities, which were established to serve us? We do not understand what they are doing and whom their work benefits."

Hemavva posed a very important question at the Raitateerpu meet. "I lost my chilly crop to an unknown disease after my neighbour started growing gherkins, which required heavy chemicals. I had to change my cropping pattern. Who will reimburse my loss, which was not my fault," she asked. As a farmer jury member of the Raitateerpu programme, Hemavva was curious to know the role of researchers in agriculture and also whether farmers have any say in deciding the priorities adopted by the national agricultural research system.

At Raitateerpu, most farmer jury members were illiterate and small farmers, the majority of whom have had no opportunity to speak at public meetings. Their concerns — such as "will GM crops have a negative impact on honeybees" — gave the discussions a new dimension. For the first time in the country, farmers interacted with scientists on an equal footing to air their doubts and seek answers from the researchers. "It was an opportunity for us to speak for ourselves and our farming community. This has definitely boosted our morale. We realised that the researchers are answerable to us," said Gangamma, another jury member.

The difference in perceptions on both sides was significant, showing clearly the gap between field and lab. In India, publicly-funded research shapes the choices available to farmers, food workers and consumers, and also the environments in which they live and work. There is an increasing need to explore ways of democratising the governance of science and technology — as shown convincingly at Raitateerpu — ensuring that it continues to serve the public good rather than narrow economic interests. These new experiments with deliberative and inclusive processes are a means to broaden citizens' involvement in decisions around science, technology and policymaking. They also consider resource allocation and institutional choices that are important — especially with the increasing impact of climate change — for the governance of food systems and biodiversity in India.

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# Kudrat, Karishma and other living seeds

Prakash Raghuvanshi has developed dozens of high-yielding, disease-resistant, open pollinated seeds, distributing them to 2 million farmers in 14 states. He also trains farmers in the basics of selection and plant breeding at his small farm near Varanasi. His aim is clear: to conserve and protect *desi* (indigenous) seed varieties, thereby freeing the farmer from the stranglehold of foreign seed companies and the cycle of debt and dependence

*ANJALI PATHAK*

PRAKASH SINGH RAGHUVANSHI epitomises the Indian tradition of grassroots research and innovation at the village level. Far more than a dry, mechanistic form of enquiry and a reductionist attitude to nature and farming, it is the approach of listening and learning that has led to Raghuvanshi's success at plant breeding.

Spurred by crop losses and financial setbacks caused by chemically-dependent farming nearly 15 years ago, Raghuvanshi resolved to overcome these difficulties and help out other farmers too. He began developing a living seed bank on 3 acres of land and chose wheat, paddy, arhar and moong seeds for their high yields, disease resistance and ability to adapt to sudden climate changes. His father had begun the process but could not take it to its conclusion. Raghuvanshi continued from the point his father left off, and in the process developed several high-yielding, disease-resistant varieties of paddy, wheat, arhar, moong, peas and vegetables.

Dr Mahatim Singh, former professor at Benaras Hindu University and a former vice-chancellor of Pantnagar Agricultural University, encouraged Raghuvanshi to develop new varieties of seed that would perform well and help small and marginal farmers improve their yields and thereby their incomes. This timely encouragement from an agricultural scientist inspired Raghuvanshi to do his best and come up with good results within a short period of time.

Ever since his work on plant breeding began, Raghuvanshi has been participating in *kisan melas* and meets. He has met several agricultural scientists and they have been amazed by the results he has produced despite lack of modern research facilities, a well-equipped lab, or research grants.

Raghuvanshi's body of work is indeed remarkable: he has developed 80 varieties of wheat, 25 varieties of paddy, 10 varieties of arhar, besides moong, peas, mustard, papaya, ladiesfinger and vegetable varieties. All of their seeds can be saved as they are open pollinated seeds.

Raghuvanshi has named his paddy and wheat varieties Kudrat and Karishma respectively, and they have performed well wherever they have been sown. The chief characteristics of his seed varieties are: they adapt very well to extremes of temperature, rainfall and other aspects of climate change; they are open pollinated and can be saved by the farmer for the next season's crop; they are superior in taste and flavour as they have been selected and developed from traditional varieties; they deliver greater yields while not requiring massive chemical inputs as do high-yielding varieties that have been developed by India's agricultural research system. Cowdung and some irrigation are all that

## Seed varieties and the Beej Dana Mahadana campaign

Raghuvanshi has listed the characteristics of his improved seed varieties:

**Wheat:** The three wheat varieties, Kudrat 5, Kudrat 9 and Kudrat 17, have plant heights of 85-90 cm, 95-100 cm and 90-95 cm respectively; yields per acre are 20-25 quintals, 15-20 quintals and 22-27 quintals respectively.

**Paddy:** The three paddy varieties — Kudrat 1, Kudrat 2 and Lal Basmati — progress through a maturity period of 130-135 days, 115-120 days and 90-100 days respectively, while yields per acre are respectively 25-30 quintals, 20-22 quintals and 15-17 quintals.

**Pigeon pea:** The Kudrat 3, Chamatkar and Karishma varieties possess 500-1,000, 400-600 and 450-650 pods per plant respectively, while yields per acre are 12-15 quintals, 10-12 quintals and 10-12 quintals.

**Mustard:** Kudrat Vandana, Kudrat Gita and Kudrat Soni have bunchy pods, a greater number of seeds per pod, and higher oil content. Their average seed yield per hectare is 1,430 kg, 1,405 kg and 742 kg respectively.

**Moong:** The Kudrat Jan Kalyani variety contains 24% protein; it can be grown by small and marginal farmers and the urban poor to make up the protein gap in their diets.

Recognising the importance of saving indigenous seeds, Raghuvanshi launched his Beej Dana Mahadana campaign nearly a decade ago. Its objectives are:

- Introduce the various Kudrat and Karishma seed varieties to farmers all over India through free distribution of 100-200 gm seed packets.
- Encourage farmers to start their own living seed banks in villages to conserve local seed varieties.
- Teach farmers the basics of plant selection and plant breeding so that they can develop their own varieties to meet future needs.
- Encourage farmers to keep local breeds of cows.
- Inspire and urge farmers to give up chemical farming and convert to organic farming.
- Inculcate pride in farming, and so halt migration to cities.
- Enable small and marginal farmers to harvest improved farm yields and earn higher incomes through cultivation and sale of Kudrat seed varieties.
- Return control of seeds to farmers thereby neutralising foreign seed multinationals, putting an end to farmer suicides, and improving India's food security.
- Improve the health of both rural and urban populations through consumption of cereals, pulses, oilseeds and vegetables produced from indigenous seeds.
- Propagate ancient Vedic practices like *agnihotra* which have a beneficial effect on farming, farm animals and farming households.

The seeds developed by Raghuvanshi are under trial at various agricultural universities and government research stations. They are awaiting patents and are not available commercially. Raghuvanshi sends small seed packets of 100-500 gm free of cost to individual farmers. If planted under good soil conditions, a 100 gm seed packet can produce up to 40 kg of seed in one growing season. This can then be utilised to plant 10-15 acres of land with paddy, in the next season. His address is: Prakash Singh Raghuvanshi, Tadia village, Jakhini post, Varanasi district, Uttar Pradesh.

Kudrat and Karishma need.

The proof of Raghuvanshi's methods is seen in the field. His paddy varieties yield 25-30 quintals per acre and his wheat varieties 18-20 quintals per acre. He has gone on several *beej yatras* distributing his seeds freely and widely — by his own estimate, 2 million farmers in 14 states, over 15 years. Raghuvanshi also trains farmers in the basics of selection and plant breeding at his small 15-acre farm near Varanasi. His aim is clear: to conserve and protect *desi* (indigenous) seed varieties, thereby freeing the farmer from the stranglehold of foreign seed companies and the cycle of debt and dependence.

Raghuvanshi is a practitioner and advocate of organic farming and of protection of indigenous cow breeds. He welcomes farmers and visitors at his farm to observe and learn firsthand.

Raghuvanshi's extraordinary work has been recognised by the National Innovation Foundation (NIF), Ahmedabad. He was given a National Award for Innovation in Agriculture on November 18, 2009, by President Pratibha Patil. The Foundation gave him a grant of Rs 1.9 lakh under the Micro Venture Innovation Fund for nursery development, cultivation and scaling up manufacturing channels for his improved seed varieties. He has also been supported financially by Shri Narayan Saiji, a religious teacher based in Ahmedabad who owns several large farms and has used the improved seeds developed by Raghuvanshi in his farms to produce bountiful harvests. Sri Sri Ravi Shankar, another spiritual teacher based in Bangalore, is also a

Raghuvanshi supporter.

What shaped Raghuvanshi's thinking and approach, and how does he live?

Nationally recognised for being an innovative farmer and plant breeder, Raghuvanshi is 50 years old and lives in a joint family with his mother, wife and six children, and one of his brothers. His family comes from the village of Tadia, 30 km from Varanasi. The land he tills and sows is held jointly by the brothers, and Raghuvanshi uses 3 acres to do his plant breeding work and to preserve his seed varieties in a living seed bank. Another 9-10 acres are given over to growing rice, wheat, pulses, oilseeds and vegetables to meet the family's needs and to grow green fodder for the cows.

Raghuvanshi's greatest advantage perhaps — and his greatest success — is that his three young sons are also farmers in the village and assist him in his plant breeding, advocacy and outreach work. In a time when farmers' children are migrating to cities and do not want to make agriculture their livelihood, Raghuvanshi's sons are an example of what concerted team effort by a farm family can achieve over the years.

Coming from a conservative rural background, Raghuvanshi has stayed away from becoming fully commercial or selling his seed varieties to seed companies. Nevertheless, in order to sustain his Beej Dana Mahadana campaign, and to support his large family, he has felt the need to raise funds. At present, he has verbal agreements with growers in Rajasthan, Gujarat, Maharashtra, Assam and Orissa. The arrangement is simple: Raghuvanshi provides the initial batch of seeds and his partners get them multiplied by various farmers in their respective areas. A rough sale price for the seeds is agreed upon when the crop is harvested, and the partners proceed to sell the seeds to farmers, acknowledging Raghuvanshi as the source of the particular seed variety. Raghuvanshi gets a commission after the sale is over.

Although the arrangement is straightforward, Raghuvanshi has been duped several times by unscrupulous partners in the past who refused to give him his due while profiting from the sale of his seeds. As the patents for his seed varieties are still pending, Raghuvanshi cannot resort to legal action against the defaulters. He relies on support from an NGO and the speedy registration of his seed patents to deal with what amounts to commercial crime. Yet, his true aim is the country's food security. His view is that foreign seed companies like Monsanto — that sell hybrid rice and wheat seeds — are holding farmers to ransom and are undermining India's food security. Wherever Raghuvanshi's seeds have been distributed to farmers, sales of companies like Monsanto have dropped sharply.

A regular at *kisan melas* in northern India, Raghuvanshi has distributed varieties of his wheat seeds to farmers in Varanasi and Allahabad in Uttar Pradesh; Jabalpur, Narsingpur, Khargaon, Indore, Bhopal and Ujjain in Madhya Pradesh; Raipur, Bhilai and Dhamtari in Chhattisgarh; Jalgaon, Yavatmal, Amravati and Pune in Maharashtra; Kota, Bharatpur, Jaipur and Sikar in Rajasthan. He was invited to NIF's informal Research Advisory Committee meeting in May 2006 to interact with fellow innovators, and also participated in the traditional food festival, Saatvik, organised by Sristi-NIF in November 2006, where his seeds evoked a lot of interest. In 2008, Raghuvanshi went to Italy with Vandana Shiva and was granted life membership to the Slow Food Movement.

While aware of the controversy raging around the introduction of Bt brinjal, Raghuvanshi believes the solution lies in showing farmers the superior yields of his improved brinjal variety. He says using neem cake and mustard oil cake as soil conditioners prevents the aggressive attack of pests to which hybrid brinjal varieties are susceptible. Although aware of the importance of millet in the Indian diet, Raghuvanshi's focus has been on paddy, wheat and pulses as he lives in a fertile zone where irrigated farming is the norm.

At the start of his campaign, Raghuvanshi recognised the importance of having strong allies in the struggle to save indigenous seed varieties. He has linked up with various small organisations working at the grassroots level in different parts of India. The Rashtriya Asmita Manch in Mumbai, convened by Ramakrishna Pandey, is one such organisation; Madhavashram in Bhopal, which has done good work at the grassroots level to promote *agnihotra* farming amongst farmers, is another; Yashpal Bansal, a philanthropist based in New Delhi, has extended valuable moral and financial support to Raghuvanshi and has helped make his *beej yatras* a success; Dr B K Sahu of Kota has popularised Kudrat paddy in Rajasthan. These are only a few examples; numerous other individuals and organisations have extended their support to Raghuvanshi, who has also benefited from regular and appreciative media coverage.

Over the years, Raghuvanshi has become proficient at coining slogans to get his message across to farmers: *Apni kheti apni khad, apna beeja apna swad,* and *Beej bachao, desh bachao* are two favourites. During *beej yatras* these are supported by a variety of banners, posters and the distribution of pamphlets.

Raghuvanshi takes a philosophical-spiritual view of his knowledge and work, crediting entirely the traditions of Indian farming for the appeal of his message and success of his campaign. "I am only an observer," is his simple, essential description of what has become a life's work.

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