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Compelling concerns of natural resource management

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India receives 400 mham of water through precipitation. Exploitable water potential is 113 mham, out of which 68 mham is being utilized. Demand for water by 2025 would be 109 mham which more or less matches with the available potential. After that year, scarcity of water would be visible in many parts of the country. Presently, out of the net sown area of 141 mha, about 65.3 mha is irrigated while 75.70 mha is rainfed. About 65% of the farmers depend upon rainfed areas only. There are 95.8 million farming families in India with a population of about 600 million. Food grains production is 55% from the irrigated area and 45% from the rainfed land. With this water situation, what should be our compelling concerns which keep the primary focus on the people and their poverty. Rainfed areas have endemic poverty.

Key words: *In situ* moisture conservation, Rainfall management, Rainwater harvesting, Water development, Water management

LACK of water or water management produces poverty and hence, solving the water or soil moisture problem would take care of the people and also their land, plant and animal resources. In the water situation it should be kept in mind that lack of safe drinking water inflicts 85% of the sickness statistics in the rural areas. Women have to bear the bigger burden as they have to fetch water daily, sometimes from far away.

In view of this scenario, compelling concerns for the rainfed areas are as follows:

- Conserving rainwater where it falls: This should be our first concern. Dry weather' deep ploughing, keeping land under cover of mulches, farming on the contour, and other such cultural practices of conservation should be our first concern. In wind erosion and arid areas, shelter belts across the wind direction conserve soil moisture.
- Contour bunding or terraces without gradient has been the traditional soil conservation practice in the rainfed areas, specially in the Deccan region where it has prevented crop failures.
- Conservation bench terraces involve leveling the lower part of the field, the upper part functioning as the catchment area. It saves crops on a part of the field at least.
- Host of other practices can be listed, but the principle is that practices are to be decided on the basis of local conditions.
- Water harvesting through ponds should be a widespread public sector program. Ponds or small storage structures of water (usually earth embankments of height below 10 m, with earthern or masonry spillway) should be constructed in the rainfed areas.
- Water development should be treated as the infrastructure of rainfed farming and hence a government concern.
- Drip irrigation can double the area benefited from ponds and other available water development works. Though costly, it should be propagated widely, with 75% government subsidy.
- First charge on money available for dry areas should be on water resource development and management. Rainfed Area Water Development Organization (RAWO) is the need of the hour if effective start is to be made in addressing the problems of the rainfed areas of India and other developing countries with similar problems.
- Rainfed areas also include high rainfall areas where the land does not dry up fast enough after the transplanted monsoon crop of rice and hence, winter or *rabi* crop cannot be cultivated. Drainage should be the programme in such areas after careful water balance studies.

Conservation farming systems, organic farming, and other field practices for enhancing agricultural growth rate, conservation capacity, productivity and profitability of rainfed agriculture and other land uses

One major background information to be kept in mind is that the farmer in the rainfed area is poor, assetless and generally old— young

men having migrated to the cities. Women have to bear considerable proportion of work. Hidden hunger and malnutrition are endemic features of these areas. Suggestions that must be exercised under the conditions are:

- Follow a cropping system instead of single crops.
- Sowing a mixture of crops is the traditional way of fighting drought. At least some crops may survive if drought strikes.
- Contingency cropping plans should be ready if the crop is sown early with the first rain and subsequent rains are delayed and the germinated crop dries up.
- Farmers' groups or cooperatives should be formed so as to distribute the risk over a group. Such groups should be helped by the government.
- Liberal subsidies should be provided to the rainfed farmers and farming. Our subsidies are much less than those being given to the farmers in the developed countries.
- As much population should be taken away from farming and given alternative livelihoods in the rural areas themselves as is possible.
- Crop insurance should be made widespread. Present coverage is too little.
- Traditional systems of no debt recoveries in case of crop failure should continue to be practiced.
- Demonstration in the farmers' fields should be taken up in each micro agroclimatic area.
- Tree crops in some rainfed areas might be a better alternative combination with cultivated crops.
- Rainfed area implements for moisture conservation should be propagated.
- "Kisaan cafeterias" may be set up to provide the drought resistant seeds and other farming inputs of rainfed farming, near the village itself.
- Research in rainfed farming and cropping systems should be intensified.

Fodder and grassland development, animal husbandry and village common property resources management (VCPRM)—the mainstay of the small and marginal farmers

Livestock is the mainstay of the 300 million poor people in the villages of the country. People sell milk to raise some cash, often depriving their own children of the needed nutrition. For the landless poor in rural areas, dependence upon the animals is the only source of income beyond daily labour wages, whenever employment is available. A useful scheme has been started by the Government of India, namely, The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in which 100 days of employment in a year for one member of a family is assured.

Despite this scheme, animals and the common property resources of the village (like pasture land and water bodies etc.) provide the main livelihood for the rural poor. The large livestock population puts pressure on the forest land and inhibits coppicing and regeneration of the forest. There is a constant conflict between the Forest Department and the in habitants, the cause of which is often the grazing animals of the villagers. Animals of course provide dung for manuring the cultivated fields and also for producing gas sometimes in the gobar gas plants. Large livestock population is a burden for the conservation and biodiversity protection programmes.

Pasture land suffers from another problem in the villages. Powerful elements in the community encroach upon the common land under pasture head, though it usually carries little grass. It is also the most eroded and degraded land in the village. Common lands are the most neglected, by the people, and also by the government. Whenever land is needed by any one, pasture land is encroached upon.

In Chhattisgarh State for example, 80,000 ha of biofuel plantation of Jatropha was raised by the Forest Department, not on the forestland (a lot of which lies vacant), but on village pasture land where poor men's cattle are supposed to graze. Some Panchayats (village level governments) even assume the right to pass resolution allotting the common village pasture land to outsiders. Similarly, common village tanks are silted up and seldom renovated. Government of India has now come up with a scheme to renovate these tanks at government cost. A scheme for improvement of pasture land is eagerly needed but has not yet come.

Alternate land uses in rainfed areas, conservation horticulture, forestry, agroforestry, and biofuel plantations

Forestland, all belonging to the State Government, extends over 69.5 mha out of the total geographical area of 328.7 mha. Forestry is on the concurrent list in the Indian Constitution, meaning that States as well as the Centre can legislate on the subject. Forests belonged to the village Panchayats. These village institutions of old were elected not formally but informally through a consensus.

This institution was unfortunately destroyed by the British rule. One fine morning in the 19th century all forests were taken over by the government under the Indian Forest Act. Conflict of the State Forest Departments with the rural people started and continues till today.

Forest establishment is well-trained in Dehradun and also in the State institutions and protects the forests of the country with zeal and authority. Grazing rights are restricted. Villagers no longer consider forests as their own. They see timber lots of "their" forest contracted to outsiders and cut for the benefit of furniture of the British in colonial days and rich city folks now. Rights of fuelwood are also restricted, often confined to dead or dying. Villagers then resort to making illegal cut trees so that die and they then get the legal right to cut and use them for their own needs of timber for the roof or fuelwood.

Repeatedly, governments, democratic as they are and dependent upon votes, pass rules giving concessions for the villagers living inside the forest or on the forest

fringe. Since people consider forests as "not their property" and hence to be exploited, forest protection suffers. Forest officials come down heavily upon those caught, make the people-department conflict worse. This has been going on for decades now. Tribal villagers want concessions and continue to live inside the forests. Forest departments, finding them mixed up sometimes with the forest mafia, want them to be ousted and rehabilitated outside the forestland.

Naxalites and Maoists have made forests their home. Village after village in Chhattisgarh state have been uprooted and rehabilitated, often unsatisfactorily from villagers' point of view, on the roadside. They are ever in the crossfire between the government and the lawless elements.

One thing has to be noted. Discipline and organization of the forest departments is well-known and instils fear. This fear does help forest wealth to be kept safe and growing. Departments continue to make efforts to eliminate the conflict described above through various schemes involving people's participation. Joint Forest Management is one of the successful attempts on these lines. The movement was started as an experiment in West Bengal and has now spread across the country. Forest committees of the villagers raise plantations under the guidance of the Department and get entitled to 25% or more of the produce. This has been a success story and offers hope for the future of the forests.

Social forestry schemes were also successful in putting eroded lands in the village under trees. There are provisions that even private land can be put under the forest and the department will help raise the forest on them. But now there are restrictions in harvesting or cutting the forest produce even when raised on private land. Forest Conservation Act of Government of India does not allow any tree to be cut without prior sanction of the Forest Department, which does not often come without hassles. The provision works to inhibit tree plantations on private lands. The legislation needs amendments.

Agroforestry has been promoted by research organizations. Returns from the system in shape of fodder, fuelwood, timber and also cultivated crops, have been encouraging. But the system has not spread widely. People still fear that trees once planted attract legal interference from outside. Alternate land use, much desired for degraded lands, thus get inhibited.

Biofuel plantations, instead of being raised on the pasture lands, should be raised on the forest land which lies without vegetation to a considerable extent.

Horticulture or trees for fruits and nuts on a plantation scale, can only attract the bigger farmers who can wait for the trees to mature and start giving returns. Poor men or small and marginal farmers cannot do that. They would, however, gladly plant fruit trees near their homes for their own consumption or for raising a little cash in the local market. Trees on the crop land boundaries are not considered healthy for agriculture as they inhibit full radiant energy reaching the crops. Horticulture can, therefore, be propagated on a large scale only when subsidies are provided while trees are growing and when collective, cooperative bargaining comes which can produce remunerative prices and counteract against the powerful middle men.

To sum up some compelling concerns could be counted as below:

- Conflicts between the forestry establishment and the villagers need to be resolved.
- Biofuel plantations should better be raised on vacant forestland instead of pasture land which the poor people use for their livelihood based upon the livestock.
- Horticulture needs subsidies as the small farmers do not have the capacity to wait through the gestation period.
- Agroforestry has not yet caught up the way it should. Constraints need to be studied and removed.
- Saline and alkali lands are best put to alternate land use of tree crops after reclamation at least for some period before their productivity returns fully.
- Grasslands and pastures along with a few trees could be promoted when panchayats find ways and means of promoting development of the common property resources of the villages.
- Joint forest management system is a bright spot and should be promoted widely.
- Whatever forests are left, it is mostly due to the strict discipline of the forest department. Nothing should be done to dilute this discipline. It should just be brought into harmony with the people.

Reclamation and development of wastelands, including arid lands, control of desertification, shifting cultivation, ravines, saline, alkali and waterlogged lands, and bare or sparsely vegetated forestland

Wastelands could be described as those lands which suffer from special ills of the soil and land and where productivity has been lost or declined to less than 25%.

Land suffering from various ailments needs to be reclaimed, but not necessarily for agriculture.

Some compelling concerns are listed below:

- There is no ongoing centre sector and state sector programme of land reclamation .
- To produce 360 million tonnes of foodgrains for a population of 1,800 million in the next 25 years or so, India would need to add more than 20 mha to the cultivable land, besides intensifying cultivation on the existing lands.
- Ravine reclamation patterns have been established through pilot projects. Shallow and medium ravines can be restored to cultivation, but irrigation must be provided.
- Saline and alkali lands need different treatments, already proven by the Central Soil Salinity shit Research Institute, Karnal. Saline land will need sub-soil drainage, new technology.
- Waterlogged lands need drainage after water balance studies establish the extent and pattern. Drainage is as important as irrigation. Multiple cropping on the flooded lands of Bihar, West Bengal, Assam and delta areas, is not possible without

drainage practices. These lands can become future granaries of the country as Punjab and Haryana exhaust their potential.

- Uncontrolled irrigation has damaged a lot of land in Punjab and Haryana and needs to be addressed. Widespread use of drip irrigation should be adopted. It is expensive but essential to expand the irrigated area and ward off future shortages of food.
- Preventive steps are needed in most places from good lands getting into the wasteland category.
- Sparsely vegetated forestlands have been neglected. Trained personnel are there along with technology. Massive investment is needed. Unfortunately, forest departments do not get the adequate funds needed.

Bioindustrial watershed management for value addition, employment, income and profitability in rainfed areas

In the first few pages of this paper it was brought out that the farmers were in distress, farming had become profitless, agriculture led to indebtedness which led to farmers' suicides. The way out is grouping the small and marginal farmers and other landless villagers into cooperatives, corporations or companies so that they may get strength of unity to bargain for remunerative marketing.

Still more profits could come if storage (which is wrongly termed as hoarding) is done and careful quantities are released when markets are high and marketing more profitable. Every business does that; and farming has got to become a business venture if profits are sought and it comes out of the centuries of mud and muck of penury. The maximum profits would come if farm produce is processed and the processing industry is owned by the farmers themselves.

While aiming at productivity and profits, ecology must also be protected and improved. The whole system combining protection of environment and ecology within natural units of watersheds, productivity, processing and marketing is called bioindustrial watershed management. Bioindustrial watersheds add industry to agriculture and bring the profits of middle men between the farmer and the consumer to the farmer himself. The industry should be owned by the farmers' themselves through their cooperatives or companies. If an outside entrepreneur is involved the farmers must get at least 40 to 50% of the shares for their group.

Supporting services

Some compelling concerns of supporting services are discussed here with the purpose that research should reach the farmers, training should spread and that there should be a benign policy umbrella and legislation putting into practice the technology available with the support of massive rural investments:

Research and Development

- The phrase, Research & Development is a misnomer. The term as applied to industrial research, does not fit into what soil conservation research has been doing so far. The focus has so far been on problems of soil, water, vegetation and other physical and biological attributes of the natural resources.
- The farmer, who is the agency of development, has not received much research attention to solve his problems. Who is doing research to increase the farming profit while remaining within the bounds of ecology and environment and resource conservation compulsions? When profits evaporate, practices while we have so assiduously developed and advocated, also vanish. So farmers need to be brought into focus of soil conservation research.
- Operational research was a good venture to try research results in field projects. Still better would be to allot some definite extension area to each research institute in the agricultural field, including soil conservation research, so that one could measure how far farmers' lot has improved by adopting new methods.
- Industry has not been added to the field of watershed management research. In other words, bioindustrial watershed research needs to be taken up to see what difference does it makes to the natural resources and its users over a period of around 5 years. A Division of Bioindustrial Watershed Management Research needs to be created if not a separate institute for this subject.
- Under the gaze of all our research Institutes, Punjab and Haryana have been practicing wheat-rice, wheat-rice rotation over years harming the soil resources and causing water problems of both excess (waterlogging and salinity) in some areas as also of lowering of water table in other areas. Field areas in these States need to be taken up for demonstration of alternatives which will also enhance

Impact of climate change on wheat and adaptation strategies

The yield potential of wheat was simulated under future climate scenarios of RCP 2.6, 4.5, 6 and 8.5 for 2020, 2050 and 2080 periods and compared with that of base line (1976–2005) using InfoCrop-wheat model. The results indicated that the climatic potential yield of wheat is projected to reduce in future climates with significant reduction in central India and in eastern parts. A gradual reduction in potential yield is likely in RCP 4.5 and above with maximum reduction in RCP 8.5. This calls for the need for developing heat tolerant varieties of wheat, specifically for central India as top priority. Further, the climate change impact on wheat yield under different management conditions is projected to have spatio-temporal variations for direction and magnitude of impact as well as with enhanced inter-annual variation. Adaptation strategies and adaptation gains were quantified for wheat crop using crop simulation (InfoCrop-wheat) analysis. The analysis indicated that adaptation gains have significant spatial and temporal variation.

Source: DARE-ICAR Annual Report 2018-19

profits.

- Research scientists and engineers should be evaluated for the benefits of their applied research to the farmers and others land users, not by the number of publications and their acceptance by foreign journals.
- Training or the newly coined word "capacity building" is not given the importance it deserves in the user departments. More effective linkages between research and development agencies need to be created.
- Training should be made mandatory for all field functionaries of soil and water conservation and agricultural development technologies.
- Since water development is the crucial factor in rainfed areas, research on the subject should be strengthened by creating a separate Division for it in the research institutes dealing with the subject.
- One area of work directly affecting the poorest of the poor in the rural areas is pastures and animal care. More research is needed on augmentation of fodder resources.
- Similarly research is needed in augmentation of fuel wood resources.
- More publications of popular nature need to be brought out both in English, Hindi and other local languages. Research centers could also prepare feasibility reports for the new projects.

Organization and legislation

- Organization and enabling legislation, is the cutting edge of soil and water conservation. How much research knowledge has affected the action programme in the field? Is there an organization which goes to the farmer, surveys his land, plans for it, gets farmer's approval, and executes the conversation plan and recovers the cost over 10 to 15 years with nominal interest rate? It used to exist, but now it has been weakened or diluted by amalgamation with extension organization, land and the land users have suffered. It is time the system is brought back on the rails.
- Old legislation is absolute. It needs complete overhaul. This field is again long neglected.
- Another area on which every one feels shy of speaking is corruption; some of the State organizations in the last two decades or so has become as notorious in the corruption perception scale as some of the public works organizations in the government. It is time truth is ascertained and vigilance improved.

Evaluation

- Evaluation is a continuous activity whether it is formal or informal. Formal evaluations, financed by the same department whose work is being evaluated, tend to be all praise. Those evaluators who dare to do otherwise, are denied further assignments. What is the remedy? Independent authorities like the audit establishment need to be created. Or evaluation studies should be allotted to far-away agencies which are beyond the influence of the department whose work is being evaluated. Evaluation funds may also be independent. They should not be disbursed by the evaluated departments.
- Reputed individuals' non-formal visit and reports would sometimes tell more truth about the work done than the elaborate formal evaluations.

Non-conventional energy sources

It is a matter of debate whether non-conventional energy development or adoption etc. should fall within the field of soil and water conservation. It is a specialized field and still not within comparable economics with the conventional sources. Fossil fuels should be got rid of as soon as possible for the health of our planet. But specialists in the fields should find the alternatives and not conservationists. Rural areas are entitled to economic sources of power as much as urban areas. No one should cover up neglect of infrastructure in rural areas by implying that rural areas need only non-conventional energy sources. Non-conventional sources are expensive, except in very remote and inaccessible areas.

Policy

A nation is a family. Everyone should have equal standard of living irrespective of what each member earns and gives to the family budget. If this principle is followed, 70% of India's annual budget should go to rural development and agriculture. We are far away form the goal. Minimum that should be done is to invest in water, land and soil conservation, rural electrification and bioindustrial watershed management to bring up the rural areas and the rural people, specially in the rainfed areas sustainable livelihood.

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Drip irrigation technology using brick to mitigate drought in sweet orange

Shri Nayum Patel, Dhawalapuri village, Aurangabad Mandal, Maharashtra, is cultivating sweet orange in rainfed situation. Dry spells of long duration affected his orchard causing loss. Motivated by special campaign to mitigate drought situation by the KVK and other farmers' organizations he decided to make use of the micro irrigation system to save his sweet orange orchard with the limited water resources. To maximize number of trees with minimum available water, he innovated a novel technology of using bricks as a moisture retainer. A hole was made at the centre of the brick and the pressure compensating dripper having discharge rate of 8 litre/h was fixed inserted into the hole. Two bricks were embedded at five to six inch below the soil surface where the active roots are present. The orchard was irrigated for half an hour on alternate days. The bricks acted as water retainers releasing it slowly in the root zone and hence enhancing the water use efficiency. The technology not only saved the crop from intense drought but also fetched an annual income of ₹ 2.40 lakh from 2 acres of orchard under severe drought condition.

Source: DARE-ICAR Annual Report 2018-19