

SUSTAINABLE DEVELOPMENT OF NATURAL RESOURCES THROUGH INDIGENOUS TECHNOLOGIES – A CASE STUDY OF MANCHAL WATERSHED IN RANGAREDDY DISTRICT, ANDHRA PRADESH

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Sustainability in agricultural production depends considerably upon proper development, conservation and use of natural resources at micro-level. It is now widely recognized those many of the available 'exogenous' technologies (emerging from formal research system) for management of above resources is not suitable for small holding situations. Critical evaluation of watershed development programme implemented during last 2-3 decades has shown that in majority of cases (where such technologies have been used with high external funding) the farmers have reverted to their earlier practices after the withdrawal of project support.

Realizing the above situation, a number of formal and informal researchers have started searching indigenous innovations to achieve sustainable development of land and water resources. The present paper is based upon a case study on the above aspect in Manchal watershed which lies in a semi-arid red soil tract of Telengana region having an annual rainfall of about 750 mm. The paper deals with distinguishing features as well as underlying principles behind indigenous innovations. It also analyses the relevance of these technologies and their implication on methodology as well as approach being adopted in the watershed programme.

Description of Indigenous Technologies

At the outset it may be appropriate to mention that indigenous technologies for Natural Resource Management (NRM) have been evolved through an informal research process. This is particularly true with respect to development and utilization of marginal lands, harvesting and utilization of runoff water, method of planting and seeding of new tree species etc. Many of the traditional practices particularly those, which relate to conservation of soil, continue to be relevant even today. Hence the term indigenous technology in the context of NRM includes

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the relevant traditional practices as well as new innovations, initiatives and ideas emerging through informal research system.

In the following paragraphs these technologies have been discussed separately for development of private land resource, common land resource and water resource. While describing these technologies a contrast has been made with exogenous technologies in order to have a better clarity regarding their distinguishing features. For the sake of convenience, the private land resource is divided into 3 parts namely cultivated land, fallow land and the land occupied under drainage course. Common land resource is divided into two types namely those which belong to forest department (where development is to be achieved through joint forest management) and those which are owned by other organizations (as discussed later on) where joint forest management or any other alternate approach can be used to develop perennial vegetation. Likewise water resource is divided into 2 parts namely runoff water and underground water.

Development of Private Land Resource

Cultivated land

The presently available exogenous technologies for cultivated land includes earthen bunds or vegetative barriers on contour / grade to achieve in-situ conservation of land resource. The indigenous technologies for this type of land consists of either stone bunding or earthen bunding with stone waste-weir (on a part of lower boundary of the field). The main purpose of this measure is not only to conserve land resource but also to achieve terracing of fields through natural leveling process (over a period of 10-15 years) by gradually increasing the height of stone bund / waste-weir as silt gets deposited on the lower side.

In red soils of this region no specific effort is made to construct new waterways. The surplus runoff in case of contour / graded bund is diverted into the existing natural water courses whereas in case of indigenous technology it flows from one field to another before joining the natural water courses.

Fallow land

The exogenous technology for fallow land is similar to that of cultivated land. The indigenous technology however varies depending upon the purpose for which the fallow land is proposed to be developed. If the land is to be used as pasture, investment on bunding is not made, as the existing grass cover is considered sufficient to take care of erosion hazard. If the land is to be used for crop production (which is generally the case) the investment is made first on

development of land resource (through removal of bushes and boulders) and then on conservation-cum-natural terracing measures indicated earlier. Fallow land is also developed either for forestry or rainfed horticulture. In such cases investment on land treatment is made for digging of trenches for conservation of moisture or for digging the pits to provide better environment for growth of trees / plants. Investment in fallow land is not made by all fallow land owners but only by those who propose to use the resource for cultivation of crops after its development.

Drainage course

Generally speaking this portion of land is considered to be a liability by outsiders. The exogenous technology in this case is used essentially to prevent its further degradation. The indigenous technology has however been designed to convert this piece of land into a productive asset.

The exogenous technology consists of a series of loose boulder checks throughout the gully course (in which the upper level of a particular structure is kept equal to the lower level of the previous structure in the gully course) so that bed erosion is prevented. The design of indigenous technology however varies depending upon the portion of the gully course where the structure is to be located. In upper portion of the gully course it consists of soil harvesting structures (made up of loose boulders) so that bed area gets gradually filled with soil and becomes a normal part of the main field. In middle and lower portion of the gully courses, the bed area is leveled into small terraces for cultivation of paddy crop.

In red soils of this region, many of the gully courses are having Jal land which suffers from water logging problem on account of lateral movement of water in the root zone due to the underlying hard pan. Innovative farmers carry out terracing in the bed area to use these Jal lands for cultivation of rainfed paddy crop. Some of the gully courses in normal lands are used essentially for safe disposal of runoff water. Farmers think that these courses are unnecessarily occupying a considerable area under the earthen walls on both the sides. Loss of this area is particularly felt by those farmers who have developed their adjoining fields for irrigated agriculture. Such farmers have preferred to replace the existing earthen side walls with masonry walls so that the area could be saved for productive purpose. For such structures farmers have willingly come forward to pay higher contribution (20 percent) than what is expected as per the present guidelines (5 percent).

Development of common land resource

Common land in a village may belong to any of the following organizations namely revenue department, forest department, village Panchayat, religious organizations etc. Under the present case study, almost all the common land belonged to forest department. The exogenous technology for development of perennial vegetation in the above land deals with plantation of new species whereas indigenous technology deals with natural regeneration of existing plant species. Social fencing is a common approach in both cases for protection against biotic interference. Under the project only a part of the area is to be developed each year on rotational basis so that social fencing could be facilitated conveniently.

The exogenous technology is based upon the concept of joint forest management which broadly includes choice of new plant species as per the preference of users; conservation of moisture through suitable land treatment (including staggered contour trenches); sharing of usufruct rights jointly by the community, forest department and forest protection committee; implementation of works through forest protection committee etc. The indigenous technology of natural regeneration requires essentially removal of unwanted shrubs; and singling of useful plants so that they could grow in a desired manner. This approach is adopted mainly in those fields where sufficient root stock of useful plants is existing.

Development of water resource

Harvesting of runoff water

In red soils of this region runoff is presently harvested for recharge of underground water resource so that wells could remain functional for a longer period. The exogenous technologies for this purpose consist of two types of measures namely cement gully checks and earthen percolation tanks. These measures are undoubtedly useful for increasing water table in the existing wells.

In this region irrigation tanks have been traditionally constructed (which can be observed in practically all villages) for cultivation of paddy crop through gravity flow. Additional construction of cement gully checks or percolation tanks indicated above often runs into conflict with the traditional irrigation tank system in the same village (as it reduces the flow of water in the existing tanks).

Recently innovative farmers have evolved an alternative measure to improve the recharge of their underground water resource. This measure consists of conversion of existing irrigation tank into percolation tank which leads to a significant

increase in the overall area under irrigation through better recharge of wells besides substantial increase in the production of fish from increased standing water in the bed area.

Farmers of this region have also evolved individual oriented water harvesting structures in the drainage course for providing supplemental irrigation. As discussed earlier, the gully bed area in jal land is terraced for cultivation of rainfed paddy crop. The sustainability in productivity of this crop is achieved through supplemental irrigation from the following two types of water harvesting structures within the gully course.

Seepage pond (generally constructed in the middle portion of the length of gully course) for providing required moisture to paddy crop in the lower field through sub-surface seepage Dug out pond (generally constructed in the lower portion of gully course which gets filled through sub-surface seepage from upper fields) for providing supplemental irrigation through manual lifting From some gullies the runoff water is diverted through low cost diversion structures for providing supplemental irrigation to the adjoining fields.

Exploitation of under ground water resource

In the red soils of Telengana region under ground water resource has traditionally been use through open wells. At present it is being used through deep bore wells. Since last 3-4 decades the underground water resource is getting over exploited resulting into heavy reduction in the water table. Due to this open wells as well as shallow bore wells are becoming non-functional where ever intensity of deep bore wells is increasing. This is resulting into lesser number of families using the underground water resource as compared to the earlier days when open wells used to be functional.

Under the watershed programme a high priority is being given to recharge the under ground water resource through various measures discussed earlier. It will be useful to see whether these efforts would lead to recharge of even open wells and promote equity in ownership of under ground resource by larger number of families.

TABLE – I : Description of exogenous and indigenous technologies for Development of land and water resources in red soil of Telengana Region

Sl. N.	Type of resource	Description of technologies	
		Exogenous	Indigenous
A	Private Land Resource		
	- Cultivated land	- Earthen bund or vegetative barrier on contour/grade	- Stone bund on a part of the lower field boundary - Earthen bund with stone waste weir on the lower field boundary
	- Fallow land	- Earthen bund or vegetative barrier as indicated above	- Removal of bushes / boulders - Stone bunding or earthen bunding with stone waste weir as indicated above
	- Drainage course	- Series of loose boulder checks	- Soil harvesting structures in the upper part of gully - Terracing of gully bed for cultivation of paddy - Replacement of earthen side walls with masonry walls in the lower part of the gully course
B.	Common Land Resource		
	- Forest department land	- Plantation of new plant species through joint forest management	- Natural regeneration of existing plant species
	- Revenue dept./ Panchayat	- Plantation of new plant species through joint forest management	- Natural regeneration of existing plant species
C	Water Resource		
	- Runoff water	- Cement gully check - Percolation tank	- Conversion of existing irrigation tank into percolation tank - Construction of diversion drains in the gully course for supplemental irrigation in adjoining fields - Construction of individual oriented water harvesting structures in gully courses having jal land - Repair of breached tank - Desilting in functional tank
	- Under ground water	- Bore well	- Open well

Underlying Principles Behind Indigenous Technologies

Field studies have clearly brought out that indigenous technologies are based upon different principles, which are specifically relevant to small holding situations. Some of these principles are discussed below to illustrate the point.

Enhancement of Productivity Besides Conservation of Land Resource

This is perhaps the most crucial distinguishing feature of indigenous technologies for management of land resource. The presently available exogenous technologies focus more on in-situ conservation of land resource with a view to achieve long term sustainability in production. The indigenous technologies on the other hand, focus on short term as well as long term increase in productivity. Because of this reason the motivation among farmers to adopt these technologies is relatively higher.

Smaller size of group action for conservation of land resource

Group action is a pre-requisite for implementation of soil conservation measures. The facilitation process for meeting this requirement becomes more difficult as the size of group action increases. The exogenous technology of contour / graded bunding requires a large size of group action among participating farmers before its implementation could start. On the other hand the boundary based soil conservation measures require a smaller size of group action between only the adjoining farmers. In low rainfall areas soil conservation measures can be implemented even on individual basis. Because of this it becomes easier not only to implement the measures but also to carry out subsequent maintenance.

Creation of micro-environments in gully courses

Indigenous technologies are based upon the concept of concentration of land resource (at appropriate place) rather than in-situ conservation of this resource at its original place. Soil harvesting structures as well as terracing of bed area in the gully course creates new pieces of field for cultivation of agricultural crop. The micro-environments created in the gully course (particularly in jal land) may have small but significant contribution towards sustainability of overall production over the vagaries of seasonal rainfall.

Relevance of Indigenous Technologies in the Present Context

By and large the traditional technologies for development and conservation of land resource are found to be highly relevant particularly for small holding

farmers. This is evident due to the fact that these measures are being implemented and maintained by farmers at their own cost. The percentage of their adoption is however limited; and the reasons for non-adoption vary from farmer to farmer. Lack of technological knowledge is not the main reason for non-adoption of soil conservation measures. Other reasons like limitation of finance, shortage of labour availability, lack of proper demarcation of field boundary, difficulty in facilitation of group action among neighbouring farmers, low motivation towards long term measures, low priority to rainfed agriculture etc. are major reasons which are adversely affecting the adoption of these technologies.

Likewise for harvesting of runoff water the indigenous technologies are found to be suitable but they are gradually becoming non-functional due to lack of proper maintenance. The existing operational arrangement has become non-functional after the responsibility for maintenance was taken over by the state. Although currently large investments are being made on construction of new types of water harvesting structures but adequate investment is not made either for construction of indigenous structures or for facilitating the maintenance of such structures.

Construction as well as maintenance of water harvesting structures requires regular group action among its users. Lack of group action becomes an important reason behind non-sustainability of both new as well as old structures. In the present watershed farmers have shown keen interest towards repair and maintenance of non-functional structures and also converting the existing irrigation tank into percolation tank. However lack of finance and inability to facilitate group action are found to be the main constraints in adoption of these technologies / measures.

IMPLICATIONS OF INDIGENOUS TECHNOLOGIES ON THE FUTURE WATERSHED PROGRAMME

New Roles for Outsiders

There are three types of major functions to be performed by outsiders for promoting proper development, conservation and use of natural resources. These include technical support, financial support and social facilitation (for group action, conflict resolution and equity). Until now outsiders have given major emphasis on providing technical support to the programme followed by financial support. Very little attention is paid to facilitate social action in the context of particular measure / structure to be constructed.

In view of the fact that in future indigenous technologies are likely to be promoted under watershed programme, the present role being played by outsiders may have to be re-examined. The case study has indicated that role of outsiders is likely to vary depending upon the type of measures to be adopted (table-2). In case of soil conservation measures the outsider may have a small role to play for providing technical support as well as social facilitation (if boundary based soil conservation measures are to be adopted). The role of providing financial support is relatively more important than the above two roles, yet it is of a medium level in itself (as compared to the high level of financial support being currently provided under the watershed programme).

In case of water harvesting structures, the technical support is expected to be of medium level (as compared to the current high level of support) because innovative farmers are also able to make important suggestions towards overall design and location of the structures. The financial support however needs to be continued at higher level (for community oriented structures). A striking change is needed in providing high level of support for social facilitation not only for planning and implementation but also for subsequent maintenance of the structures.

For natural regeneration of tree component in the common land, requirement of technical and financial input is of low level. However requirement of social input is of high level in order to facilitate social fencing as well as equitable sharing of usufruct in favour of resource poor families.

Thrust on replication of successful experiences

Watershed development programme is being implemented since last 3-4 decades in various parts of the country. Majority of the watersheds is funded by Govt. while some are funded by non government organizations. Besides this, individual watershed components are also being implemented by farming community without any external funding.

It may be appropriate to identify successful examples of watershed development within a particular region and put major thrust on replicating these examples rather than focusing the attention on new and unverified technological options for trial / demonstration. While replicating these successful examples required attention may be paid to the technical content, social context and participatory process with reference to the successful cases. A special attention may be paid to replicate community led success stories as these are likely to provide more sustainable results.

Investment of Public Funds on Indigenous Technologies

At present public funds are used mainly for exogenous technologies. The indigenous technologies are rarely funded even if lack of finance has been the major constraint in their adoption. In view of successful experience in favour of indigenous technologies, it would be appropriate to enhance investment of public funds on such technologies through appropriate policy and administrative decision.

TABLE – 2 : Role of outsiders for Development of Natural Resources through indigenous technologies

S.No.	Type of measures	Requirement of External Support		
		Technical	Financial	Social Facilitation
1	Soil conservation measures	Low	Medium	Low
2	Water harvesting structures	Medium	High	High
3	Natural regeneration of trees in common land	Low	Low	High

Attention Towards Repair and Maintenance of Water Harvesting Structures

For development of water resource at micro level, the current emphasis is only on construction of new water harvesting structures (using exogenous technological design). However repair and maintenance of existing indigenous water harvesting structures is hardly carried out under the ongoing watershed programme. Emphasis on this aspect would require not only financial assistance from outside but also a high level of facilitation for social action (related to group action and conflict resolution) among the concerned user group members. It may however be kept in view that external role for this purpose may be played in such a manner that it leads to sustainable results. Organization of a proper institution base at the village level and working out proper modality for contribution by users towards future maintenance of structures may be considered as a pre requisite to any external investment on water harvesting.

Flexibility in Sequence of Implementation

Ridge to valley is considered as a standard scientific approach for deciding the sequence regarding implementation of various measures. The rationale behind this approach is clear and sound. On the other hand it is also recognized that participation of people into the programme does not follow the sequence mentioned above. People take their own time to get motivated for implementation of works even for items which are highly relevant for them. Other compulsions and priorities are as crucial as the relevance of an intervention.

In view of this, appropriate flexibility may be introduced in the implementation of the programme. The experience with indigenous technologies (namely boundary based soil conservation measures, small size water harvesting structure in gully course etc.) has clearly revealed that such options can be implemented in a scattered manner throughout the watershed area (as and when the people get ready to participate) without rigidly following the ridge to valley concept. Such a flexibility would help in better participation of people.

Possibility of Improving the Financial Management Under Watershed Programme

At present watershed programme is highly subsidized through external funding. This is justified because it is a community oriented activity and also it has long term effects on sustainability of production. The above assumptions are true only when the programme is based on exogenous technologies. The indigenous technologies on the other hand leads to short term as well as long term increase in productivity and can be implemented on individual farmer or small group basis. This opens up a distinct possibility of improving the financial management in the watershed programme. To begin with the following four specific steps may be considered on experimental basis:

Higher Rate of Contribution from Farmers

At present watershed development measures are being implemented with very low or no contribution from farmers. This is one single factor, which is becoming a barrier in genuine participation of people in the programme. There are a number of examples in the NGO sector where farmers have gladly paid upto 50 percent contribution for watershed works provided they had a final say in the choice of technologies and manner of their implementation. Contrary to the common assumption contributory approach becomes a means of their empowerment rather than imposing a hardship on them.

Many of us have a fear that the programme would not be implemented at a faster rate if contribution rate is increased. While this may be true as long as there is a restriction on choice of technology. There are numerous community led successful examples where natural resources have been developed without any financial support from outside. If the focus is shifted towards replication of such technologies, there would be no difficulty in asking higher contribution from farmers.

Fixing Ceiling on Allocation of Funds for each Family

The exogenous technology requires a compact area approach with an assumption that the entire area falling within the watershed must be treated. This results in a heavy inequitable investment in favour of resource rich farmers as they own most of land as well as water resources. The above approach is not a requirement if indigenous technologies are used (as discussed earlier). For the sake of equity it may be advisable to fix a maximum ceiling regarding investment for each family particularly for those who possess large holdings, so that higher percentage of funds could be diverted for resource poor families.

Incremental Rate of Contribution from Resource Rich Families

In view of the fact that entire area within a watershed need not necessarily be treated under the project it may be appropriate to introduce the concept of incremental rate of contribution for those farmers where total investment is likely to exceed the ceiling amount. The higher rate of contribution may not become very discouraging for those farmers who propose to use the land and water resources for productive purpose after its development.

Linkage with Credit Institutions for Implementing Bankable Technologies

It is well recognized that many of the technologies in the community led success stories are cost effective even in the short run. These technologies are currently being used by a small percentage of families who have either better financial resource (to hire external labour) or who have availability of their own family labour (during lean periods). It would be worthwhile to link credit institutions with other farmers who are not falling within the above two categories and whose lands are not getting covered due to ceiling amount under the project.

Modification in the methodology for preparation and approval of technical plan

Under participatory approach preparation of detailed action plan is essential before funds are released to the community for its implementation. Conventionally the technical plans are prepared by junior level subject matter specialists and presented before the village community for their reaction. Afterwards these plans are sent to senior technical experts and administrators for final approval. There is a need to make major change in the above methodology if indigenous technologies are to receive due attention in the watershed programme.

Needless to mention that farmers have better understanding of indigenous technologies (for natural resource management) than the junior level subject matter specialists. Hence, the role of outside facilitators may be to arrange exposure visits of watershed community members to the successful examples (irrespective of their source of innovation) and then leave the decision about choice of technology / intervention to the concerned participants. For this purpose an open ended 'application form' may be designed and made available (on nominal cost basis) to each member or user group in the watershed village. Subsequently the role of watershed management committee and outside facilitators may be to collect and consolidate above proposals. The technical approval of consolidated action plan may be carried out at the village level in 2-3 rounds of the open meetings of the watershed association members. However, the financial and administrative approval of the action plan may be provided by the concerned institution who is funding the project.

Need to Discourage Digging of Private Deep Borewells

As discussed earlier the open wells are gradually becoming non-functional in villages where intensity of deep bore wells is increasing. On the other hand there is enough evidence that open well system could be revived if construction of new percolation structures is carried out nearer to the open wells in the watershed area. Ultimate functioning and effectiveness of these recharged wells would however be vitiated if deep bore wells are existing or dug in a nearby area. It is therefore essential to critically examine whether public sector support is justified in either digging of bore wells or construction of percolation structures nearer to bore wells without working out modality for equitable sharing of additional water resource developed through new percolation structures.

At this stage it may be worthwhile to raise a basic question, whether the private deep bore well system is sustainable and equitable. In case digging of bore wells seems to be inevitable under some situation, should these wells belong to individuals or to a group of members whose fields are located within its jurisdiction. Whether deep bore wells should be operated in all seasons and during all years or only in rainy season and during high rainfall years so that they do not unduly suck the water from nearby open wells. Could the concept of rationing of bore well water per family be worked out so that equitable use of the new resource can be facilitated even in situations where private deep bore wells are existing.