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SUBJECT I

WATERSHED DEVELOPMENT

Integrated Watershed Development in India: Some Problems and Perspectives*

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THE SETTING

Integrated watershed development is a process by which land and water resources are conserved *in situ*, for intensive use and management through a holistic perspective of agricultural systems. There are two types of watersheds, *viz.*, irrigated wet farming and dryland farming systems. During the past four decades of agricultural development, the research and extension efforts have focused on the former irrigated agriculture through projects such as intensive cultivation schemes, Intensive Agricultural District Programme (IADP), Intensive Agricultural Areas Programme (IAAP), Command Area Development Authority (CADA), and Special Food Production Programme; and the case of the latter drylands, which account for about 70 per cent of cultivated area (1984-85), has virtually been bypassed in planned development.

The acute food scarcity and the urgent need for achieving food self-sufficiency in the shortest possible time had rendered the policy interventions to favour investment in irrigated agriculture. The seed-fertiliser revolution of the sixties and the seventies had been biased towards irrigation and the green revolution (Abbie *et al.*, 1982; Ascher and Heaty, 1990; Brown *et al.*, 1990; Byres, 1982; Mayer, 1984), as it was known, had widened the development gap between wet and dryland agriculture. Furthermore, immediate distributional impact of the green revolution, a much debated theme, has been inequitable within irrigated agriculture, due to differential access to technology and resources and between resource rich and resource poor farmers. The most striking paradox seems that in the process of analysing the 'class' inequity, the widening spatial imbalance between irrigated and dryland agriculture had been less noted and analysed until the seventies when serious issues of regional development surfaced and by that time food self-sufficiency was achievable on a sustained basis. One might argue that programmes such as Drought-Prone Area Programme (DPAP) did underscore the concern about drought-prone and dryland areas since the Fourth Five Year Plan; but they were targeted for a narrow base of clientele and coverage, nevertheless. In the Sixth and Seventh Plans, explicit emphasis was laid for dryland agriculture and the need for orienting R & D efforts towards dryland farming was succinctly brought out. Currently, the emphasis is on development of dryland agriculture as a source of generating additional employment and income opportunities for those farmers who account for 70 per cent of the farming population.

* Keynote paper.

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There have been development interventions, albeit disjoint and incomplete, through wastelands development, soil and/or water conservation, reclamation of problem soils, dry farming and backward area development projects, besides emergency programmes of drought relief and environmental protection. Against all these programmes the common thread of criticism is that the results have been partial and incomplete with less gain through assets creation for long run growth and poor reach down to the targeted groups. Further, dryland farming suffers from heavy incidence of risks of all kinds and around 40 per cent of the population is subject to sustained poverty and which creates problems of insufficient aggregate demand for food amidst a plenty of about 15 million tonnes of food surplus during the eighties. Incidentally, this has dampened the enthusiasm of irrigator farmers as well as evidenced in cost minimisation instead of output maximisation behaviour in response to increasing cost and depressed prices. Earlier, the Draft Eighth Five Year Plan, in its overall approach for agricultural development, gave importance to dryland development with greater emphasis on watershed management. Since the wet watersheds are covered already by CADA and other intensive production programmes (Jayaraman, 1983), dryland development should be handled by specialised agency, such as Integrated Watershed Development Authority (IWDA) which should programme for dryland development. It should have adequate power to decide on plans and investment at watershed level. The present paper will focus on issues related to watersheds and their development and also implementation strategies. Relevant organisational problems will be examined and options identified.

II

ISSUES

The basic premise for watershed intervention strategy is that dryland farming is much handicapped due to seasonal fluctuations and unstable income, and also the Government's neglect due to their low order of prioritisation; and that this bypassed sector needs specific thrust to alleviate the most inequitable situation obtaining at present and abject poverty concentrated in this section. The issues arising out of this premise can be grouped depending upon the nature of constraints for implementing watershed development programmes as technical, organisational and socio-economic.

Technical issues are related to the basic question: are there technologies in general and techniques in particular available for optimising resource use at watershed level? There is a whole gamut of questions as to choice of crops, livestock and other activities with variety and breed specific information; as to optimal levels and methods of fertiliser use; and on methods of irrigation. Requirements of sustainable agriculture and appropriate technology are carefully evaluated (Ascher and Heaty, 1990). There are some recommendations propounded by research and extension agencies which are too general to be adopted at watershed level. This warrants for site specific research such as on-farm research and a multi-disciplinary perception of issues by research and development agencies.

Dryland farming has different sets of problems, such as uncertain rainfall, availability of extremely short period for land preparation and seeding and high physiological stress on crop due to unfavourable distribution of rains during growth and maturation stages. Research in farming in black soils seems to have generated better information to offer than that of red soils, mainly because of inherent soil characteristics. Technical information currently available is inadequate and inappropriate to site specific problems, particularly under

unfavourable conditions of farming. Second, organisational issues are related to contingencies arising out of seasonal conditions. How land preparation could be organised immediately after rains through mechanised tillage with least loss of soil moisture; how seeding and fertilisation are arranged through timely acquisition and use; how rain water is used through management of run-off and how inundation and erosion are controlled, are some of the issues one should address in order to find efficient modes of transfer of technology and adoption. Third, about socio-economic issues which focus on conditions of farmers of dryland agriculture, their ability and skills to manage and bear risks in production; access to resources and information for maximum efficiency - allocative and income.

III

DIMENSIONS OF NATURAL RESOURCES ENDOWMENT

Land and water resource level, intensity of their use and its impact on income and employment vary among the zones. Zones are mega agro-climatic units extending often beyond state boundaries (Basu and Rajagopalan, 1989, 1990). To analyse the factors underlying such inter-regional variations, certain indicators such as *(i)* land-man ratio, *(ii)* net sown area (NSA), *(iii)* gross area sown irrigated (PGI) and *(iv)* poverty ratio are developed from the zonal profiles.

For all zones together land-man ratio is 0.47; and zones which have land-man ratio >1 are Northern Himalayan belt, Rajasthan arid west and Islands region of the Andamans. Environmental factors influence human settlements and low population intensity with varying quality of lands, *viz.*, with high mountains, arid deserts and dense forests, have accounted for high land-man ratio. Zones with lower ratio (< 0.4) are the zones of Gangetic Plains and East and West Coast Plains of the Peninsular India. They are the most populous regions. Poverty ratio for these zones is also around 40 per cent, except the case of regions of Trans-Gangetic and West Coast Plains, both enjoying high marketable surplus and high income through exports; and the other six zones have high population base with relatively larger land resource base which make the land-man ratio moderately high. Among them the Eastern Himalayan region has moderate population base whereas the other three zones, *viz.*, the East, Central and Western Plateau and Hills have under-developed water and land resources; and the Southern Plateau and Hills have land development as prime problem and the Gujarat Plains does have soil and water problems to be tackled.

Net sown area (NSA) which reflects the capacity of land and water to support population in general and agricultural households in particular, is a measure expressed as per cent to the total reported area and also NSA per capita. The overall average of the share of NSA for the country is 47.7 per cent and the per capita average of NSA is 0.223 ha. NSA share has been very low (< 20 per cent) in zones in the West and East Himalayan ranges and in the Islands region. They are dominated by forests. The same is the case for the Eastern Plateau. NSA share is very high (> 50 per cent) in the Gangetic Plains and the East Coast Plains and Hills and it is moderate (21-50 per cent) in the East, Central, Southern Plateaus and Hills; and the West Coast Plains and Western Dry regions whereas per capita NSA is moderate. Furthermore, percentage of GSA irrigated (PGI) is another measure of inter-zonal variations. High PGI (more than 40 per cent) is noted in the Gangetic Plains and the East Coastal deltas and interestingly, excepting the Trans-Gangetic Plains, they belong to high

and moderate levels of poverty. The low PGI (< 20 per cent) is noted in the Central and Western Plateau and Hills besides the East and West Coast Plains and the Western Dry region with high poverty ratio.

In sum, the land-man ratio, per cent of gross area irrigated and poverty incidence suggest that *(a)* special emphasis must be given for reclamation of land in the Middle and Upper Gangetic regions; and land and water resources development in the Eastern, Central and Western Plateau and Hills regions, *(b)* water use efficiency must receive priority in the Lower, Middle and Upper Gangetic regions and the East Coast Plains and Hills and *(c)* additional area must be brought under the plough in the Western and Eastern Himalayan zones by reducing shifting cultivation. The potential watershed areas are predominantly in the East, Central, West and Southern Plateau and the Gujarat Plains where the major strategies for consideration are integrated watershed development (IWD), land reclamation for improving saline, alkaline and acid soils, and augmentation and stabilisation of water resources. They are discussed below.

IV

WATERSHEDS

Use of land and water resources optimally would require identification of spatial units *viz.*, watersheds, delineated on the basis of lay of land, rainfall-quantity and distribution, and natural course of irrigation flows. The concept of watershed therefore covers not only the nature of endowment of land and water resources but also their use. Functionally, they refer to a situation where water is scarce and therefore, needs to be conserved and distributed for cultivation of crops, even though the concept does not preclude problem situations of high rainfall followed by floods, erosion of soils in catchment, silting of reservoirs and inefficient irrigation system down below. In watershed management in drylands there are two distinct phases: first is related to investment in and development of land and water resources, which is influenced by technical and engineering treatments. Land shaping, bunding, vegetative checks and soil corrections besides arresting of run-off are some action points for which investment of fairly long-term vintage is necessary. Assumptions on rainfall and run-off tend to be tenuous against which provisions are necessary to arrive at realistic cost-benefit ratios with partially subsidised investment, and without it. The range of options is extremely limited.

Second, management of watershed at an efficient level and on a sustainable basis. This would involve a review of resource availability, technical and managerial skills required for, scope for optimal use of resources, keeping environmental and inter-generational equity very much in view (Byres, 1982; Dasgupta and Maler, 1990). Then, decisions are taken on farm budgets at farm level and resources use plan for watershed, an interface issue which needs harmonisation of goals at different hierarchies. Further, this would involve co-ordination and integration of economic activities, technology, resources and skills across departments and disciplines. For this, participation by resident farmers can not be taken for granted but they have to be motivated, their co-operation enlisted through a well conceived persuasive educational approach. The two phases of watershed development involve integrated efforts by all development and administrative agencies in a continuous, interactive and iterative fashion such that most of the decisions are through learning by doing. This

becomes necessary as information available currently has to be sensitised to ground facts in order to build a response nexus between users and agencies. Planning at watershed level is by discussions and consensus and therefore it is iterative and indicative for making decisions by individual farmer participant (Patil, 1987). The concept of commons (Blaikie *et al.*, 1985) is relevant here and a set of tasks and the required rules are drawn with pragmatic understanding of issues involved in the management of watershed and is adopted. This is a sufficient condition for the stability in organisation and for growth.

Given this backdrop of integrated watershed management, the programme for the Eighth Plan and after may perhaps be reviewed. It may be necessary to examine the potential for watershed development, identification and location of watersheds among the identified regions. The materials which will be presented are drawn heavily from the works at the Agro-Climatic Regional Planning Unit of the Planning Commission functioning at Ahmedabad. The responsibility for accuracy and interpretation of the data presented is solely of the present author. The data are chosen and used to highlight issues and problems of watershed development in the country. By the very nature of the problems, they are location specific and therefore comments and suggestions made in the course of discussions should be taken as indicative at best.

V

INTEGRATED WATERSHED DEVELOPMENT (IWD)

Earlier, the case for intensive development of land and water and their uses has been established and particularly as in the Eastern, Central, Southern and Western Plateaus and Hills, and Gujarat Plains where the felt need for development exists but would require different location specific approach. The regions have relatively sparse population, and high rainfall but its distribution is rather unimodal and where rainfall is around 700-1,000 mm it is well distributed. Two critical issues are: *(a)* heavy and intensive rainfall and surface run-off leading to soil erosion and sedimentation below; ravines and gulleys are strewn across the regions; *(b)* severe drought in summer with acute scarcity of water with declining water table; and loss of crop productivity due to inadequate water for major and minor crops; and *(c)* the need is for soil and water conservation.

The watershed development for land and water management is relevant here.

The IWD is a system combining erosion and run-off and controlling land management (*i.e.*, through vegetative cover, bunds, check dams and small percolation tanks) with irrigation wells for lifting groundwater on a sustainable basis such that the amount of water withdrawn is less than or equal to the annual recharge of groundwater. This system is an extension of the idea of water harvesting by which run-off water is collected in small ponds directly for gravity irrigation. By the very nature of tasks to be carried out, IWD is organisationally multi-disciplinary and multi-agency and functionally participatory with active involvement of farmers of the watershed. Generally, a watershed covers about 2,000 to 3,000 hectares in extent and a micro or mini-watershed can be around 1,000 hectares. The key for success of IWD is participation: participatory planning and implementation by all, official and non-official agencies. The impact of IWD can be seen in improvement in resource

productivity, increase in employment, better crops and crop system which ensure continuous sales and regular cash flow, additional area under sustained irrigation and cropping, and reduced production risks.

VI

LOCATION OF WATERSHEDS

Earlier in an exercise to delineate agro-climatic zones in functionally meaningful agglomerations, eight typologies were defined with reference to net sown area (NSA), land productivity and availability of groundwater for development (Basu and Rajagopalan, 1990). Based on these typologies, 28 watersheds are identified on the basis of rainfall, land available for cultivation and land productivity in juxtaposition with poverty ratio and irrigated area and 22 watershed regions are identified as potential areas for priority investment for dryland development. Approximately, 34 per cent of total reporting area of the country, 27 per cent of the population and 37.1 per cent of net area sown are accounted by the specified watershed regions. They are presented in Appendix Table 1.

One might note the high incidence of poverty which tend to decline as the share of rural population decreases. Land available for cultivation which is a sum of culturable wastes and fallow lands remains fairly high, indicating the potential for treatment and development of lands. The latter categories can be included and discussed under irrigation commands where management focus is on efficient storage and distribution of irrigation water from reservoirs to farmers' fields. Among water scare regions, some have shown extreme arid condition with annual rainfall being less than 600 mm in 40-60 days which are too low to take up arable farming with annual crops, even jowar and bajra.

The bulk of the regions are in medium (600-1600 mm) rainfall regime where conservation *in situ* and/or in percolation and system tanks is a significant problem. One may note from the analysis that watershed development needs different strategies to solve location specific problems. Furthermore, these are the regions where per capita or per hectare investment in agriculture is low because they are economically poor, struggling around the vicious cycle of under-development. It seems that a strong logic, in terms of spatial equity, exists in support of development of these regions. They are not benefited by irrigation development through investments in massive reservoirs which could have brought prosperity to their commands. The rainfed area of about 70 per cent of NSA suffers from neglect and poverty. Considering this vital issue of spatial equity and the compulsions to promote living standards of farmers of these regions, investment in watershed management is an appropriate development intervention which warrants top priority.

VII

INTEGRATED WATERSHED DEVELOPMENT AUTHORITY (IWDA)

IWDA requires, stepwise, *(i)* delineation of micro and macro watersheds, *(ii)* survey of land and soil resources for assessing quantitative and qualitative attributes in detail in order to estimate potentials, *(iii)* identification of systems components such as crops, animal husbandry, horticulture, forestry and pasture development, *(iv)* identification of components/technologies for production such as varieties/breeds, inputs and services and evaluating them, *(v)* evaluation of production modes and linkages with development agencies for transfer of technology, *(vi)* formulation of IWD strategies and plan of action, *(vii)* ordering

the sequence of development and the related investment, *(viii)* monitoring and evaluation, and *(ix)* appraisal and review.

Institutional support has to be built to service the needs of IWD. The components of IWD are listed as:

(a) Land Development
- * Leveling and terracing
- * Improving soil quality and productivity
- * Watershed reclamation

(b) Water Development
- * *in situ* water harvesting and conservation
- * Percolation ponds, open wells, tanks and small reservoirs
- * Improving water quality
- * Conjunctive uses of water of different sources

(c) Activities
- * Farming systems
- * Crop mix of high productivity and high value crops
- * Horticulture
- * Forests for timber, fuel, pulp and minor products
- * Social and agro-forestry
- * Dairy and
- * Poultry

(d) involves contemporaneous decision and at different hierarchies. At watershed level, the kind of decision will be on
- * Aggregate indicative planning and harmonising of interests in and demand for land and water resources and for infrastructural support
- * Research for appropriate technology and Extension services for rapid transfer of technology at farm level
- * Drawing individual farm plans subject to IWD systems goal and constraints
- * Arrangements to acquire production inputs such as seeds, feeds, fertilisers, chemicals and credit.

The above decision framework indicates for involvement of three groups: Development Departments of Agriculture, Revenue, Irrigation, Forestry, Animal Husbandry; the other group represents scientists and planners and the third includes farmers and voluntary agencies (Patil, 1987). The three groups interact closely and with understanding the process of interactive planning and with a sense of commitment for IWD. How this could be done? What institutions are found to plan for and implement IWD? How do they stand with the existing institutions, on what relations as to investment and accountability? The manifests of group dynamics are evident and the process of accommodation has to be built. Roles are defined, tasks assigned and monitored. Beyond the line control, what is perhaps needed is co-ordination between the groups. The incentive and penal implications are adequately spelled out and codified. The entire process of IWD is a part of management, innovation in group decision and action involving joint decision, individual action and independent monitoring and evaluation. The Karnataka model seeks to answer these issues and progress

has been reported on rationalising administrative procedures and organisational structure in Karnataka.

Furthermore, integration in IWD has two major aspects: first, financial related to how incremental funding for IWD is dovetailed with the ongoing programmes for irrigation development, rural employment and for development of agriculture, animal husbandry and horticulture and forests. Funds need to be reallocated to support IWD projects. The other related question is, what type of amalgamation of on-going programmes would be effective and what are the other options available? Then, how new investment could be scheduled in relation to short-term contingencies and long-term growth? What kinds of institutional finance - scale, mode and procedures for lending and recovery - are relevant and facilitating for IWD. Investment in horticulture, pastures and energy forests have larger gestation periods during which financial support for consumption and maintenance of plantation is necessary. The pattern of financing has to be considered as a special case for IWD.

Institutionwise, do we have technical backup for components of farming system and does our R & D system require orientation to solve not only the on-going issues but also upcoming problems of processing and marketing? What are the research priorities and how they could be organised to find solution in the shortest time? State Agricultural Universities, Departments of Agriculture in the Centre and the States have yet to perceive this problem in this perspective for drawing research, training and extension programmes for IWD with regional orientation. Finally, how farmers are motivated to participate in IWD? Part of decisions on resource use is jointly taken and implemented by individuals. The former helps the latter to conform with the system needs. The success of the system of IWD depends much on perception, aptitude and appreciation of what is that improvement which makes IWD useful and profitable individually and sustainable and growing as community's assets. Extension education and communication modes play a vital role in this process of appreciation and motivation. Are our present approaches relevant and useful for the programme? Do we have adequate knowledge of training modules and case studies for discussion in groups? How deep has management bias steeped into our thinking and behaviour and how they are moduled to reflect on problems and issues of IWD? Because this is a complementary programme to irrigated agriculture, it is necessary to define clearly and with specific contents of the R & D backup for IWD (Brown *et al.*, 1990; Postal, 1990). Though the information system is incomplete, problems-awareness exists which should be operationalised into a set of regionally differentiated strategies.

The answers to the issues raised are mixed. Except a few experiments in Karnataka, Maharashtra and Punjab which have been a sort of 'guided tour', no significant breakthrough has been realised. The ICAR model is technique oriented and the Karnataka and Maharashtra model is department target oriented and participatory to an extent but not people centred. The IWD model, with emphasis on integration of organisations/agencies and of farming activities, has to be tried in a number of regions as pilot projects in order to identify constraints of the watershed concerned and modify the model suitably. People are central to IWD in designing and implementing land and water use programmes.

APPENDIX TABLE 1. MATRIX OF WATERSHED REGIONAL CHARACTERISTICS

Region/ Zone	Population (million)	Reporting area (mha)	Share of			Rural population (%)	Poverty ratio (%)	Watershed area (lakh ha)
			NSA (%)	FORS (%)	LAC (%)			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
7/1	19.5	13.9	37.6	40.0	14.8	85	51.4	2.0
7/4	9.7	5.2	28.8	28.1	26.4	87	56.9	0.1
8/1	5.4	3.0	62.8	8.2	18.5	80	68.8	4.6
8/3	1.0	1.3	31.8	43.0	16.3	93	61.0	1.5
8/4	6.9	5.0	41.9	27.1	17.0	79	61.0	0.6
8/5	5.1	4.3	52.4	28.4	12.6	72	45.8	1.5
8/6	2.2	2.2	40.5	38.9	13.0	83	45.0	0.3
8/8	5.3	4.3	45.8	18.4	18.2	75	36.5	1.1
8/9	2.2	1.8	44.9	25.4	15.8	72	41.8	0.9
8/10	1.6	0.9	39.5	18.7	21.2	94	61.0	0.2
8/11	1.8	1.8	43.3	12.6	26.2	82	47.5	0.4
8/12	4.9	4.0	26.0	14.1	31.6	86	50.7	0.7
8/14	5.2	2.6	56.8	10.9	13.3	86	41.8	1.1
9/1	12.5	5.7	57.4	15.8	13.8	79	35.9	2.4
9/2	9.2	5.5	66.9	15.0	11.2	79	38.2	2.7
9/3	27.4	17.2	67.2	8.7	14.7	67	48.9	9.1
10/1	14.7	9.0	71.0	7.1	14.2	74	45.3	16.7
10/2	20.2	10.4	41.4	17.0	24.6	80	45.6	4.5
10/3	10.9	4.0	47.3	11.4	28.2	63	36.4	4.7
13/3	7.9	2.7	57.2	12.0	8.0	77	34.2	1.0
13/4	9.9	4.4	58.5	6.8	19.0	65	34.7	1.0

Source: Agro-Climatic Regional Planning Unit (1989).
NSA = Net sown area.
FORS = Area under forests.
LAC = Land available for cultivation.

APPENDIX TABLE 2. WATERSHED REGIONS

7/1	Wainganga (MP) Eastern Hills and Orissa Inlands	9.1	Hills sub-zone (Maharashtra)
7/2	Chotanagpur South and West Bengal Hills and Plateaus	9.2	Scarcity zone (Maharashtra)
8/1	Bundelkhand (UP)	9.3	Plateau sub-zone
8/3	North Hills (MP)	10.1	West Karnataka Plains
8/4	Kymore Plateau and Satpura Hills	10.2	Rayalaseema region
8/5	Vindhya Plateau	10.3	Telengana region
8/6	Satpura Plateau	13.3	Middle Gujarat
8/8	Gird (MP)	13.4	North Gujarat
8/9	Southeast Humid Plains (Rajasthan)		
8/10	Southern Humid Plains (Rajasthan)		
8/11	Transitional Plains (Rajasthan)		
8/12	Sub-humid Southern Plains		
8/14	Flood Prone Eastern Plains		

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