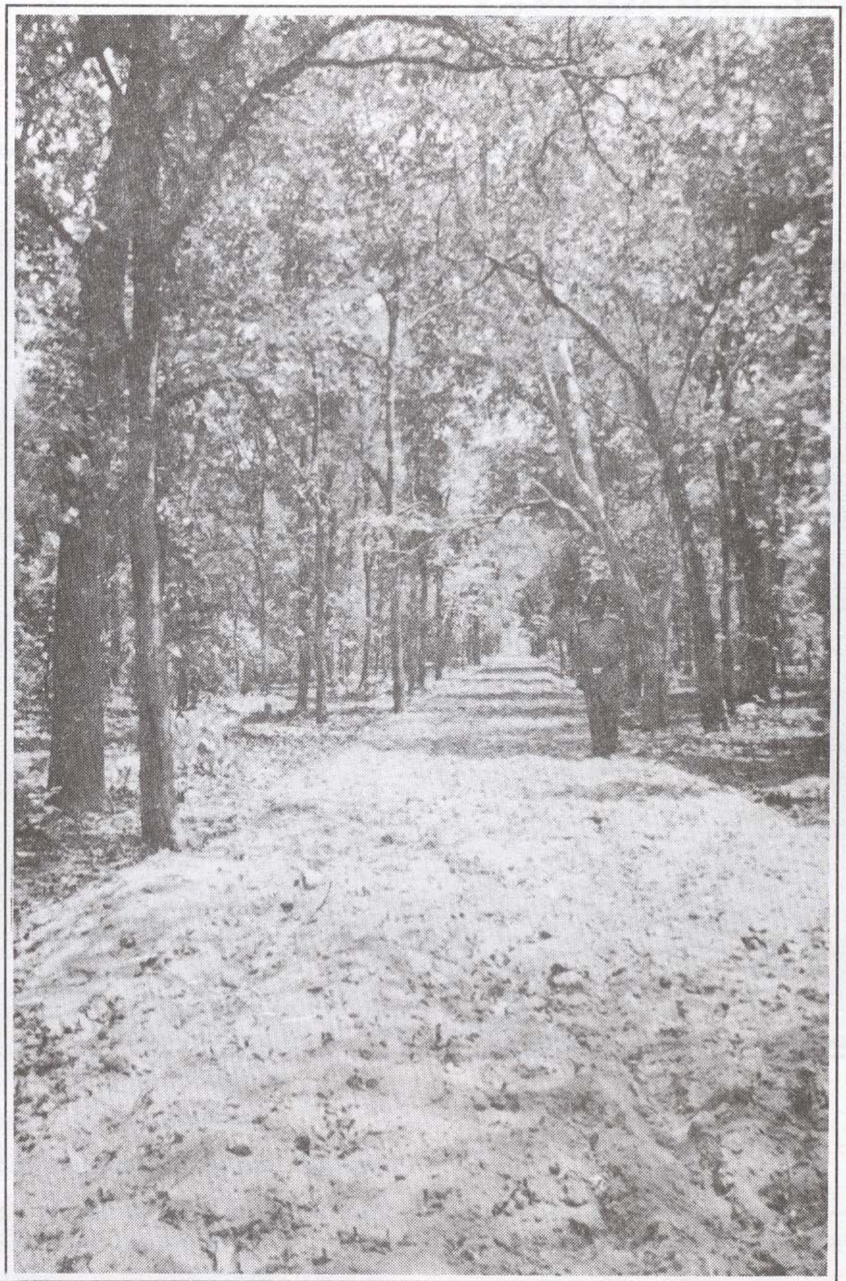

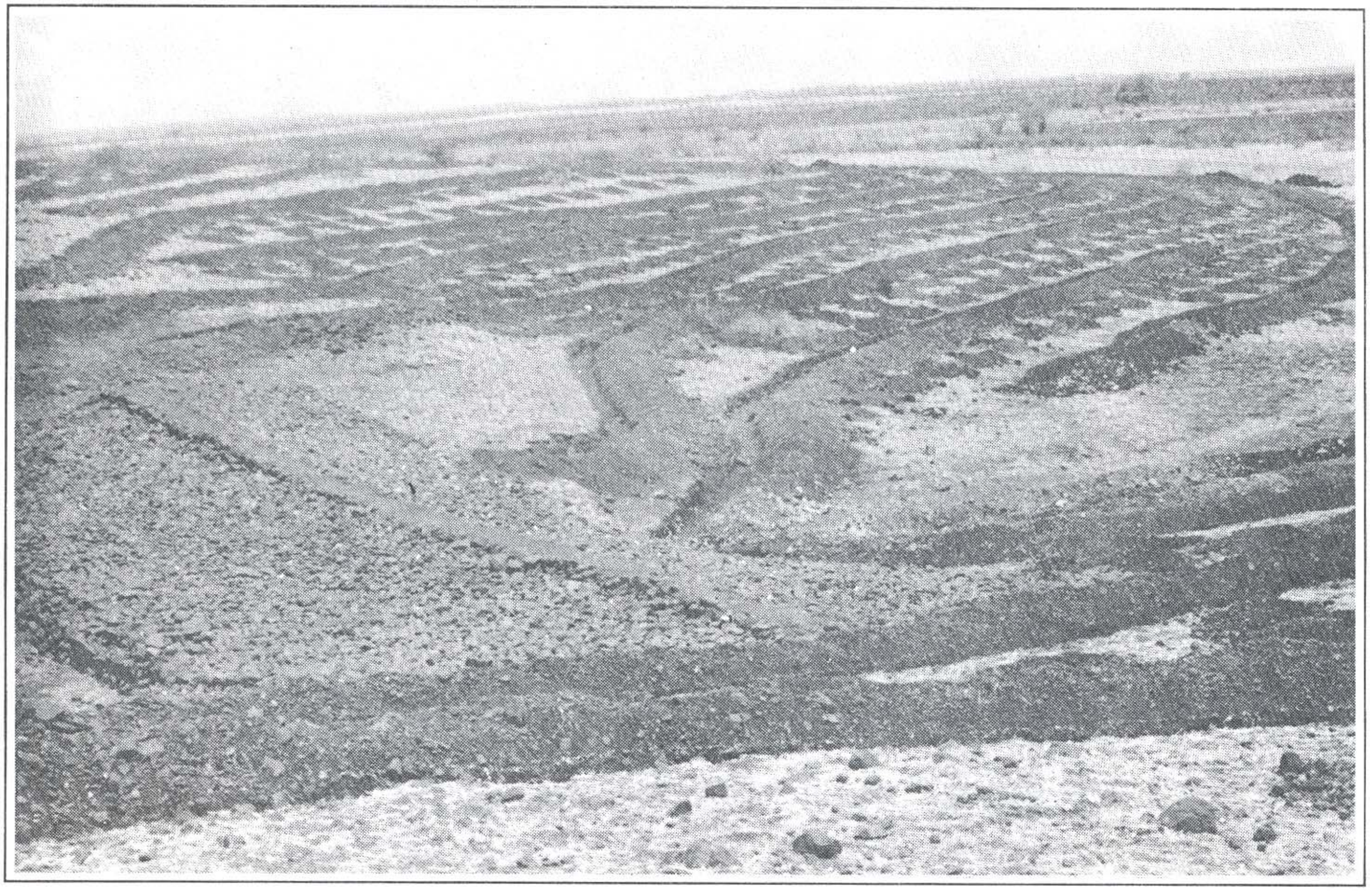

Water Management for Livelihood Security

1.The Challenge of Food Security

As we approach the next millennium, India faces a daunting challenge of maintaining food security in the face of rapidly growing population. The gross food grain consumption in India was 176 million tonnes (MT) in 1991 -92 On the basis of the projected growth of population and shifts in the pattern of consumption (given income elasticities), the planning Commission estimates the gross food demand to be around 285 MT by the year 2006. The same figure is obtained with projections using the rate of growth of food grain demand during the 1980's which was between 3.5% to 4.0% per annum It is clear, therefore, that to maintain food security even at the per capita nutritional levels (2100kcal per day,) 109 MT of foodgrains have to be produced additionally by 2006.

Where is the increase going to come from ? The net area sown in India has remained remarkably static at 140 million hectares since the end of 1960's Even though there are regional variations in the regard there is a clear indication that extension of cultivated area is no longer a major source of growth in Indian agriculture, The required additional foodgrain output has to come from three sources:

1. Expansion and fuller utilisation of the irrigation potential .
2. Yield improvements in irrigated agriculture.
3. Yield improvements in irrigated agriculture,

Expansion and Fuller Utilisation of the Irrigation Potential

Irrigation potential from surface water in India has been estimated at 73 million hectares, The latest Central Ground Water Board (CGWB) estimate of the groundwater potential is 64 million hectares, The total irrigation potential from surface and groundwater together is , threfore, 137 million hectares, The Gross Irrigated Area (GIA) WAS 62 million hectares in 1990 -91 , which left a balance of 75 million hectares of be exploited, The medium to high rainfall regions of bihar, Orissa, eastern Madhya Pradesh, eastern Uttar Pradesh and northern Andhra Pradesh together account for nearly 65% of the unutillised irrigation potential. Let us realistically estimate how much of the irrigation potential could be realised by 2006. Since the mid-1970s , the rate of expansion of irrigated area has undergone a global decline at a precipitous rate (FAO,1990) . The global rate of expansion of irrigated area, which was 1% per annum in the early 1960 s, peaked between 1972 and 1975 at the rate of 2.3 % per annum., after which it has steadily declined, falling to below 1% per annum, in the late 1980sThe expansion of irrigated area in India also follows a similar pattern , The rates of growth as also the average absolute increment per annum in the GIA over the last three decades, suffered a decline during the 1980 s form their peak levels reached in the previous decade (see Table1). Expansion of irrigated area in India seems to be facing several definite and fast approaching environmental and financial constraints:

Table 1: Rates of Growth of Irrigated Area 1926 -1990

Period	Rate of Growth(%)	Annual Rise (million ha)
1962-65to1970-73	2.93	0.94
1970-73to 1980-83	3.20	1.36
1980-83 to 1988-90	2.23	1.23
1962-65 to 1988-90	2.80	1.20

Source: India 's Tribal Societies and Development through Environmental Regeneration

1 For an elaboration of this see Shah , M, D Banerji, P S Vijay Shankar and Pramathesh Ambasta (1997) : India 's Drylands: Tribal Societies and Development through Environmental Regeneration (forthcoming), New Delhi: OUP

Given this past record, the Eighth Plan's projection of the GIA by the year 2006 at 114 million hectares seems to be very optimistic Alternatively, disaggregated state-level Projections have been made on the basis of past trends and incorporating a locational shift in the pattern of irrigation towards the hitherto un-irrigated tracts, On the basis of these calculations, the GIA can be expected to reach a maximum of 88 million hectares by the year 2006 , implying an addition of 26 million hectares at a rate of 1.7 million hectares per year, This is more than what has been achieved in India during the three decades ending 1990 Assuming that the share of rice and wheat in GIA (65%) dies not change significantly , about 17 million hectares can be expected to come under these two crops Since the large, irrigated tracts of the Indo - Gangetic plains and South India are approaching saturation, much of this irrigation expansion would take place in eastern region. Given the low yield levels of these crops even under irrigated conditions, we can assume that average yield levels there would stabilize around 2 tonnes per hectare, Expansion in irrigated area may therefore expected to contribute an additional 34 million tonnes of rice and what to total output of foodgrains in the year 2006.

Yield Improvements in Irrigated Agriculture

Another part of the additional foodgrain output can come from yield improvements in the areas already under irrigation Out of the 62 million hectares of GIA 40 million hectares were under rice and wheat in 1990-91 The average annual increment in foodgrain yield recorded by irrigated agriculture was 0.04 tonnes per hectare in the 1970 s and 1980s. Assuming that this trend is sustained during the fifteen years period ending 2006 AD, a yield rise of 0.6 tonnes per hectare can be expected under irrigation This would mean and additional 24 million tonnes of foodgrains from this source.

Yield Improvements in Rainfed Agriculture

The contribution of irrigated agriculture to foodgrain production from area expansion and yield improvements is therefore, likely to be around 58 million tonnes, leaving a shortfall of 51 million tonnes of foodgrains. In other words, even in the best possible scenario of irrigation development, nearly half the additional supply of foodgrains needed to match the future rise in demand will have to come from the rainfed segment of Indian agriculture, Most of this is located in the dryland regions (seeTable2).

Table 2: Projected Foodgrain Demand and Supply Scenario (in million tonnes), 2006 AD

Food Determined by 2006	285
current production	176
shortfall to be met	109
maximum potential of irrigated Agriculture:	
a)Through area Expansion	34
b)Through yield improvements	24
Total (a+b)	58
Balance Required form Unirrigated Agriculture	51

Source : India,s Drylands: Tribal Societies and Develoment throgh Enviromenttal Regeneration

in a recent study Bhaduri (1993) has shown that labour productivity in Indian agriculture has fallen relative to average labour productivity in the economy as a whole. This follows from the well-known fact that over the last 60 years, the share of agriculture in national income has fallen dramatically (from 54% in1931 and 28% in 1993-94)without a corresponding decline in its share in the workforce (Which was 71% in 1931 and 65% in 1993-94).

Thus while employment has not risen fast enough in the non agricultural sectors to draw labour away from agriculture, this labour has increasingly been employed in very low productivity work in agriculture, The flip side of this phenomenon suggests the conclusion that if we want to raise overall output and employment in the economy the most effective means would be raise the productivity of agriculture,

Indian agriculture is complex entity comprising a diversity of social and ecological elements, indeed, agricultural policy in India since the mid-1960s has concentrated on extending the Green Revolution package all over the country irrespective of these variations, Even in the mainlands of the Green Revolution the strategy is already reaching a point where its sustainability is doubt. What is more, the dryland regions are characterised by a qualitatively different set of constraints, which not only pose unique challenges, but also represent a vast unutilized potential This potential is completely over looked today The drylands sector is characterised by the lowest levels of productivity even while employing nearly 50% of the labour force Indian agriculture, Both the scope for raising productivity and its potential aggregate impact is the highest in this sector Moreover, since the poorest sections of the Indian society live here, a rise in productivity in this sector would have an immediate impact on poverty alleviation It would also have a positive impact on the pattern of interregional inequality by benefiting the most backward areas, Finally, if we concentrate our investment in these areas on labour intensive works which raise the productivity through the process of environmental regeneration we could also go a long way towards making the overall growth path of the Indian economy both employment -oriented and sustainable in the long run.

Thus, from the point of view of growth, equity food security and sustainability we must concentrate employment planning in Madhya Pradesh on raising the productivity of the dryland agriculture sector. Here the focus must be on the lands of the poorest farmers, Latest data from the Rural Labour Enquiry, 1987-88rreveals that the proportion of the landed among agricultural labour households[2] has risen to a high as 79% in 1987-88(this is the figure of both all India and Madhya Pradesh). According to the NSS 48th Round data in 1992% as many as 72% of the rural households in the country owned less than one hectare of land (Planning Commission, 1997).This an increasing number of small and marginal landowners, operating low productivity holdings are being forced to enter the labour market. Work allocation in the following areas would make a 3-fold contribution to employment generation:

- Providing short run (revolving ') employment:
- Increasing the productive capacity of the economy. which would create demand for labour in the next round (sedimented employment')[3]
- Raising the ability of the land to sustain the household, which Would reduce the dependence of these farmers on wage labour, thereby improving prospects of other workers in the labour market.

3. The Context of Madhya Pradesh

Madhya Pradesh has the highest pproportion of India's dryland districts within its area. 23% of India"s 177 dryland districts occupying 19% of India 's dry area are in Madhya Pradesh. 89%of the districts in Madhya Pradesh covering 81% of its area are drylands, According to the comprehensive classification of the National Bureau of Soil Survey and Land Use Planning (NBSS-LUP), most of Madhya Pradesh has a growing period the (the period in which the moisture of the soil is adequate for supporting plant growth) of 150-180 days, At present only 19% of the cropped area in the State has irrigation facilities. Even if the ultimate irrigation potential from surface and groundwater sources is realised, over 55%of the net sown area in Madhya Pradesh would still remain dependent on unagenda for development of certain rainfall A breakthrough in the dryland sector should therefore be given the highest priority in the agenda for development of Madhya Pradesh Further, the all - India pattern of declining labour productivity in agriculture is visible in equal measure in Madhya Pradesh as well The need to break low productivity in equilibrium trap of the agricultural sector cannot bbe overstated There is another dimension to the unique significance of Madhya Pradesh in the national scene, Encompassing as it does a wide variety of agro -ecological regions, Madhya Pradesh can be said to typify the two most important development experiences within India's rainfed agriculture-the near stagnation in the relatively high rainfall eastern region and the increasingly unsustainable rock regions of the country . We present a tentative outline of the agricultural development experience of two such regions in Madhya Pradesh to illustrate the need to adopt a completely new strategy of water management for development in the agricultural sector,

A study of Agricultural Development in Two Regions of Madhya Pradesh

In order to assess the ground pictures for the problems stated above for Madhya Pradesh two areas have been taken up to study closely On represents the Malwa- Nimar region in western Madhya Pradesh and the other the Bilaspur division in the Chattisgarh region in eastern Madhya Pradesh.

2. Landed households which derive a majority of their income from agricultural labour.
3. This is the distinction suggested by K N Raj in 1956: the employment associated directly with the investment process may be called revolving employment, the other type of employment, which is connected with the sediment of productive capital left by the investments, may be referred to as sedimented employment" (Raj, 1990. P.179)

In order to present a comparative picture, we profile 5 districts of the Malwa-Nimar region in Western Madhya Pradesh These districts together account for nearly 25% of the total geographical area, 22% of the population of the state, and about 40% of the tribal population of Madhya pradesh.

Table3 shows that these districts are predominantly rural in character with 70% to 90% of the population living in rural areas, with the economy of these districts being largely rural in character the share of agriculture in the work force is quite high. 70% of the workers were engaged in agriculture as the principal activity in 1991

However when we examine the composition of the work force, it is seen that the share of self-employed farmers is high in the tribal dominated districts (Jhabua in Western). Madhya Pradesh and Sarguja in Eastern Madhya Pradesh.) This is in conformity with the all India pattern as revealed by Census data which show that over two -third of the tribal workforce in India are in the category of self-employed farmers, while or the combined population of triblas and non-triblas, the corresponding percentage is much lower (38%)

These Predominantly rurla districts with a substantial chunk of tribal population are among the poorest and the most backward districts in the country Small and marginal farmer and agricultural labour households account for the bulk of the poor In the next two sections, we summarise the available data on the development experience of the districts, We will show how the similarities in the overall socio-economic indicators of there regions have resulted from two entirely different development trajectories in the past three decades - trajectories with are moreover representative of the development experience in the country as a whole :

4.Bilaspur Division (Eastern Madhya Pradesh) Untapped Potential

Located in the Chattisgarh region of Madhya Pradesh the division with three districts of Bilasppur, Raigarh and Sarguja typify the backwardness of India'seastern regions as well as its growth potential . Situated in the Central Indian tribal belt, this division has a large concentration of tribal

Table3: Total Rural Tribal Population in Selected Districs, 1991

District	Population (Lakhs)	Rural Population		Tribal populaton		Agriculture Labour	Cultivators	Agriculture Workers
		Lakhs	%	Lakhs	%			
Western Madhya Pradesh								
Jhabua	11.30	10.33	92	9.68	86	30	41	71
Dhar	13.67	11.88	87	7.31	54	23	56	79
Dewas	10.33	7.70	75	1.56	15	30	41	71
West Nimar	20.28	17.23	85	9.38	46	27	52	79
East Nimar	14.32	10.37	72	3.83	27	31	38	69
Bilaspur Division								
Sarguja	20.83	18.32	88	11.18	54	16	65	81
Raigarh	17.22	15.59	91	8.21	48	23	59	82
Bilaspur	37.94	31.45	83	8.74	23	23	53	76
Total	145.89	122.87		59.89	41			

Source: Statistical Handbooks (various issues)

Table 4: Ultimate Irrigation Potential, Potential Created and Utilised from Surface Water, 1997							
Area	**Gross Cropped Area (GCA) (000ha)**	**Irrigation potential (000ha)**			**Irrigation potential/GCA (%)**		
		I	II	III	I	II	III
Chattisgarh Plains	3783	1934	1016	852	51.1	26.9	22.5
Northern Hills	1778	435	142	76	24.4	8.0	4.3

Note: I = Ultimate;, II= Created III= Utilised

Source: Indian Gandhi Krishi Vishwavidyalaya, 1997

population. Nearly 4% of India's tribals and 18% of Madhya Pradesh 's trebles live here, Tribals account for nearly half the population in Raigarh and Sarguja districts, and 37% of the entire division.

Bilaspur division falls to two distinct agro-climatic zones: the Chhattisgarh Plains zone , covering the entire district of Bilaspur and parts of Raigarh district, and the entire district, and the Northern Hills zone covering the remaining part of Raigarh district and the entire district of Sarguja. The two major rivers Mahandi and Son control drainage in the divistion. On account of these large perennial rivers and their numerous tributaries criss-crossing the terrain,. availability of surface water in the division is high, the ultimate irrigation potential form surface water sources and its utilisation is given in Table 4, The table shows that at present, about 60% and 80% of the ultimate irrigation potential of the Chattisgarh plains and the northern zones respectively remains unutilised, A. similar picture emerges in the case of ground water as well (Table5).

Table5: Groundwater Potential and Utilisation in Bilaspur Division (hectare Meter), 1994

	Annual utilisable recharge	**Net annual with drawal**	**Balance unutilised**
Bilaspur	183081(100)	21600(12)	161481(88)
Raigarh	94506(100)	4736(5)	89770(95)
Sarguja	141777(100)	9186(6)	132951(94)
Division Total	419364(100)	35522(8)	383842(92)

Source: Mission Document, Rajiv Gandhi Mission for Mission for Watershed Development 1994

Table 6: Irrigated Area (%) and Cropping Intensity, 1993 -94

	NIA / NCrA	**GIA/ GCA**	**Cropping intensity**
Bilaspur	29	23	129
Raigarh	7	7	129
Sarguja	4	4	113
Division	16	14	118

Source : Basic Agriculture Statistics of Madhya Pradesh. 1989-90 to 1993

Note : NIA = Net Irrigated Area ,
NCrA= Net Corppped Area; GCA = Gross Area

Table 5 shows the groundwater balance of the Division. According to the Central Groundwater Board estimates, the net annual withdrawal of groundwater amounnts to merely 8% of the annual utilisable recharge for the division as a whole, With most of its resources potential remaining unutilised, the irrigation ratio (gross irrigated area as a proportion of the gross cropped area) is higher in Bilasppur district (23%),. while in other tow districts, the ratio is about 14% which is lower than the average of Madhya Pradesh (Table 6.) Surface irrigation sources (canals + tanks) account for the 81% of the net irrigated area in the division. In must also be noted that nearly 80% of the irrigated area in the division is located in the Bilaspur district, 85%of the cropped area in the division is dependent on erratic rainfall food crops occupy over 90% of the cropped area, with paddy accounting for 65% It should also be noted that over 80% of the area under paddy in the division is rainfed Much of the cropped area being rained, a substantial gap exists in the principal crops the current yield level of rice in the division is only about 65% of the national average.

An important factor contributing to the prevalence of poverty seems to be the inequalities in the distribution of the productive assets, particularly land, In the division as a whole, the size of 70% of the operational holdings (with a share of about 27% of the operational) is below 2 ha and 50% of the holdngs are smaller than even 1 ha in size Thus, inspite of its vast endowment of natural resources, Bilaspur division paradoxically remains one of the poorest regions in the country the backwardness of the region , and of the tribal communities is a direct consequence of the lack of a build up in the natural resource base of the area, A sustainable growth path for the division can be opened up by a development strategy based on renewal rather than replacement which views the regeneration of the natural resources base as a powerful engine of growth The synergy of growthe and environment must be exploited through a comprehensive resource management perspective, which is sensitive to the diversity of natural environments and cropping systems. From this perspective, what is looked upon as a constraint is turned in to possibility Nothing could illustrate this better than reflection on the rainfall pattern of Bilaspur division the average annual rainfall of the division is as high as 1200to 1600mm. However, 85to 90% of it is received during the months June to September with most of the rain in a few discrete and high intensity bursts (lasting four to five days). typically producing a large volume of runoff Table 7 gives the average monthly climatic data and water balance of Bilaspur district for the decade 1985-95 It shows the annual rainfall is sufficient to meet only 70% of the annual potential evapo-transpiration (PET) demand , laving an annual water deficit of 520 mm. Rainfall exceeds the PET during the period from the mid-june to early October (humid period) . From mid -October onwards, PET exceeds rainfall and the stored soil moisture gets gradually exhausted Soil remain dry during the months December to May.

Table 7: Rainfall Evapo -transpiration and Water Balance (mm) in Bilaspur.

Month	Monthly Rainfall	Monthly PET	Water Balance (p-pet)
January	22.1	84	-61.9
February	28.2	114	-85.8
March	16.3	165	-148.7
April	12.6	243	-230.4
May	22.6	243	-220.4
June	200.4	273	-72.6
July	415.6	195	+220.6
August	322.8	99	+223.8
September	178.2	93	+85.2
October	37.9	102	-64.1
November	5.9	105	-99.1
December	8.4	75	-66.6
Total	1271	1791	-520.0

Source: Regional Agriculture Research Bilasppur

Thus a critical constraint to rice production in Chhattisgarh is the moisture regime For assessing the suitability of a crop the rainfall distribution during the growth period rather than the total quantum needs to be assessed, Table 8 gives the water demand for evapo-transpiration for rice varieties of different maturity Taking seepage and percolation losses together with this demand, the total water requirement of rice per week works out to be about 50 mm. Together with the variability of monsoon rain this figure is used to determine the stable rainfall period for rice, which is defined as the period when the when the weekly average rainfall is greater than 50 mm and corresponding coefficient of variation is less then 100% For Bilaspur District the stable rainfall period is estimated to be 86 days long, thus, it is clear that in the absence of irrigation , the rice, crop is highly prone to agricultural droughts the probability of which is estimated to be once in three years.

Table 8: Evapo transpiration (ET) during Different Growth Stages of Rice						
Crop Stage	**Early Maturity**		**Medium Maturity**		**Late Maturity**	
	Duration (weeks)	**ET (mm)**	**Duration (weeks)**	**ET (mm)**	**Duration (weeks)**	**ET (mm)**
Seeding	5	43.9	3	90.5	3	100.3
Vegetative	5	178.9	6	249.3	8	300.8
Reproductive	4	164.3	6	209.4	6	248.2
Maturity	3	73.8	3	77.7	4	100.7
Total	14	460.9	17	626.9	21	750.0

Source: Impact of National Agriculture Research Project on the Agriculture Development in Eastern Madhya Pradesh; Indira Gandhi Krishi Vishwavidyalaya(1996)

What is required, therefore, is a new approach to agricultural development, which seeks to plug this crucial moisture deficit through a package of measures of rainwater harvesting combined with a farming strategy in tune with the water cycle of the region

5. Western Madhya Pradesh: Intensive Groundwater Exploitation

Compared with the Bilaspur division, five districts of Western MadhyaPradesh, namely Dewas, Dhar, Jhabua, East Nimar, and West Nimar have followed an entirely different trajectory of develop merit. These districts broadly represent the two agro-climatic zones Malwa plateau and Nimar valley. All five districts have at least part of their land in the Narmada valley agro-climatic zone, with East and West Nimar districts being located almost entirely in the Narmada valley. Northern portion of Dewss and Dhar districts occur in Malwaplateau. Dewas, E'har and Jhabuaare located to die north of Narmada river and East and West Nimar districts occur to the south. Most of the tribal settlements are located in the hilly and forested upper catchment of the Narmada valley. These districts arc located in the semi-arid and dry sub-humid climates in the annual rainfall of 800-1000 mm. The rainfall is highly seasonal, 90% of it concentrated in the period June to September, with the total number of rainy days ranging between 40 to 50 days.

The agrarian economics of these districts show a more diversified cropping pattern than the single crop agriculture of Bilaspur division. Food crops occupy only about 60 7c of ihe cropped area here. Within the non-food crop sector soyabean has the largest acreage in Dewas and Dhar districts, with its share being higher than that of jowar, heat and maize put together. Interestingly, however the tribal dominated Jhabua remains largely subsistence oriented, with food crops accounting for nearly 85% the area. In East and West Nimar districts cotton has been and remains to be the single most important cash crop. It is noteworthy that unlike in the Bilaspur division, the cropping pattern in the districts of western Madhya Pradesh has undergone dramatic changes over time with the share of the traditional jowar crop declining and new crops like soyabean emerging in its place. This shift seems to be primarily away from food crops towards oilseeds and other cash crops. Along with a remarkable shift in the cropping pas tern, it is also seen that total area under crops has been growing steadily in western Madhya Pradesh during l.is period 1970-94. The pace of agricultural expansion seems to iiave accelerated during the period 1980-94, as can be seen from the substantial jump in the annual rates of growth of cropped area (Table 9). It was during this period that the Green Revolution Technology made major inroads into the rainfed dryland agriculture of this region.

Table 9: Annual Compound Rates of Growth of Gross Cropped Area, 1970-94

Districts	1970-71 to 1980-81	1980-81 to1993-94	1970-71 to 1993-94
Dewas	0.79	2.08	1.52
Dhar (%)	0.53	1.44	1.05
Dhabua (%)	0.05	2.22	1.27
East Nimr (%)	0.47	0.82	0.67
West Nimar (%)	0.17	0.67	0.45
Madhya Pradesh	0.48	0.93	0.72

Source: Calculated from Indian Agricultural Statistics (various issues)

Following the introduction of this package, there has been a substantial rise in the area under irrigation and cropping intensity. With the notable exception of Jhabua, the irrigation ratios are in general higher than the average for Madhya Pradesh as a whole. The cropping intensities in the case of Dewas and Dhar districts are high on account of double cropping made possible by development of irrigation sources. The cropping intensity in East and West Nimar districts, is low in spits of high irrigation on account of the predominance of an annual crop (cotton), occupying over 25% in the cropped area.

The agricultural expansion and intensification in western Madhya Pradesh following the introduction of the Green Revolution Package have been aided by and have resulted in a rapid growth of irrigated area. Most of this growth in irrigated area took place during the 1980's. As a result, even though the cropped area has been growing at a fairly rapid rate (roughly between I to 2 % per annum in different districts), GIA/ GCA ratio went up by over four times in the last three decades in all districts. Thus, driven by the impetus of the hybrid seed technology, the agriculture in this dry land region has moved in to the water and energy intensive regime during the last few years. It is noticeable that in these districts a substitution of relatively less water consuming local varieties of seeds with hybrids, which need irrigation, is also taking place at a rapid rate. This process of substitution has almost completely displaced unirrigated varieties of wheat in all districts. Even in the case of cotton, which is still largely grown as dry land crop the movement towards the irrigated varieties is clearly visible. Given their v/ater resource endowment, the pathways of agricultural development in Bilaspur division in East Madhya Pradesh and lhe Western Msdhya Pradesh districts present an interesting paradox. In spite of an apparently high potential, water resources remain under utilised in Bilaspur division. On the other hand, located in a comparatively low rainfall regime, the districts of the Nimar valley and Mal'.'.'a plateau have moved far ahead in the matter of utilisation of water resources. As most of ths streams here are carriers of seasonal run-off having very little post-monsoon flow, irrigation potential from surface water is limited. The expansion has entirely been driven

Table 10: Irrigated Area ('000ha) by Source, 1993-94

Districts	1970-71 to 1980-81	Tanks	Wells	Tubewells	Net Irrigated Area
Dewas	3.2(3)	1.0(1)	59.4(53)	49.2(44)	112.87(100)
Dhar (%)	11.2(7)	4.3 (3)	64.6(40)	80.3(50)	160.4(100)
Dhabua (%)	12.6 (21)	4.6 (8)	18.7 (31)	25.3 (41)	61.2(100)
East Nimr (%)	4.9(5)	0.7(1)	78.1(78)	16.9(17)	100.7 (100)
West Nimar (%)	24.0(13)	0.5(1)	114.1(63)	41.9(23)	180.4 (100)

Source: Basic Agricultural Statistics of Madhya Pradesh 1989-90 to 1993-94, Gwalior : Commisioner for Land Records and Settlement

Table 11: Growth in Number of Tubewells in Western Madhya Pradesh, 1970-94										
	Dewas		**Dhar**		**Jhabua**		**E. Nimber**		**W. Nimber**	
	W	**TW**	**W**	**TW**	**W**	**TW**	**W**	**TW**	**W**	**TW**
1970-71	8263	0	23875	18	9936	0	28116	10	17277	22
1980-81	16840	188	36585	1386	13287	0	31410	19	44336	18
1989-90	28674	4530	43517	10045	16971	75	45527	381	64911	664
1993-94	29047	6044	44858	13955	17532	157	43830	806	71410	7117

Source: 1, Indian agricultural statistics, various issues;2. Basic Agricultural Statistics of Madhya Pradesh 1989-90 to 1993-94, Gwalior : Commissioner for Land Records and Settlement

Note W= Welts; TW-Tube=Tube wells

by groundwater. The break-up of irrigated area by source is given in the table 10.

It can be seen from the table that nearly 90% of the irrigation in western Madhya Pradesh is accounted for by goroundwater. The rapid expansion of irrigated area has been facilitated by an intensive exploitation of the groundwater resources of the region. Break-up of the irrigated area by source reveals the most striking aspect of ihe dependence on groundwater, namely, the growing share cf Uibewells in irrigated area (Table 11).

Jn fact, by beginning of 1990's, lubewells had became the inosi important mode of irrigation in Dewas and Dhar districts. During the same period, the number of wells also underwent a quantum leap in all five districts.

Even though extraction of groundwater has been growing at an exponential rate, official estimates of groundwater development in the districts, prepared by the Central Groundwater Board (CGWB), presents a rather comfortable picture. The groundwater balance ofthe districts of western Madhya Pradesh is shown in table 12.

However, the question nseds to be posed whether the agricultural expansion fuelled by extraction of groundwater on such a scale is sustainabls in a predominantly hard region. The natural rate of replenishment of ground water is usually very low in hard rocks. Hence, while there can often be fairly large reservoirs of stored water in hard rock aquifers (accumulated over several years), renewability of this resource in flow terms is likely to be

Table 12: Groundwater Balance					
District	**Annual Utiliable Recharge**	**Net Annual Withdrawal**	**Balance Unutilised**	**Level of Groundwater Development (%)**	
Dewas	67402	25238	42164	37	49
Dhar	97901	31268	66633	35	46
Jhabua	46222	5005	41217	11	13
East Nimar	71111	24364	46747	34	42
West Nimar	98629	32462	66167	33	40

Source: Mission Document, Bhopal: Rajiv Gandhi Mission for Watershed Development (1994) limited. The second important characteristic of the hard rock geology is the high variability of groundwater availability within a drainage basin. This means that we must be very modest in ths rate and depth of extraction of groundwater. Thus, the crucial fact to be monitored in both areas, is the absolute number and share of tubewells in groundwater irrigation, which provides an indication of the rate and depth of extraction. The increasing depth of groundwater extraction creates a very real danger of groundv;ater mining in these districts.

It is clear that the traditional categorisation of the areas by the level of groundwater development adopted is deeply flawed. One just cannot have the same classification across geological strata. A much lower level of development in the hard rock regions, for instance, could be as serious as a higher level elsewhere. It is often misleading to assume a high groundwater potential in hard rock areas, and thereby derive figures for low level of groundwater development, as the CGWB has done. In contrast to alluvial areas (characterised mainly by geological continua), in hard rock regions there is a sharp spatial distinction between the zones of rccharge and the zones of discharge. Thus, given the nature of their geology, great caution needs to be exercised in the development of groundwater in hard rock areas,

Extremely detailed data on water level fluctuations in the network of 89 hydrograph stations periodically monitored by CGWB in the five districts of Western Madnya Pradesh indicate that many of these fears may not be unfounded. The pre-monsoon water level shov/ed a steady declining irends in nearly 75% of the hydrogra.ph stations between mid-1980s and mid 1990s, with die deci"is being over I metre in nearly 40% of the stations (Table 13). It should be remembered that the quantum of annual rainfall during the same period shows no tendency of a secular decline.

This is reinforced by the reports of the Irrigation and Water Resource Departments (Government of Madhya Pradesh) on pre-monsoon water levels in 10 observation wells in Dewas block. Time series data available from 1977-93, show that the average depth to water level has been steadily declining and the decline has become more sustained after the mid 1980s.

Thus, any simple-minded attempt at extending the Green Revolution strategy to the hard rock regions like the districts of Western Madhya Pradesh is likely to be unsustainable in the long run. The sanguine presumption in this respect must be sobered by the realisation that the very foundation of this strategy of tubewell irrigation can have little hope for success in these areas. There is an urgent need to work out a path of sustainable prosperity for this area through interventions, which significantly deviate from the current development models.

6. Watershed Developments and Total Watershed Planning

It is, moreover estimated that of the total water sources of the country over 40% is in the form of soil mixture. Water used for irrigation from surface and groundwater sources together, even at their fullest development, would come to less than 20 % of the total. Strategies are needed which optimise the utilisation of soil moisture.

Such a development strategy requires the adoption of an appropriate water management and utilisation system referred to here as the Total Watershed Planning (TWP)

Table 13: Frequency distribution of decline in water level (3 yearly average), 1983-95

Decline in water level (m)	Dewas	Dhar	Jhabua	East Nimar	West Nimar	Total
< 0	0	3	7	3	8	21
0-1	7	4	6	11	5	33
1-3	4	8	3	7	4	26
> 3	3	0	0	0	6	9
Total	14	15	16	21	23	89

Source Central Groundwater Board, Regional Office, Bhopal approach. This approach attempts to identify endowments and constraints of an environmentally balanced, equitable and. sustainable growth path for a region. It integrates interventions in areas of soil conservation, water harvesting, groundwater recharge, sustainable agriculture, land use optimisation, forest conservation, wasteland development and renewable energy. The objective of such a TWP is to stabilise the natural resource base so as to facilitate its equitable and long-term use.

The TWP approach recovers the crucial link between development and 6nviromnent. It provides an insight into the synergetic relationship between environment and growth with energy conservation and resource recycling being inscribed into the very fabric of technological development. What is more, TWP does not remain concerned only with technological choices regarding resource allocation for creating productive social infrastructure. It goes further and includes reservoir management and the cropping pattern, as also the methods of irrigation.

The distinguishing feature and unique strength of the total watershed planning approach is its sensitivity and fine-tuning to variant base conditions prevalent indifferent areas. These conditions such as soil, rainfall, topography, forest type, geology, crop regime, pattern of land holding, percentage of tribal population etc. constitute what may be termed the "constraint matrix" which defines the area and consists of the parameters within which our "solutions matrix" needs to operate. By identifying and making a social choice about the "optimal" solutions for each constraint set TWP achieves a match between the two matrices.

This development strategy consists of three crucial respects:

1. TWP regards environmental regeneration as a source of labour intensive growth, while augmenting productive capacities, increasing the efficiency of resource use, reducing inflation by expanding the supplies of essentials, and correcting regional imbalances.

2. Rather than positing growth in income as the principal aim of development, the fundamental objective is to provide livelihood security to the resource poor lds. Livelihood security in backward regions adequate stable and sustainable access to resources meet the basic needs such as food, fodder, firewood, potable drinking water, health facilities and educational opportunities.

3. Rather than viewing growth as a process to be engendered from above, it places emphasis on a participatory development process, which entails the empowerment of the people.

Underlying the strategy of water management for development are certain principles of natural resources use. These are :

Livelihood security the poor and marginalised people

The primary objective of the resource use is livelihood security of poor and marginalised sections of people. From this perspective, a poor tribal household in the Bilaspur division is seen as operating with six critical *"budgets':* food, fodder, fertilizer, firewood, water (the **5** natural resource budget) and transactions with the rest of the world (ROW). The process of natural resource emasculation and environment degradation that these regions are subjected to, results in massive deficits in the 5 budgets. As a result the burden of adjustment falls in the ROW budgets, which only deepens the dependence of poor households on external axes of power. This, in turn, aggravates deficits in the 5 natural resource budgets and deepens the dependence on the external relationship of interlocked exploitation, and so on, in an endless spiral. For achieving livelihood security, this spiral of resources emasculation, poverty and indebtedness needs to be broken by checking the degradation of the natural resource base of the area through environment regeneration. Households have to be protected against the vagaries of erratic rainfall and market fluctuation through guaranteed access to food. In water-scarce areas, assurance of minimum water is the primary instrument of food security.

Equitable arrang*ements entitling the poor to natural resource base*

At the same equitable arrangements need to be worked out which entitle the poor to regenerated natural resource base. The natural resource base of an area comprises land, water and biomass. Livelihood security to the poor household is insured by institutionalising their entitlement to water and biomass through resource right. This is possible only if the resource base regenerated is treated as common property over which community control is exercised. For instance, the assurance of minimum water for food security can be made operational only if conditions of equitable access for all to the 'new' water (i.e, that which is conserved and made available), is laid down. In such a framework of institutionalisation of equitable water right, the satisfaction of the basic needs of the user community is given priority. Basic needs are ascertained on the basis of what is needed to sustain a family at minimum nutritional level. Surplus water after meeting the basic needs can be made available for providing other economically valuable services, for which the community could charge a price. The same principle applies in the case of biomass as well, priority being given to meeting the basic needs of the community for the fodder, firewood and NTFP.

Maximising the end-use efficiency of resources

To get the maximum out of the limited resources, it is necessary that the community exert strict end-use control over its utilities. In the case of water, this implies the regulation of the cropping pattern to optimise water use. In place of a high value irrigation intensive plan, a low risk agricultural package would give priority to crops and varieties that are less water intensive and have an assured yield to a given level of water application. Irrigation, therefore, is primarily seen as protective, to drought proof the crop against risks associated with the rainfall fluctuations. Similarly, in the choice of species for afforestation, those that satisfy the basic needs of the community for fodder and firewood would be preferred to the water intensive 'horticulture-flower' type, oriented towards external market.

Sustainable and location-specified strategies of development

With an assessment of the minimum requirement of water and biomass for meeting the basic needs of the people, the alternative modes of deriving it from local and external sources could be worked out. The idea of ecological balance is, the guiding principle here.

Land use system based on the TWP approach

The TWP approach has very definite implications for pattern of land use, which is based on the following decision-criteria:

a) Optiniising match between different land-types and the alternative system of biomass production.

b) Maximum biomass production from the soil by careful water management and choice of vegetative species which optimise use of soil moisture; and

c) Maximising the biomass input into the soil so as to raise soil productivity and biomass output over dm-

A synoptic view of the kind of choice that could be made in the Chhatisgarh and Nimar valleys is presented below-

***Chhattisgarh* Region**

Soils with poor water retention are *bhata* or lateritic soils and *matasi* or sandy loams. When occurring in the unbunded unplanned (tikra) farming situation these soils are subjected to heavy erosion and leaching. It would be better to PK these soils under perennial, tree-based land use system. with multi-purpose tree species such as *Dalbergia sisoo, Pongamia pinnata and Terminalia belerica.* They could also be brought under silvi-pastoral land use by combining these trees with grass species like *Stylosanthes haniata* and *Pennisitum spp.*. In uplands with relatively more retentive soil *likealftsol (dorsa* or clayloarns), horticultural species such as *Zizyphus Mauritania, Punica gr Anona squamosa and Anocardium occidentale,* could **be** combined with grass species mention below.

Table 14 : Suggestions for kinds of plantations different land and soil types

Land	Water Available - poor (Bhata/ Matasi)	Water Available -Good (Dorsa)
Upland	* Silviculture * Silvi- Pastures	*Horti Pastures *Dryland Horticulture
Midland	*AGri-Pastures *Agro-Forestry	*Horticulture *Horti Based *Alley Cropping
Low land	* Paddy with Trees * Plantation on Bunds	* Paddy

In gently sloping midland, agro-forestry system combining trees with agriculture crops could be attempted on *and matasi* soil. Trees species such *Dalbergia* sisoo *Albizzia lebbek, Gmelina arboria* etc, could be combing with agricultural crops like *urad, til, soyabean, gram* CIL. Alternatively, agricultural crops could be rotated with *leguminous,* fodder grass species in a two or three year cycle. In slightly more water retentive soils, agricultural

Crops such as pigeonpea, soyabean, black gram etc., could be combined with the horticultural trees s[ecoes ;ole Punica granatum and Emblica officinalis though alley cropping agro forestry system could optimally utilise the area occupied by bunds on paddy fields (estimated to be 10% of the total area under paddy). Tree plantation on the bunds would stabilise them over the years as well. Tree species such as Acacia catechu, Terminalia arjuna, Sesbania grandiflora or agricultural crops such as long duration pigeonpea could be used for bund stabilisation in the system.

The major farming situation, together with the existing cropping pattern and proposed interventions in Bilaspur division are given in the table to follow.

Nimar region

Except in the extreme cases of severely handicapped soils all land can support some form of biomass production. In the land less suited for agricultural uses, cropping system can be integrated with pastures (through lay farming) or perennial vegetation (through agro forestry system). When

Table 15: Farming situation, existing cropping pattern and proposed interventions in Bilsapur division.

Farming Situation	Constraints	Existing Crop System	Proposed Interventions
Hilly	Low Soil Fertility Shallow Soil Depth High Rill Erosion	Mixed Cropping with Pigeonpea, Koda-Kutki, Til, Urad, Niger etc Fallow in Rabi	1. Soil & Water Conservation (SWC) Measures with Agro-Forestry, Vegetative Bunds and Improved Crops Varieties
Upland Bunded Crops	Low Soil Fertility Shallow Soil Depth High Rill and Sheet Erosion Low Productivity	Extra Early Rice Kodo-Kutki, Pigeonpea, Urad, Til, etc Fallow in Rabi	1. SWC Measures as in Hilly Farming Situation 2. Small On Farm Reservoirs (OFR) at relative sites 3. Double cropping with of Legumes, Wheat Vegetables, etc. with runoff conserved in OFRs
Upland Bunded	Drought in Rice Low Fertility Soil	Early Rice Fallow in Rabi	1. Small OFRs and Dug wells 2. Double cropping with Grams, Wheat etc., with watering from OFRs 3. Soil Improvement 4. Trees on Bunds 5. Fish culture in OFRs
Lowland Bunded	Drought in Rice	Medium duration Rice Fallow in Rabi	1. Small OFRs and Dug Wells 2. Double Cropping with Grams, Wheat Etc., with Watering from OFRs 3. Soil Improvement 4. Trees on Bunds 5. Fish Culture in OFRs
Extremely Low land	Flooding in Rice prolonged Soil Wetness	Long Duration Tall Rice	1. OFRs towards the Sites of Bahara Land 2. Rice-Rice-Moong with Watering from OFRs. 3. Fish Culture in OFRs

Source: Impact of National Agriculture Research Project on the Agriculture Development in Eastern Madhya Pradesh; Indira Gandhi Krishi Vishwavidyalaya(1996) such integration is not possible, silviculture and silvi-pasture can be tried.

Table 16 : Land use system for different situations in the Nimar valley.

Water	Land type Good (LCC: 1-3)	Land type Medium (LCC:4)	Land type Poor (LCC:5-7)
Available	Agriculture	Horti-based Agro-forestry	Horticulture
Not Available	Lay farming	Dry land Agro-forestry	Silviculture

Note: LCC refers to Food and Agriculture Organisation's (FAO) land capability classes 1 to 8

In horti based agroforestry (HAF), horticulture trees are combined with arable crops. Mangifera indica (mango), Citrus species etc., can be integrated into these systems. HAF is suitable for actively cultivating farmers with watering facilities. The dryland agro-forestry system (DAF) is suitable for those farmers who own land of medium quality and have no watering facilities. Species such as Zizyphus mauritania, Emblica officinalis, Psidium guajava etc., are good for such land use system. In lay farming, a period of pasture is rotated with field crop in a 3 to 4 year cycle. Stylosanthes hamata, Serhima sulcatum (excellent fodder) and Cenchrus ciliaris are commonly rotated with sorghum. Silvi-pasture and silviculture land use system are appropriate for LCC 5 to 7. Anogeissus latifolia, Prosopis cinneraria are good fire wood species. Other species suitable for these system are Pterocarpus marsupium, Terminalia arjuna (for fodder), Acasia catechu (for construction timber) and Dendrocalamus strictus (bamboo).

7. Livelihood Security, Rural Employment and Watershed Development in Madhya Pradesh

An analysis of historical expenditure on employment programmes in Madhya Pradesh, as elsewhere in the country, reveals a predominance of roads and building which reflects an imbalance in the composition of the investment in the employment programme. Works related to land and water development, which are labour intensive in the construction and- the post construction phase haye traditionally been neglected. Thus, the primary objective of employment generation is undermined. This can be clearly seen from the fact that the wage to non-wage cost ratio which remained between 70:30 and 60:40 in the sixth plan period, fell to 53:47 in the seventh plan. For Madhya Pradesh the figure was 44:56.

Moreover the profile of the assets suggests that the interventions are not properly planned and do not represent a long term vision. The lack of planning means an absence of proper prioritisation of expenditure between different assets, in response to local needs. The national commission of rural labour laments the absence of a shelf of projects, as a result of which projects are selected on an ad hoc basis and assets are created under pressure from the village political elite. In the context of such severe imbalance in asset creation, it is worthwhile to remember that the type of asset created has a role to play in aggravating or mitigating the possible inflationary consequences of public work. This is particularly so if the size of the works programme has to increase in order to generate greater employment and cover more of the employment and the poor than they are doing at present. It is therefore, desirable that priority is assigned to work which helps to increase the productivity of agriculture.

The preoccupation with the resource constraint arises from the vision of these employment programmes that allow no role for Rural Public Works Programmes (RPWPs) themselves to ease such constraints. Such a vision is inappropriate in treating these programmes as mere relief measures with no potential to contribute to economic growth. Infact, increasing the productivity of agriculture through labour intensive techniques can create the basis for easing the real resource constraint. The fear underlying the argument for relief orientation is that a productivity raising emphasis would encourage excessive expenditure on capital equipment and administration and on employment of skilled labour. The presumption here is that all productivity increases must necessarily be labour displacing. Such a view ignores the immense vista of possibility of labour - intensive, productivity-increasing technologies opened up by total watershed planning.

Madhya Pradesh has a total land area of 44 million hectare, of which about 55 % is under cultivation. As mentioned above, 81% of the total land area is a dry land watershed. Not all of these would require watershed treatment. Assuming the watershed programme embodying labour intensive work is initially targeted to 50% of the dryland watershed, the total area under such a programme would come to 17.93 million hectares. At a treatment cost of rupees 4000 per hectare (which is the national norm for watershed development for drylands), the cost of watershed development programme in Madhya Pradesh would amount to rupees 71720 million. With the wage cost forming 70% of this expenditure (i.e, rupees 50204 million) and at a wage rate of rupees 35 per labourer (the statutory minimum wage prescribed for employment programme during 1996), the programme can generate a total of 1435 million person- days of employment.

To put this figure in perspective, we have estimated the total unutilised rural labour time in the state for the year 1996. Total rural population for 1996 is arrived at by projecting the growth of the base figure of 1991 census at a rate of 2.01% per annum (which is the rate of growth of rural population in Madhya Pradesh between 1981 and 1991). Applying the unemployment rates according to the concept derived from the 50th round of the national sample survey (NSSO, 1996) on the projected rural population, the number of unemployed persons can be estimated. The total number of openly unemployed in the rural area in Madhya Pradesh, according to this method of estimation, work out to 0.168 million, 0.450 million and 0.618 million as per the Usual Principal Status, Current Weekly Status and Current Daily Status definitions respectively. Even with the most liberal estimates of the unemployment, the watershed treatment programme has the potential to generate about 2300 person-days of employment per unemployed person in the rural area of Madhya Pradesh. In other words, assuming an average employment of 200 days per person in a year, the watershed programme can guarantee full employment in the rural area for the next twelve years. In addition to providing relief employment to the poorest of the poor, and while setting in motion the unemployed rural labour to arrest the process of environmental degradation, the watershed development programme can also lay the foundation within the agrarian economy for long term growth.

In this context, the Government of Madhya Pradesh has already taken the largest initiative of its kind in the country through setting up the Rajiv Gandhi Watershed Mission. Watershed management works were completed in 10 lakh hectares by June 1998. The Mission now covers an enhanced target of over 31 lakh hectares under 702 milli watersheds spread over 45 districts. It covers 7002 villages and 3800 watersheds in Madhya Pradesh, and there are 101 collaborating Non-Government Organisations. This makes the Mission India's largest watershed management programme. The initial results of the Mission are extremely encouraging. It also raises larger issues regarding an alternative model that integrates concerns of poverty reduction and environmental management which deserve immediate attention.