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Indian Floriculture - Status and Future Scope

Opportunities for the Private Sector in Soil and Water Conservation Programs in Rainfed Areas

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Rainfed areas are threatened by problems of high population, poverty, land degradation and drought. Water is a key factor increasing the risks for investments by the farmers as well as private entrepreneurs. However, integrated watershed management has shown that productivity could be doubled and incomes increased substantially in rainfed areas. Investments in soil and water conservation measures catalyze the regional development. Vast untapped potential of 94 million ha rainfed areas could be harnessed to achieve food security, reduce poverty and also to fuel the targeted 8 percent growth in India's GDP. Watershed programs in the country are silently revolutionalising the rainfed areas, however, large investments are needed to tap the full potential. Once water security for the crop growth is achieved, private investments from the farmers and industries come along. There is an urgent need for a paradigm shift in thinking of the industries for investments in soil and water conservation programs in rainfed areas not only with profit motive but also as a corporate social responsibility. Rainfed areas development opens up new opportunities for industries to provide backward and forward linkages and increase business through diversified opportunities.

Introduction

Rainfed agriculture is very important globally as it covers 80 percent of the cultivated area and contributes about 55-60 percent food. Ninety five per cent of the projected population growth in the world is expected to be in the tropical developing countries. Most of the hungry people are in Asia, Particularly India (221 million) and China (142 million). These two economies are also developing rapidly and are expected to be the powerhouse of the global development in near future. Rainfed agriculture in India occupies an important place in development initiatives as 66 percent of 142 m ha arable land is rainfed, and productivity is low (» 1 t ha-1) although potential is quite high (Wani *et al.* 2004). This region has to take urgent steps to meet the millennium development goal of halving the number of hungry people by 2015. Eighty percent of the hungry people are in rural areas, 50 percent are small land holders, 22 percent are landless and 8 percent are pastoralists and forest dwellers (Sanchez et al. 2005). Further, the task force on hunger of the Millennium Project recommended increasing agricultural productivity of food-insecure farmers through improving soil health, improved and expanded small-scale water management, improved access to better seeds, diversified farm enterprises, and establishing effective extension services (Sanchez *et al.* 2005). From water for food perspective as well as poverty, hunger, equity, development, and growth perspective, a hotspot emerges, namely the drought prone arid, semi-arid and dry sub-humid (rainfed) areas in India, where rapid population growth, resource poor rural communities, hosted in landscapes subject to serious human induced land degradation coincide. In order to achieve the projected growth of 8 percent in the country agriculture has to grow at 4 percent and rainfed agriculture will play a major role in this growth Moreover, crop yields in these areas are around 1 t per ha and vast potential to double the productivity on large area is quite possible. There is an urgent need to increase investments in rainfed areas substantially for achieving overall

development in the country. This paper showcase the potential as well as substantial opportunities for developing and building public-private partnerships in rainfed agriculture for harnessing the existing potential through win-win propositions.

Water Management - a Key Driver

Ever-growing human population, increasing incomes and improved lifestyles along with industrial development in the country has resulted in the competing demand for the finite water resources. Growing awareness for environmental protection and recreational needs are further compounding water demands. Agriculture is a major consumer (80 percent) of fresh water withdrawals in the world. In most developing countries agriculture is the engine of social and economic development. In India, currently 70 percent of the population depends directly on agriculture for their livelihoods. It is anticipated that by 2030, worldwide 20 percent area under irrigation (40 m ha) will be added. In India, even after achieving the full irrigation potential, around 50 percent of the agriculture will be rainfed.

Green revolution drove away the food scarcity from the country but still number of food insecure people in the country is quite large (350 million) and Green Revolution areas are showing signs of yield fatigue and unsustainability. It is estimated that by 2025 one third of the population in the developing world will be facing physical scarcity of fresh water.

Under these circumstances for achieving food and fodder security along with tackling the water scarcity for the country, untapped potential of rainfed agriculture will have to be harnessed. Efficient use of the rainwater for increasing food production must be achieved. Currently rainwater use efficiency for crop production is only 35 to 45 percent and rest of the rainwater is lost in the system through runoff, deep drainage, and evaporation without productive use. With the inherent global warming and the associated climate change will bring in more variation in the rainfall and also increase the frequency of occurrence of drought in the tropics. Investments in rainfed areas are lower due to associated risks for assured crop yields due to insecure crop growing period due to frequent occurrence of drought. Private investments generally follow the path of minimum risk and after the public investments in infrastructure.

Watershed Management as an Entry Point for Improving Livelihoods

There is a strong nexus between the water scarcity during the crop growing period or drought, associated land degradation due to poor land cover and soil erosion accompanied by nutrient depletion and poverty (Fig 1). This unholy nexus between drought, land degradation and poverty has to be broken for improving the livelihoods of millions of rural poor residing in rainfed areas. Rainwater management is the key issue for enhancing the productivity of rainfed systems. Most suitable entry point to break this nexus is to manage water and land resources sustainably for improving livelihoods.

These regions, generally defined as "drylands" which cover vast areas in the country, are of particular concern in terms of their environmental vulnerability, due to high incidence of human induced land degradation, or desertification, the importance of which was manifested through the creation of the UN Convention on Desertification (UNEP, 1999). These are regions where rainfed agriculture dominates. The Government of India (GoI) has undertaken strategic investments through watershed approach for development of rainfed areas in the country for sustainable management of natural resources in the region. India is in unique position as the country has reached self-sufficiency for food through the Green Revolution. However, to

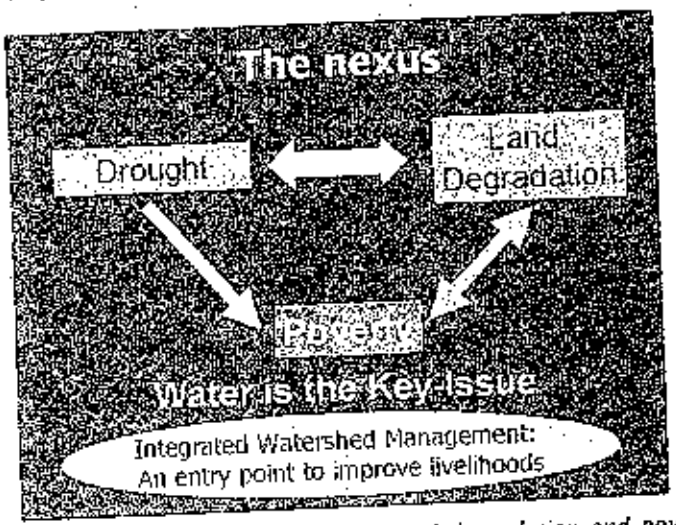

Figure 1: Nexus between drought, land degradation and poverty

achieve food security and reduce poverty, second Green Revolution in India is urgently needed. Now Grey to Green revolution through development of rainfed agriculture could provide necessary solutions. Moreover, integrated watershed management programs have shown the potential of doubling the productivity of rainfed areas while sustaining the natural resource base (Wani *et al.* 2002 and 2003).

Watershed programs are recognized as a potential engine for agricultural growth and development in fragile and marginal rainfed areas. Since the Seventh Five-year plan, the GoI accorded high priority to rainfed areas after realizing that the impacts of the green revolution in irrigated areas was gradually diminishing. Approximately US $ 7 billion have already been invested for watershed development till 10th plan.

Evolution of Watershed Programs in India

A close look through watershed programs in India from the beginning reveals that the approach has evolved over time from compartmental towards integrated and holistic approach for managing the natural resources. The issues of enhancing productivity, sustainability, gender mainstreaming, capacity building and equity concerns have become important. The journey through watershed approach evolved in India is depicted in Figure 2. In the beginning, watershed programmes went through structure-driven approach for soil conservation and rainwater harvesting, aiming at only some productivity enhancements. Soil conservation programmes became synonymous with contour bunding and water conservation with check-dams. This was a compartmental and top-down contractual approach. This led to less transparency and inequitable benefits among the community members. The rich who could invest in a bore-well have harnessed the benefits of the augmented water sources. On the other hand, small and poor landholders comprising of about 80% of the community could not get any tangible and equitable benefit from the conservation measures. Small landholders always looked at these interventions as employment opportunities during the project period and people's participation was not adequate. Also, most of the projects lacked technical backstopping.

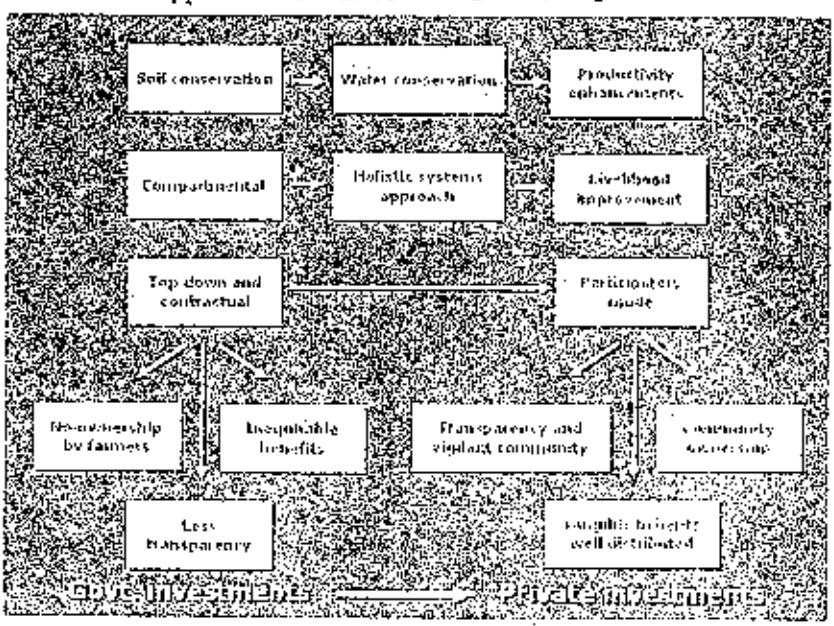

Figure 2: Journey through watershed approach in India

Watershed programs were initiated more than four decades ago, however, the activities have become more vigorous since 1990s. The watershed programs covered different agro-ecological regions of the country and their nature and scope were continuously modified.

ICRISAT and IWMI have assessed the performance of watershed programs by employing meta-analysis (Joshi *et al* 2005). Based on an exhaustive review of 311 case studies on watershed programs in India, their study attempted to document efficiency, equity and sustainability benefits. It was noted that the mean benefit-cost ratio of watershed programs in the country was quite modest at 2.14 (Table 1 and Fig. 3). The internal rate of return was 22 percent, which is comparable with many rural developmental programs. The watershed programs generated enormous employment opportunities, augmented irrigated area and cropping intensity and conserved soil and water resources. Performance of watershed program was best in rainfall ranging between 700-1000 mm, jointly implemented by state and central governments, targeted in low and medium income regions, and had effective people's participation. The study concluded that the watershed program is silently rejuvenating and revolutionizing the rainfed areas. It was noted that lack of appropriate institutional support is impeding the tapping of potential benefits associated with these programs (Table 2).

Table 1 Summary of benefits from the sample watershed studies

Indicator	Particulars	Unit	No. of studies	Mean	Mode	Median	Min	Max	t- value
Efficiency	B/C ratio	Ratio	128	2.14	1.70	1.81	0.82	7.06	21.25
	IRR	Percent	40	22.04	19.00	16.90	1.68	94.00	6.54
Equity	Employment	Person days/ha/yr	39	181.50	75.00	127.00	11.00	900.00	6.74
Sustainability	Irrigated area	Percent	97	33.56	52.00	26.00	1.37	156.03	11.77
	Cropping intensity	Percent	115	63.51	80.00	41.00	10.00	200.00	12.65
	Rate of runoff	Percent	36	-13.00	-33.00	-11.00	-1.30	-50.00	6.78
	Soil loss	Tons/ha/yr	51	0.82	-0.91	-0.88	-0.11	-0.99	39.29

Source: Derived from various studies (Joshi et al. 2005)

Table 2 : Returns from watersheds were higher in medium (2000-4000 Rs. Ag GDP) and low (<2000 Rs. Ag GDP) income state.

Indicator	Particular	Unit	Per capita income of the region		
			High	Medium	Low
Efficiency	B/C ratio	Ratio	1.98 (16.86)	2.21 (12.28)	2.46 (7.73)
Equity	Employment	Person days/ha/year	132.01 (4.14)	161.44 (5.29)	175.00 (4.66)
Sustainability	Irrigated area	Percent	40.34 (9.73)	23.01 (6.24)	36.88 (4.19)
	Cropping intensity	Percent	77.91 (8.67)	36.92 (11.99)	86.11 (7.64)
	Rate of runoff reduced	Percent	12.38 (5.31)	15.82 (3.39)	15.43 (6.01)
	Soil loss reduced	Tons/ha/year	0.82 (40.32)	0.88 (37.55)	0.69 (4.60)
Extent of people's participation			High	High	Low

Note: Figures in parentheses are the t-values ; Source: Joshi et al. 2005

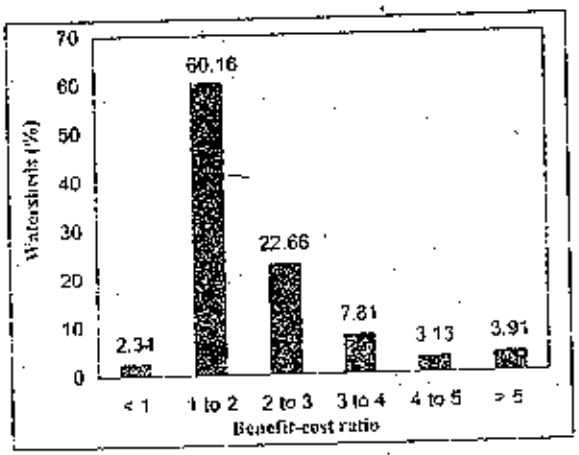

Figure 3 : Distribution (percent) of watersheds in India according to benefit : cost ratio

There is a change now and models are developed giving priority to the empowerment of the community and the stakeholders so that programs are operating not as a supply-driven project but as a demand-driven project (Joshi et al. 2004). Earlier experiences from the various watershed projects have indicated that a straightjacket approach did not yield desired results and mix up of individual and community-based

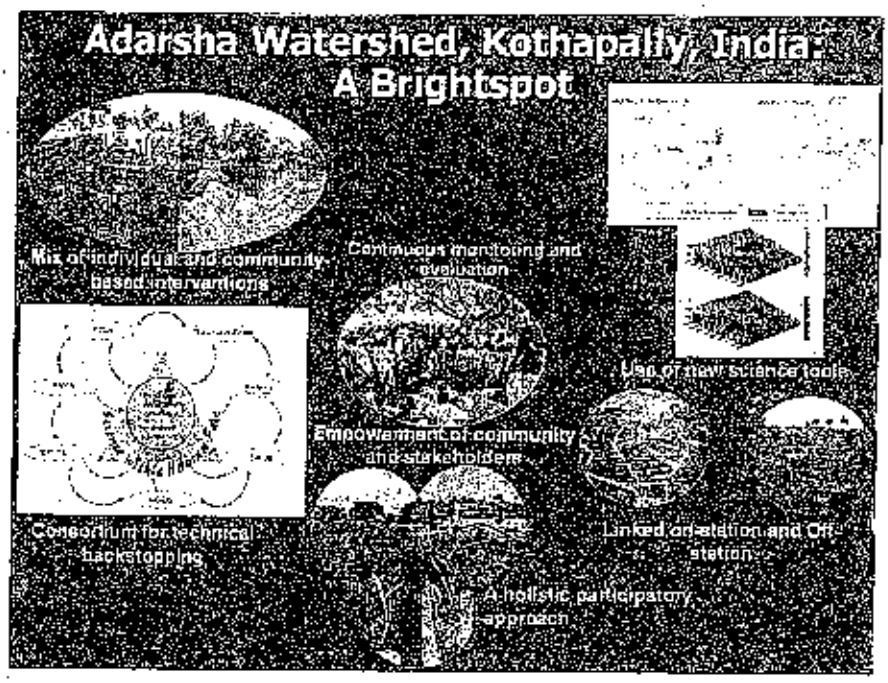

Figure 4 :
An innovative consortium model for integrated watershed management

interventions are essential. Multi-disciplinary teams are involved to provide the technical expertise to solve the problems at community level. The benefits are transparent and distributed well among the community members including women resulting in higher participation. In this approach, it is ensured that good participation is there and watershed is considered as an entry point for improving the livelihoods of the people. As evident from the results of meta analysis few bright spot watersheds are there in India and lot many watersheds need to be improved in terms of impact, equitable economic benefits, efficient and sustainable use of conserved natural resources, and most importantly people's participation. ICRISAT undertook a detailed study in India to assess past experiences and future research needs with a special emphasis on socioeconomic and policy research on watershed management for enhancing impact of such development programs Joshi et al 2004).

An Innovative Farmers Participatory Consortium Approach for Integrated Watershed Management

Based on detailed studies synthesiszing the results, impacts, shortcomings, learnings from large number of watershed programs and on-farm experiences gained, ICRISAT-led consortium developed an innovative farmers' participatory consortium model for integrated watershed management (Wani et al, 2004). Important components of the new watershed consortium model, which are different from earlier models are:

Collective action by farmers and participation from beginning through cooperative and collegiate mode in place of contractual mode.

A consortium of international, national, governmental, non-governmental organizations (NGOs), and community-base organizations (CBOs) to provide technical backstopping to community watershed programs (Fig. 4). Private entrepreneurs in the consortium to provide forward and backward linkages.

Figure 4. An innovative consortium model for integrated watershed management

Knowledge-based entry point to build rapport with community and enhanced participation of farmers and landless people through empowerment.

Tangible economic benefits to individuals through on-farm interventions enhancing efficiency of conserved soil and water resources.

No free inputs for farm-based interventions on private/individual land, where as for community-based interventions it is largely government/ project invests with only 10-30 percent contributions from beneficiaries.

Low-cost and environment-friendly soil and water conservation measures through out the toposequence for more equitable benefits to larger number of farmers.

Holistic system approach through convergence for improving livelihoods as against traditional compartmental approach such as soil and water conservation.

Empowerment of communities, individuals and strengthening of village institutions is achieved through concerted efforts to foment sustainable development.

Continuous monitoring and participatory evaluation by all stake holders for enhancing impact as well as sustainability.

Involvement of youth, women, and landless people through income-generating micro-enterprises within watershed projects.

What is Achieved through Consortium Model

During last six years rainfall in Adarsha Watershed at Kothapally in Ranga Reddy district of Andhra Pradesh varied significantly. For example, rainfall received in 1998 and 2000 was 36 and 47 percent more than normal, and in the other years deficit ranged from 24 percent to 36 percent. In spite of such a large rainfall variation, following benefits are harnessed by the community.

Increased productivity

Farmers evaluated improved soil, water, crop, nutrient, and pest management options with researchers. Improved crop management technologies and cultivars increased crop yields significantly, maize has increased by 2.2 to 2.5 times, while sorghum has increased by 2.3 to 3.0 times, intercropped pigeon pea has increased by 4 to 5 times (Wani *et al.* 2003 and Sreedevi *et al.* 2007).

In Andhra Pradesh with different crops in five districts through amendment with micro-nutrients which were found deficient in soils and best-bet soil, water, and crop management options crop yields increased substantially along with net income also (Table 3 & 4).

Such increased productivity resulted in marketable surplus and opportunities for market development emerged. For example, in Kothapally with increased maize productivity and production through increased adoption of improved management options and area traders/vendors come to village and sign contract with individual farmers to buy standing maize crop and they undertake harvesting also.

Increased commercialization of crops

Improved water availability in the watershed not only resulted in increased crop productivity but significant shift in area took place towards high-value cereals (29.4 vs. 22.2 percent), cash crops (66.2 vs. 56.5 percent), vegetables, flowers, and fruits and areas under low-value cereals such as sorghum declined (26.4 percent from 33.3 percent).

Watershed development resulted in increased number of farmers growing more commercial crops and high-value crops as compared to the farmers from the surrounding non-watershed villages (Fig. 5).

Currently 100 farmers collectively send 10 t fresh vegetables daily directly to retail vendors in Hyderabad and get Rs 2000 more per tone than the prevailing wholesale price. Farmers in the developed watershed marketed more quantity as well as earned more income through sale of surplus produce (Fig. 6). Watershed development benefited farmers not only during normal rainfall year but also benefited during drought year. In fact during drought year such as 2002, total amount as well as value (15500 Rs) of produce marketed was significantly higher as compared to the non-project village (9500 Rs) (Fig. 7).

Table 3: Micronutrient amendments increased crop productivity in 50 watersheds in three districts of Andhra Pradesh, 2002

Crop	*Average grain yield (kg ha^{-1}) control*	*Average grain yield (kg ha^{-1}) MN treatment** controlgrain	% increase
Maize	2800	4560	79
Greengram	770	1110	51
Castor	470	760	61
Groundnut pod	1430	1825	28

** Micronutrients applied: Boron (0.5 kg ha^{-1}), Sulphur (30 kg ha^{-1}) and Zinc (10 kg ha^{-1})*

Table 4: Micronutrient amendments along with recommended macro-nutrients doses increased crop productivity in 50 watersheds in three districts of Andhra Pradesh, 2003

Crop	Treatment Yield (kg ha^{-1}) Control(C)	Sulphur (S)	Boron(B)	Zinc(Zn)	C+SBZn	C+NP +SBZn
Maize	2790	3510 (26)*	3710 (33)	3710 (33)	4140 (49)	4890(75)
Groundnut	830	930 (12)	1000 (20)	1060 (27)	1230 (48)	1490(78)
Mungbean	900	1210 (33)	1130 (24)	1320 (46)	1390 (54)	1540(70)
Sorghum	900	1190 (32)	1160 (29)	1330 (47)	1460 (62)	1970(119)

(% increase over control)

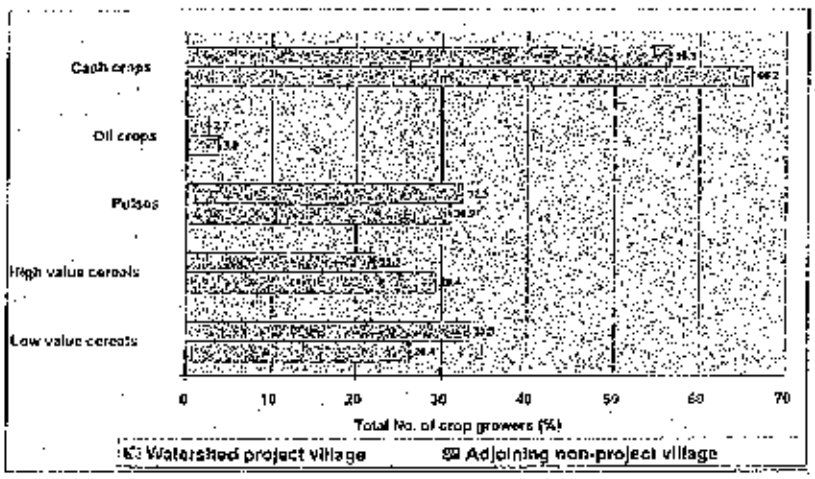

Figure 5 : Effect of watershed management on commercialization of production, Kothapally, AP, India

electric and diesel pumpsets as well as irrigation equipments such as pipes and sprinklers were observed (Table - 5).

Table 5: Increased groundwater development in Rajasamadhiyala watershed in Gujarat

Description	No. of wells	
	1995	2003
Open wells	255	308
Bore wells	102	200
Pumping hr/day	5.25	10.4

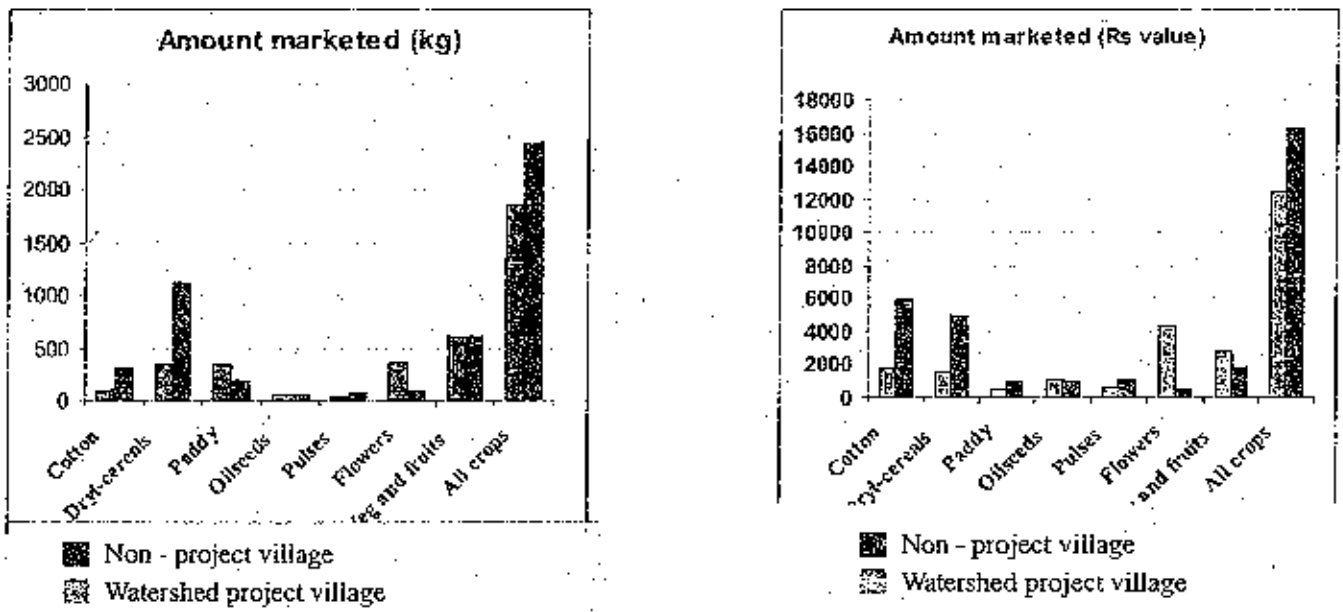

Figure 6: Effect of watershed management on crop commercialization, Kothapally, 2001-2002

Improved groundwater and reduced soil loss and runoff

There was a significant improvement in water yields of most wells and with additional groundwater recharge in Kothapally, a total of 200 ha were irrigated in post-rainy season and 100 ha in post-rabi season, mostly vegetables. Significant reduction (45 percent) in soil loss and 29 percent reduction in run-off volume was recorded than the untreated area (Wani et al. 2004). Improved groundwater in the watersheds resulted in increased private investments from the farmers. In a case study of Rajasamadhiyala watershed in Gujarat showed substantial private investments in digging of open and bore wells. However, such large scale investments could result in over exploitation of groundwater resources and there is an urgent need to develop groundwater policies for sustainable development.

Increased household incomes

Detailed census and household survey of 308 families in watershed and 825

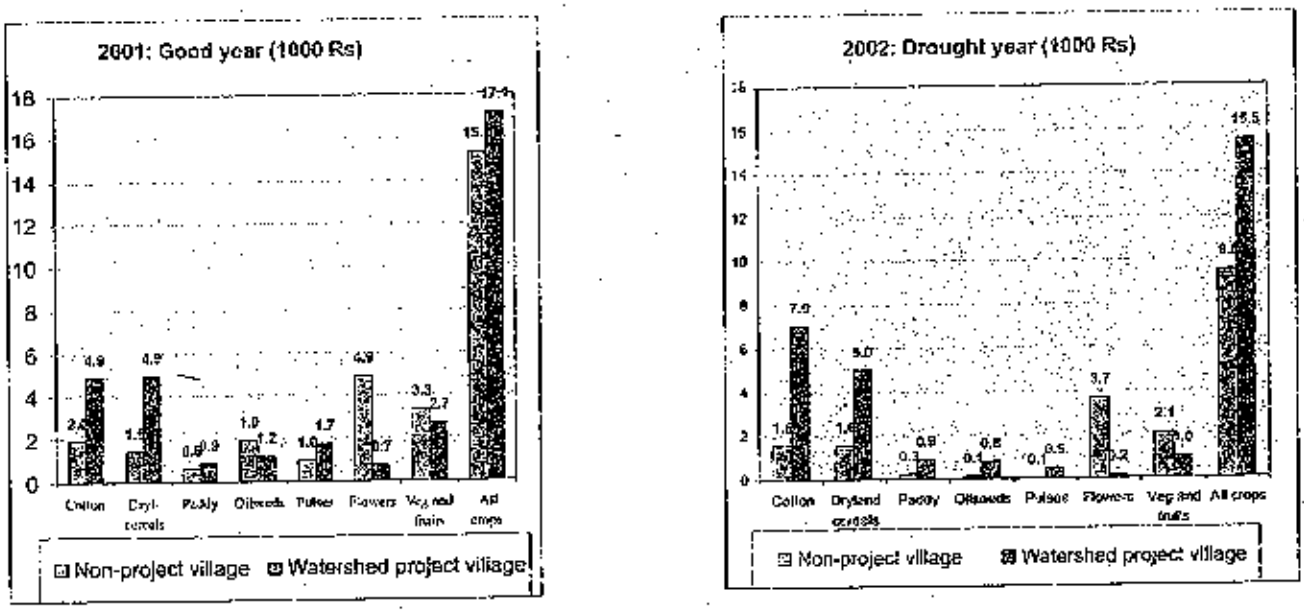

Figure 7: Effect of watershed management on amount marketed and value in good and drought year Kothapally

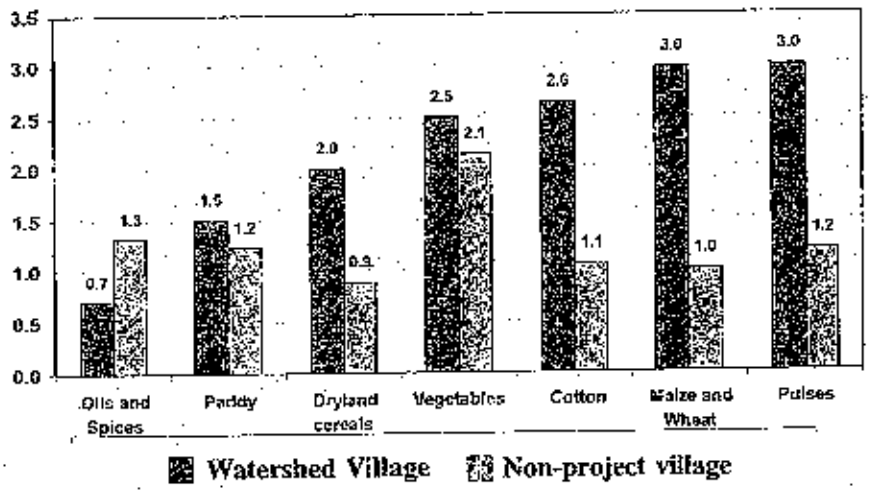

Figure 8 : Effect of average household crop income, Kothapally, AP, India, 2001 (Rs. 1000)

families in non-watershed surrounding villages revealed that for cereals, the returns to family labour and land (net income) are 45 percent higher even with irrigation, while the net returns on rainfed cereal crops have more than doubled. Similarly for pulses also income in the watershed is more than doubled mainly because of watershed development approach based on integrated genetic and natural resource management (IGNRM). Income from all the crops except oil seeds and spices was higher in Adarsha Watershed as compared to income from crops in non-project villages (Fig. 8)

Analysis of household income revealed striking differences in household income from crop production, within watershed crop income was Rs. 15400 as compared to Rs.12700 in non-project villages. The respective per capita income is Rs.3400 in Adarsha watershed as against per capita income of Rs.1900 in non-project villages.

Development of watershed not only increased income from crops and total income but also provided stability and resilience for income even during drought year such as 2002. Total household income during drought year was reduced by 29.4 percent to Rs. 29000 from Rs. 42500 in a normal year. In non-project villages reduction in income during drought year was 26 percent to Rs.20200 from Rs.29000 in normal year of 2001. Drastic impact of drought on crop income was observed in non-project villages as the share of crop income in total household income decreased to 12 percent in drought year from 44 percent in a normal year. In watershed village share of crop income in total income during drought year was 37 as compared to 36

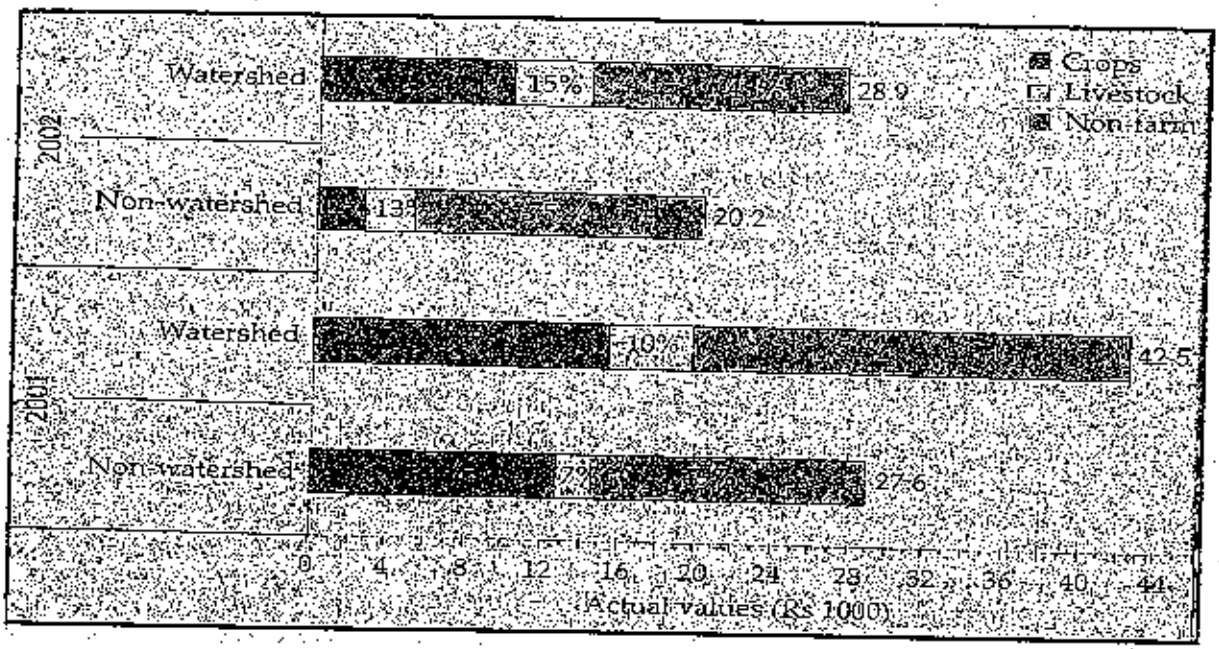

Figure 9: Income stability and resilience effects during drought year (2002) in Adarsha watershed, Kothapally, AP, India

percent in normal year (Fig. 9) Similarly, non-project villagers had to earn income from non-farm activities mainly through migration as share of non-farm income in total income increased to 75 percent as compared to 49 percent in normal year. In watershed village share of non-farm income was reduced to 48 percent in drought year as compared to 54 percent in normal year.

Micro-enterprises and diversified livelihood opportunities

Through new consortium approach with empowerment landless people as well as women and youth groups are involved in micro-enterprises such as livestock rearing, biodiesel plantations, oil extraction, biopesticide production, vermicomposting, nursery raising, value addition through processing for e.g. dhal making from pulses etc. These activities resulted in extra income for families, improved livelihoods, reduced migration, and put extra disposable income in families' hands.

Opportunities for private investments

Watershed development secures crop growing period and increase farmers' incomes from crops enhancing farmers' capacity to invest in improved management options such as nutrient management, seeds of high-yielding cultivars and high-value crops, pest and disease management options, etc. Increased opportunities exist for providing backward and forward linkages for increasing productivity in rural areas. Already there are good examples of public and private partnerships in rainfed areas are emerging several projects in the area of natural resource management and improving livelihoods are supported by Sir Dorabji Tata Trust (SDTT), Mumbai in rainfed areas in India. The consortium approach provides very good opportunity for industries to join developmental efforts as new business opportunities come up. For example, in the area of medicinal and aromatic plants (MAPs) in Andhra Pradesh private entrepreneur (Mak Royale) has joined ICRISAT-led watershed consortium to provide seeds and seedlings of MAPs and also to buy back the processed products. ICRISAT and other research institutions provide technical support to the farmers and Government of Andhra Pradesh supports financially watershed development. It is a win-win-win proposition for all the stakeholders. In Madhya Pradesh, ITC has capitalized on the consortium approach for increasing production and productivity of soybean which is a raw material for their industries. Bharatiya Agro-Industries Foundation (BAIF) a reputed national NGO working with ICRISAT for last 10 years in Madhya Pradesh joined hands with ITC. The ITC provides inputs, information and knowledge through E- Choupal as well as buys back the produce from farmers through decentralized purchase points, BAIF provides social support at village levels

ensuring better farmers participation and also improved soil, water, and nutrient management options based on their learnings from the ICRISAT-led consortium. ICRISAT provides technical support and guidance to BAIF and in the process farmers contribute significantly in development initiatives and also improve their livelihood and incomes. New partnership at national level with Morarji Borax is in offing with ICRISAT-led watershed consortium for increasing productivity of rainfed systems through amendments with micr-nutrients which are severely deficient in farmers' fields. Moraji Borax will ensure decentralized availability of boron and other micro-nutrient formulations, ICRISAT-led consortium provides technical backstopping to the watershed programs of GOI and state governments in selected states and farmers will implement productivity enhancement initiatives by adopting improved soil, water, crop, and nutrient management options and contribute to development of the nation.

Conclusion

In conclusion, there are lots of opportunities emerging for the industries to join development of rainfed agriculture in the country. It is well established that once watershed development assures improved water availability, lot of private investments from individual farmers come and also from the industries. Along with the business and profit motives, industries also need to take concrete steps to join research and development for rainfed areas as Corporate Social Responsibility. To achieve the target of 8 percent growth in India's GDP, concerted efforts of private industries along with public investments in rainfed areas are must. Large untapped potential of rainfed agriculture could be tapped through win-win pro-poor-public-private-partnerships (5Ps). There are number of successful case studies of PPPs in rainfed areas and scaling-up and scaling-out of such initiatives is needed.

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References

Joshi, P.K., Vasudha Pangare, Shiferaw, B, Wani, S.P., Bouma, J. and Scott, C. 2004. Socioeconomic and policy research in watershed management in India: Synthesis of past experience and needs for future research. Global Theme on Agroecosystems, Report no. 7. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 88 pp.

Joshi, P.K., Jha, A.K., Wani, S.P., Laxmi Tewari and Shiyani, R.L. 2005. Meta-Analysis to Assess Impact of Watershed Program and People's Participation. Comprehensive Assessment Research Report 8. Colombo, Sri Lanka: Comprehensive Assessment Secretariat.

Sanchez, P., Swaminatha, M.S., Dobie, P. and Yuksel N. 2005. Halving hunger: it can be done. Summary version of the report of the Task Force on Hunger. The Earth Institute at Columbia University, New York. USA.

Sreedevi TK, Suhas P Wani and P. Pathak 2007. Harnessing Gender Power and Collective Action through Integrated Watershed Management for Minimizing Land Degradation and Sustainable Development. Paper submitted to Journal "Financing Agriculture".

UNEP 1999. Global Environment Outlook - 2000. United Nations Environment Programme. Earthscan

Publications, London. 20 pp.

Wani, S.P. Pathak, P., Tam H.M., Ramakrishna, A., Singh, P. and Sreedevi, T.K. 2002. Integrated watershed management for minimizing land degradation and sustaining productivity in Asia. Pp207-230 in Integrated land management in dry areas:proceedings of a Joint UNU-CAS International Workshop, 8-13, September 2001, Beijing, China.

Wani, S.P., Singh, H.P., Sreedevi, T.K., Pathak, P., Rego, T. J., Shiferaw, B., Shailaja Rama Iyer. 2003. Farmer-Participatory Integrated Watershed Management: Adarsha watershed, Kothapally India, An Innovative and Upscalable Approach. A Case Study. In Research towards Integrated Natural Resources Management: Examples of research problems, approaches and parmerships in action in the CGIAR. (eds. R.R. Harwood and A.H. Kassam) Interim Science Council, Consultative Group on International Agricultural Research. Washington, DC, USA: pp. 123-147.

Wani, S.P., Balloli, S.S., Kesava Rao, A.V.R. and Sreedevi, T.K. 2004. Combating drought through integrated watershed management for sustainable dryland agriculture. Regional Workshop on Agricultural Drought Monitoring and Assessment using Space Technology on 4 May 2004, National Remote Sensing Agency. Hyderabad, India. pp. 39-48.

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