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Artificial recharge of ground water in hard rock terrain through Chakriya Vikas Pranali - a case study of Palamau district in Bihar State

P. K. VERMA and S. P. SINHA
Society of Hill Resource Management School (SHRMS), Chakriya Vikas Yojana, Abadganj, Daltonganj - 822 101 (Bihar), India

Abstract

"Chakriya Vikas Pranali" (CVP) is a natural cycle of growth where profit of the first cycles becomes capital for the next linked cycle of employment generation and thus refinancing of the programme is not required. After the gestation period the system will have its own internal resources to run the project.

Land and water management programme is one component of CVP by which regeneration of degraded land is taking place with increasing forest cover, which facilitates insitu conservation of rain water as it falls and where it falls. Scientifically the following are basic achievements besides socio-economic gain to the society :

Change in environment,
Artificial recharge of ground water in hard rock terrain in Palamau,
Change in soil composition which ultimately increases the soil fertility rate.

An alternative mechanism for regeneration of degraded land with increasing biomass cover due to innovative Chakriya Vikas mechanism for insitu conservation of rain water has shown remarkable change during recent years. This paper compares ground water recharge in undulating surface in hard rock terrain of Palamau division in Bihar. The protective measures to check surface run-off ultimately recharge ground water table and an apparent improvement of level was observed.

INTRODUCTION

Chakriya Vikas Pranali is an innovative system developed at Society of Hill Resource Management School, Daltonganj by a team of multi-diciplinary professionals for natural cycle of growth using land, water, plant, sun and human muscle power for creation of natural resources as sustainable base for sustainable growth. Incourse of time the created resource stock changes the socio-economic status of the people kept at nucleus of all developmental programmes. The created assets are protected, managed and harvested for equitable sharing of benefits. The internal returnable revenue becomes the eternal source of income in the village and also creates a sizable surplus which becomes capital for other inter linked cycles.

The study is based to show the improvement in water table due to such operations in one of the project villages of Chakriya Vikas. The different techniques used for insitu conservation of water has resulted increasing production of crops and hence the improvement in overall status of the people.

OPERATIONAL MECHANISM OF CHAKRIYA VIKAS

Chakriya Vikas Yojana (CVY) is basically the natural cycle of growth where profit from one investment cycle becomes capital for next linked cycle of employment generation. The idea is to create, manage, protect, harvest, market and share the usufructs of commonly pooled privately owned land resources by the users group irrespective of caste, class, religion or gender. The basic idea is to take care of all partners of development with special emphasis on weaker section of society. The tribal landless and women economic upliftment is the yard stick for assessment and overall prosperity is visible indicator of the programme.

The direct benefit interms of asset creation like fuel, fodder, fibber, fruit, grass, plants, trees, agricultural crops, water harvesting structures increase the natural resource base at the village institution. While strong village samaj, social audit, financial management of project, equitable sharing system, social fencing makes the village institution mentally and morally solvent.

Indirect benefit interms of openness, health, education, reduction of court case, solution at village level increase in management calibre, increase in decision making ability adds to the samaj.

Scientifically increase in oxygen content, reduction in green house gases, reduction of atmospheric temperature, increment in storage capacity of rain water due to insitu arrest and conservation techniques. Increase in water table, increment in humous and improvement in soil type and class due to these operations are visible.

The simple operational mechanism of CVY is its all protect, all receive, all pay nature.

LOW COST INSITU WATER CONSERVATION TECHNIQUES USED IN C.V.Y

Initially operational area is surveyed to know the existence of perennial sources like River, Canal, Nallah, Checkdam, Ponds and type of land & adjoining topography. We can use different low cost techniques depending upon the terrain.

Small tanks

These small tanks may be dugout by the side of perennial nallah. The tanks at 10’ away from flowing source with 10’ depth will have eternal, internal charging. The steps of 3’ at each 1’ by all side drastically reduces the cost and water becomes available alround the year due to such tanks.

Nallah Bunding

For Nallah’s in which upper flow ceases in summer but ground flow continues, if we put concrete pitching below 5’ the ground and place water proof plastic sheets or iron sheets, it will stop the internal flow and water will come-up.

Small Closed Pond

These small closed ponds are dugout by the side of flowing water. It can have hammering at the bottom floor and bio-cover on the upper dugout and filled mud banks for soil binding. The

leaf's of plants like soobabul plants at banks becomes good food for fish which is kept in ponds. The total cost varies from Rs. 35 - 40 thousand depending upon the size 80' - 100' length 60' - 80' width with average depth of 10' with provisions of steping which are normally 1' deep and 2' wide. (Rs. 50 x 800 mandays)

Boulder Checks

At very low cost boulders are systematically arranged with patches of clay in between layers to intervene flowing water. This is valid intervention in cases where speed of flow is slow and this type of barrier costs for 30' X 5" bund about Rs. 5,000/- (Rs. 50 x 100 mandays)

Tieridges

It is most successful insitu soil moisture conservation technique used in SHRMS plantation areas. Small tie-ridges of 5' X 5' spacing formed by connecting corners of plants stores rain-water for a very long time and insitu percolation restricts the sudden flow of rain water, charging the ground water of the area. About 4000 tie-ridges at a cost of Rs.1.50/ tie-ridge are made per hectare which drastically improves the soil moisture of the area where slope is more than 8^0. It costs about Rs. 4000 x 1.50 = Rs. 6000/ hec. (Rs. 50 x 120 mandays).

Wire Net Intervention

Two strong pillars at end base point of Nallah are erected and a strong wire net is tied on it upto a height of 6 - 8' from ground. It is filled with store boulders with mud patches. This intervention restricts the water. Thus a long durational check is possible at a very low cost. This improves water regime in the area. Cost of wire net Rs. 1000 x labour cost for arranging loose boulders Rs. 9000/- for 40' wide nallah.

Sand bag Checkdams

The empty plastic bags of cement are collected and filled with sand. These sand bags are piled-up in horizontal and vertical steps upto a vertical height of 6 - 8'. With small patch of clay in between two layers. This is a very low cost water intervention technique and is durable. This type of intervention works for about 10 years. Costs about Rs. 10,000/- for a nallah of 30'. (Cost of 1000 empty bags of polythine @ Rs.2 = Rs. 2000 + Rs. 8000 for 160 mandays to fill-up and arrange stack of sand bags).

Earthen Wells

Earthen wells of diameter 10' upto a depth of 20' can be dugout at a cost of below Rs.10,000/- with arrangement of Lath-kuri in Rs.1,000/- and is good for irrigation of about 1/2 acre of land. This technique is commonly used for vegetable cultivation.

Ring-ridge Technique

In this technique big round and ring shaped ridges are made to surround fruit plants. This keeps the soil moisture for longer duration. The plants are planted at a distance of 20' x 20'. Thus per hectare 250 plants are planted. The cost of plant ranges from Rs. 15 - 25 and plantation cost is about Rs. 10/plant. Thus the total cost varies from Rs. 6250 - 8750/ hectare. These plants need maintenance at a cost of Rs. 3000/hec. for 2 more years. Thus the total cost of orchard development becomes Rs. 12250 - 14750/ hectare. These plants are given social fencing so cost on fencing is saved.

Ridge-ditch Technique

If gradient or slope of land is high, then one another technique is helpful. In it 20' X 2' ridges with 20' X 1' ditch is dugout. Fast growing species or sabai or khus grass is planted at ridges which causes storage of rain water in ditches. This type of intervention breaks the speed of flow of rain water and stores water for longer duration in ditches. The total cost comes out to Rs. 7000/hec. (140 mandays/hec.)

Contour Ridge & Trenches

The contours are outlined and ridges and trenches as per requirement are made on contour to check the surface run-off. This is done to prepare agricultural land for regular agricultural practice.

Thus by these low cost techniques of insitu conservation of rain water the plant growth is improved and polycropping is done effectively which improves fertility of the land in CVY. The cost per hectare is Rs. 6000/- (120 mandays @ Rs. 50/-)

Table 1. Geophysical Report on Ground Water Condition of Tandwa & Sakanpirhi Village in Year 1998.

No	AB/$_2$ m	MN/$_2$ m	Apparent Resistivity Pa in ohm meter on VES point number											
			TANDWA						SAKANPIRHI					
				V	E	S	NO			V	E	S	NO	
			20	21	22	23	24	25	26	27	28	29	30	31
1	1.5	0.5	99.41	99.41	44.46	19.21	71.8	84.45	239.27	--	30.38	1.19	7.28	8.51
2.	2.0	0.5	90.94	116.97	48.4	22.3	66.9	89.94	208.50	104.13	33.10	11.43	8.83	9.54
3.	2.5	0.5	60.13	122.15	--	24.8	66.7	59.30	175.30	108.58	34.11	10.55	7.16	7.91
4.	3.0	0.5	35.73	130.3	--	27.49	69.2	38.25	162.19	151.74	37.38	10.12	7.03	6.04
5.	4.0	0.5	96.49	177.63	68.50	32.16	77.6	86.45	207.82	217.71	39.08	11.03	7.22	6.08
6.	6.0	0.5	409.93	573.3	41.46	40.99	95.4	315.50	330.19	185.31	44.92	7.79	7.92	5.50
7.	6.0	2.0	116.85	72.37	136.19	36.03	82.14	111.40	148.02	107.81	50.26	10.75	8.06	7.29
8.	8.0	0.5	598.6	688.9	47.12	48.06	108.15	498.30	668.93	252.5	30.06	10.63	9.21	6.00
9.	8.0	2.0	113.08	89.06	51.27	61.09	98.00	110.30	256.80	143.24	52.77	14.01	9.09	8.15
10.	10.0	2.0	94.25	159.80	69.72	74.95	99.50	89.43	229.21	25.14	--	18.04	10.40	11.45
11.	15.0	2.0	347.14	454.70	80.86	71.65	98.35	341.40	336.72	--	55.54	11.34	14.40	14.30
12.	20.0	2.0	108.25	712.20	77.18	92.18	96.41	119.50	547.39	282.06	15.33	22.43	18.35	14.86
13.	20.0	6.0	269.76	144.80	87.79	88.77	126.70	261.40	287.77	--	112.44	20.41	18.29	10.36
14.	25.0	2.0	87.9	780.30	92.52	105.17	102.40	82.50	653.35	353.11	34.14	30.25	23.89	77.73
15.	25.0	6.0	336.15	183.40	99.52	133.34	137.20	331.40	343.95	422.97	121.81	51.31	29.20	28.25
16.	30.0	6.0	357.38	232.90	118.74	176.30	175.30	327.30	298.57	536.97	135.71	44.73	29.63	42.92
17.	40.0	6.0	429.92	331.60	158.60	161.60	196.50	425.40	429.92	580.50	171.97	68.30	39.30	40.96
18.	60.0	6.0	606.48	498.50	188.79	191.60	195.90	601.40	540.16	490.09	251.92	69.20	58.78	58.31
19.	60.0	20.0	552.92	289.03	168.61	185.60	289.00	468.30	517.73	590.50	281.49	62.13	54.28	58.33
20.	80.0	6.0	607.80	549.80	222.89	185.90	860.00	601.40	560.50	513.65	333.21	78.41	73.30	76.15
21.	80.0	20.0	--	379.30	225.60	189.00	749.20	625.30	--	593.40	395.84	--	73.30	78.30
22.	100.0	20.0	645.40	444.80	256.36	211.80	610.70	641.6	600.00	650.00	552.25	---	36.46	90.45

ANALYSIS OF GEOPHYSICAL DATA

The Slumbergar data analysis shows apparent resistivity which is used to draw characteristic curves showing availability of ground water and corresponding depth from the data and curve drawn on its basis clearly indicates the variation due to CVP operation over years. The data is given in Table 1.

The Slumbergar data analysis shows apparent resistivity which clearly shows variation in water level within the plantation. From the data generated on the basis of geophysical analysis using resistivity meter and verification from the measurement of depth of water in existing open sources clearly indicates that water level has improved upto 3 meters in some cases within plantation area. This increment in water tables due to CVP operation was also evidence from the moisture status in the plantation region. The data is provided in Table 2.

Table 2. Geophysical Report on Ground Water Condition of Tandwa & Sakanpirhi Village in Year 1999 from the same points as in table 1.

No	$AB/_2$ m	$MN/_2$ m	Apparent Resistivity Pa in ohm meter on VES point number											
			TANDWA						SAKANPIRHI					
				V	E	S	NO			V	E	S	NO	
			20	21	22	23	24	25	26	27	28	29	30	31
1	1.5	0.5	239.27	--	30.38	99.41	99.41	44.46	1.19	7.28	8.51	19.21	71.8	84.45
2.	2.0	0.5	208.50	104.13	33.10	90.94	116.97	48.4	11.43	8.83	9.54	22.3	66.9	89.94
3.	2.5	0.5	175.30	108.58	34.11	60.13	122.15	--	10.55	7.16	7.91	24.8	66.7	59.30
4.	3.0	0.5	162.19	151.74	37.38	35.73	130.3	--	10.12	7.03	6.04	27.49	69.2	38.25
5.	4.0	0.5	207.82	217.71	39.08	96.49	177.63	68.50	11.03	7.22	6.08	32.16	77.6	86.45
6.	6.0	0.5	330.19	185.31	44.92	409.93	573.3	41.46	7.79	7.92	5.50	40.99	95.4	315.50
7.	6.0	2.0	148.02	107.81	50.26	116.85	72.37	136.19	10.75	8.06	7.29	36.03	82.14	111.40
8.	8.0	0.5	668.93	252.5	30.06	598.6	688.9	47.12	10.63	9.21	6.00	48.06	108.15	498.30
9.	8.0	2.0	256.80	143.24	52.77	113.08	89.06	51.27	14.01	9.09	8.15	61.09	98.00	110.30
10.	10.0	2.0	229.21	25.14	--	94.25	159.80	69.72	18.04	10.40	11.45	74.95	99.50	89.43
11.	15.0	2.0	336.72	--	55.54	347.14	454.70	80.86	11.34	14.40	14.30	71.65	98.35	341.40
12.	20.0	2.0	547.39	282.06	15.33	108.25	712.20	77.18	22.43	18.35	14.86	92.18	96.41	119.50
13.	20.0	6.0	287.77	--	112.44	269.76	144.80	87.79	20.41	18.29	10.36	88.77	126.70	261.40
14.	25.0	2.0	653.35	353.11	34.14	87.9	780.30	92.52	30.25	23.89	77.73	105.17	102.40	82.50
15.	25.0	6.0	343.95	422.97	121.81	336.15	183.40	99.52	51.31	29.20	28.25	133.34	137.20	331.40
16.	30.0	6.0	298.57	536.97	135.71	357.38	232.90	118.74	44.73	29.63	42.92	176.30	175.30	327.30
17.	40.0	6.0	429.92	580.50	171.97	429.92	331.60	158.60	68.30	39.30	40.96	161.60	196.50	425.40
18.	60.0	6.0	540.16	490.09	251.92	606.48	498.50	188.79	69.20	58.78	58.31	191.60	195.90	601.40
19.	60.0	20.0	517.73	590.50	281.49	552.92	289.03	168.61	62.13	54.28	58.33	185.60	289.00	468.30
20.	80.0	6.0	560.50	513.65	333.21	607.80	549.80	222.89	78.41	73.30	76.15	185.90	860.00	601.40
21.	80.0	20.0	--	593.40	395.84	--	379.30	225.60	--	73.30	78.30	189.00	749.20	625.30
22.	100.0	20.0	600.00	650.00	552.25	645.40	444.80	256.36	---	36.46	90.45	211.80	610.70	641.6

The open well, pond and handpump data were collected from 70 availablesources in February, June September of 1999 and again from the same sources in February & June, 2000. From the specimen data tabled above, it is apparent that in all the cases the water level has increased ranging from 0.3 meter in case of ponds to 6 - 7 meter in case of handpumps. These ground datas not only shows a theoretical improvement due to vegetative cover but simultaneously it has improved the overall production of crops in the village. The depth of well and pond were measured by droping calibrated wire tied with heavy bob while the depth of handpumps were measured by droping small bob tied with thread and the distance of waterless section was measured on getting the sound of bob touching the water level when inserted through the suction pipe.

It is apparent from vertical electrical sounding results that the water table increased in the area due to coverage of good plant stock. This was due to capillary action for growth of plants. The increase in water table is also apparent from the data of open well depths and availability of water round the year.

The tieridges made among plants stored rain water insitu and improved soil fertility of the area.

Arhar is the common intermediate crop being used by the villagers .

Poor W.T. has been witnessed when we go away from plantation area. In one analysis very poor water availability data in VES 22 clearly indicates presence of vertical dyke.
The overall water percolation has improved the soil and reduced the average temperature. The temperature reduction is apparently felt on entering the plantation and comparing with outside plantation temperature.

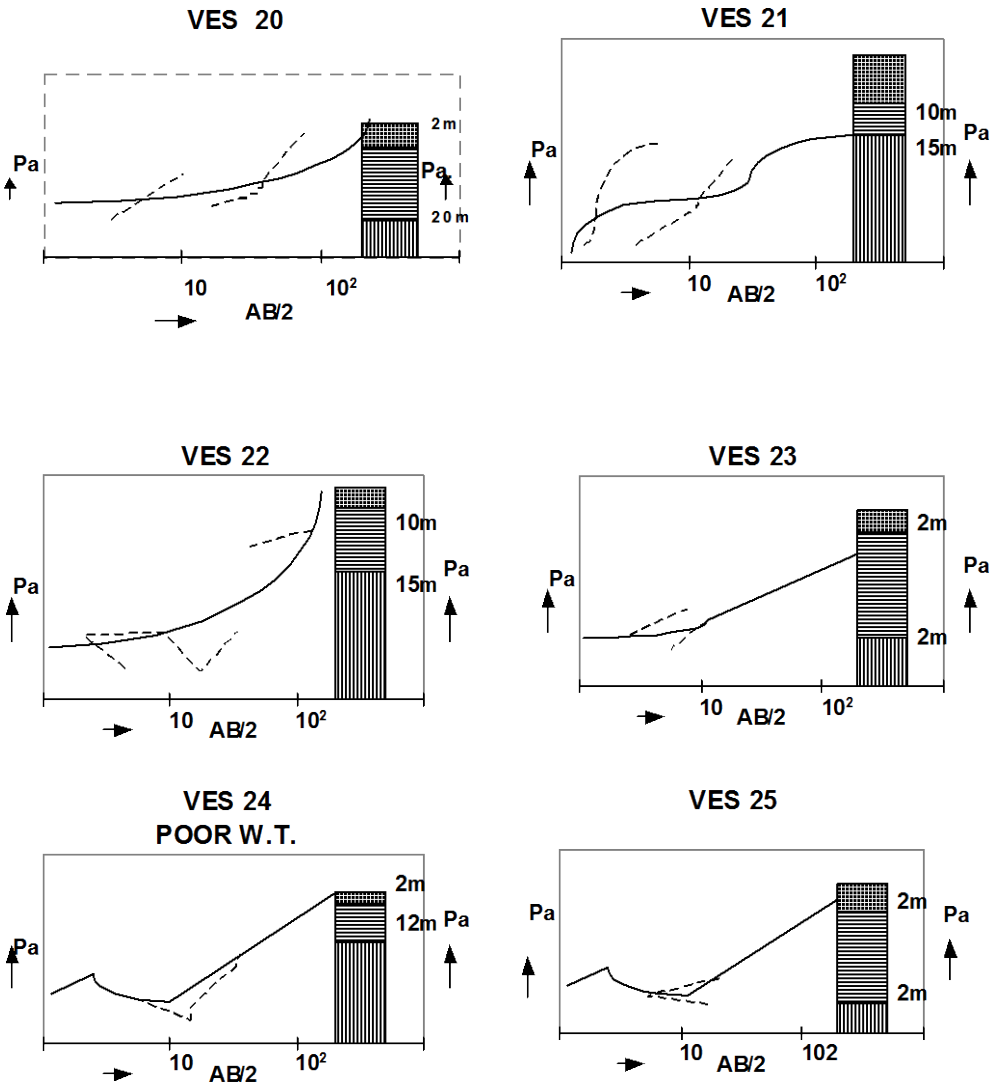

Figure 1. Resistivity VES curves.

Table 3. Depth of water level in some selected water sources within Tandwa-Sakanpirhi -Nawada micro watershed during different months over years.

Sl. No.	TYPE OF WATER SOURCE			NAME OF WATERSHED :- Jinjoi River Watershed (Tandwa - Sakanpirhi - Nawada)					
	Well	Pond	Hand pump	Name of owner or Location	Depth of Water table (in meter) 1999/ 2000				
					Total depth in feet	Feb.	June.	Sep-tember	Feb, 2000	June, 2000
1.	3	5	5	Sri Sudeshwar Singh	6.3	1.2	dry	2.4	2.1	0.6
2.	3	5	5	Sri Ramkesh Singh	6.6	1.5	0.3	2.7	2.4	1.5
3.	3	5	5	Sri Jagdish Dubey	7.5	1.5	0.9	2.4	2.1	1.8
4.	3	5	5	Sri Narang Singh	7.5	1.8	0.9	2.4	2.1	1.8
5.	3	5	5	Sri Suvansh Singh	7.5	1.8	1.2	2.7	2.4	1.8
6.	3	5	5	Sri Lalvansh Singh	7.5	2.7	1.5	3.6	3.3	2.7
7.	3	5	5	Sri Satdeo Dubey	6.3	1.5	0.6	2.4	2.1	1.8
8.	3	5	5	Sri Baldeo Dubey	6.3	1.2	dry	2.4	1.5	0.9
9.	3	5	5	Sri Naresh Singh	7.5	1.5	0.6	2.7	2.6	2.1
10.	3	5	5	Sri Chandrika Pandey	7.5	1.5	0.6	1.8	1.5	1.2
11.	3	5	5	Sri Bidesh Bhuiyan	6.0	1.8	0.9	2.7	2.5	2.1
12.	3	5	5	Sri Satyanarayan Ram	6.0	1.5	0.6	2.4	2.1	1.9
13.	3	5	5	Sri Munrika Singh	7.5	1.5	0.6	2.4	2.2	1.7
14.	3	5	5	Sri Ramnath Singh	6.3	1.5	0.6	2.7	2.5	2.1
15.	3	5	5	Sri Jagdish Singh	6.3	1.8	0.9	2.7	2.4	2.2
16.	3	5	5	Sri Saryu Singh	6.0	1.8	0.9	2.7	2.4	1.6
17.	3	5	5	Near School	6.3	1.5	0.6	2.4	1.8	1.6
18.	3	5	5	In Sukhnandan Singh Dohar	6.0	2.4	1.5	3.3	3.0	2.6
19.	3	5	5	Sarwajanik Pidhari ahar	6.3	2.4	1.5	3.0	2.8	2.4
20.	5	3	5	Barwaha	3.0	1.5	0.9	2.4	1.8	1.2
21.	5	3	5	Bihar Govt.	3.0	1.2	dry	2.4	1.5	0.3
22.	3	5	5	Sri Brahm Singh	6.3	1.5	0.9	2.7	2.1	1.2
23.	5	5	3	Near Bachu Singh residence road side	45.0	10.8	8.0	20.0	15.5	11.0
24.	5	5	3	Near Devi Mandap	51.0	12.0	9.0	21.0	16.0	12.0
25.	5	5	3	Harijan tola	51.0	12.3	10.0	20.0	15.0	12.0
26.	5	5	3	Near School	48.0	10.0	9.0	15.0	14.0	12.0
27.	5	5	3	Near Dhirju house	48.0	9.0	8.5	13.0	12.0	9.5
28.	5	5	3	Near Uday Narayan Singh house	51.0	12.0	10.0	20.0	18.0	16.0
29.	3	5	5	Near Uday Narayan Singh house	6.3	2.1	1.2	3.3	3.0	2.7
30.	3	5	5	Dharmdev Singh	6.3	1.8	1.2	3.3	3.0	2.7
31.	River	5	5	Near Jinjoi Tandwa Bhalko Lift	2.4	1.5	0.6	2.4	2.1	1.5

The humous covered due to leaf litters is improving soil class.

It was common practice to donate purely wasteland for CVY work. With the increased fertility. Good land are being used for such operations.

The sharing of usufructs from sale of plants, vegetables and fish were done equitably under 1:3:3:3 pattern.

The practice of sharing over ruled the legal ownership right on land which is the excellent example of common property land resource management.

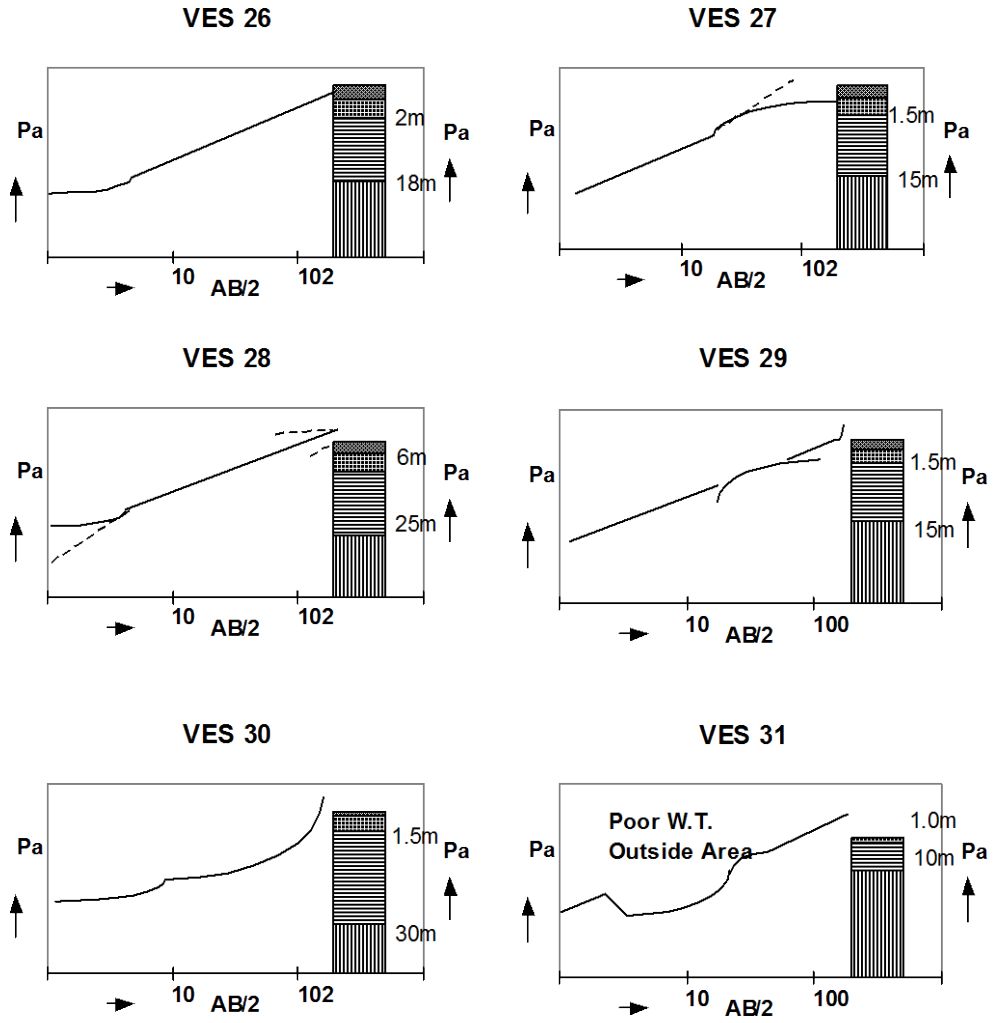

Figure 2. Resistivity VES curves (contd.).

CONCLUSIONS

SHRMS, CVY is an effective alternative model of sustainable development.

The geophysical analysis in detail of the village over period of time shows the overall improvement in water stock of the area which is essential requirement for area development plans.

The goal oriented project planning in Chakriya Vikas with requisite, effective action plan will prepare a practical model for development at micro level.

The bio-diversity and soil moisture relation clearly indicates the improvement in socio-economic condition of the people.

With harvest and sharing of usufructs from sale of fuel/timber stock will give incentive to each family and a practical case of socio-economic upliftment programme.
The money available in village development fund after sharing of expected harvest will initiate secondary enterprenureship to increase the socio-economic condition and the system will complete its first cycle of operation.

Self-sprouting of CVY will initiate with village development fund and Kalyan Kosh from the village.

The villagers have produced a number of seasonal crops in the water scarcity area and have received the benefit of production from the drought prone area.

Due to improved soil water condition, the villagers have created their own water intervention channels in the area and are joining together for community effort for bigger interventions.
Due to awareness of the people micro watershed development project has been initiated in the area which caters the need of asset building interms of soil moisture conservation, creation of chechdams, tanks, lift irrigation, contour bunding, agro forestry and allied programmes for peoples benefit.

Thus it has been observed through the case study of village Tandwa - Sakanpirhi where Society of Hill Resource Management School has taken up micro watershed development programme that with change in biomass of the area the ground water has been artificially recharged and it has charged the people of the area with enthusiasm for their own development. The standing resource stock developed in form of trees in the village at a cost of about Rs. 15.00 lakh has been estimated to be of value more than Rs. 250.00 lakh, which is 1:15 growth ratio. From phased harvest of the created asset as per agreed 1:3:3:3 pattern the cordon society (SHRMS) will be benefited by 10% which is about Rs. 25.00 lakh sufficient to expand similar programmes in other areas and monitoring the progress while Rs. 75.00 lakh will be available in the village fund for area improvement programme. This amount will be in addition to normal production of the village thus it could create a corpus for enhancing the periphery of the developmental programme in adjoining areas. Thus the system development called Chakriya Vikas has inbuilt mechanism to improve the ground water for overall improvement of the society inwhich we live and which is ultimate of our all developmental programmes.

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