Integrated Watershed Management Programme: An ultimate tool for soil conservation

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Abstract: **Population in India is growing at the rate of about 1.92 percent per annum. According to 2001 census, the population was around 100 crores and it gradually increased to 121 crores by 2011. As per the recent estimates, India's population is more than 130 crores and growing at the rate of 1.64% per annum. This being the rate, the days are not very far, where, India will be overtaking China's population, which is around 141 cores. Every newly born child needs to be fed. If this is the case, to meet the growing demand for food the country needs to plan to feed the increasing population by increasing the production of food grains to that level. However, the food production is increasing at a mere rate of 0.2 percent, which is not on par with the growth rate of the population in the country. To meet this demand, the best technological approaches have been adapted in terms of HYV seeds, fertilizers, pesticides, machines etc. Since agriculture sector is prone to diminishing returns to scale, further improvement in technology will not help in increasing the productivity levels. Thus, there is a need to explore, other possibilities of increasing the agricultural production and productivity. In this process, increase in cropping intensity, by utilizing the existing water resources is an important area to be explored. But extensive use of arable land has resulted in drastic soil erosion. This gets reflected in reduced agricultural productivity. Soil erosion is a widespread environmental problem that threatens human beings in the developing countries. Each year, 75 billion tons of soil is removed in the globe due to erosion with most of it from agricultural land. An average rate of soil erosion in Asia is more than 138 tonnes (ha. year). Proper environmental planning at different levels has been called for by watershed managers during the last 17 years with the introduction of KAWAD Project (2001) to integrate natural resources and human needs continually and effectively. Therefore soil conservation is the need of the hour and a well structured integrated watershed management programmes can play a vital role in soil conservation.**

Key Words: Population growth, Soil erosion, Agricultural productivity, Soil conservation.

INTRODUCTION

Soil conservation refers to all those measures, which are undertaken to prevent soil erosion and also to improve the fertility of the soil. The soil erosion can be controlled through a number of measures. Some of the important measures are:

- Afforestation: Soil erosion can be prevented by planting more and more trees in hilly regions and on Deforested land and preventing reckless felling of trees.
- Control of over Grazing: By controlling the unscrupulous grazing of animals, soil erosion can be controlled. Following of some scientific methods like "Turfing" {growing grasses on the land} also prevents soil erosion.
- Use of coal and wood as fuel must be regulated: instead LPG, Gober Gas or Electric stoves must be used.
- Contour Cultivation: Cultivation across the slopes will check the velocity of running water and thereby prevents Soil Erosion.
- By Constructing bunds, barriers on the agricultural fields across the slopes prevents soil erosion.
- Crop rotation and growing of cover crops will increase the fertility of soil and keeping the land fallow for some years will replenish the fertility.
- Adopting proper water management and flood control measures soil erosion could be provided

- Maintaining a separate, well constructed passage for quick running of waste water, prevents soil erosion.
- Wind Screening (Growing trees in Rows) for stopping soil erosion by wind may be adopted.

Out of all these above mentioned measures for soil conservation, Integrated Watershed Management Programme appears to be an ultimate solution because growing population and related socio-economic developments are placing increasing pressure on the water resources in India. Demand for water, in all the sectors of the country, is increasing, while adequate supply is constantly diminishing. Failure of monsoon rains and the increasing water stress are greater concerns coupled with anthropogenic carbon dioxide emissions, global warming and climate change that lead to the intensification of the hydrologic cycle. Growing convexity of water resource systems and the challenges of its management led the international community to introduce the concept of Integrated Water Resource Management (IWRM). Since the daily lives of 600 million people in India depend directly on functioning of watersheds providing drinking water, irrigation, energy, groundwater recharge and inland fisheries, suitable strategies of watershed prioritization and planning is necessary. Failures in watershed prioritization and planning can have serious ramifications.

The balanced ecosystem and human system are vital indicators of a sustainable environment and better quality of human life. In rural areas, livelihoods and natural resources such as land, water, vegetation and livestock are interlinked. India's national economy is dependent on agriculture and the magnificence of its natural resources is legendary. With the heavy discharge of water, degradation of the natural resources, biotic pressure on the fragile eco-system with breakdown of traditional local management institution is threatening the entire human population. Water resource development is highly crucial for ensuring food security in many regions of world. Irrigated agriculture has been estimated as a major consumer of water, which accounts for 80 percent at the global and 86 percent of the total water use in developing countries. Watershed development program is accordingly communicated as an effective device for tending to a considerable lot of those issues and perceived as potential motor for farming development and improvement in delicate and minimal rainfed territories. Apart from soil conservation, a decent administration of normal assets at watershed scale delivers numerous advantages as far as expanding nourishment generation, enhancing jobs, securing condition, addressing gender orientation and value issues alongside biodiversity are concerned.

Meaning of Integrated Watershed Management Programme

Global water partnership (2000) defines "IWRM as a procedure which advances the planned improvement and administration of water, land and its related assets, keeping in mind the end goal to augment the resultant monetary and social welfare in an evenhanded way without trading off the supportability of key biological communities". Watershed is a geo-hydrological unit comprised of all land and water within the confines of a drainage divide. Essentially a watershed is all the land and water area, which contributes run off to a common point. Watershed is a land area that captures rainfall and conveys the overland flow and runoff to an outlet in the main flow channel. It may be flat or may include hillocks, hills or mountains. Each and every water and land area is a part of watershed. Generally, the following distinction is made to know the size of watershed; micro watershed, sub-watershed, watershed, catchment and river basin with a view to increase the size. To re-establish the environmental balance by monitoring and creating characteristic assets, for example, soil, vegetable cover and water. In order to encourage legitimate management of the reserves, which incorporates regular territories, woodlands, minerals, agri-business urban terrains, water and different assets. Also, to share the responsibility for environmental planning at all levels of government and to provide opportunities for community involvement in planning. Therefore, it promotes social and economic welfare of the community.

Watersheds are naturally occurring phenomena in the form of landscape, containing a complex arrangement of inter linked and interdependent resources and activities which are not decided by political boundaries. They constitute dynamic and integrated bio-physical, economic, social and environmental and political systems including people, agriculture, industries, communications, services and recreational facilities. The land resources of soil, water and vegetation cannot be managed in isolation from each other. There is a danger of mismanagement of fractional resources through improper planning. Integrated watershed management recognizes that the natural resources and the environment of a watershed can be successfully well preserved and protected by integrating and well managing the available natural resources which are decaying. Some are being misused, vulnerably protected and they are also prone to excess use. The main objective is to develop policies which promote the sustainable use of natural resources and take into consideration of economic, social and environmental issues of the watershed. Therefore, against this background successful implementation of IWMP concept requires coordinated action by the various government authorities that are concerned with land and water management.

REVIEW OF LITERATURE

Research scholars like Chang et al., (1995), Peel and Lloyd (2007), Gezelins and Refsgaard (2007) expressed that the conflict between ecological problems and the monetary growth by diverse terrestrial uses within a watershed are experiments facing land use organizers in numerous emerging countries. Kenstofer (2001), Seppelt and Voinov (2002), Heilman et al., (2003) Wang et al., (2004) observed that an appropriate ecological design at diverse levels has been in demand by watershed supervisors during last few years to incorporate natural resources boundaries and human needs constantly and efficiently. The watershed development for separate land use, predominantly horticulture as one of the remarkable groups of the ecological humiliation is in this manner significant to realize sustainable progression.

Lin et al., (2000), Chang et al., (2008), said that separation from subdivision to the outlet has noteworthy effect and can impact contaminant rot wander. Faures etal., (1995), Chaubey et al, (1999) Dijk etal., (2002), Chang (2007), have told that in addition to influence the pollutant decay phenomenon, rainfall features, such as precipitation, rainfall strength and rainstorm shape, can change watershed returns.

Ranadhir et al., (1999) have specified that by relating integrated model to a watershed in North Central Indiana, it was perceived that it is potential to reach economic and water quality purposes in the watershed by spatially enhancing site precise practices. Chattopadhya et al., (2006) expressed in their study paper that no accessibility of uninterrupted rainfall and overflow accounts in majority of Indian watershed has led to the expansion of practices for appraisal of surface overflow from un-gauged basins.

Sadeghi et al., (2005) expressed that the core of management science is involved in modeling approach. Moreover, planning methodology to stipulate optimum use of limited resources is the most significant applied approach in watershed management to gain the optimum benefit. Singh et al., (1997) in a case study in Mani command Watershed, India exploited the production and benefit using linear optimization. The result of their study discovered that the presentation of optimal plan could increase the agricultural production and net returns nearly 36 percent.

Research Gap

The main drawback of the NWDPRA is incomplete works and the lack of interest shown by the villagers over the project. Evidently, most of the respondents have experienced no improvement in the productivity levels of the Kharif and Rabi crops. The respondents awareness about their village watershed committee in most implemented states is low and even members are not attending the meeting regularly.

In EAS scheme the villagers are not aware of the benefit of the scheme. On the other hand, the method adopted for implementation is not up to the mark and will not meet prescribed objective. The allocation of the funds concentrated on only allotted eligible

blocks. Finally, the role of coordination between the stake holders in this project has not been recognized. The study results found that the impact of KAWAD project on crop yield, annual income, employment generation, cropping intensity and on material status was not meeting the objective of the scheme.

Many writers have observed that the soil conservation activities being labour intensive were also undertaken as calamity relief measures during floods, droughts, etc. as a measure of sustenance for the poor people of the affected areas. The authors have further pointed out that these programmes though they were part of watershed works, they did not yield the expected result. The reason for poor results has not been explored from the respondents point of view. Further to achieve the inclusive growth in the villages, agricultural production and productivity with regard to cost aspects have not been probed by earlier literature. Most of the literatures have examined the different concepts from the macro point of view but it lacks an analytical study at the micro level.

OBJECTIVES OF THE STUDY

- To review the operating mechanism of integrated watershed programmes at national and state levels.
- To measure the impact of the watershed works on socio-economic status of farmers.
- To analyze the economic impact of watershed interventions on agricultural productivity, which results because of reduced soil erosion.

RESEARCH METHODOLOGY

Study Area: In order to understand the impact of implementation of watershed programme, watershed project implemented in Kolar district, which is one of the most backward districts in the state has been chosen. In Kolar district, Lakshmisagar grampanchayat, which contains 10 villages have been chosen for study.

Sample Size: For the purpose of data collection, a minimum of 350 sample respondents from all the villages were interviewed. Random sampling method by using Random table method was applied to draw sample respondents from the population.

Data Collection: Primary data was collected through questionnaire, direct personal interview method, method of schedule. Secondary data was collected though many published and unpublished sources.

Primary data collected from a sample of 350 respondents by using descriptive as well as certain sophisticated statistical methods. Simple statistical methods including averages and percentages/ratios as well as frequency distribution to compare the socio-economic status of the beneficiaries farmers was used. Statistical methods viz., correlation and regression analysis as well as Gini coefficient were used to examine the relationship between different socio-economic characteristics / variables to throw more light on the impact of watershed project.

RESULTS OF CORRELATION ANALYSIS

Sl.No.	Associated Socio-economic Variables	Karl Pearson's Correlation Coefficient
1.	Number of functioning bore wells and Cropping intensity	+ 0.63
2.	Cropping intensity and employment in person days	+ 0.71
3.	Cropping intensity and number of person days of hired labour	+ 0.82
4.	Cropping intensity and area under vegetable crops	+ 0.59
5.	Number of protective irrigation for standing crop and yield per ha (of ragi/maize/groundnut crop)	+ 0.72
6.	Cropping intensity and quantity of institutional credit availed	+ 0.54
7.	Farm household income and number of defaults in repayment of credit	(-)0.61

8.	Farm household income and amount of loans (from both money lenders & institutions) outstanding	(-)0.86
9.	Cropping intensity and quantity of fodder (produced both exclusively and as by-product of field crops)	+ 0.56
10.	Cropping intensity and number of livestock possessed (including bullocks, dairy animals, sheep and goats)	+ 0.67
11.	Cropping intensity and farm household income	+ 0.87
12.	Cropping intensity and value of farm assets possessed	+ 0.53
13.	Farm household income and farm assets possessed	+ 0.67
14.	Cropping intensity and value of non-farm assets possessed	+ 0.79
15.	Farm household income and value of non-farm assets possessed	+ 0.81
16.	Cropping intensity and number of agricultural extension programs attended/farm specialists consulted	+ 0.78
17.	Farm household income and number of school drop-outs	(-) 0.48
18.	Farm household income and average number of years of schooling of children	+ 0.67
19.	Farm household income and expenditure on children's education	+ 0.85
20.	Farm household income and expenditure incurred on health care	+ 0.87
21.	Farm household income and household savings	+ 0.34

CORRELATION ANALYSIS

The Correlation coefficient is a measure of the linear dependence between two variables X and Y, giving a value between +1 and −1, where +1 indicates positive linear correlation, -1 negative correlation while '0' (zero) indicated no relationship. The formula for Pearson correlation coefficient ('r') is Correlation coefficient is a very useful statistic that shows the direction and magnitude of dependence between two variables. One of the cognizable impacts of watershed development program is increase in the cropping intensity, which is defined as the ratio of gross cropped area (GCA) to the net sown area (NSA) expressed in percentages. Thus Cropping Intensity = (GCA / NSA) x (100).

$$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2}\sqrt{(N\sum Y^2 - (\sum Y)^2}}$$

N = Number of pairs of scores

$\sum XY = $ Sum of products of paired scores

$\sum X = $ Sum of X scores

$\sum Y = $ Sum of Y scores

$\sum X^2$ = Sum of the square of X scores

$\sum Y^2$ = Sum of the square of Y scores

Computing the Gini Coefficient

For an empirical Lorenz curve generated by discrete data points, Gini coefficient is calculated with the formula:

$$G = \frac{n+1}{n} - \frac{2\sum_1^n (n+1-i)X_i}{n\sum_1^n X_i}$$

where the Xi is ordered from least to greatest.

Cropping intensity and Ground water table

Cropping intensity improves as a result of both increase in the availability of harvested rainwater and rise in the ground water table as a result of rain water seepage. This is evidenced by a positive and high Coefficient of Correlation (+ 0 63) between the number of functioning bore wells and cropping intensity in the watershed command area.

Cropping intensity and Cropping Pattern

Watershed development brings about diversity in the cropping pattern in the command area due to improvement in the availability of water for irrigation. Farmers tend to shift cultivation from cereal crops like ragi to vegetables, fruits and flowers fetching higher incomes. Farmers in many taluks in Kolar region including Srinivasapur taluk are known to grow vegetables like tomatoes using ground water irrigation

to profit themselves from the nearby metropolitan markets. Watershed development improves ground water table thereby increasing the cropping intensity and enabling farmers to grow vegetables using bore well water. The coefficient of correlation between cropping intensity and area under vegetable crops is + 0.59.

Cropping Intensity and Yield Per Ha.

The yield per ha. of field crops like ragi, maize, and groundnut has gone up with theincrease in the number of protective irrigation provided to the standing crops. The coefficient of correlation between the number of protective irrigation for standing crops and yield per ha (of ragi/maize/groundnut crop) is found to be + 0.72.

Impact of Watershed Development on Farmers' Social Traits

With the rise in farm incomes facilitated by increased cropping intensity, the educational and health care aspects of farmers as also their consumption pattern change significantly. For instance, increase in household income leads to a decline in the incidence of school drop-outs, although the correlation coefficient between the household income and the number of school drop-outs rather low, (-) 0.48. The correlation between farm household income and the average number of years of schooling of children is positive and fairly high (+ 0.67). The household income has been found to have a strong positive impact on the expenditure incurred on children's education, the correlation coefficient in this regard is + 0.85.

FINDINGS

- The total area was cultivated before watershed works was 262.50 acres in case of marginal farmers, which has gone up to 33.50 acres. The average land per household in case of Marginal Farmers was 1.75 acres, which is about 2.25 acres as on today. Therefore, per capita increase in land per family is about 0.50 acre.
- Before watershed works the Marginal Farmers were having 87 acres of irrigated area, which is increased 162 acres. Before watershed works on an average per family they had 0.58 acre, which is increased to 1.07 acres showing an increase of about half an acre per family.
- The migration rate has come down to 52 percent from the before the implementation situation to after the implementation of the IWMP. The number of people who were migrating before the implementation of the IWMP was 22 persons, which has come down to just 10 persons.
- Cropping intensity improves as a result of both increase in the availability of harvested rainwater and rise in the ground water table consequent upon rain water seepage. This evidenced by a positive and high Coefficient of Correlation (+ 0.63) between the number of functioning bore wells and cropping intensity in the watershed command area.
- Watershed development brings about diversity in the cropping pattern in the command area due to improvement in the availability of water for irrigation. Farmers tend to shift cultivation from cereal crops like ragi to vegetables, fruits and flowers fetching higher incomes.
- Increase in cropping intensity has a positive impact on fodder production and livestock possessed by farmers. The quantity of fodder (produced both exclusively and as by-product of field crops) increases with the increase in cropping intensity and thereby facilitates maintenance of larger number of livestock by the farmers. The coefficients of correlation of cropping intensity with fodder production and livestock are + 0.56 and +0.67 respectively.

CONCLUSION

The integrated watershed programmes implemented in the study area shows potentiality of helping the agriculturists and horticulturists. Watershed programmes are successful in controlling soil erosion, in promoting soil conservation. Excessive use of available water resources by the growing population has profoundly affected its availability and its judicious usage. This problem must be addressed immediately for the betterment of beneficiaries. The threat of water degradation in rural areas with breakdown of traditional local management institution can be addressed by effective implementation of integrated watershed programmes.

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