ANALYSIS OF SOIL AND WATER CONSERVATION INVESTMENTS IN KERALA AND FARM LEVEL FINANCIAL GAINS

By

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2016-21-004

DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE
VELLANIKKARA, THRISSUR - 680 656
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LOKESH S
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THESIS

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COLLEGE OF AGRICULTURE, VELLANIKKARA
KERALA AGRICULTURAL UNIVERSITY, THRISSUR - 680 656
KERALA, INDIA

2020

DECLARATION

I, hereby declare that this thesis entitled **"ANALYSIS OF SOIL AND WATER CONSERVATION INVESTMENTS IN KERALA AND FARM LEVEL FINANCIAL GAINS"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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Certified that this thesis entitled **"ANALYSIS OF SOIL AND WATER CONSERVATION INVESTMENTS IN KERALA AND FARM LEVEL FINANCIAL GAINS"** is a bonafide record of research work done independently by **Mr. Lokesh S. (2016-21-004**) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associateship, fellowship to him.

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We, the undersigned members of the Advisory Committee of **Mr. Lokesh S. (2016-21-004)**, a candidate for the degree of **Doctor of Philosophy in Agriculture**, with major field in **Agricultural Economics**, agree that the thesis entitled **"ANALYSIS OF SOIL AND WATER CONSERVATION INVESTMENTS IN KERALA AND FARM LEVEL FINANCIAL GAINS"** may be submitted by **Mr. Lokesh S.,** in partial fulfillment of the requirement for the degree.

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Introduction

1. INTRODUCTION

Climate change is expected to increase stress on water resources which impacts the agricultural production and farmers' livelihoods. There are instances where annual rainfall shows decreasing pattern while increase in high precipitation days and the gap between two high precipitation days is leading to drought, especially in the second half of the 20th century (Trenberth *et al.,* 2007; Peterson *et al.,* 2008a). India is also facing similar climatic changes where extreme rainfall events are increasing (Rajeevan *et al.,* 2008; Krishnamurthy *et al.,* 2009) and it is more frequently observed in monsoon seasons (Roy, 2009; Pattanaik and Rajeevan, 2010). These climate change events alter the stream flow (Stahl *et al.,* 2010) and impact the ground water level (Jeelani, 2008; Miranda *et al.,* 2011). There are large number of reports on the impact of climate change on the declining water availability and water table (Mukherjee, 2007; Krishnakumar *et al.,* 2009; Kumar, 2014 and George, 2016) and its negative impacts on agricultural production (Latha *et al.,* 2012) and farm household welfare (Bobojonov and Awhassan, 2014; Narayanan and Sahu, 2016). The climate change in peninsular India is manifested as changes in precipitation pattern and temperature (Gawali *et al.,* 2019; Krishnan *et al.,* 2020). The modified patterns of rainfall events are causing floods and droughts and other ecological impacts like soil erosion.

High latitude and tropical regions are more vulnerable to climate changes where warming up of these regions is taking place at the faster rate along with the increased number of droughts and temperature effects (Cavazos *et al.,* 2008; Ohmura 2012; IPCC 2014; Bandopadhyay 2016). Wayanad is one such district in Kerala with the altitude ranging between 700 to 2100 meters and is declared as one of the hot spots of climate change in the State (Nandakumar, 2014). The annual increase in mean temperature in Wayanad is reported at 0.45 ^{o}C (Gopakumar, 2012). There is considerable variation in the rainfall distribution, wherein rainfall intensity and duration are also changed (Nair *et al.,* 2014; Ajithkumar and Vysakh, 2018). The average rainfall in the region is decreasing and is getting skewed (Swaran, 2015; Kandiannan *et al.,* 2018;

Guhathakurta *et al.,* 2020). Navyashree and Ajithkumar, (2018) reports 17 percent reduction in annual rainfall during the period 1983 to 2016.

The manifestations of climate change in Wayanad is mainly water scarcity, reflected as droughts at varying levels (Kumar and Srinath, 2011). During the past 30 years, (1983 to 2020) the district has experienced drought in 15 years. The ground water level has decreased by 42 per cent in 2009 compared to 1989 (Jayashankar and Babu, 2017; GoI, 2017). The skewness in rainfall during 2018 and 2019 (flood in August and drought in September, November and December) have resulted in ecological disasters. The people in Wayanad have incurred heavy losses due to floods and landslides during 2018 and 2019. In 2018, the District suffered agriculture losses amounting to 1008.65 crores from the 1,00,060 ha flood affected cropped area (Sinto and Remya 2018; PDNA, 2018).

Being a part of the Western Ghats ecosystem, the hilly district has an undulating topography with an average gradient of more than 10 per cent. This situation leads to heavy top soil loss during intense rainfall and slow erosion during the normal rainfall regime. The landuse and cropping pattern changes (Varghese, 2012) has also substantially contributed to the soil erosion in the region.

The climate change induced factors like uneven rainfall leading to soil erosion, decrease in ground water table and lack of irrigation facility have adversely impacted the agricultural situation in the District among other sectors. Being an agrarian economy, with coffee, black pepper and rubber as the major crops, the changes are severely influencing the output and farm income. (Sunil, and Devadas, 2004; Rao, 2016; Jayakumar *et al.,* 2017; Ajithkumar and Vysakh, 2018). Wayanad also houses highest proportion of tribal communities and is the only district in Kerala identified as aspirational district.

Soil and water conservation measures assumes significance in such situations where the gradient, land use and rainfall factors facilitate top soil loss and is considered as one of the major adaptation strategy to address the problem. Studies estimate the topsoil loss to the tune of 15 - 18 t $h^{-1}y^{-1}$ (Prasannakumar *et al.,* 2011; DES-K, 2014; Das, 2017) whereas the soil erosion rate has been reduced to 6 t $h^{-1}y^{-1}$ in the watershed

treated areas (Balasubramani, *et al.,* 2015) and is successful in controlling the soil erosion between 50 – 80 per cent. Soil erosion rate in the Western Ghats Areas of Kerala range between 0 - 09.31 t $h^{-1}y^{-1}$and majority of the areas are facing the severe soil erosion (>25 t $h^{-1}y^{-1}$) risk in the area (Prasannakumar *et al.,* 2011a). SWC measures have proved to be effective in managing the situation and securing farm income and ecological safety. (Adimassu *et al.,* 2016; Manivannan *et al.,* 2017; Uwizeyimana *et al.,* 2018)

The state efforts to propagate the soil and water conservation measures in the district was initiated during 1981. The major schemes are Arable Land Treatment (ALT), Drainage Line Treatment (DLT), Drought Mitigation Scheme (DMS) and Western Ghats Development Scheme (WGDP). These schemes mainly include structures like Earthen bunds, stone pitched bunds, water conservation pits, check dams, farm ponds, wood check dams, side protection walls and well recharge on a watershed based approach.

Though there are large number of studies that assess the extent of climate change, its impacts, coping and adaptation strategies in Wayanad (Srinath and Kumar, 2012; Swaran 2015; Gaetaniello *et al.,* 2014), specific studies to assess the level, impacts and efficiency of long term adaptation strategy (SWC) is not seen reported from this region. Hence this study was taken up with the specific objectives of

1. The study proposes to analyse the institutional credit flow towards soil and water conservation investments in Kerala
2. To assess the household level investment on soil and water conservation
3. To assess the farm level economic viability and efficiency of such investments
4. To understand the local preferences for soil/water conservation methods, and
5. To understand the farmers' perceptions on effectiveness of conservation measures

Scope of the study

Climate change is expected to increase relative stress on water resources which impacts the agricultural production and farmers' livelihoods. There are large numbers of reports on the declining water availability/water table and its negative impacts on agricultural production and farm household welfare. The Management and adaptation strategies to water stress mainly focussed on increasing the supply through investment intensive options like digging open/borewell, technological changes to increase the rate of extraction and the like. The cheaper conservation efforts are often limited in practice. Groundwater recharge through conservation measures is more sustainable than intensive extraction measures. The results of the study can help in designing policies for implementing effective strategies for conservation which are socially acceptable and economically viable. The empirical information of the financial gain can be used in awareness creation programmes.

Limitations of the study

The present research work is a part of doctoral degree programme which has all the restrictions of time, finance, mobility and other resources. However, careful and rigorous procedures were adopted in conducting the research as objectively as possible. Data was collected from farmers centred on their remembrance and also the chance of remembrance bias is high. In spite of those limitations, every effort was made by the investigator to conduct the study as systematic as possible. It's believed that the findings and conclusions drawn from the present study could form the source for future research and basis for policy research

Presentation of the thesis

The thesis is divided into five chapters. The present chapter gives the introduction to the research problem, covers the scope, objectives and states the

limitations of the study. The second chapter deals with review of literature, relevant to the study. The third chapter details the study area, the methodological framework, analytical tools and conceptual issues. The fourth chapter narrates the results and also discusses the results in detail. The fifth and final chapter presents summary and policy prescription based on the study. The references and abstract of the thesis are given at the end.

Review of Literature

2. REVIEW OF LITERATURE

2.1 Institutional credit flow towards soil and water conservation investments in Kerala

2.1.1 International

Hoag (2004) reviewed about the economic incentives for soil conservation in the United States and opined that US had received money than any other country for implementing the Soil and Water Conservation (SWC) mechanisms. US Government used EITS (education, information, technology and subsidies) model for the effective implementation of the SWC measures. The author also concluded that the SWC measures were neither profitable in short run nor in the long run.

Rola *et al.* (2004) studied the watershed management approach in the Manupali watershed in Philippines. The Government had expended around 3,20,000 PhP for the development of 4 different micro watershed programmes under Tugsan, Maagnao, Alanib and Kulasihan rivers in the country. The Government also allocated 1.89 crore PhP budget between the years 1994 to 2003.

Gray and Srinidhi (2013) studied the economics of Kumbharwadi watershed project in Maharashtra. NABARD had contributed about $ 3,559, WOTR had contributed $ 9804 and the total cost of the project was around $ 39,50,380 which includes capacity building costs, staff time and technical expenditure, ecosystem values, social intervention costs *etc.* The project received the benefits of $ 90,20,520 with the low benefits and high costs scenario, with major share in agriculture sector.

2.1.2 National

Kotru (2003) reported that US $400 million was spent annually on watershed development programmes in India. About US $100 million was foreign aid. Out of which US $18 million was donated by Federal Republic of Germany. It was aimed at rehabilitation of the half of the India's degraded land (170 million ha) of semi-arid areas.

Reddy *et al.* (2004) reported that fifty per cent of the geographical area in India had faced land degradation problems, viz., soil erosion, degraded command areas and intensive cultivation. The Government had outlined an institutional set up that included research and development, made arrangement for the investments in soil conservation measures like bunding and river catchment treatments.

Desai (2005) studied the about the watershed development projects implemented in Dharwad and Haveri district of Karnataka. The study had identified that about 88 different watersheds projects were implemented in Dharwad district viz., 17 NWDPRA projects, 16 RVP, 9 under Sujala (World Bank Sponsored Scheme), 45 DPAP projects and one under WGDP scheme. It covered an area of 4.27 lakhs ha at the cost of 1.11 crore.

GoTN (2005) compiled the investments done on watershed development in Tamil Nadu till 2001-02. It was observed that 11 different programmes were implemented in the state of worth 867.20 crores.

Arya and Yadav (2006) studied the economic viability of ponds renovation in Watershed of Johranpur (HP). The authorities had invested 9.21 lakhs over five years of time, present worth of a cost was 28.40 lakhs and it had fetched the benefit of worth 48.49 lakhs.

Lokesha *et al.* (2008) conducted the economic analysis of Kolaramma tank watershed in Eastern dry zone of Karnataka. A total of 78.89 lakhs was expended on the area of 6570 ha area. The money spent was decomposed into information cost (4.41 %), contractual cost (13.56%) and enforcement cost (82.03%). The amount expended was 1880.66 per hectare and 104.43 per beneficiary in the watershed area.

Kareemulla *et al.* (2009) studied the National Rural Employment Works through National Guarantee Scheme (NREGS) In India. The study identified that under NREGS Madhya Pradesh had the highest work share followed by Rajasthan and Andhara Pradesh (undivided). A total of 24370 crore rupees was expended under the scheme in which Rajasthan got highest share of 25.30 per cent. In Andhra Pradesh 2964 crores was expended out of which 97 per cent of money was expended on the

SWC measures. It was almost same case in all the states *i.e*. majority of the works carried were SWC activities.

Tilekar *et al.* (2009) evaluated the economic viability of Bahirwadi watershed project in Maharashtra. 1.10 crore had been invested on the Bahirwadi watershed by the government with the anticipation of 1.44 crore annual returns.

Bhan (2013) studied the land degradation and integrated watershed management in India. There were different watershed programmes implemented in India *viz.,* NWDPRA, RVP & FPR, WDPSCA RADAS and WDF implemented from the Department of Agriculture and Cooperation, Ministry of Agriculture. DPAP, DDP, IWDP, EAP and IWMP were the programmes implemented by Ministry of Rural Development. Total of 27.50 thousand crores in which 11.78 thousand crores were spent by Ministry of Agriculture and 15.72 crores were spent under Ministry of Rural Development.

Kumar and Sharma (2013) identified the different watershed programmes implemented by the GoI. Ministry of Agriculture, Department of Land Resources (MoRD) and Ministry of Environment & Forests have implemented different schemes for development of watershed in the country. A total of 17,037 crore was spent on 10 different watershed schemes till March 2005.

Bhan and Arora (2018) studied the efforts of soil and water conservation in Ravinous watersheds of Uttar Pradesh, India. The authors enlisted the efforts of Uttar Pradesh state government efforts in reclamation of ravine lands. The Government had expended about 29.89 million from 1951 to 1971 and reclaimed 62.34 thousand hectares into agriculture and forest land.

NABARD (2018) is refinancing agency to agriculture in India 1982. It had identified soil and water conservation as potential sector for refinancing and it had refinanced around 15,662.06 crores for the same in between 2014-15 and 2016-17.

Assavani (2019) identified NABARD as one of the leading institute supporting the development of watersheds in India. The study identified that NABARD had started to refinance the watershed programmes since 1992, and watershed had played a vital

role by increasing the ground water level, contributed in forest saving and impacted the crop planning of the country. NABARD had formulated different projects like WDF, SDP, Climate proofing Soil Project, Climate Proofing in Indo-German Watershed Development Projects and Springshed based Watershed Development Projects.

2.2 Household level investment on soil and water conservation, to understand the local preferences for soil/water conservation methods

2.2.1 International

Barbier (1990) studied the farmers concern for investing on the soil and water conservation measures in the uplands of Java, Indonesia. The study concluded that farmers were not ready to modify their land use pattern without proper economic incentive measures since the said structure were not fetching the expected returns together with high costs for conservation measures.

Lambregts (1993) studied the cost and profitability of farm ponds implemented in the farms of Upper Texas Coast. The farmers incurred on an average $ 347 (small farmers) to $ 1317 (large farmers).

Amsalu and Graaff (2006) identified the SWC measures adopted by the farmers in the Beressa watershed, central highlands of Ethiopia. The farmers had adopted the contour cultivation, drainage ditches, stone terracing, water ways, tree planting, grass strips and soil bunds on their fields.

Loeffen *et al.* (2008) studied the implementation of SWC technologies in West Africa. In the study area majority of farmers had adopted at least one SWC technology. The adopted technologies were stone bunds, branch barriers, half-moon structures, stone lines vegetative bands, live fences and small dikes.

Rosenberg and Margerum (2008) studied the motivation for watershed restoration in different watersheds of the Western Oregon, Monmouth United Kingdom. Land use types and types of watershed mechanisms available and income of the farmers had played a prominent role in the restoration of adopted watersheds.

Salia (2008) analysed the soil and water conservation investments in Mozambique, farmers had expended about $ 356 for the construction of 500 m^2 pond. The amount invested returned within 8 years of investments and was of $ 5,845 worth.

Adimassu (2013) studied the farmers preference for soil and water conservation practices in Central highlands of Ethiopia. The study considered structures like earthen bunds, earthen bunds with vetiver grass, earthen bunds with elephant grass and earthen bunds with *Susbania susban.* The Multi-Criteria Analysis (MCA), showed that farmers preferred more of earthen bunds with elephant grass followed by earthen bunds with *Susbania susban*, earthen bunds with vetiver grass and earthen bunds.

Bobasa (2013) identified the perception of farmers about the farm ponds on their lands of Gumara-Maksegnit watershed in Ethiopia. Among the farmers interviewed 80 per cent of the farmers interested in having a pond on their land and rest was reluctant because of land constraint. Only 20 per cent of the farmers were ready to pay and remaining farmers were waiting for the government to support being economically poor and less educated.

Kumar and Sharma (2013) studied the SWC measures adopted by the farmers in the different villages of Gujarath, Tamil Nadu, Jharkand and West Bengal. The results showed that field bunds/land levelling, vegetative barriers/pasture development and farm ponds were more preferred than the check dams, percolation tanks and tank renovation/repairs.

Mishra and Rai (2013) identified the indigenous SWC structures adopted by the farmers of Sikkim Himalaya. The farmers adopted both mechanical measures and biological measures, former included terraces, contour bunds, water ways, gully control, diversion channels and stone barriers and later includes alley cropping, mulching, minimum tillage, crop rotation, mixed cropping, vegetative barriers and agroforestry.

Mithun (2013) studied the preferences of the farmers for different SWC measures in Haveri and Dharwad of Karnataka. The farmers were more interested for adopting the Shrub checks (86.25%) followed by water ways, boulder bunds, recharge

pits and vegetative bunds. However, showed less interest for staggered contour trench (6.25%), contour strip, rubble check, contour bunds. Land holding, annual income of the family, extension participation and awareness about the soil erosion contributed more for the adoption of SWC measures.

Mulat (2013) studied the indigenous knowledge about the SWC practices adopted by the Konso people of Ethiopia. Terracing, contour ploughing, surface mulching, agro forestry and field boundaries were the important SWC measures adopted by the farmers.

Belay (2014) studied the different soil and water conservation technologies adopted by the farmers in Ethiopia. Farmers in the region had successfully adopted the diversion ditches, contour ploughing, crop rotation and terracing activities.

ICRISAT (2014) identified the SWC measures adopted by the farmers of Sandur taluk in Bellary of Karnataka. The farmers had adopted gully plugs (90), recharge pits (15) farm ponds (9) and check dams successfully.

Teshome *et al.* (2014) studied the preference of farmers to adopt the soil and water conservation measures in the North-Western Ethiopian Highlands. The farmers preferred stone bunds followed by soil bunds and *Fanya juu* (vegetative bunds) in the steep sloped area. In the moderate and gentle sloped area farmers preferred soil bunds first, followed by vegetative bunds and stone bunds.

Vongsana (2014) measured economics of pond irrigation in southern rural areas of Lao. On an average about 12,000 LAK/m^2 was expended by each farmer, NPV of such investments at 10 per cent interest rate was around 23 LAK (small farmers) to 55 LAK (large farmers). IRR varied between 14 LAK (large farmers) and 41 LAK (small farmers) and BC ratio was more with small farmers (3.77) and 1.23 with large farmers.

Ashoori *et al.* (2015) examined the soil and water conservation measures adopted by the paddy farmers in the Guilan province, Iran. Plastic mulch on the boarders of rice fields, use of bunds, levelling and terracing farms and cleaning sediments in canals and farms drainage were the SWC measures practiced in the region

by the paddy farmers. Overall adoption of SWC measures was low owing less education and lack of awareness.

Turinawe *et al.* (2015) studied the SWC measures adopted by the farmers in the South-western Uganda. About 81 per cent of the respondents adopted the SWC measures and they preferred Fanya chini terraces, trenches and grass strips mainly. Household size, social position, livestock units of the household, size of the plot, steepness and neighbours adoption had led the adoption of SWC measures.

Walie (2015) studied the farmers preferences for SWC structures In Wyebla watershed, Northeast Ethiopia. The farmers adopted normal bunds, contour cultivation, cut off drain and check dams as a measure of SWC in their plots.

Birhanu (2016) identified the SWC measures adopted in the Libo Kemkem Woreda region of Ethiopia. The farmers preferred stone faced soil bunds and stoned bunds over soil bund cut drains and check dams. Age, education, slope of the land, access to credit, training and farm size were the factors contributed significantly to the adoption of above said SWC measures.

Walie and Fisseha (2016) studied the preference for SWC measures by the farmers of Wyebla Watershed, Northwest Ethiopia. The farmers preferred normal bunds, contour cultivation, crop rotation, area closure, improved cut off drain and check dam structures for adopting in their land.

Asfawa and Neka (2017) studied the factor affecting the adoption of SWC practices using binary logistic regression in Wereillu, Ethiopia. The results showed that age, sex, education level, off farm activities, access to training services were factors contributed significantly to adopt the SWC structures.

Moges and Taye (2017) identified the preference of the farmers to adopt SWC measures North-West Highland of Ethiopia. The farmers preferred to adopt cut off drain, and terracing over the other structures. They faced the difficulties like reduction farming area and labour availability however had doubt about the effectiveness SWC measures.

Zerssa *et al.* (2017) studied the adoption of SWC measures South West Shewa, Ethiopia. The farmers successfully adopted the soil bunds, cultural ditch, stone bunds, water ways and contour ploughing measures.

Olawuyi (2018) studied the farmers preference towards soil and water conservation measures in Nigeria. The study revealed that farmers in the study area had preferred agronomic practices (mixed cropping, mulching, planting of cover crop, crop rotation and agroforestry) over the soil management practices and cultivation practices. These preferences were affected by age, education, gender, extension contacts and access to extension services.

Ashuro and Takele (2019) assessed the farmers preference for indigenous and modern soil and water conservation structures in Kechabira Woreda of Southern Ethiopia. The results revealed that in traditional structures farmers preferred stone bunds, traditional ditches, cut-off drains and terraces. While in modern measures, vegetative bunds, improved cut off drains, soil bunds and check dams were adopted.

Darkwah *et al.* (2019) studied the farmers preference for adopting soil and water conservation measures in Techiman Municipality of Ghana. Most of the farmers preferred to adopt zero tillage and was followed by crop rotation, intercropping, row planting and cover cropping.

Mengistu and Assefa (2019) studied the factors affecting the adoption of watershed management in Gibe basin of Southwest, Ethiopia. The results revealed that the around 82.60 per cent of the households in the study had adopted at least any one of the SWC structures like earthen bund and vegetative bunds. Age, education and household size, extension contacts and knowledge on the soil erosion were the factors contributed to the adoption of SWC structures.

Mosissa *et al.* (2019) studied the farmers preference for soil and water conservation measures in Gumuz region of Northwest Ethiopia. The results revealed that 9.30 per cent of the respondents had adopted at least one SWC structures and about 37.80 per cent of the people adopted a minimum of four structures. SWC structures preferred by farmers were vegetative terraces and levelled bunds and crop rotation.

Siébou *et al.* (2019) studied the farmers interest in adopting the Soil and water conservation techniques in Northern Burkina Faso. The results revealed that farmers were more interested in adopting the stone rows and zai method of cultivation (growing the crops in a water conservation pit).

Sileshi *et al.* (2019) studied the farmers preference for soil and water conservation in Ethiopia. The study identified that farmers fond of structures like stone bund, soil bund, bench terraces and check dams. The factors like education, extension contacts, income, extension contacts and plot size had affected the adoption.

Belachew *et al.* (2020) studied the preferences of farmers to adopt the soil and water conservation measures in Northwest Ethiopian highlands. The results revealed that farmers in the study were preferred earthen bunds, stone pitched bunds, check dam and strip cropping.

2.2.2 National

Rao *et al.* (2003) evaluated economics of few dryland technologies in Bijapur (Karnataka) and Solapur (Maharashra). The farmers in Bijapur had adopted two technologies *viz.,* conservation furrow and deep tillage that includes residue incorporation. In Solapur, farmers adopted only deep ploughing mechanism that includes deep furrows for water conservation.

Desai (2005) studied the investment pattern of farmers on rain water harvesting structures in Dharwad and Haveri district of Karnataka. Under different watershed projects farmers had adopted the rain water harvesting structures like farm ponds (□ 25,200), contour bund (□ 6,360), diversion channels (□ 2,120), rubble check (□ 3000), sunken ponds (□ 8,008) and nala bunds (□ 21450).

Dhyani *et al.* (2005) identified the SWC measures implemented in the Chhajawa watershed in Rajasthan. The results showed that farmers had successfully adopted the graded bunds, waste weirs, low height masonry check dams, land levelling and smoothening structure in their land.

Mansur *et al*. (2007) studied the preferences of the farmers in the contour bunding in Dharwad District of Karnataka. The Farmers preferred the contour bunds over graded bunds and local grass over khus grassed bunds.

Kareemulla *et al.* (2009) identified the farmer preferences for the SWC measures in Andhra Pradesh under NREGS scheme. The farmers were fond of farm ponds, earthen field bunds, stone bunds and tank de-silting works in Ananthpur district.

Palanisami and Kumar (2009) studied the impacts of watershed development programmes in Tamil Nadu. The study found that beneficiaries were preferred bunds and land levelling over summer ploughing and farm ponds because of low cost. The maintenance was done by few in farm ponds and was higher in summer ploughing. The people participation was high during planning and was gradually decreased in implementation and maintenance stage.

Tilekar *et al.* (2009) studied the farmer preferences for the soil and water conservation structures in Bahirwadi watershed area in Maharashtra. The earthen nala bunds, cement nala bunds and percolation tanks were the most adopted structures in the watershed area.

Barman and Das (2010) enlisted the SWC measures adopted in the Riverine areas of North bank Plains Zone of Assam. The farmers adopted SWC measures like zero tillage, SRI cultivation, bunds for waters storing in the field, farm ponds and terracing. Tobit model confirmed that awareness, yield perception, income, off farm employment and land tenure were the variables which significantly contributed for the adoption of SWC measures.

Nagaraj *et al.* (2011) studied the cost benefit of the rain water harvesting structures for groundwater recharge in Thotli Micro-Watershed of Kolar District of Karnataka, India. The farmers had invested □ 23,200/farm pond, and were receiving □ 3,925/year as additional annual returns with the BC ratio of 1.80. The farmers were also constituted recharge pit and field bunds which fetched the returns with the BC ratio of 1.67 and 3.01 respectively.

Pande *et al.* (2011) evaluated the incentives received by the farmers who adopted the SWC methods at Ravines of Gujarath. Out of 52 adopted farmers 33.33 per cent were adopted on own interest and 66.66 per cent were adopted with the help of the state government. The problems like top soil runoff, fertilizer wash, soil wash and yield loss occurred more in the non-adopters field (up to 94 %) and it was less for SWC adopters (up to 75 %). Even though with all these benefits many farmers were not interested in maintaining SWC structures, only few farmers (27.66%) had done the maintaining activities at an average amount of □ 50/m.

Santosh *et al.* (2013) evaluated the water conservation measures for economic efficiency. The farmers adopted different methods like contour bund, recharge pit, contour bund + recharge pit, contour bund + farm pond and combination of all (contour bund + recharge pit + farm pond). Among all the measures recharge pit alone had the highest net present worth of □ 6582 with BC ratio of 1.66 and PBP of 4 years.

Bagdi *et al.* (2015) studied the effect of non-formal training on the knowledge and adoption of SWC technologies in Mahi ravine area of Gujarat. Knowledge, symbolic adoption and adoption of technologies was less before the training programme. Whereas training had motivated the farmers and was successful in making the trainees to adopt SWC structures on their own and without any government support. The farmers had adopted the structures like check dam, bunds, land levelling, farm ponds and *etc.*

Kudachi *et al.* (2014) studied soil and adoption of water conservation practices among the beneficiaries of Sujala watershed project in Northern Karnataka. The farmers successfully adopted SWC measures like shrub check, waters ways, vegetative bunds, boulder bund and recharge pits. Overall 43.75 per cent of farmers were adopted the SWC measures successfully. Land holding, awareness on soil and water conservation problem and extension participation contributed significantly in successful adoption.

Surve *et al.* (2014) evaluated feasibility of the watershed works carried out in the Navasari Agricultural University, Gujarat. Watershed works like surface drains, farm pond, and 2 check dams were implemented in 4 different locations with the

expenditure of □ 2 lakh, □ 29.50 lakh, □ 10 lakh and □ 5 lakhs and total of □ 46.5 lakhs. The SWC measures were irrigating around 32 ha of land per year and their net present worth was □ 12.77 lakhs. BC ratio was crossed 12 per cent in all the structures except one structure which was yielding 1:10.

Bagdi *et al.* (2015) studied the post adoption behaviour of the respondents. The study observed that 73 per cent of the farmers were retained the structures on field and continued to adopt. 27 per cent of the respondents had discontinued the adoption and in that 19 per cent of the respondents had knowledge gap.

Chellappan and Sudha (2015) had identified that the farmers preferred staggered trenches over the other structures like stone bunds, water ways and bench terraces in the Western Ghat area of Tamil Nadu. Majority of the farmers had stated that they were ready to pay between □ 5000 - 10,000 perstructure.

Gulati and Rai (2015) evaluated the willingness to pay for the adoption soil and water conservation measures in Chotanagpur Plateau, India. The farmers preferred to adopt bunds, summer ploughing and small ponds over the other structure provided. They were willing to pay both in cash and kind and were ready to pay □ 50/month/household.

Bhattacharyya *et al.* (2016) reviewed the preference of farmers for SWC mechanisms and benefits of them. The farmers preferred contour bunds, graded bunds, broad based bunds, zing terrace and contour ditches, among these zing terrace had the highest BC ratio and less PBP.

Palle *et al.* (2017) studied the SWC structures adopted by the farmers under the NRM practices in watershed areas of the Andhra Pradesh. Majority of the farmer adopted the technologies like stone bunding, mulching with agricultural waste, vegetative barriers, loose boulder structures, farm ponds, dug out ponds, check walls, check dams, small and mini percolation tanks, contour bunds and contour trenches. Correlation analysis of the independent variables confirmed that farm size, training undergone, input usage pattern, environmental awareness, socio-political participation,

risk taking ability and team work had positive and significant impact on the adoption of above said practices.

2.2.3 Kerala

Thomas *et al.* (2009) studied the watershed based development works in the rural area of Kerala. The farmers were preferred to adopt the conservation measures like contour bund (30%), trench (8 %), rain pit (48 %), bunds (40%), terrace, (72%), mulching (76%) and earthen bunds (76%).

2.3 The farm level economic viability and efficiency of SWC investments

2.3.1 International

Regan (1947) identified costs and benefits of soil and water conservation on farm lands. The study identified the needed costs as initial investment cost, costs of operations and costs of maintenance. The benefits vary widely viz., increase in the crop yield, reduction in sedimentation, water runoff and flood damages.

Barbier (1990) recorded change in the cropping pattern due to the formation of bench terraces in the Uplands of Java. The farmers switched from low valued crops to the high valued crops and production also had higher impact *i.e.* cassava production fell from 42.4 to 12.4 per cent of the mean value per plot. Rice had observed increase in production from 7.1 to 26.8 percent while for groundnut it was 3.40 to 17.80 percent.

Herweg and Ludi (1999) reported the efficiency of SWC measures in Ethiopia and Eritrea. The farmers were adopted the SWC such as grass strip, graded *Fanya Juu* and graded bund, all these measures were efficient in stopping soil loss and runoff loss also contributing to the biomass and crop yield.

Zougmoré *et al.* (2004) formulated an experiment including the soil and conservation measures and nutrient management for the sorghum crop in the semiarid regions of Burkina Faso. Among the treatments in the experiment, treatment with stone rows + compost mixture (25.35 q /ha) performed well than other treatments. The

farmers had laid around 75,520 FCFA per stone row with useful life of 10 years and were spending of 3000 FCFA for annual maintenance.

Awulachew and Tenaw (2008) studied the impact of watershed structure on the soil erosion reduction in Blue Nile basin, Ethiopia. The Farmers had adopted the vegetative strips which reduced the annual sedimentation by 52-62 per cent in the different micro watersheds.

Balana *et al.* (2012) analysed the cost and benefit of soil and water conservation measures in Northern Ethiopia. Adoption of soil and water conservation measures developed many advantages *viz.,* protection of reservoir from the sedimentation of worth ETW 83/ha/year, protection of crop from being flooded (ETW 43/ha/year), possibility of new irrigation (ETW 79 to 120/ha/year) and generated labour service (ETW 48/ha/year). The soil and water harvesting structures implemented in the less productive field were having the present worth of ETW 3031 and ETW 5620 worth on the productive lands at the eight per cent discount rate.

Qiu *et al.* (2012) studied the economic benefits of wetland reservoir subirrigation system in Southern China. The farmers had invested around 6,00,000 Yuan for the instalment of subirrgation structure and was worth of 885000 Yuan in the 20 years' duration.

Bobasa (2013) analysed Gumara-Maksegnit watershed in Ethiopia. The study revealed that farmers investment to adopt farm ponds varied from Birr. 11,384 to Birr. 22,439. Benefits because of farm ponds varied from Birr. 1,33,200 to Birr. 65,180.

Birhanu (2016) measured the impact of SWC measures in Libo Kemkem Woreda region of Ethiopia. The study had identified that off farm activities were less practiced and number of livestock were also higher at the adopters compared to non-adopters and number of animals per family were with the beneficiaries. The beneficiaries had more accessibility comparatively to the credit and extension activities in the region.

Burnett *et al.* (2017) calculated the present worth of collecting individual unit of water at Hawai'i Island. The amount of investment per hectare of watershed varied

from $ 1266 to $ 7675 and an average of 1565 litres of water is saved per dollar of investment.

Hossain *et al.* (2017) conducted experiment on the effect of strip tillage on the yield of *T. aman* rice in Bangladesh. The study revealed that with strip tillage, yield obtained was 6.27 t/ha with BC ratio of 1.69.

Dimtsu and Yeibyo (2018) studied the impact of Integrated Watershed Management (IWSM) on the farmers income at Maego watershed, Ethiopia. The farmers in the study had successfully adopted the SWC structures like trenches, stone bunds and cut off drains. The study identified that number of households maintaining the livestock had increased after the adoption of IWSM together with introduction of exotic breeds.

Mosissa *et al.* (2019) analysed the impact of soil and water conservation measures on the livelihoods of the farmers in Ethiopia. The study revealed an increase in the crop yield, soil fertility, fodder availability and reduction in the soil erosion.

Sileshi *et al.* (2019a) studied the impact of soil and water conservation impact on food vulnerability of farmers in Ethiopia. The study revealed that age, education, gender, irrigation, source of information and cultivable land had played a vital role in the adoption of soil and water conservation measures. It had greatly impacted the food consumption of the household and reduced vulnerability to the food insecurity.

Tanto and Laekemariam (2019) studied the impact of soil and water conservation measures on soil properties and wheat production in Southern Ethiopia. The study witnessed increase in the soil pH, organic carbon and available phosphorus increase in the grain yield of wheat by 73 per cent.

Traoré *et al.* (2020) had studied the impact of water conservation technologies on agricultural crops in Burkina Faso, West Africa. The study revealed that because of the SWC structures *i.e.* stone lines, grass bunds and crop rotation, farmers successfully obtained a 50 per cent higher yield in sorghum and an income rise by $ US 98/ha.

2.3.2 National

Url (2000) conducted a survey on the economic benefits of the conservation tillage, the results confirmed that the yield of corn and winter wheat under conservation tillage was higher from 1990 to 1995.

Rao *et al.* (2003) evaluated the economics of conservation technologies adopted by the farmers in different locations of Andhra, Karnataka and Maharashtra. The study found that yield was increased in all the crops and cost of production was less under conservation furrow along with deep ploughing.

Wani *et al.* (2003) studied the impact of farmer participatory integrated watershed Management in Adarsha Watershed, Kothapally India. Where the implementation of watershed had affected the cropping pattern. The area under maize, sorghum pigeonpea, chickpea, rice and vegetables had been increased while it had declined for cotton.

Babu *et al.* (2004) studied the socio-economic impact of watershed development in Kanpur. The study revealed that area under the income fetching crops like irrigated wheat, lentil, barley and linseed had increased after the implementation of watershed. The farmers were also diversified their income sources *viz*., increasing the total livestock in the area after the implementation of watershed. Cropping pattern and employment rate in the own farm had also reported to be increased after the adoption and in the long run soil compaction, nutrient depletion, soil erosion and overgrazing problems had resolved.

Sreedevi *et al.* (2004) studied the impacts of Adarsha Watershed of Kothapally Andhra Pradesh on the livelihoods of the farmers. The watershed structures had contributed to reduce the soil erosion and to increase the ground water level in the study area. After the implementation of watershed project about 200 ha area was cultivated in kharif season and about 100 ha in rabi season, it also helped in adopting the high yielding varieties, INM and IPM practices by the farmers. Area under maize, chick pea and pigeon pea had increased after the implementation of the watershed and yield of maize had been increased by 25 per cent under sole cropping and four folds in inter

cropping system. The net returns from the watershed areas had doubled after the adoption SWC structures also the household income had doubled compared with the four year before production levels.

Desai (2005) studied the yield differences of selected crops with farm pond and without farm pond at the Dharwad, Karnataka. Even though net area under cultivation was more at farmers without pond (79.84 ha) than farmers with farm pond (77.81 ha), gross cropped area was more at farmers with farm pond (110.04 ha) and the cropping intensity was 141.42 per cent. The productivity of all the crops grown under farm pond system was high and it ranged from 16.15 per cent (ground nut) to 41.26 per cent (green gram).

Dhyani, *et al.* (2005) measured the impact of SWC measures in the Chhajawa watershed in Rajasthan. The study revealed that before and after effect of Chhajawa watershed, livestock (cows, buffalo and goats) count in the households of watershed had been increased. The farmers became capable of purchasing farm machineries like tractor, thresher, bund formers *etc.* Cropping pattern had been increased from 80.50 to 121.5 and farm employment had been increased from 94.9 to 141.30 man days/worker/year.

Arya and Yadav (2006) studied the impact of renovation in watershed of Johranpur (Himachal Pradesh) which had changed the cropping pattern of the farmers. Before the renovation only 3 rain fed crops (Maize, sorghum and wheat) were grown in 26 ha area. While after the renovation many irrigation crops were cultivated *viz.*, tomato, mustard, ginger, gram, irrigated wheat and paddy and the area cultivated had been increased to 29.20 ha which had resulted in increase of 29.5 man days of employment.

Nasurudeen and Mahesh (2006) studied the economic and environmental perspectives of watershed of Pondicherry. The study evaluated the soil properties of watershed and non-watershed areas viz., organic matter, NPK, Zn, Co, Fe and Mn. Crop yields and farmers' incomes of watershed area were better than the non-watershed areas.

Singh *et al.* (2006) studied the impact of land tenure systems on the adoption of watershed development programmes in Meghalaya. The study observed that there was an increase in the contour ploughing in the horticultural orchards and decrease in the *Jhum* cultivation. The family income from the farm had been increased among farmers of community owned lands than individually owned and Gini concentration ratio was better in community owned farms.

Desai *et al.* (2007) assessed the impact of farm ponds in Dharwad district of Karnataka and reported the changes in cropping pattern, productivity, employment generation and household income. Cropping intensity of the farm pond beneficiaries (141.42%) was much higher than the non-beneficiaries (112.67%), green gram and maize were the crops with most increase in productivity and least was observed in groundnut (16.15%). There was an increase in the on farm employment in agriculture (5.59%) and animal husbandry (3.28%) because of farm ponds. The total household income was increased by 48.21 per cent and income from agriculture was increased by 57.16 per cent.

Dhanapal (2008) reported about the profitability of farm pond based cropping systems in Karnataka. The study identified that second crop would be taken in a year with the adoption of run off collection and farm ponds in the field. On an average construction of farm pond costed about □ 33,330 per 250 m^3. The study confirmed that with the adoption of farm pond based cropping system about 18.90 per cent of the yield was increased for finger millet with 2 lifesaving irrigations and BC ratio was higher by 0.31 per cent together with this an additional income of □ 1500/pond was obtained from fishing activity.

Mula *et al.* (2008) studied the impact of integrated watershed management on farmers livelihoods in Rajasamadhiyala, Gujarat. Crop productivity was increased from 20 to 30 per cent and income of the farmers had increased by 84 per cent. Integrated watershed had also helped in increased carbon sequestration and decreased migration of labours.

Rao (2008) evaluated the soil and water conservation technologies, the study compared the economics of conservation with other farmer practices in CRIDA,

Hyderabad. The farmers had implemented farm pond which had the present worth of 29,849 with the BC ratio of 1.57 and 18.97 internal rate of returns. They had also invested about 3,981/ha on conservation furrows and received 4,593/ha and received additional benefit of 1,245/ha.

Shaheen *et al.* (2008) conducted a study on watershed programmes implemented and their impact on the beneficiaries in the North-eastern States of India. The study confirmed that about 37 watersheds being implemented in North East region of the country and among Umpling-Umrynjah, Lyngiong, Wah Umroi and Nongpoh micro watershed were considered for the study. The average BC ratio was 1.79, IRR was 19.40 and productivity was increased by 28.89 per cent. The employment was increased by 164 days/ha/year and Jhum cultivation reduction in soil loss were also reduced.

Palanisami *et al.* (2009) studied the impact of watershed for beneficiaries around Coimbatore district of Tamil Nadu. Net area irrigated, net cropped area and cropping intensity was significantly increased in the adopted villages whereas same was reduced in the control villages. The changes had been observed in the yield also, sorghum (33%), maize (31%), pulses (36%), vegetables (32%) and milk (28%).

Palanisami and Kumar (2009) studied the economics of watershed development structures in Tamil Nadu. The authors found that there was 25-50 per cent increase in the yield at 60 per cent of the watersheds, about 65 per cent of the watershed area observed increase in the irrigated area up to 25 per cent. BC ratio of the watershed development activities was ranged between 1.27 and 2.3 and IRR was between the 15-30 per cent.

Satyasai (2009) had applied internal rate of returns method to evaluate four different watersheds, two from Maharashtra and two from Tamil Nadu. MIRR of all the watersheds considered for the evaluation were near to 15 per cent. It had highest MIRR value *i.e.* 17.95 and ranked first among the considered watersheds.

Tilekar *et al.* (2009) studied the impact of watershed cropping pattern, yield and employment in Ahmednagar, Maharashtra. Un-irrigated and area under cereal crops

had reduced after the adoption of watershed and area under vegetables and fruits had increased with the change in cropping intensity (15 %) and productivity. Farm employment had increased for both men and women and BC ratio of the farm had raised by 0.30.

Arya (2010) studied about the migration in the Shivalik foothill villages of Haryana. The study had identified that area under irrigation and families depending on agriculture had been high in the watershed adopted villages than non-adopted villages. The study also found that migration of farm families with livestock was very less in watershed adopted villages.

Mondal *et al.* (2010) assessed the Mastihalla watershed of Bellary district in Karnataka. There was an increase in the productivity of crops after the implementation of watershed. BC ratio of the project was 2.7 per rupee invested with net present worth of □ 9,700/ha at 10 per cent interest rate and payback period of 8 years. The project caused increase in the livestock population, moisture availability and social status of the farmers along with increase in income of the farmers.

Rao *et al.* (2010) did an *ex-ante* evaluation on the benefits of the soil and water conservation at different places in the country like Agra, Kota, Varanasi and Jabalpur. The study employed consumer surplus and producer surplus, results showed that cost of cultivation in crop was increased by 46.91 per cent for chick pea at Varanasi. The results also confirmed that the net return for all the crops considered had increased along with increase in the yield. The consumer surplus and producer surplus was analysed for the adoption of conservation measures, producers will had the surplus of worth □ 196.8 million, consumers had the benefit of worth □ 79.9 million.

Arya *et al.* (2011) studied the role of watershed in bridging the fodder gap in Sivaliks of Haryana. The fodder gap was 52.85 per cent in the treated area whereas in the untreated area the fodder gap was 76.98 per cent.

Koul *et al.* (2011) studied the impact of soil and water conservation on livestock status in Semi-Arid districts of Madhya Pradesh. Herd size had been increased by 0.37/household and milk yield was increased by 0.73 litres/animal/day. Income of □

2,215/household/month was increased from the milk production in the Ratlam District and was highest.

Pande *et al.* (2011) evaluated the benefits expected by the farmers who adopted the SWC methods at Ravines of Gujarath. The farmers had received cash flow benefits of worth □ 489 (marginal farmer) to □ 5415 (medium farmers) and □ 68 (marginal farmers) to □ 842 (medium farmers) of opportunity cost with 10 per cent interest rate and 30 years' duration.

Singh *et al.* (2011) studied the effectiveness of watershed development programmes in different states of India. Soil erosion was decreased in all the states and micro watershed programmes had performed well in all the states and were effective in decreasing the soil erosion. There was a two-meter increase in ground water level after the implementation of WDP in Gujarat and Tamil Nadu on wide area compared to other states. Every state had witnessed change in the cropping pattern and intensity of cropping along with the increase in the productivity of the crops.

Eknath (2012) studied the impacts of SWC structures on farmer livelihoods in Barpita Nalla Micro-Watershed. Irrigation intensity had increased by 45 per cent and cropping intensity was increased from 113.62 to 186.37 per cent. The farmers had changed their cropping pattern from mono-cropping to mixed cropping and multiple crops. BC ratio of the project was 2.27 with NPV of 16,41,809 and IRR of 28 per cent.

Mondal *et al.* (2012) studied the technical efficiency of agricultural crops production in the watersheds of Bundelkhand Region, Madhya Pradesh. The study analysed the efficiency of crops like wheat, gram, lentil, urad, paddy and soybean and conducted stochastic frontier and inefficiency models. In the inefficiency model watershed was used as the dummy variable and was significant in all the crops. Technical efficiency was found to be higher in watershed villages than the control villages for all the crops.

Reddy *et al.* (2012) compiled the money needed for the construction of farm ponds with different dimensions. Among the different dimensions, 27.5m x 27.5m (at top) and 17m x 17m (at the bottom) dimensioned pond was costing high however when

compared to cost per unit volume of stored water (□/m^3) *i.e.* 104/m^3 it was best among other size ponds.

Kumbhar *et al.* (2013) studied the change in cropping pattern and production level owing to the watershed in Kolhapur district of Maharshtra. The study showed that the area under jawar had increased from 0.3 to 1 ha and new crops like Corn, Tur were introduced in the study area. Also, fallow land had been decreased from 0.50 to 0.35 ha. The production of jawar had increased from 3.75 to 6.50q and groundnut production had been increased from 6.75 to 7.25q.

Manjunath (2014) studied the impact of watershed on production level in Chitradurga District of Karnataka. The study had identified an increase in the production level of groundnut (15.67%), ragi (13.88%), pomegranate (24.71%) and sapota (17.51%). Milk yield was increased by 14.32 per cent when compared to pre adoption of SWC structures.

Prabha (2014) concluded that cropping pattern was changed after the adoption of farm ponds in the Vembedu village of Tamil Nadu. Before farm ponds only vegetables like brinjal, and tomato were cultivated. While crops like paddy, red gram and black gram were cultivated after adoption of farm ponds. The irrigated area was increased from 24.58 to 40.28 per cent. There was also a change in average net income of the households.

Surve *et al.* (2014) conducted the impact study on crops cultivated under the watershed structures adopted at Navasari Agricultural University, Gujarat. SWC techniques like, surface drains, farm pond and two check dams were adopted and crops like sugarcane, gram, tur, jowar rice, cotton and wheat were grown under the SWC techniques. BC ratio was highest in sugarcane ratooning (2.09) followed by wheat (1.55).

Thakur *et al.* (2014) studied impact of integrated watershed project of Una District of Himachal Pradesh. Implementation of watershed had affected the cropping pattern of the study area. Maize and wheat accounted for 85 per cent of the cropped area prior to implementation french bean, bottle gourd and bitter gourd crops were

introduced after implementation. Implementation of watershed structures was resulted in the increase in farm. Income farm employment opportunity to the respondents.

Chavai *et al.* (2015) appraised effect of farm pond on beneficiary farmers of Maharashtra. Beneficiaries' income was increased by 37,028. Cropping intensity was increased by nine per cent together with productivity in tur (34.38%), wheat (30.16%), jowar (19.67%) and gram (17.11%).

Chellappan and Sudha (2015) studied the investments, adoption, attitude and extent of participation of farmers in soil conservation projects in the Western Ghats of India (Tamil Nadu). NPV was calculated for the tea cultivation under staggered trenches and was 74,335 and BC ratio was 1.03.

Kulshrestha *et al.* (2015) studied the impact of watershed in Morena District of Madhya Pradesh. The cropping pattern was changed after the adoption of SWC structures, area under Bajra (93.33%), Arhar (300.00%) had been increased in kharif seasons likewise in rabi area under wheat (366.67%). The productivity has increased in all the crops and maximum was for Arhar (20%). The cropping intensity had been increased to 107.69 per cent and area under irrigation had increased 366.67 per cent. Livestock status was increased along with fodder availability.

Mane *et al*. (2015) conducted a comparative study on economic impact of farm pond on beneficiaries and non-beneficiaries in Amravati district of Andhra Pradesh. The study revealed that both the per ha cost and returns of soybean was higher (24,389/ha) beneficiary farmers (50,564). Soybean fetched returns of about 1.48 per cent (BC ratio).

Venu *et al.* (2015) conducted economic analysis of farm ponds in Tungabhadra project command area in Karnataka. The farmers in the study area had expended 11.08 lakh rupees for construction of the farm ponds. The farm ponds were having the net present worth of 11.12 lakhs with the BC ratio of 1.35, payback period of 6 years and with 18 per cent internal rate returns. The farmers were getting around 7.46 lakh/pond/year, with maximum share from fish rearing was fetching most followed protective irrigation to paddy (28.82%) and remaining by lifesaving irrigation for

different crops. The farm ponds fetched 29.07 percent higher labour days in the farm than farms without farms.

Bhattacharyya *et al.* (2016) reviewed the impact of SWC measures on crop productivity. The study concluded that productivity of the crops was increased after the SWC structures adoption and effected the socio-economic position of the respondents. SWC measures also had positive impact on the ground water levels in the study areas.

Chavai and Shinde (2017) studied the socio economic impact of farm pond on livelihoods of the farmers in Maharashtra. The study identified that there was an increase in the productivity of pigeon pea, green gram, wheat, sorghum and gram. The cropping intensity of the respondents increased from 106.11 to 115.03 per cent and the area under the crops like rabi sorghum, rabi wheat, gram and vegetables were also increased.

Deshmukh *et al*. (2017) evaluated for the impact of farm ponds on beneficiaries of Marathwada region of Maharashra. The study reported that respondents had successfully adopted the soil and water conservation measures such as land levelling, graded bunding, broad bed furrows and nala training under the MGNREGA scheme. Adoption of the conservation measures in the farm affected the cropping pattern and productivity. Crops like cotton, sorghum, wheat, redgram had observed the changes in productivity. It also affected the input purchase together with employment generation on the farm.

Negash *et al.* (2017) reviewed that soil surface crop residue was most effective soil erosion control could increase the yield of wheat crop.

Prem *et al.* (2017) evaluated different soil and water conservation techniques such as subsoiling, open and tied ridges, no till, and conventional tillage in Godhra, Gujarat. The study had identified the performance of adopted techniques varied with the land slope gradient, seasonal rainfall distribution and intensity. Soil moisture was increased more in tied and open ridges (15 - 24 %) followed by subsoiling (3%).

Vitthal (2017) studied benefits of the farm ponds to the farmers who adopted in the Marathwada region of Maharshtra. The study reported that land levelling, graded

bunding, broad bed furrows and Nala training were the conservation measures adopted. There was an increased yield in cotton (5 %), sorghum (8 %), soybean (13 %) and tur (10 %) after adoption of farm ponds. About 16.25 per cent of the farmers had witnessed the increase in cropping intensity because of the conservation measures.

Chaturvedi *et al.* (2018) reported about the economics of watershed mechanisms adopted in Rivanr. The study had identified that cropping intensity had risen at 207 per cent from 69 per cent and productivity enhanced by 20 – 60 per cent for different crops. The water productivity had increased by □ 2.5 to □ 5.0 per m^{-3} and the farmers income doubled to the tune of □ 27,500 /ha/year.

Mosaffaie and Jam (2018) conducted a research on assessment of economic benefits of soil and water conservation projects in Qazvin, Iran. The study indicated that there was a decrease in the runoff of water with an increase in the production by 163.9t/ha and area under cultivation by 57.60 per cent. The NPV of the project was positive after eighth year of adoption.

Addis *et al.* (2019) studied the impact of soil and water conservation measures in northern highlands, Ethiopia. The study revealed an increase in the yield of teff (grain crop), sorghum and chickpea. The returns realized was $102, $96.9 and 140.25 per ha annually respectively.

Basha *et al.* (2019) studied the impact of soil and water conservation on socio-economic aspects of farmers in Konaki Wateshed in Prakasam District, Andhra Pradesh. The study had identified the change in cropping pattern *i.e*. area under chilli and redgram had increased while cotton had decreased. The yield of black gram yield had increased by 19.5 per cent and was highest among the other crops and followed by cotton (17.60%). Livestock had decreased per family whereas milk yield had increased.

2.3.3 Kerala

Thomas *et al.* (2009) studied the impact of watershed on farmers livelihood. Cropping pattern of the sample farmers had changed, area under rubber, banana crops was higher among the beneficiaries. Labour use pattern, productivity and income pattern of sample farmers in the watershed was increased.

2.4 Understand the farmers' perceptions on effectiveness of conservation measures

2.4.1 International

Pagiola (1996) wrote about the price policy and soil conservation returns in the semi-arid Kenya. The study had assessed that one-hectare area with 15 per cent slope would face an annual loss of 46mg/ha and yield loss of 20 per cent by every 10 years. The study advocated, policy should be formulated in such a way that the initial income loss should be compensated by the price rise to encourage the soil and water conservation.

Herweg and Ludi (1999) collected the perceptions of farmers about the soil and water conservation measures in Ethiopia and Eritrea. The study identified that farmers had negative attitude towards SWC measures. The maintenance of SWC needed huge labour and also difficult to adopt their traditional method of ploughing in the field.

Ruben and Vaessen (2000) identified the factors that influence the adoption of watershed technology in Costa Rica. The factors identified in the study were farm size, tenancy relations, information and knowledge, access to credit, and risks. Among education, membership to organizations, access to technical assistance, distance from the market and access to credit were significant at one per cent level.

Demeke (2003) studied the farmers awareness about the benefits of SWC measures in Northwest Ethiopia. The farmers perceived that retention of soil itself is benefit followed by increase in the soil fertility and yield. The farmers also faced the difficulty in ploughing with bullocks, needs high labour, overlaps with off farm activities, reduce the cultivable land and food availability and caused increase the rat infection. Logit analysis confirmed that farm size, farm distance and off farm income contributed significantly in the adoption of SWC measures.

Poudel (2003) identified and listed challenges and constraints of watershed management in Nepal. General consensus needs to be developed by watershed managers and planners on the scale of operation, where there were clearly defined physical boundaries.

Bekele (2005) conducted a stochastic dominance analysis of soil and water conservation in Eastern Ethiopian Highlands on the subsistence crop production. Non-parametric test of first order and normalized second order tests were used in the analysis. The study revealed that adoption of soil and water conservation techniques had resulted in increased yield at the adopters than non-adopters.

Drechsel *et al.* (2005) studied the resource conservation technologies and factors contributing for the adoption in sub Saharan Africa. The factors contributed to the adoption of SWC structures in the study includes accessibility of the information, increased yield, improvements in the nutrient availability and capital requirement.

Amsalua and Graaff (2007) identified the factors determining adoption and continued use of stone terraces in Beressa watershed of Ethiopian highlands. The study analysed using bivariate probit model, age, land size, effectiveness of technology and steep slope were the variables found to had a positive and significant consequence.

Deressa *et al.* (2009) identified the determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. The study used multinomial logit (MNL) model for evaluating the farmers' choices for adaptation strategies. Education, gender of the household size, credit availability and temperature of the area were the factor that were contributed to the adoption of soil conservation activities. Farm income and precipitation were hindering the farmers from adopting the soil conservation activity.

Birhanu and Meseret (2013) studied the factors affecting continued use of soil and water conservation structures in Farta, North Western Ethiopia. The study identified that only 47.20 per cent of the respondents were used the SWC structure on continues basis and maintained the structures. The factors which affected the continued use of SWC structures were knowledge on soil and water erosion, profitability, extension contacts and mass media contacts.

Mulat (2013) studied the attitude of the farmers towards soil and water conservation measures in Konso region of Ethiopia. Land size, types of crops, location

of the farm and farmers knowledge about the soil erosion were contributed to the adoption of SWC measures in the study.

Wolka *et al.* (2013) conducted research on farmers' perception on the effects of soil and water conservation structures on crop production. The study mainly interested in the level Soil Bunds (LSB) and Stone Bunds (SB), which were widely implemented in the Bokole Watershed Ethiopia. The farmers were happy after the adoption of soil and water conservation measures because the structures were positively contributed in restoring the soil fertility and in improving the crop production.

Belay (2014) studied the farmers perception about the SWC measures adopted in Dejin, Ethiopia. The respondents in the study were well aware about the causes of soil erosion and soil fertility and they were also known about the benefits of the SWC measures adopted by them.

Meseret (2014) studied the farmers perception of soil and water conservation practices on cultivated land in Akesha, Ethipia. Half of the respondents in the study perceived that SWC structures could be effectively used for controlling of soil erosion. The study identified that adoption of SWC structure was influenced by education, extension contact and slope of the land.

Miheretu (2014) studied the farmers' perception on adoption of soil and water conservation measures in Gidan Wereda, Ethiopia. In the study, knowledge on the soil erosion was the important factor that affected the adoption of soil and water conservation measures and were followed by availability of labour, land size and access to the extension services.

Wolka and Negash (2014) identified the perception of farmers on SWC technologies in the Bokole and Toni Sub-Watersheds, Southern Ethiopia. In the study farmers perceived that SWC measures would improve the crop yield, reduces the soil loss, reduces the surface runoff, improves the soil fertility and create better farming area. The farmer also faced constraints like high labour need, no technical advice, lack of government support, awareness and material shortage while adopting the SWC conservation structures. Logit analysis of independent variables showed that farm area

and expectation about the uses of SWC were the two important factors which made respondents to adopt the SWC structures.

Walie (2015) studied the farmers' perception about the SWC measurers in Northwest Ethiopia. The farmers in the study had opined that increase in land productivity and farm size was reduced because of the SWC measures. Also, farmers had an opinion that SWC measures will had long term benefits.

Biratu and Asmamaw (2016) studied the factors affecting the participation of farmers in soil and water conservation activities in Temela watershed, Ethiopia. The factors that affected the participation of farmers in the SWC programme were family size, labour availability, extension contacts, annual income and age.

Eze and Osahon (2016) constructed a knowledge index on farmers' perception on benefits of SWC measures in South East, Nigeria. Knowledge index was constructed in the study for understanding the perception of farmers on SWC measures and the results showed that farmers knew better about the benefits of the strip cropping, contour bunds, tie ridges, sod water ways and wind breaks.

Mekonnen *et al.* (2016) observed farmers perception on SWC conservation measures in Eastern Hararghe, Ethiopia. The study found that SWC measures reduced the surface run off, increased soil fertility and enhanced the yield in the long run. Generalised Linear Model (GLM) showed that training programme about SWC, plot size and plot distance were contributed significantly towards the opinions about SWC measures.

Meshesha and Tripathi (2016) studied the farmers' perception on soil degradation and management practices in Beressa watershed of Ethiopia. The respondents in the study had the knowledge on benefits of the conservation practices (75%) and 92 per cent of the farmers practiced the SWC measures on their lands.

Teshome *et al.* (2016) studied the opinion of the farmers about the profitableness of the North-Western Ethiopian Highlands. In the study farmers voted that adoption of SWC structures was a profitable venture and resulted in decreasing the

soil and water erosion. Land size, slope, SWC training, labor assistance and soil erosion were the factors contributed to adopt the SWC structures.

Walie and Fisseha (2016) studied the farmers' perception about the SWC in Wyebla watershed, Northwest Ethiopia. The farmers opined that SWC were helpful in reducing the soil erosion and it could increase the productivity of the lands with long term effects.

Bijani *et al.* (2017) studied the concern and behaviour of paddy farmers for the conservation measures in Sari province of Iran. The study identified that farmers' attitude and concern for soil conservation made them to adopt SWC conservation measures.

Dabi (2017) reviewed economic implications and farmers' perceptions about the Soil and Water Conservations (SWC) techniques in Ethiopia. The study opined that farmers were discommending SWC because it takes too much land, doesn't protect from the soil erosion but worsens it. In the study only 37 per cent of the farmers opined that SWC measures as very good.

Mango *et al.* (2017) studied the awareness and adoption of soil and water conservation practices in Chinyanja Triangle, South Africa. Awareness was high about the structures like contour ridges, box ridges and basins. Adoption rate was high for contour ridges and box ridges among the different structures considered in the study. The factors which affected the knowledge and adoption of SWC structures includes age, education, agricultural advice reception and farmers group membership.

Moges and Taye (2017) determined perception of the farmers to adopt SWC measures North-West highland of Ethiopia. The farmers in the study had the perception that soil erosion could be controlled with the adoption of SWC measures. About 47 per cent of beneficiaries were forcibly adopted the SWC measures. Logistic regression confirmed that age, education, ownership, slope extension participation in training were the factor which contributed significantly to the adoption of SWC measures in the study.

Omer and Migane (2017) assessed the factors affecting the adoption of soil and water conservation measures in Aburin area. Place the study identified that education level, family size, farm size, experience were the important factors affected the adoption of SWC measures.

Zerssa *et al.* (2017) studied the farmers awareness on SWC measures in South West Shewa Ethiopia. The farmers who had adopted the SWC had opined that, crop yield was increased in their lands after the adoption. Non adopters in the study mentioned that high labour requirement, initial cost, decrease in the cultivable land and lack of knowledge as the reasons for non-adoption.

Akkaraboyina, and Tareke (2018) studied the perception of farmers towards soil and water conservation practices in Amhara region of Ethiopia. In the study it was found that only 33 per cent of the participants had adopted the structures on voluntary basis remaining people had adopted forcefully and respondents had no proper information about why the structures had implemented.

Dimtsu and Yeibyo (2018) studied the farmers' perception on impacts of integrated Watershed Management (IWSM) structure in Maego Watershed, North Ethiopia. The farmers in the study had felt that IWSM structures had positive impact on soil moisture, fertility, area under irrigation, fodder availability and ground water levels. It also reduced the dependency of fuel woods consumption from the nearer forest areas.

Gedefaw *et al.* (2018) studied the factors that affected adoption of soil and water conservation measures in Semein Mountail National Park Ethiopia. Among the respondents, 76 percent had adopted the SWC structures. Factors like knowledge of the farmers on SWC structures, institutional and Government support were the factors that influenced the adoption of SWC structures.

Mekuriaw *et al.* (2018) interviewed the farmers for the factors that were influencing them to adopt SWC measures in Ethiopian highlands. Majority (87 %) of the respondents in the study had adopted the SWC structures. Every farmer in the low land area were managing the structures successfully whereas only 56 per cent of the

high lands doing the same. The difference was due to the government support for the low lands people *viz.*, technical, financial and farmers' involvement in the activities.

Alemu *et al.* (2019) studied the farmers perception about the soil and water conservation tehnologies in Gojeb river catchment, Ethiopia. The study revealed that SWC measures were helpful in controlling the soil erosion, increasing the soil fertility and agricultural productivity. 95 per cent of the respondents were interested in maintaining the structures in future.

Darkwah *et al.* (2019) studied the factors affecting the soil and water conservation measures in Techiman Municipality, Ghana. In the study factors like household size, farm size, training on crop production, credit availability and extension contacts affected the adoption of soil and water conservation.

Gurebiyaw (2019) studied the factors affecting adoption of soil and water conservation in Ethiopia. The study had identified that awareness on soil and water conservation, soil erosion, local available structures, age, education, farm size and slope of the farm land were the factors that were affected the adoption of soil and water conservation measures.

Janet *et al.* (2019) studied the factors influencing the adoption of soil and water conservation in West Pokot, Kenya. The factors like land ownership, slope, soil erosion, easiness of technology affected the adoption of SWC technologies in the study.

Siébou *et al.* (2019) studied the impact of soil and water conservation measures crop production in Northern Burkina Faso. The farmers had opined that SWC structures had successfully increased the soil fertility, moisture, vegetation, fodder availability and crop yield.

Assaye (2020) studied the adoption behaviour of soil and water conservation measures in Ethiopia. The study revealed that families with female as a head were more interested in adoption of soil and water conservation measures but whereas these families had limited investment and had restricted use of SWC measures. Age, education, off farm jobs, knowledge on soil erosion, availability of irrigation and extension contacts had affected the adoption behaviour of farmers.

Belachew *et al.* (2020) studied the factors affecting the preference for soil and water conservation measures in Ethiopian Highlands. The study revealed that age, gender, education, household size, land holding, livestock number, credit availability were the factors that affected the adoption of SWC structures.

Lasway *et al.* (2020) studied the determinants of soil conservation technologies in Tanzania. In the study extension services, number of trainings attended and land values were the sectors affected the adoption of SWC structures. SWC structures had influenced the crop yield and environmental quality.

Toromo *et al.* (2020) studied the farmers perception about the soil and water conservation measures in Kenya. The study revealed that soil and water conservation technologies were effective in decreasing the soil erosion, increased the soil fertility status and increased the productivity of land. The few respondents didn't adopt the soil and water conservation structures because of less awareness, high cost, labour intensiveness and the financial constraints.

2.4.2 National

Pender and Kerr (1998) studied the factors affecting the investments on soil and water conservation in semi-arid India. Education, family labour, erosion factor and area under irrigation were the factors contributing significantly to the investment on SWC structures. Low farm income, smaller area, lease in and out were factors discouraging the farmers from investment.

Desai (2005) compiled the farmers' perception about RWHS and constraints in adopting the RHWS in Dharwad and Haveri districts of Karnataka. The study used low, medium and high ratings for the analysis about the benefits. More than half of the farmers had adopted because RWHS were effective in reducing the erosion (51 %), increasing the moisture availability (60%) increasing the income (56%) and yield (53%). Lack of credit (64%) was the main constraint faced by the farmers. Also, farmers had felt that they need to invest too much on RHWS (51%) and fragmented land holding (47%) were the severe constraints.

Badal *et al.* (2006) studied the farmers' participation in different stages of watershed planning in Rajasthan. The study identified that in the planning stage participation was comparatively high (44 per cent) and was less in implementation the stage (27%). After the implementation about 78 per cent of the watersheds were functioning. Determinants of the participation in the SWC were age, training, operational land holding, off farm income, visit of the extension worker and presence of operating local institutions.

Mansur *et al.* (2007) studied the perception of the farmers about the contour bunding in Dharwad district of Karnataka. Majority of the farmers perceived that contour bunds will reduce the soil erosion, conservation of moisture, gully erosion and increase the soil moisture availability.

Rai and Singh (2008) studied the awareness level of the farmers about the recommended practices in Watershed programme. In the study majority of farmers had partial awareness about practices suggested in the watershed development programme. Among the different practices suggested, farmers were better aware of mixed cropping, contour bund and water harvesting structures. The farmers wanted more trainings about water harvesting technologies and SWC measures.

Palanisami and Kumar (2009) studied factors influencing the people participation in watershed development programme in Coimbatore District of Tamil Nadu. The study had identified that number of people in the family, distance between the rain water harvesting structure and number of wells in the farm were the factors contributed to the adoption of watershed conservation technologies.

Rao *et al.* (2010) interacted with farmers and concluded that adoption levels were less because of the lack of awareness. The farmers also opined that yield was sensitive to the conservation techniques and lack of access to draught power.

Pande *et al.* (2011) evaluated factors affecting the farmers decision of adopting the SWC at Mahiravine of Gujarath. Probit analysis was used for the study credit worthiness and area under cash crop were the two parameters that were significantly affected the decision.

Kumar and Sharma (2013) identified the determinants of farmer conservation investments in four different states of India. The study identified that additional returns over the adoption, relative input and output prices, market access and off-farm employment opportunities, land water scarcity, farmers' capacity, gestation period, risk and government policies were the factors that were affected the adoption. Most of the farmers opined that SWC measures reduced the rate of siltation and ground water got recharged.

Mithun (2013) studied the perceptions of farmers on usefulness of the soil and water conservation practices in Dharwad, Karnataka. Majority of the farmers in the study accepted that SWC measures would improve the underground water availability, drains out the excess water collected, increases the soil moisture, infiltration rate. About 56 per cent of the farmers opined that the SWC structures were highly benefited them. Non availability of the suitable implements, lack of technical guidance, training and high cost of adoption, small land holdings were the few constraints faced by the farmers.

Chavai *et al.* (2015) identified the farmers who adopted farm ponds and studied the characters contributed for the adoption. Land holding, family type, social participation, area under protective cultivation, risk preferences, extension contact and utility perception contributed significantly. The study also listed the constraints faced by the respondents in adopting the SWC structures, difficulty in obtaining the subsidy, less awareness about the farm pond schemes, and electricity problems for utilizing the stored water were the most important ones.

Mithun and Bheemappa (2015) studied the perception and constraints of the farmers who adopted the SWC measures under the Sujala project in Karnataka. The study identified that usefulness of Nala bunds, contour bunds and contour strips was high for the respondents. Non availability of suitable structures, lack of technical guidance and training were important constraints faced by the respondents in the study.

Venkatesh (2019) studied the soil conservation activities taken up under IWMP programme Kolar Karnataka. The study had observed increase in area sown and area under irrigation. Cropping intensity changed due to increase in both surface water and

ground water in post adoption period. Study also recorded increase in the crop yield and milk yield.

2.4.3 Kerala

Thomas *et al.* (2009) identified the constraints in adopting the watershed development programme in Kerala. Non availability of irrigation water, non-availability of inputs and subsidy on time, lack of awareness, supervision follow up and technical guidance were the important constraints faced by the farmers in the study.

Methodology

METHODOLOGY

Methodology plays a vital role in research, as it narrates the details of sampling data collection and analytical tools as detailed below:

3.1 Description of the study area

3.2 Sampling procedure

3.3 Nature and sources of data

3.4 Analytical tools used

3.5 Definitions of terms and concepts used

3.1 Description of the study area

3.1.1 Wayanad District

Wayanad, known as the Kashmir of Kerala, is part of Western Ghats which is well known for its biodiversity with a great proportion of endemism (Rajan 2016). The District was formed on 1st November 1980 with Kalpetta as capital with three Taluks *i.e.* Mananthavady, Sultan Battery and Vythiri (Kalpetta). It was formed as 12th district including the areas from existing districts of Kozhikode and Kannur. The term Wayanad is derived from "Vayal Nadu" which means the land of paddy fields (GOK 2018). It is a beautiful hilly district located at an elevation between 700 meters and 2100 meters over the Mean Sea Level (MSL) nested between the highlands of Western Ghats. It is bordered by Tamil Nadu (Nilgiri District) and Karnataka (Mysore and Chamarajanagara Districts) on the eastern side, Kodagu/Coorg district of Karnataka and Malappuram district in Kerala on the north side and on the West by Kozhikode and Kannur districts. (GOK, 2018a; Antoney, 2015; Volga *et al.,* 2013). The district is divided into 3 Taluks namely Mananthavady, Sulthan Bathery and Vythiri (Fig 1) and 4 Developmental Blocks Panchayats (BP) comprising of Gram Panchayats (GP) viz., Kalpetta (9), Sulthan Bathery (5), Panamaram (5) and Mananthavady (6). Kalpetta is the district headquarter (GOK, 2018a).

Wayanad is a district with 2,12,966 ha of geographical area, comprising 78,787 ha of forest area, 1,12,907 ha net sown area and with the cropping intensity of 128 per cent (GOK, 2019). British authorities were the first to take efforts to open up the hill plateaus of Wayanad for the cultivation. Coffee and tea were the main crops initiated by the British authorities along with few cash crops. They established the road network, linking from Kozhlikod and Thalassery which hastened the agricultural development (GOK 2018). Presently, 46 different crops are cultivating in the district *viz*., paddy, pulses, coconut, fruits crops (10), vegetable (22) plantation crops (4), spices (11) and fodder grasses along with livestock and fisheries (GOK, 2019).

3.1.2 Weather and soil

Hot and humid weather conditions are common in Wayanad, March and April months are the warmest and January and February months are the coolest. Temperature starts increasing from the months of March and April and decreases during the monsoon months *i.e.* June to September. Highest temperature in the district ranges between 28.9 and 36.2°C and lowest temperatures range from 17.0 to 23.4°C (GOK, 2016).

Wayanad is the second in position among the districts that receive maximum annual rainfall. In any normal year the district receives around 3253 mm rainfall which is much higher than the state average *i.e.* 2928 mm (GOK 2017). Rainfall starts from the month of May and continues up to November and considerable amount of rainfall occurs in the months of June (515 mm), July (1096 mm) and August (565 mm) because of South West monsoon (Anon., n. d.). However, there are reports of declining rainfall and increasing temperature and high variability in the precipitation, over the period of 1951 to 2008 (Gaetaniello *et al*. ,2013; Kandiannan *et al.* ,2018; Kumar and Srinath ,2011 and Nair, 2016). Wayanad is declared as one among the hot spots of climate change in Kerala (Nandakumar, 2014). These changes influence the land use pattern and agricultural production of the region (Gaetaniello *et al*., 2013: Radhakrishnan and Gupta, 2017). Consequently, State and Central Governments have launched Soil and Water Conservation programme in Wayanad District viz., Western Ghats Development Programme, Arable Land Treatment, Drainage line treatments and Drought Mitigation Scheme (DSC, 2018) which are being implemented since 1981.

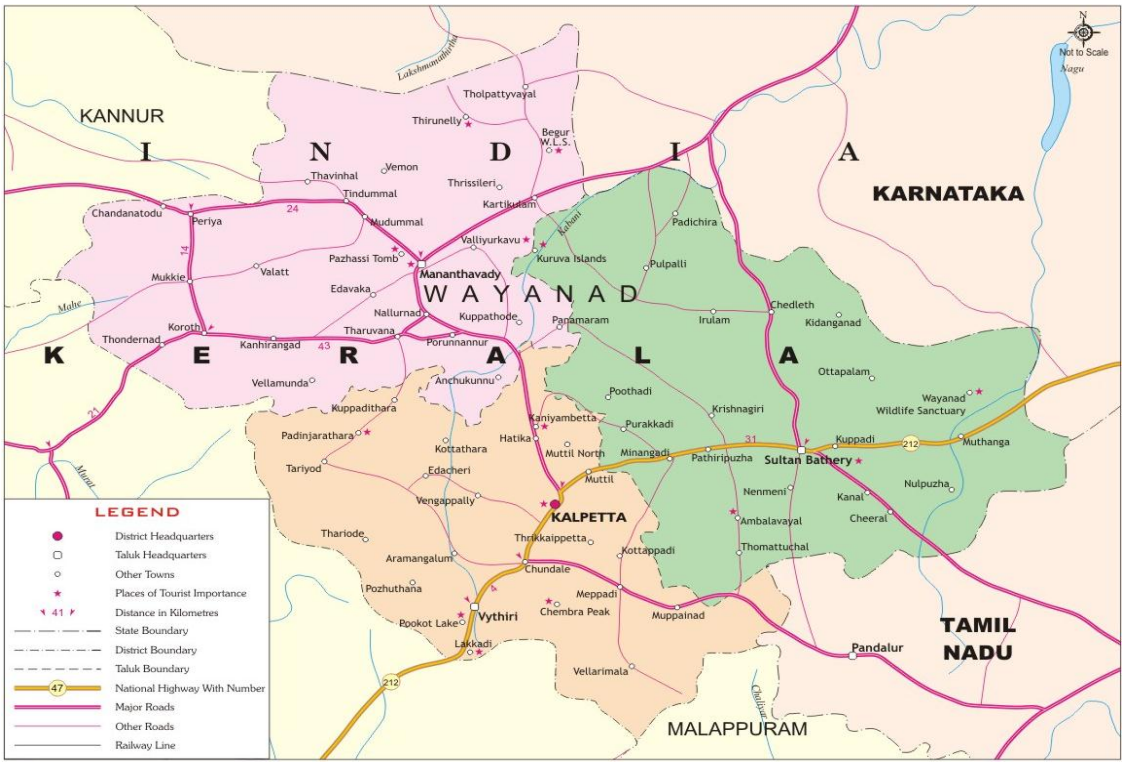

Fig 1. Map of the Study area (Wayanad)

Soil

Four types of topsoil *viz*. laterite soil, brown hydromorphic soil, loam and riverine alluvium are seen in Wayanad. Laterite soil is reddish brown in colour, formed under tropical monsoonal climate with alternate wet and dry seasons. Mananthawady, Kalpetta and Sulthan Bathery blocks are having the loamy soils, which are rich in organic matter, nitrogen and humus. Brown hydromorphic soil (BHS) is seen between undulating topography in Wayanad district. Alluvial soils are found along the banks of Kabani, Chaliyar and its tributaries (GOK, 2018b; GOK, 2016).

3.1.3 Demographic features

Wayanad is the least populated district in Kerala, with population of 8.17 lakhs, of which 4.01 lakhs are male and 4.15 lakh female with a growth rate of 4.71 per cent. The population density is 384/km^2, and it is second to Idukki (GOK, 2016a). The district holds 2nd rank with respect to work participation ratio of 41.60 per cent (56.92 per cent male and 26.80 per cent female). Literacy rate in the district is 89.03 per cent, male literacy level being 92.51 per cent and that of females at 86 per cent (GOI, 2011).

Wayanad houses the largest population of tribals in the state. Paniyar, Kurichyar, Kattunaikkar, Mullukkurumar, Adiyar, Kanduvadiyar, Thachanadar, Kanaladi are the major tribal communities. The economic development rate in the district is comparatively low owing to high dependence on agriculture, high proportion of tribes, climate change and fragile ecosystem.

3.1.4 Land Use Pattern

Total geographical area of the district is 2,12,966 ha of which 37 per cent is forest (78,787 ha) (2015-16). Agriculture is being practiced on an area of 1,44,872 *i.e.* 68 per cent of the total geographical area. With 10,917 ha (5.13%) sown more than once, gross cropped area is 1,55,789 ha (DES-2019) (Table 3.1).

Table 1. Land use pattern in the Wayanad (2015-16)

Sl No	Particulars	Area in Ha	Percentage
1	Forests	78787	37.00
2	Land put to Non-Agri uses	11789	5.54
3	Barren & Uncultivable Land	87	0.04
4	Permanent Pastural & Other Grazing Land	0	0.00
5	Land under Tree crops	205	0.10
6	Cultivable waste	9423	4.42
7	Fallow Lands Other Than Current Fallows	2449	1.15
8	Current Fallow	2435	1.14
9	Net area Sawn	144872	68.03
10	Area Sown More Than Once	10917	5.13
11	Cropped Area	155789	73.15
12	Geographical Area	212966	100.00

Source: DES, 2019

3.1.5 Cropping Pattern

Cropping pattern describes share of each crop in the total cultivated area in any year. It also describes the growers' choice making ability in order to cope with the available resources and to maximize the returns.

Paddy was the important crop cultivated in Wayanad, especially in the valleys amidst the hills. Hence, the District was known as the "Wayal Nadu" *i.e.* "Land of Paddy Fields" with the gross area of 20,388 ha under paddy in 1995-96. Gradually, hilly slopes were converted into coffee estates and pepper was introduced as an intercrop in coffee estates. In the later stages Pepper and Arecanut crops have managed to occupy the cultivable area as monocrops since these crops were fetching more income than the mixed cropping of Coffee + Arecanut or Coffee + Pepper (Joy, 2004).

At present the District reports a cropping area of 1,71,341 ha (2015-16) out of which 41.30 per cent (70,768 ha) is under food crops and 58.70 per cent (1,00,573 ha) under non-food crops. Around 60 per cent area is under plantation crops which includes Tea, Coffee and Rubber. Coffee has been the principal crop in the district with a lion share of 39.32 per cent of the cropped area. Betel Nut / Areca Nut (6.78%), Rubber (6.30%), Banana (6.26%), Coconut (6.03%), Black Pepper (5.87%) and Rice (5.66%) are the other important crops cultivated in the District (Table 3.2).

Table 2. Cropping Pattern of Wayanad (2015-16)

Sl No	Particulars	Area (Ha)	Percentage
1	Rice	9690	5.66
2	Maize	1	0.001
	Cereals and Millets	**9691**	**5.66**
3	Arhar (Tur)	648	0.38
	Pulses	**648**	**0.38**
	Food Grains	**10339**	**6.03**
4	Sugarcane	1	0.001
5	Other Sugar Crops	55	0.03
	Sugar Crops	**56**	**0.03**
6	Black pepper	10064	5.87
7	Ginger	1925	1.12
8	Turmeric	161	0.09
9	Cardamom	4125	2.41
10	Betel nut	11613	6.78
11	Other Condiments and Spices	261	0.15
	Condiments and Spices	**28149**	**16.43**
12	Mango	4531	2.64
13	Banana	10719	6.26
14	Citrus Fruits	129	0.08
15	Papaya	344	0.2
16	Other Fruits	10374	6.05
	Fresh Fruits	**26097**	**15.23**
17	Cashew nut	718	0.42
	Fruits	**718**	**0.42**
18	Tapioca	2327	1.36
19	Sweet Potato	8	0.005
20	Other Vegetables	3074	1.79
	Fruits and Vegetable	**32224**	**18.81**
Total Food Crop		**70768**	**41.30**
20	Coconut	10326	6.03
21	Other Oilseed Crops	51	0.03
	Oilseed Crops	**10378**	**6.06**
22	Tea	5306	3.10
23	Coffee	67364	39.32
24	Rubber	10790	6.30

25	Other Plantation Crops	395	0.23
	Plantation Crops	**83855**	**48.94**
26	Fodder Crops	399	0.23
27	Green Manure	566	0.33
Total Non-Food Crop		**100573**	**58.7**
Total Cropped Area		**171341**	**100.00**

Source: DES, 2019

3.2 Sampling Procedure

With the increasing number of drought incidences over the years in the district both Central and State Governments have accelerated the soil and water conservation in the district with the through NABARD and other agencies. Department of Soil Conservation is the implementing agency. Soil and Water Conservation Programme is implemented as four major schemes *viz.*, Arable Land Treatment (ALT), Drainage Line Treatment (DLT), Drought Mitigation Scheme (DMS) and Western Ghats Development Project (WGDP).

3.2.1. Arable Land Treatment Measures

These measures include contour trenches or staggered trenches, earthen bunds, moisture conservation pits, stone pitched contour bunds, vegetative hedges, Contour staggered trench, Agrostological measures and Terracing. These structures were implemented to conserve the rainfall preventing water erosion.

3.2.2. Drainage Line Treatments

Drainage lines are carriers of runoff and sediment in watershed. Steep bed gradient (Slope) of a channel cause high runoff velocities with associated heavy sediment flow. Hence channel gradient needs to be reduced in order to bring the runoff velocities within permissible limits. Activities under the scheme were water harvesting structures, renovation of water harvesting structures, retaining wall, side protection wall, coir geo textiles, percolation ponds, check dam and logwood check dam.

3.2.3. Drought Mitigation Scheme

This scheme included the strategies for moisture conservation, increasing the plant population, rainfall harvesting *i.e.* construction of check dams, water harvesting

structures like farm ponds, retaining wall, side protection walls, dry rubble check dam, gully plugins and logwood check dam.

3.2.4. Western Ghats Development Scheme

In enactment of the fast-tracking the development of hill areas in the country and at the suggestion of the National Development Council (1972) the centrally sponsored Western Ghats Development Programme (WGDP) was introduced in 1981 for integrated development of Western Ghats Region. The scheme covers Kerala, Karnataka, Maharashrtra, Tamil Nadu and Goa. It was aimed at the development of hilly areas. This Project included the construction Earthern bund, Contour staggered trench, Agrostological measures, terracing, irrigation channels, water harvesting structures, side protection walls, check dam, percolation and ponds.

3.2.5 Sample Selection

Arable Land Treatment (ALT), Drainage Line Treatment (DLT), Drought Mitigation scheme (DMS) and Western Ghats Development (WGD) scheme were implemented in all Blocks of Wayanad District. List of beneficiaries was collected from the District Soil and Water Conservation Department and Deputy Soil and Water Conservations office Mananthawadi and Meenangadi, NGO's like Brahmagiri Development Society, Wayanad Service Society, Jeevana and Arshabharathi.

Among the various structures implemented under each scheme, 3 important structures from each scheme were selected based on the number of structures implemented. Earthen Bund, Stone Pitched Bunds and Trenches were selected form ALT scheme (Plate 1), Farm Ponds, Check Dams and Stream Bank Stabilization under DLT scheme (Plate 2), Well Recharge, Farm Ponds and Logwood Check Dam from DMS (Plate 3) and Earthen Bund, Check Dam and Farm Ponds from the WGD scheme (Plate 4) for evaluation.

The sample selection for the study was done based on Multistage Random Sampling method. 30 beneficiaries (10 beneficiaries * 3 structures) were selected from each scheme and 120 beneficiaries (30 * 4 schemes) from each taluk, thus making a total sample of 360 farmers (30 beneficiaries * 4 schemes * 3 taluks) (Fig 2). One

Earthen bunds

Stone Pitched Bunds

Trenches

Plate 1. Different structures implemented under Arable Land Treatment (ALT) Scheme

Stream Bank Stabilization

Farm Ponds

Check Dam

Plate 2. Different structures implemented under Drainage Line Treatment (DLT) Scheme

Well Recharge

Farm Pond

Plate 3. Different structures implemented under Drought Mitigation Scheme (DMS)

Earthen Bunds

Farm Ponds

Check Dam

Plate 4. Structures implemented under Western Ghats Development Prtogramme Scheme

neighboring farmer to the respondent was interviewed to the find out externalities received by the adjacent farmers because of the adoption of SWC structures.

3.3 Nature and sources of data

The study is based on both Primary data and secondary data. Primary data was collected from the beneficiaries of different Soil and Water Conservation Schemes implemented in the district. A well-structured and pre-tested interview schedule was employed in order to collect the data from the sample respondents. Interview schedule was constructed based on the review of literature, and has been sent to the experts in the field and finalized with the pilot study in the Ambalwayal GP of Kalpetta Block (Copy attached as Annexures 1). The data collection was done as personal interview method employing the interview schedule developed for the purpose, during the month of February and March 2019. Sample farms were visited personally for understanding different adaptation strategies through direct observation during field visits. One PRA each (Participatory Rural Appraisal) was conducted in each block to get farmers opinion about the rainfall pattern, drought incidents and effects of Soil and Water Conservation measures on cropping pattern and crop productivity.

Secondary data regarding credit support given for adopting Soil and Water Conservation measures was collected from the published sources of NABARD, Lead Bank of Wayanad and District NABARD office Wayanad.

3.4. Analytical tools and techniques

The first objective of the study was to analyze the pattern of credit flow to SWC. For this the time series data on credit lending (2006-07 to 2017-18) and refinance support (1990-2017) to agriculture (purpose wise and agency wise) was compiled. The flow of institutional credit in Wayanad (Purpose wise and Agencywise) was compiled from Lead Bank Wayanad and NABARD (Wayanad District Branch).

The data was analyzed employing the following statistical tools.

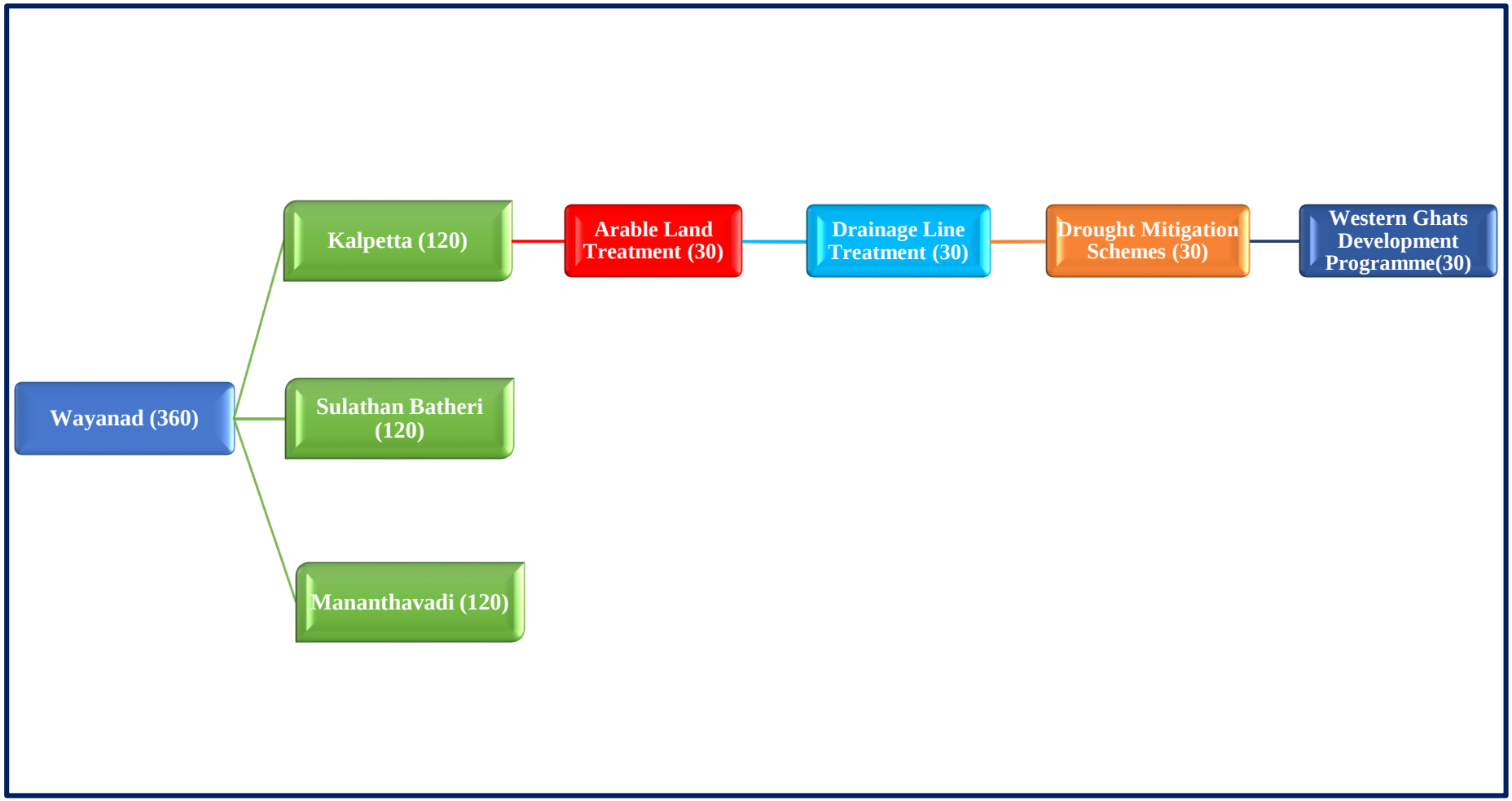

Fig 2. Respondents selection procedure for the study in the district

3.4.1 Growth Rate Analysis

For computing the growth rate of institutional credit support disbursement to the different sectors, following exponential function was used.

$$Y=a * b^{t} * e^{Ui} \quad (1)$$

Where,

Y = Amount of credit disbursed

a = Intercept

b = Regression co-efficient

t = time period

Ui = Disturbance term

The log linear form of equation (1) can be written as

$$\text{Log } Y = \log a + t \log b + U_t \quad (2)$$

Ordinary Least Square (OLS) technique was used to solve the equation (2). Then the compound growth rate (g) was computed

$$g = (b-1) * 100 \quad (3)$$

Where,

g = Compound growth rate in per cent per annum

b = Antilog of b

The standard error of the growth rate was estimated and tested for its significance with ‘t’ statistic.

3.4.2 Financial feasibility analysis

Economic feasibility analysis identifies how much investment is needed for a project and expected returns from the investment. It is used to identify the financial feasibility of the structures implemented under the different projects.

The techniques used for the financial feasibility analysis are:

1. Net Present Value / Worth (NPV)

Net present value (NPV) is difference between the Present Value of cash inflows and the Present Value of cash outflows over a period of time. It is mainly used to analyze the profitability of a new project. Project with positive NPV is worth considering and ranking the projects based on magnitude of NPV is also made. NPV also indicates the scale and magnitude of the project investments and returns.

It is estimated using the following equation

$$NPV/W = \frac{P_1}{(1+i)^{t_1}} + \frac{P_2}{(1+i)^{t_2}} + \ldots\ldots\ldots\ldots + \frac{P_n}{(1+i)^{t_n}}$$

Where,

$P_{1\ldots n}$ = Net Cash flow in year n (Difference between cash outflows and inflows)

i = Discount rate (9%)

t = Time period (the economic life of the SWC structure)

Projects with positive NPW are economically viable

2. Benefit – Cost Ratio (BC Ratio)

It is the ratio of benefits and costs of a project expressed in monetary terms. It reflects the efficiency of the investment. It is estimated using the following equation

$$BC\ Ratio = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}}$$

Where,

Bn = Benefits (Cash Inflowes) received in year t

C_t = Costs (Cash Outflows) in year t

I = rate of discount (9%)

t = Time period (economic life of the SWC structure)

i = Discount rate

BC ratio of more than one indicates the profitability of the project. Project is selected if BC ratio is more than one.

3. Internal Rate of Return (IRR)

Internal rate of return (IRR) is the discount rate at which NPV of net cash flows (NPV/W) from a project or investment is equal zero *i.e.* NPV/W=0. It is calculated by using the following formula

$$IRR = \begin{pmatrix} Lower\ discount \\ rate \end{pmatrix} + \begin{pmatrix} Difference\ between \\ the\ two\ discount\ rates \end{pmatrix} X \begin{pmatrix} Present\ worth\ of \\ the\ cash\ flow\ at \\ \underline{the\ lower\ discount\ rate} \\ Absolute\ difference \\ between\ the\ present \\ worths\ of\ the\ cash\ flow \\ at\ the\ two\ discount\ rates \end{pmatrix}$$

IRR should be higher than the opportunity cost of capital for the project.

The discount rate (opportunity cost of capital) for financial analysis was assumed to be nine per cent as it was rate of interest on term deposits in Commercial Banks during the study period (2018-19) (Reddy and Ram, 2017).

3.4.3 Markov Chain Analysis

According to Elashoff (1984) "Markov chain is a stochastic model describing a sequence of possible events in which the probability of each event depends only on the state attained in the previous event". "Markov chain analysis was employed to analyze the structural change in any system whose progress through time can be measured in terms of single outcome variable" (Dent, 1967). Kusuma and Basavaraja (2015) studied the stability of mango export markets of India. Satishkumar *et al.* (2016) studied the consistence of Basmathi and Non-Basmthi rice export Markets of India. Tejaswi *et al.*,

(2010) identified changes in the direction of Indian coffee exports using Markov Chain analysis.

Markov chain analysis is used here to analyze the dynamic nature of credit/refinance support *i.e.* gains and losses in the fund allocation between the different purposes/sectors within agriculture. It identified the changes in the direction of NABARD's refinance allocation for the different agricultural purposes in Kerala and in changes in the lending pattern of credit institutions in Wayanad District. It involves developing a transitional matrix probability matrix 'P', whose elements, P_{ij} indicate the probability of refinance allocation switching from a sector 'i' to sector 'j' over time. The diagonal element P_{ij} where i=j, measures the probability of a sector retaining its market share or in other words.

In the present study, structural change was meant to be random process with the purposes for funds allocation. Hypothesis was that the mean allocation for selected purposes in any year depends only on the allocation of the previous year and the dependence was same among all the time. the equation is as follows

$$A_{ji} = \sum_{i=1}^{n} (A_{it-1}) P_{ij} + e_{jt}$$

Where,

A_{jt} = Refinance allocation by NABARD to the j^{th} purpose in the year t (Crore)

A_{it-1} = Allocation to the i^{th} purpose during year $_{t-1}$

P_{ij} = probability that allocation will shift from i^{th} sector to j^{th} sector

e_{jt} = error term which is statistically independent of E_{jt-1}

n = number of sectors/purpose

The transitional probabilities P_{ij}, which can be arranged in a (c x n) matrix, have the following properties.

$$\sum_{i=1}^{n} P_{1j} = 1 \qquad And\ 0 \leq P_{ij} \leq 1$$

Thus, the expected allocation shares of each purpose during the time 't' is obtained by multiplying the allocation to these purposes in the previous period (t-1) with the transitional probability matrix. The probability matrix was estimated for the period 1991-92 to 2017-18.

3.4.4 Henry Garret Ranking Method

Garret's Ranking technique is used to rank the relative preference for adopting the SWC structures and problems faced while adopting the SWC structures, indicated by the respondents on different aspects. To cite as an example, Lokesh (2015), has used Garret ranking technique to rank the coping strategies adopted during drought. Rangegowda (2017) used to enlist the factors influencing the banana purchase by consumers. Desai (2005) and Mithun and Bheemappa (2015) used for ranking the constraints in adopting the SWC structures in Karnataka.

In this method, respondents were asked to rank all preference for the SWC structures and statements connected with the problems faced by them and the outcomes of such ranking were converted into scores using Garret score table. The steps involved in this method are as follows.

1. Each respondent is asked to rank the preference for adopting SWC structures and problems faced. In the study, 360 respondents were asked to rank the SWC structure listed.

2. Count the frequency of respondents giving 1st rank to first structure/problem, 1st rank to second structure/second problem and so on.

3. Tabulate the number of responses, in the order of ranks under each factor.

4. Calculate percent position with the help of the formula

$$\text{Per cent position} = [100*(R_{ij} - 0.5)]/N_j$$

Where,

Rij = rank given for ith structure by jth individual

Nj = number of structures ranked by jth individual

5. For each percent position find corresponding Garret value: To find Garret value use Garret ranking conversion table. Using the table, check per cent position calculated and obtained nearest corresponding Garret value.

6. Multiply Garret value with respective ranks. Say, the Garret value of F1 percent position is 60, then multiply it to all the frequencies tabulated under 1st rank of F1 and so on.

7. Add the values thus obtained for each factor.

8. Obtain average of the total sum of each factor by

Average = Total Value/ No of respondents

9. Rank the average score as 1st rank for the highest, second rank to the second highest and so on

10. Thus obtained ranks are used to prioritize the factors.

This method is employed to find out the preference for SWC Structures to adopt and to prioritize the constraints faced by the lessors and lessees.

3.4.5 Resource Use Efficiency

3.4.5.1 Cobb-Douglas Function

Production function analysis was employed to assess relative efficiency of various inputs on production. Cobb-Douglas is one of the widely used production function in the field of agriculture and industries (Sankhayan, 1988). Ordinary Least Square (OLS) technique was used to estimate the Cobb-Douglas production function and the co-efficient values were tested for the statistical significance.

The algebraic forms of Cobb-Douglas production function is given by,

$$Y = a_0 \; X_1^{a_1} X_2^{a_2} \; X_3^{a_3} \; X_4^{a_4} \; X_5^{a_5}$$

Where,

Y : Returns of Coffee / Pepper / Areca Nut / Banana (□/ha)

X_1 : Amount spent on manures (□/ha)

X_2 : Human labour (□/ha)

X_3 : Irrigation (□/ha)

X_4 : Weeding (□/ha)

X_5 : Quantity of Lime (□/ha)

The constants a_0 and a_i (i= 1, 2 . . . 5) represent the efficiency of the parameters and the production elasticities of the respective input variables. The estimated form corresponding to this equation is,

$$\ln y = \ln a_0 + \ln X_1 + \ln X_2 + \ln X_3 + \ln X_4 + \ln X_{5+Ui}$$

The 't' test was used to test the significance of co-efficient.

3.4.6 Ordered probit model

Ordered Probit Model is widely used when the dependent variable is of categorical in nature. It is built around a latent regression, similar to the binomial probit model. It is used by Singh (2011) to identify factors influencing financial crisis of Indian States. Pietrovito, *et al.*, (2015) used the model for analysing the factors influencing selection of industries for Foreign Direct Investment (FDI). Ade and Bosede (2017) studied the factors affecting the adaptations to the climate change in South West Nigeria. Model of Ade and Bosede (2017) was adopted after making the suitable modifications according to the variables considered in the study.

Let

$$Y_i^* = X^i\beta_i + U \text{---------- (1)}$$

The latent factor (farmer's contributions) in this study exhibits itself in ordinal categories which was coded as 1, 2. . . . . j. The response of category is thus observed

when the underlying continues response of category j is thus observed when the underlying continues response falls in the j^{th} interval as

Y* = 1 (Respondents who adopted the largely implemented structure under each scheme)

Y* = 2 (Respondents who adopted the second large implemented structure under each scheme)

Y* = 3 (Respondents who adopted the third large implemented structure under each scheme) ---------- (2)

Green (2002) noted that when an intercept coefficient is included in the model, Y_1^* is normalized to a value and hence only j additional parameters estimated with X's. Like the models for binary data, the probabilities for each of the observed ordinal response, that is, farmer's level of contributions to decision making in this study had 3 responses which could be low, moderate and high with ordinal values of 1, 2, 3 was given as:

$$Prob(y=1/x) = \Phi(\mu_1 - x'\beta) - \Phi(-x'\beta) \text{ ---------- (3)}$$

$$Prob(y=2/x) = \Phi(\mu_2 - x'\beta) - \Phi(\mu_1 - x'\beta) \text{ ---------- (4)}$$

$$Prob(y=3/x) = \Phi(\mu_3 - x'\beta) - \Phi(\mu_2 - x'\beta) \text{ ---------- (5)}$$

where, 1<Y1*<Y2*< - - - <Y*j-1. . . . .n, is the cumulative normal distribution function such that the sum total of the above probabilities is equal to one.

The specification of the ordered probit model in this study is as follows. Let Yi denote the adoption of SWC structures: $Y_i = 1$ (Respondents who adopted Earthen Bund/ Stream Bank Stabilization/ Well Recharge/ Earthen Bund in ALT, DLT, DMS and WGDP schemes respectively), $Y_i = 2$ – (Stone Pitched Bunds/ Farm Ponds/Logwood Check Dam/ Farm Ponds) and $Y_i = 3$ (Trenches/ Check Dam/ Farm Pond/ Check Dams). The marginal effects of the regressors X on the probabilities are not equal to the coefficients. The marginal probabilities could therefore be calculated from the probit model as:

$$\frac{dprob[Y_j]}{dx_j} = \left[\Phi\left(\mu_{j-1} - \beta'^{X_j}\right) - \Phi\left(\mu_j - \beta' X_j\right)\right]\beta - - - - - - - - - (1)$$

where, Φ is the normal density function, j the threshold parameter and X_j the j the explanatory variable. Farmers decision about the adaptation of Soil and Water Conservation measures decision is specified as follows:

$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + u_i$ - - - - (2)

Where,

Y = 1 (Most preferred SWC measures), 2 (2^{nd} most preferred structure), and 3 (least preferred structure)

X_1 = Age of the farmers (1 - Young, 2 - Middle and 3 - Old)

X_2 = Education in years (0 – illiterate, 1 – Primary, 2 - higher primary, 3 – secondary, 4 - Higher Secondary and 5 - Graduation & Above)

X3 = Occupation (1 – agriculture, 2 – labour, 3 – business, 4 – private, 5 – government)

X4 = Number of family members (No/household)

X5 = Number of Literates in the family (No/household)

X6 = Organizational Membership (0 – No membership, 1 – membership)

X7 = Total Land Holding (1 – marginal farmer, 2 – Small farmer, 3 – medium farmer)

X8 = Area Under Irrigation Before (in acres)

X9 = Knowledge on Soil Erosion (0 – No knowledge, 1 – Complete knowledge)

3.5. Definitions of terms and concepts

3.5.1. Cost concepts

1. Cost A: Comprises all the actual expenditures in cash and kind expended in the production period.

Following items are considered while finding cost A_1

a) Cost of hired human labour and machine labour

b) Value of material inputs

c) Interest on working capital

d) Land Cess

e) Depreciation on farm implements/machinery.

f) Other expenses

2. Cost A2 is equal to Cost A1 plus rent paid for leased in land

3. Cost B1 equals cost A1 plus interest on own fixed capital.

4. Cost B2 is sum of cost B1 and rental value of own land plus rent paid for leased in land.

5. Cost C1 is Cost B1 plus imputed value of family labour.

6. Cost C2 equals Cost B2 plus imputed value of family labour

Fixed costs

It included the investment on fixed assets and it was included in the estimation as interest on fixed capital and depreciation. Land revenue was taken at the rates levied by the government. As per GOK, 2014c cost of cultivation report, land tax and irrigation cess together was Rs. 188/ha.

Variable costs

The variable costs include cost of seeds, organic manures, fertilizers, growth hormones, chemical pesticides and wages of human labour, bullock labour, machine labour and repair and maintenance charges.

The criterion followed by Commission for Costs and Prices, GoI was followed for assessing the input use and its valuation (CACP, 2018)

3.4.3 Details of Soil and Water Conservation measures implemented in Wayanad

1. Earthen Bunds

Bunds are the small heap like structures made up of locally available structures. These structures help to check the speed of the water flow and helps to increase the moisture content of the field. Also, these structures are helpful in diverting the excess water into drainages and natural streams.

2. Stone Pitched Bunds

These structures are constructed along with contour at suitable intervals of slopes. It will increase the water availability and moisture level in the fields adopted also these structures will reduce soil erosion. It is suitable for the laterite soils, where stones are available and these structures can be installed in the area with the slope of 35 %.

3. Trenches

These are the structures that are adopted at hills, degraded lands, barren lands and *etc.,* for moisture conservation and afforestation purposes. These helps in reducing the velocity of surface runoff and this structures can be used in all the slopes regardless of rainfall and soil type.

4. Check Dams

Check dam is barrier that is constructed across the natural streams and drainages to stop the water flow and sediments. These structures will be constructed using different materials like clay, stone, cement and *etc.* Earthen dams or embankments are types of check dams that are constructed by the farmers themselves.

5. Stream Bank Stabilization

In the hilly and high rainfall areas, the rainfall water will over flow in the drainage lines and this over flow will create huge soil erosion along the drainage lines also it will affect the adjacent agricultural lands. Hence, walls of these drainages or steam banks will be covered with retaining walls with different materials with this water flow can be regulated and erosion will be avoided.

6. Farm Ponds & Water Harvesting Structures

These are the structures that are meant for storing the runoff water and using the saved water at the water crisis situations. These structures are usually constructed in the low lying areas and these will also contribute in increasing the soil moisture around these structures.

7. Well recharge

It is the collection of roof top water during the rainy season and diverting the collected water into open dug well after filtering it. The water fallen on the roof top will be collected through PVC pipes and will be diverted into sedimentation tank which contain sand, gravel, charcoal *etc.* The refined or purified water will be directed into open dug wells which will intern helps to increase the ground water table and make the water available on off season.

8. Logwood Check Dam

These are the check dams which are made of wooden material and are positioned across the streams. These are mainly utilized to stop the soil erosion *i.e.* to stop the movement of fine and coarse sand materials conceded by flowing water especially in the gully areas.

Results and Discussion

4. RESULTS AND DISCUSSION

This section deal with the findings from the study. Results are presented under various headings, in accordance with the objectives as follows.

4.1 Socio-Economic profile of the respondents

4.2 Institutional credit flow to the agriculture

4.3 Farm level investments, economic efficiency and viability of SWC methods

4.4 Preferences for soil and water conservation methods

4.5 Perceptions of respondents on soil and water conservation measures

4.1 Socio-economic profile of the sample farmers

The socio-economic profile of the farmers has prominent role in decision making, as it influence the knowledge and behaviour towards innovation and in adopting the same (Taylor and Yu, 2009). It is said to have an impact on the ability of a person to take risk bearing decisions (Mittal and Mehar, 2015; Bahtera, 2015). The details of age, education, type of family, occupation and social contacts of the respondents are discussed in this section.

4.1.1 Age

Age of the sample respondents in the study area is presented in Table 03. Respondents were post classified into ‘Young’ (<30 years), ‘Middle aged’ (31 to 60 years) and ‘Old’ (>60 years) based on the age. Nearly two third of the respondents were middle aged (58.33 %) followed by ‘old age group (33.33%) and youngsters (8.33%). Average age of the respondents was 52.91 years and it was lowest for the respondents of DLT scheme (49.84 years). Compared to the other schemes, there were higher proportion of (13.33%) young farmers among the respondents in the Drainage Line Treatment scheme.

Middle aged group play a major role in the agricultural sector, whereas the younger people often tend to migrate to urban areas. The presence of young people in agricultural sector is to be made more, as it influences the sustainability of profession. The age pattern of the study was in parallel with State trend. The average age of farmers in the state is reported as between 41 years and 68 years (Balachandran, 2004). 50 per cent of the respondents in the study conducted by Prasad *et al.* (2017) belonged to middle age category in Wayanad District.

Table 03. Age of the respondents in the study area (in numbers)

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	Young (<30)	5 (5.56)	12 (13.33)	9 (10.00)	4 (4.44)	30 (8.33)
2	Middle (31 – 60)	48 (53.33)	56 (62.22)	51 (56.67)	55 (61.11)	210 (58.33)
3	Old (60<)	37 (41.11)	22 (24.44)	30 (33.33)	31 (34.44)	120 (33.33)
Total		90 (100.00)	90 (100.00)	90 (100.00)	90 (100.00)	360 (100.00)
Average Age (years)		55.76	49.84	53.14	52.91	52.91

(Figures in the parenthesis are percent to total)

4.1.2 Education level

Kerala is the state with highest level of literacy in the country with the literacy rate of 95 per cent. Respondents are classified into different education groups in the post-survey period *i.e.* Primary (1st to 7th standard), Higher Primary (8th and 9th standard), Secondary (10th), Higher Secondary (12th), Graduation and above and details are presented in the Table 04. Roughly one third of the respondents completed the 10th standard education (30.00 %). Only very few were graduates (5.56%). Higher education was less among the respondents because most of the respondents belonged to the generation where formal education was not ensured. Also, Wayanad is the district with highest proportion of tribes where lack of awareness on formal education prevails and people don't show much interest in formal education. The literacy level of the respondents is comparatively low among the respondents of WGDP scheme, as it was mostly implemented in the remote tribal areas of the District. Varghees (2012) reported

similar results *i.e.* about 70 per cent of the respondents were educated up to secondary school in Wayanad and Nair *et al.* (2007) reported 25 per cent of respondents in Wayanad were with Secondary education and were highest.

Table 04. Education level of the respondents in the study area (Numbers)

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	**Primary**	17 (18.89)	13 (14.44)	19 (21.11)	26 (28.89)	75 (20.83)
2	**Higher Primary**	32 (35.56)	21 (23.33)	20 (22.22)	30 (33.33)	103 (28.61)
3	**Secondary**	32 (35.56)	29 (32.22)	29 (32.22)	18 (20.00)	108 (30.00)
4	**Higher Secondary**	7 (7.78)	16 (17.78)	18 (20.00)	13 (14.44)	54 (15.00)
5	**Graduation & Above**	2 (2.22)	11 (12.22)	4 (4.44)	3 (3.33)	20 (5.56)
Total		90 (100.00)	90 (100.00)	90 (100.00)	90 (100.00)	360 (100.00)

(Figures in the parenthesis are percent to total)

4.1.3 Family type

Family is the basic unit of society. It has prominent role in agriculture since Indian agriculture is highly dependent on the family labours (Baliyan, 2018). Family has a considerable influence in the adoption of innovations. In this study there are two categories *viz.*, if the family size was less than or equal to 6, it is classified as a nuclear family and if the family size was 7 or more, it is classified as a joint family and details are presented in the Table 05. Nuclear families were more with the share of 86.11 per cent. Among the schemes, WGDP had greater number of Joint families (21.11%) compared to other schemes because the scheme is mostly implemented in the interior places and adivasi area where joint family system exists very strongly. Increase in the nuclear families is a threat to agriculture since in most cases parents of nuclear family is migrating to cities for employment (Singh, 2009).

Table 05. Family type of respondents in the study area (Numbers)

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	**Nuclear (≤6)**	76 (84.44)	80 (88.89)	83 (92.22)	71 (78.89)	310 (86.11)
2	**Joint (7≤)**	14 (15.56)	10 (11.11)	7 (7.78)	19 (21.11)	50 (13.89)
3	**Grand Total**	90 (100)	90 (100)	90 (100)	90 (100)	360 (100)

(Figures in the parenthesis are percent to total)

4.1.4 Occupation pattern

Occupation often decides the social status of an individual. Occupation also influences the risk bearing ability. Details on the respondent's main occupation is presented in Table 06. Even though tertiary sector of the country was growing rapidly and opportunities were more, dependency on agriculture has not reduced, especially in the rural areas. Around 3/4th (73.89) of the respondents in the study were depending on agriculture as the major source for livelihood. 11.67 per cent of the respondents were labour (kooli), it was their primary occupation followed by agriculture as the secondary source of income. Few respondents (7.22%) were involved in business and other activities *viz*., ginger merchants in Karnataka, vegetable shop, grocery stores *etc.* Around 3.33 per cent of the people were working in service sector (fashion stores, shopping malls, private school teachers, van drivers, lawyers *etc*.). Government job holders were 3.89 per cent which include School Teachers, KSRTC Driver, Engineer and Peon. Overall, 3/4th of the respondents practiced agriculture as a primary occupation. Varghese (2012) reported 59 per cent of the respondents opted agriculture as main occupation and remaining as secondary occupation in the same District. In the study conducted by Nair *et al.* (2007) only 29 per cent of the families were following agriculture as primary occupation and was very low when compared to the present study.

Table 06. Occupation pattern of the respondents in the study area (number)

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	**Agriculture**	62 (68.89)	63 (70)	70 (77.78)	71 (78.89)	266 (73.89)
2	**Labour**	17 (18.89)	11 (12.22)	6 (6.67)	8 (8.89)	42 (11.67)
3	**Business**	2 (2.22)	11 (12.22)	6 (6.67)	7 (7.78)	26 (7.22)
4	**Private**	5 (5.56)	1 (1.11)	4 (4.44)	2 (2.22)	12 (3.33)
5	**Government**	4 (4.44)	4 (4.44)	4 (4.44)	2 (2.22)	14 (3.89)
Grand Total		90 (100)	90 (100)	90 (100)	90 (100)	360 (100)

(Figures in the parenthesis are percent to total)

4.1.5 Membership in Social groups

Social groups are the platforms for exchange of opinions, ideas, information and are very important informal means for transmitting information. These groups have leading role in India because they are the primary means to satisfy the information needs of an individual. Social groups in agriculture have vital role in the transfer of knowledge to the farming community and farmers with better social contacts are leading in adopting the innovations (Matuschke and Qaim, 2009; Rajesh, 2012). In the study, 60 per cent of the respondents were members in one of the social groups in the study area whereas remaining 40 per cent of the respondents were not having any memberships (Table 07). In the 216 (60 per cent) membership holders, 93.06 per cent respondents were members of "farmers clubs" followed by 4.17 per cent in youth clubs and 2.78 per cent in village panchayats.

Many of the respondents were not even aware whether they have membership in any of the groups, because of the inactiveness of the groups and some of the groups existed only in paper. Farmer clubs are mainly patronized by Coffee Board and VFPCK which were conducting group meetings and knowledge dissemination programs on various aspects on regular basis.

Table 07. Categorization of respondents based on social group membership (in numbers)

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	No Membership*	36 (40)	36 (40)	35 (38.89)	37 (41.11)	144 (40)
2	Farmers Club	49 (90.74)	51 (94.44)	52 (94.55)	49 (92.45)	201 (93.06)
3	Youth Club	3 (5.56)	1 (1.85)	3 (5.45)	2 (3.77)	9 (4.17)
4	Village panchayat	2 (3.7)	2 (3.7)	0 (0)	2 (3.77)	6 (2.78)
	Total	54 (100)	54 (100)	55 (100)	53 (100)	216 (100)
	Grand Total	90	90	90	90	360

(* - Figures in the parenthesis indicates percent to grand total)
(Figures indicates Figures in the parenthesis are percent to total (Row 2 - 4))

4.1.6 Social participation of respondents (Frequency of attending the meetings)

It is important to understand the effectiveness of group activity and participation as many of these groups were inactive. Table 08 furnishes details of frequency of participation in meetings. The presence of an individual in the meeting was important since most of the meetings conducted were based on the current needs of the farmers and these could help farmers in effective management of the crops/farm and increasing productivity of the land. Coffee Board and VFPCK were conducting the farmers meeting once in a fortnight. Farmers participating in all the meetings were meagre (4.17%) and most of them (43.06%) were participating once in a month. Around 43 per cent of the respondents were only 2-3 times in a year and were feeling that there was not much of knowledge gain from the meetings. Hence they were not attending regularly. The participation level was highest among the respondents of WGDP scheme, among all other groups. The Coffee Board the main promoter of the farmer club, was holding the meeting based on farmer needs and responses. The WGDP scheme is implemented in tribal areas and rural areas. These meetups are the major source of information. A study conducted by the Narayanan (2016) in Wayanad has reported low social participation among farmers. It might be due to the irregularity in meetings conducted or due to content of the meetings.

Table 08. Social participation of respondents (frequency of attendance in the meetings)

Sl No	**Participation**	**ALT**	**DLT**	**DMS**	**WGDP**	**Total**
1	Once in a fortnight	1 (1.85)	6 (11.11)	0 (0)	2 (3.77)	9 (4.17)
2	Once in a Month	24 (44.44)	18 (33.33)	22 (40.00)	29 (54.72)	93 (43.06)
3	2-3 times in a year	19 (35.19)	21 (38.89)	31 (56.36)	21 (39.62)	92 (42.59)
4	No Participation	10 (18.52)	9 (16.67)	2 (3.64)	1 (1.89)	22 (10.19)
	Grand Total	54 (100)	54 (100)	55 (100)	53 (100)	216 (100)

(Figures in the parenthesis are percent to total)

4.1.7 Extent of social media usage

Social media is one of the popular platform in modern days for the dispersion of information and educating people. Groups in these social medias are called as virtual groups. It connects the people from different geographical areas in a single platform and helps in easy and quick dissemination of information. Table 09 represents social media usage by the respondents (e-mail, WhatsApp, Facebook and YouTube). WhatsApp was the most used social media by the respondents (22.13%), followed by Facebook (9.91%), YouTube (6.39%) and email (4.81%). Similar results were observed in all the four groups. Use of social media was very less which may be because most of the respondents belonged to older age groups and the literacy rate was lower.

Table 09. Social media use by the respondents (Per cent)

Particulars	ALT	DLT	DMS	WGDP	Total
E mail	3.70	8.89	4.44	2.22	4.81
What's app	19.26	29.26	17.04	22.96	22.13
Facebook	8.52	15.56	5.19	10.37	9.91
YouTube	9.63	7.78	4.44	3.70	6.39

4.1.8 Land holdings

Holding size of land is a reflection of economic status of the farmer. In Kerala the proportion of Small Farmer (SF), Medium Farmer (MF) and Large farmers (LF) is reported at, 78.74 per cent, 14.46 per cent and 06.80 per cent respectively with an average size of 0.18 ha (Agril. Census, GoK 2016).

The respondents in the study, when post stratified, constituted 62.22 per cent marginal farmers, 36.39 per cent small farmers and 1.39 per cent medium and large farmers, the pattern being in tune with the state scenario (Table 10). The average holding size was 0.94 ha, with marginal farmers enjoying 0.71 ha, small farmers - 1.28 ha and medium and large farmers - 2.60 ha, this is much higher than the state average. The agriculturally important economy and presence of plantation crops might be the reason. Mathew *et al.* (2018) reported that average holding of small farmers who were cultivating ginger was to be 1.27 ha and out of which only 6 per cent was under

irrigation. Jose and Padmanabhan (2015) reported the average land holding of Wayanad farmers at 0.44 ha in 2010-2011.

Table 10. Average land holding size among the respondents (in ha)

Sl No	Participation	ALT		DLT		DMS		WGDP		Total	
		No	Area	No	Area	No	Area	No	Area	No	Area
1	Marginal (<1)	56 (62.22)	0.66	52 (57.78)	0.73	55 (61.11)	0.7	61 (67.78)	0.73	224 (62.22)	0.71
2	Small (1-2)	33 (36.67)	1.35	35 (38.89)	1.31	34 (37.78)	1.23	29 (32.22)	1.22	131 (36.39)	1.28
3	Medium and large (2<)	1 (1.11)	4.00	3 (3.33)	2.33	1 (1.11)	2	0 (0.00)	0.00	5 (1.39)	2.60
4	Total/Average	90 (100.00)	0.95	90 (100.00)	1.01	90 (100.00)	0.92	90 (100.00)	0.89	360 (100.00)	0.94

(Figures in the parenthesis are percent to total)

4.2 Institutional credit support to agriculture and Soil and Water Conservation (SWC) in Kerala

In developing countries like India, credit is one of the important input in farming. Apart from supporting agriculture, agricultural credit has also played a vibrant role in constructing rural India (Reddy *et al.,* 2019, Kumar *et al.,* 2007). Small and marginal farmers constitute 86 per cent of the total farmers in India and are completely depending on the credit supply system for cultivation (Sidhu and Gill, 2006). Non institutional sources were leading the agricultural lending in the early days after independence and were found to be exploitative in nature. Hence, GoI announced Nationalization of Banks in 1969 and 1980 with the main aim of decreasing the farmers' dependency on non-institutional credit sources and to increase the share of institutional credit lending to agriculture (Kumar *et al.,* 2007). Even though there is change in share of credit issued by institutional sources, there are large section of farmers who still depend on the non-formal sources, since there was an inadequacy of credit distributed by institutional sources (Devaraja, 2011). Farmers who availed credit from non-formal sources are generally exploited by money lenders (Kumar *et al.,* 2010) while the social status of farmers who availed institutional credit has increased (Ramakrishna, 2010).

This section discusses the institutional credit flow to agriculture in Kerala and Wayanad District in particular. Credit flow to agriculture in Kerala is compiled for 13 years and data on refinance support (source-wise and purpose-wise) by NABARD is compiled (29 years) and are as follows.

4.2.1 Credit support to agriculture in Kerala

The state is having a net sown area of 20.40 lakh ha area for which it received a total credit of 67,089 crores with an average of 3.28 lakhs/ha in 2017-18 (Table 11). Total credit supply was increased by 15.11 per cent over the years. Nearly 1/3rd of the share in the credit was issued as crop loans in 2017-18 and was increased by 13.43 per cent over the years with an average of 29511.38 crores/year. 18,847 crore was issued as term loans with an average of 9038.62 crore and it observed a growth rate of 20.22 per cent. Growth rate of the term loans (20.22%) was loans was higher than crop loans (13.43%) and total credit lending rate (15.11%). Higher growth rate in the term

loans indicates the preference of financial institutions in supporting the farm development is increasing.

Table 11. Credit flow to agriculture by different financial institutions in Kerala (in Crore □)

Sl No	Particulars	2017-18	Average	CAGR
1	Crop Loan	48242.00 (71.91)	29511.38 (76.55)	13.43
2	Term Loans	18847.00 (28.09)	9038.62 (23.45)	20.22
	Total	**67089.00 (100.00)**	38550.00 (100.00)	**15.11**

(Figures in the parenthesis are percent to total)

4.2.2 Refinance support to agriculture in Kerala

Commercial Banks, Co-operative Banks and Regional Rural Banks are the important credit lending institutions to agriculture. Data on refinance support by NABARD to these institutions for the past 29 years (1990-91 and 2017-18) is furnished in Table 12. In the financial year 2017-18 a total of □ 10,024.29 crores was refinanced to the agriculture sector in Kerala by NABARD. Regional Rural Banks enjoyed one third share *i.e*. 33.28 per cent (□ 3,336.53 crores), followed by Commercial Banks (27.58 %) and State Co-operative Banks (26.72 %). KSCARDB's received only 12.42 per cent (□ 1,245.02 crores) though they are the prime agency intended to supply long term credit to agriculture. Co-operatives (SCBs and KSLDBs) together enjoyed 16.94 per cent during the 29-year period. An average □ 1,463.84 crores/annum was refinanced by NABARD and commercial banks (35.82%) enjoyed the lions share in the total amount refinanced.

The refinance support to agriculture increased at the rate of 17.87 per cent during the period with a refinance rate of □ 1,461.84 crores/year. Refinance support to commercial bank was increasing at the fastest rate of 21.63 per cent, followed by Regional Rural Banks (20.32%) and KSCARDB's (14.06%), whereas the State Co-operative Bank has witnessed a negative growth rate in refinance received *i.e*. 45.28 per cent. The State Co-operative Bank did not receive any refinance support between 2006-07 and 2014-15.

With a higher share of 33 per cent (2017-18) and faster growth in refinance support RRB's are reflecting their active presence in agriculture finance in the state, though co-operatives together (SCB and PCARDB's) accounted for 40 per cent share. The decline in the growth rate in short term and medium term sector and comparatively lower growth rate in the long term sector show the challenges faced by the co-operative sector. Despite better capital position and strength, commercial banks enjoyed the major share of refinance support over the years which shows 21 per cent growth. It is important that the co-operative sector be given more importance, it being the 'best hope of rural India' even now.

Table 12. Source-wise refinance by NABARD to different financial institutions in Kerala (in crore □)

Sl No	Year	2017-18	Total (90-91 to 17-18)	Average	CAGR
1	Commercial Banks	2764.71 (27.58)	14663.23 (35.82)	523.69 (35.82)	21.63
2	State Co-op. Banks	2678.03 (26.72)	6933.2 (16.94)	247.61 (16.94)	-45.28
3	KSCARD's	1245.02 (12.42)	11083.73 (27.08)	395.85 (27.08)	14.06
4	Regional Rural Banks	3336.53 (33.28)	8251.49 (20.16)	294.7 (20.16)	20.32
Total		10024.29 (100.00)	40931.65 (100.00)	1461.85 (100.00)	17.87

(Figures in the parenthesis are percent to total)
Source: Compiled from annual reports of ER 1990-91 to 2017-18.

4.2.3 Purpose wise refinance support to agricultural sector by NABARD in Kerala (in crore □)

NABARD refinance to institutions mainly under two broad categories *i.e*. Farm Sector and Non-Farm Sector (NFS). The farm sector includes 15 activities and Non-Farm Sector (NFS) includes three activities. Data on refinance by NABARD to the various sectors of agriculture in Kerala has been compiled for 29 years *i.e.* 1991-92 to 2017-18 from the various issues of Economic Review of Kerala (Table 13). □ 544.24 crores were released to farm sector during 2017-18 *i.e.* 38.57 per cent of total refinance to the agricultural sector, which shows an increase of 12.07 per cent annually. However,

NFS is gaining more focus, which enjoys a share of 61.43 per cent and CAGR of 16.49 per cent.

In the farm sector, Planation and Horticulture component gained top priority in refinancing and it received 170.15 cores which was 31.26 per cent of the farm sector total. It was followed by Land development (145.55 crores), minor irrigation (73.07 crores) and dairy development sector (64.52 crores). Plantation and Horticulture (12.06%) was one of the most preferred sector for refinance in Kerala as the climate and weather of the State best suits for plantation and horticultural crops. Land development (10.31%) and minor irrigation (5.18%) occupied the second and third position respectively. State's cropping pattern mainly consists of plantation and horticultural crops like Coffee, Pepper, Arecanut, Cashew and Cardamom. Refinance pattern of NABARD in the previous 29 years shows same trend *i.e*. Plantation and Horticulture was given the prime importance with a refinance of 3,844.79 crores at an average of 142.40 crores/year with a CAGR of 9.71 per cent.

Land development investment assumes great importance in Kerala due to the undulating terrain and high gradient and rainfall. The soil and water conservation measures ensures higher productivity in upstream areas, while regulating the siltation in lower stream. The highest growth rate in refinance support (13.50%) of this sector reflect the higher levels of importance given to the sector especially in the climate change scenario.

Table 13. Purpose-wise refinance support to agriculture by NABARD in Kerala (in crore)

SL No	Purpose	2017-18	Total (90-91 to 17-18)	Average	CAGR (%)
I	**Farm Sector**				
1	Plantation & Horticulture	170.15 (12.06)	3844.79 (17.10)	142.4 (16.9)	9.71
2	Land Development	145.55 (10.31)	1249.24 (5.56)	46.27 (5.49)	13.50
3	Minor Irrigation	73.07 (5.18)	953.12 (4.24)	35.3 (4.19)	3.04
4	Dairy Development	64.52 (4.57)	521.41 (2.32)	19.31 (2.29)	7.52
5	Poultry	39.16 (2.78)	519.95 (2.31)	19.26 (2.29)	2.88

6	AH others	13.1 (0.93)	400.33 (1.78)	14.83 (1.76)	NA
7	SHGs	0.00 (0.00)	386.67 (1.72)	21.48 (2.55)	NA
8	Farm Mechanization	20.08 (1.42)	301.91 (1.34)	11.18 (1.33)	4.13
9	SG/MY (PMRY/IRDP)	0.00 (0.00)	134.43 (0.60)	4.98 (0.59)	NA
10	Fisheries	3.42 (0.24)	105.16 (0.47)	3.89 (0.46)	-6.10
11	Sheep, Goat, Piggery	13.15 (0.93)	41.98 (0.19)	2.8 (0.33)	NA
12	SGSY	0.00 (0.00)	31.10 (0.14)	1.73 (0.21)	NA
13	Bio-gas	0.16 (0.01)	8.96 (0.04)	0.33 (0.04)	NA
14	Forestry	0.00 (0.00)	8.37 (0.04)	1.05 (0.12)	NA
15	Others	1.88 (0.13)	2920.43 (12.99)	108.16 (12.84)	19.87
Total FS		544.24 (38.57)	11427.85 (50.82)	**432.97 (51.39)**	**12.07**
II	**Non-Farm sector**	866.93 (61.43)	409.53 (48.61)	**409.53 (48.61)**	**16.49**
Total		1411.17 (100.00)	22485.24 (100.00)	**842.50 (100.00)**	**14.4**

Source: Compiled from annual reports of ER 1990-91 to 2017-18.
NA - indicates that CAGR calculation was not possible because of irregular allocation of funds to the sector
(Figures in the parenthesis are percent to total)

4.2.4 Changing priorities of NABARD's refinancing in Kerala

Markov Chain analysis was attempted to identify the direction in which NABARD's refinance is moving. NABARD refinance support includes, Minor Irrigation, Land Development, Farm Mechanization, Plantation and Horticulture, Dairy Development, Fisheries, Poultry, Bio-gas, SG/MY, Non-Form Sector (Artisans, Handicrafts, Handlooms, Power Looms *etc*.), Sheep/Goat/Piggery, SGSY, Self-Help Groups, AH others, Forestry and other purposes. The transitional probability matrix of NABARD's refinance allotment to different purposes of agriculture is presented in Table 14. The results show the relative importance in allotting the funds during the study period (1990-91 to 2017-18). Among the purposes considered, "Sheep, Goat and Piggery (SGP)" sector has received consistent importance *i.e*. the sector has retained 87.00 per cent of its share from the previous year's allocation. SGP sector has lost its 8.00 per cent share to others, 4.00 per cent to AH and others and remaining one percent

to fisheries from its previous allocation. It has attracted 55 percent share of Bio-gas sector during the study period.

Land Development was successful in retaining 50 per cent of the amount allocated. It has lost its share to different sectors like others (37%), fisheries (6%), Dairy Development (6%) and Biogas (1%). Minor irrigation has retained only 38 per cent its share from the previous year and it has lost its 52 per cent of its share to Plantation and Horticulture sector, 5 per cent to the Farm Machinery and 5 per cent to SG/MY sectors.

SGP (87.00%), Non-Farm Sector (68.00%), Fisheries (66.00%) SG/SY (65.00%), Poultry (45.00%), SGSY-Swarnajayanti Gram Swarozgar Yojana (42.00%) and Minor irrigation (38.00%) were given consistent priority for refinance by NABARD. This prioritisation of NFS and diversifying is to be viewed as part of efforts to secure higher farm income through diversification and secondary agriculture. Land Development (50%) and Dairy Development (46%) also were given due importance which is almost on par with the NFS and agri-allied activities. From this, it is confirmed that the NABARD's policy was to support the allied sectors rather than the primary sectors like Land Development and Irrigation which may be due to necessity of increasing the income to the farmers and to achieve the objective of doubling of farmer's income. It may also be due to stagnation of income from the primary sectors like agriculture and horticulture (Nair and Dhanuraj, 2016).

4.2.5 Credit support to the agriculture by different financing institutions in Wayanad District

Credit flow to the agricultural sector has importance in India since, farmers in the country were poor and some of the farmers were even couldn't afford the cost of inputs (Reddy et al., 2019) and Wayanad District was not an exception. The details of institutional credit flow to agriculture sector in Wayanad is furnished in the Table 15.

Wayanad district with 1.67 lakh ha gross cropped area is serviced by 63 commercial bank branches, 173 cooperatives and 31 RRB's. Institutional credit flow to the agricultural sector in Wayanad, during 2017-18 was 2,469.89 crores with an average of 1,432.99 crores/year during the period 2007-08 to 2017-18. The CAGR for the period is 18.97 per cent per annum. Of the total credit supply 86.40 per cent is distributed as short term loans and commercial bank (51.83%) supplied the major share

Table 14. Transitional probability matrix of refinance support to agriculture by NABARD in Kerala (1990-91 to 2017-18)

Particulars	MI	LD	FM	P&H	DD	Fisheries	Poultry	Bio-gas	SG/MY	SGP	SGSY	SHGs	AH others	Forestry	NFS	Others
MI	0.38	0.00	0.05	0.52	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LD	0.00	0.50	0.00	0.00	0.06	0.06	0.00	0.01	0.00	0.00	0.0033	0.00	0.00	0.00	0.00	0.37
FM	0.68	0.00	0.00	0.00	0.00	0.02	0.18	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00
P&H	0.00	0.00	0.01	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.00
DD	0.36	0.17	0.00	0.00	0.46	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fisheries	0.00	0.00	0.00	0.00	0.12	0.66	0.22	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Poultry	0.00	0.00	0.00	0.55	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bio-gas	0.07	0.13	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.55	0.01	0.01	0.00	0.00	0.03	0.15
SG/MY	0.18	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SGP	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.87	0.00	0.00	0.04	0.00	0.00	0.08
SGSY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.58	0.00	0.00	0.00	0.00
SHGs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.91
AH others	0.04	0.00	0.02	0.10	0.15	0.00	0.00	0.02	0.00	0.57	0.00	0.10	0.00	0.00	0.00	0.00
Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.21	0.00
NFS	0.04	0.07	0.00	0.13	0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00
Others	0.02	0.05	0.01	0.45	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.35

of the credit. The growth in Short Term Loan (STL) is lower than the Term Loan (TL), which is a welcome sign, considering the importance of capital formation in agriculture in Wayanad.

The short term credit delivery system is expected to be almost monopolised by commercial banks, if one looks at the relative share and very high growth rate. RRB's and State Co-operative structure is to gain momentum in this sector.

In case of term loan, the cooperative agency, PCARDB's deliver only a meagre 2.98 per cent while commercial banks and RRB's take the lead. It is however relieving to note that the PCARDB's (31.61%) registered a better CAGR compared to commercial banks (21.77%) though not at the level of RRB's (31.61%). The significance of co-operatives and rural banks in credit delivery to agriculture in the districts like Wayanad is always to be understood and priority may be given by the banking sector.

Table 15. Institutional credit flow to Agriculture Sector in Wayanad District (crores □)

Types of Loans	Particulars	Financial Institutions				Total
		Commercial Banks	Co-Operative Bank	Regional Rural Banks	PCARDB's	
Crop Loans	2017-18	1138.52 (53.35)	625.48 (29.31)	363.48 (17.03)	6.74 (0.32)	2134.22 (100)
	Average	556.71	608.63	219.80	15.94	1392.39
	CAGR	24.62	11.69	12.49	-50.96	18.54
Term Loans	2017-18	141.67 (42.21)	61.01 (18.18)	123 (36.64)	9.99 (2.98)	335.67 (100)
	Average	82.63	31.90	37.39	11.08	713.67
	CAGR	21.77	3.77	57.70	31.61	22.77
Total	2017-18	1280.19 (51.83)	686.49 (27.79)	486.48 (19.70)	16.73 (0.68)	2469.89 (100)
	Average	639.35	640.53	257.19	27.02	1432.99
	CAGR	24.20	11.42	15.66	-11.5	18.97

(Figures in the parenthesis are percent to column total)
Source: Potential Linked Credit Plans, NABARD

4.2.6 Credit support to Agriculture by Commercial Banks in Wayanad District

Commercial banks through their 63 branches in the district has distributed 1,280.19 during 2017-18 (Table 16). The amount was growing at a rate of 24.20 per cent per annum. Of the total, major share (88.93 %) was for crop production loans (STL) and the Long Term Loans (LTL) constituted only 11.07 per cent. The quantum of STL were increasing at a higher pace of 24.62 per cent per annum, compared to term loans at 21.77 per cent.

In tune with the refinancing pattern share of the plantation and horticulture sector in term loans was the highest (39.50 per cent) followed by land development (10.29%) investments over the period of under study (2007-08 to 2017-18). Wayand district is reported as one of the most sensitive district to experience the change climate. It is reported that Wayanad is in second position with respect to drinking water scarcity in the State after Idukki (Economic Review, 2017). Navyashree and Ajithkumar (2018) and Lokesh *et al*. (2019) have reported that the district has faced agricultural drought in 14 years during the period of 1983-2016. Gaetaniello *et al.* (2014) have reported a deviation of rainfall in both South-West and East-West monsoons, during the period of 1951 to 2008. In this background, it is appropriate that the pace of growth in minor irrigation investment is the highest (45.43%) followed by the land development (43.95%) investment. It is also desirable that the allocation to dairy development and poultry is also gaining importance. Dairy is the most important risk management enterprise at household level in Wayanad.

Table 16. Institutional credit flow to agriculture by commercial banks in Wayanad District (in Crores)

Sl No	Particulars	2017-18	Total (07-08 to 17-18)	Average	CAGR
I	Short Term Loan	1138.52	6123.86	556.71	24.62
II	**Term Loans**				
1	Minor Irrigation	5.23 (3.69)	13.68 (1.50)	1.24 (1.5)	45.43
2	Land Development	12.02 (8.48)	93.50 (10.29)	8.5 (10.29)	43.95
3	Farm Mechanization	8.41 (5.94)	54.76 (6.02)	4.98 (6.03)	39.89

4	Plantation and Horticulture	14.38 (10.15)	359.03 (39.50)	32.64 (39.5)	8.94
5	Dairy Development	6.80 (4.80)	98.67 (10.85)	8.97 (10.86)	12.64
6	Poultry	2.63 (1.86)	24.45 (2.69)	2.22 (2.69)	97.10
7	Sheep/ Goat/ Piggery	0.00 (0.00)	7.71 (0.85)	0.7 (0.85)	-47.88
8	Fisheries	0.20 (0.14)	4.46 (0.49)	0.41 (0.5)	20.86
9	F/WLD	0.23 (0.16)	5.27 (0.58)	0.48 (0.58)	-2.96
10	SMY	0.28 (0.2)	66.92 (7.36)	6.08 (7.36)	18.77
11	Others	91.49 (64.58)	180.51 (19.86)	16.41 (19.86)	-30.67
Term Loan Total		**141.67 (100.00)**	**908.94 (100.00)**	**82.63 (100.00)**	**21.77**
Grand Total		**1280.19**	**7032.81**	**639.35**	**24.20**

(Figures in the parenthesis are percent to term loan total)
Source: Potential Linked Credit Plans, NABARD

4.2.7 Credit support to Agriculture by Co-Operative Banks (PACS and SCB) in Wayanad District

Loan disbursement pattern by co-operative banks is presented in Table 17. Co-operative banks have disbursed about 686.49 crores to agriculture sector in 2017-18, with major share to short term loans at 625.48 crores. Similar pattern has been observed in the overall study period also, at the annual average being 640.53 crores. 608.53 crores was advanced as crop loans. The amount of credit supply increased at the rate of 11.42 per cent per annum over the study period. Short term loans increased at the rate of 11.69 per cent per annum whereas, term loans growth rate was only 3.77 per cent per annum. Being the agencies for supply of short term loans, this is quite expected.

Cooperative Banks have advanced 61.01 crore as term loans in 2017-18, of which 41 per cent was for the development of Plantation and Horticulture sector. This was followed by Dairy development (13.36%), Poultry (10.59%) and minor irrigation (7.90%). The pattern was same throughout the period under study. However, the bank is shifting their priority to dairy development sector as evidenced by the high growth

rate (30.22%). The important sectors like minor irrigation and land development sectors have recorded the negative growth rate *i.e.* 18.08 per cent and 46.66 per cent. These institutions are focussing on short term loans and medium term loans.

Table 17. Institutional credit flow to Agriculture sector by the Co-operative Banks (STL) in Wayanad District (in crore □)

Sl No	Particulars	2017-18	Total (07-08 to 17-18)	Average	CAGR
I	Short Term Loan	625.48	6694.92	608.63	11.69
II	**Term Loans**				
1	Minor Irrigation	4.82 (7.90)	50.25 (14.32)	4.57 (14.33)	-18.08
2	Land Development	0.48 (0.79)	66.46 (18.94)	6.04 (18.93)	-46.66
3	Farm Mechanization	1.49 (2.44)	9.01 (2.57)	0.82 (2.57)	NA
4	Plantation and Horticulture	25.13 (41.19)	132.05 (37.63)	12 (37.62)	5.16
5	Dairy Development	8.15 (13.36)	50.56 (14.41)	4.6 (14.42)	30.22
6	Poultry	6.46 (10.59)	7.14 (2.03)	0.65 (2.04)	NA
7	Sheep/ Goat/ Piggery	0.00 (0.00)	1.01 (0.29)	0.09 (0.28)	NA
8	Fisheries	0.57 (0.93)	0.65 (0.18)	0.06 (0.19)	NA
9	F/WLD	0.00 (0.00)	0.00 (0.00)	0 (0.00)	NA
10	SMY	0.11 (0.18)	1.83 (0.52)	0.17 (0.53)	NA
11	Others	13.80 (22.62)	31.91 (9.10)	2.9 (9.09)	31.51
Term Loans Total		61.01 (100.00)	350.88 (100.00)	**31.90 (100.00)**	**3.77**
Grand Total		686.49	7045.80	**640.53**	**11.42**

NA - indicates that CAGR calculation was not possible because of irregular allocation of funds to the sector

(Figures in the parenthesis are percent to term loan total)

Source: Potential Linked Credit Plans, NABARD

4.2.8 Credit support to Agriculture by Regional Rural Banks (RRB)

RRB's were established in 1976 with the aim of supporting rural economy by providing credit support to the development of agriculture and other allied sectors. There are 31 RRB branches in Wayanad district through which 486.48 crores were distributed in 2017-18 (Table 18).

Disbursement of short term loans from RRB's were nearly thrice that of term loans. However, it is worth noticing that the growth in term loans was high 57.70 per cent as against 12.49 percent of short term loans. Major share of term loans was given to land development (24.42%), followed by dairy development (18.61%) and plantation and horticulture (6.62%) which are the major focus areas in Wayanad.

The growth rates also reflected highest priority for plantation and horticulture (288.93%) sector followed by fisheries (193.44%). Inland fisheries are promoted in big way in Wayanad. The bank is giving priorities to the major sectors that suit rural development.

Table 18. Institutional credit flow to Agriculture sector by the Regional Rural Banks in Wayanad District (in crore)

Sl No	Particulars	2017-18	Total (07-08 to 17-18)	Average	CAGR
I	Short Term Loan	363.48	2417.77	219.80	12.49
II	**Term Loans**				
1	Minor Irrigation	2.09 (1.70)	20.46 (4.98)	1.86 (4.97)	86.42
2	Land Development	30.04 (24.42)	101.29 (24.63)	9.21 (24.63)	94.10
3	Farm Mechanization	1.48 (1.2)	6.13 (1.49)	0.56 (1.5)	23.37
4	Plantation and Horticulture	8.14 (6.62)	38.16 (9.28)	3.47 (9.28)	288.93
5	Dairy Development	22.89 (18.61)	130.92 (31.83)	11.90 (31.83)	44.74
6	Poultry	1.68 (1.37)	7.87 (1.91)	0.72 (1.93)	88.05
7	Sheep/ Goat/ Piggery	0.00 (0.00)	19.74 (4.8)	1.79 (4.79)	-41.83

8	Fisheries	0.01 (0.01)	1.44 (0.35)	0.13 (0.35)	193.44
9	F/WLD	0.11 (0.09)	0.80 (0.20)	0.07 (0.19)	NA
10	SMY	0.07 (0.06)	12.95 (3.15)	1.18 (3.16)	NA
11	Others	56.49 (45.93)	71.55 (17.4)	6.50 (17.38)	-15.93
Term Loans Total		**123.00 (100.00)**	**411.30 (100.00)**	**37.39 (100.00)**	**57.70**
Grand Total		**486.48**	**2829.07**	**257.19**	**15.66**

NA - indicates that CAGR calculation was not possible because of irregular allocation of funds to the sector
(Figures in the parenthesis are percent to term loan total)
Source: Potential Linked Credit Plans, NABARD

4.2.9 Credit support to agriculture byPrimary Co-Operative Agriculture and Rural Development Banks (PCARDB's)

PCARDB's are the specialized co-operative institutions for long term credit delivery. There are six branches of PCARDB's in Wayanad. Credit lending pattern of PCARDB's was collected for the period of 2013-14 to 2017-18 and the results are presented in the Table 19.

PCARDB has lent around □ 16.73 crores as loan to the agricultural sector, out of which □ 6.74 crores was as crop loans and □ 9.99 crore was as term loans. PCARDB has advances to the crop loan, has noticed 50.96 per cent of decreasing annual compound growth rate whereas advances to the term loans has increased at the rate of 31.61 per cent per annum.

In the term loans (□ 9.99 crores) advanced, preference was given to Plantation and Horticulture (46.65%) and was followed by dairy development sector (19.32%) and forest and watershed development sector (12.11%). By observing the lending pattern of term loans by the PCARDB's, it could be understood that the bank was following its mandate of lending to the agriculture/land development. Plantation and horticulture (89.38%) sector observed the fastest growth rate, followed by land development (50.23%) and Dairy development (16.73%).

Table 19. Institutional credit flow to Agricultural sector by PCARDB's in Wayanad District (in crore □)

Sl No	Particulars	2017-18	Total (13-14 to 17-18)	Average	CAGR
I	Short Term Loan	6.74	79.70	15.94	-50.96
II	**Term Loans**				
1	Minor Irrigation	0.34 (3.4)	19.78 (35.7)	3.96 (35.74)	-30.11
2	Land Development	0.58 (5.81)	5.6 (10.11)	1.12 (10.11)	50.23
3	Farm Mechanization	0.1 (1)	1.41 (2.54)	0.28 (2.53)	-35.65
4	Plantation and Horticulture	4.66 (46.65)	14.72 (26.57)	2.95 (26.62)	89.38
5	Dairy Development	1.93 (19.32)	7.9 (14.26)	1.58 (14.26)	16.73
6	Poultry	0.54 (5.41)	1.31 (2.36)	0.26 (2.35)	NA
7	Sheep/ Goat/ Piggery	0.00 (0.00)	0.24 (0.43)	0.05 (0.45)	-12.18
8	Fisheries	0.10 (01.00)	0.18 (0.32)	0.04 (0.36)	NA
9	F/WLD	1.21 (12.11)	1.21 (2.18)	0.24 (2.17)	NA
10	SMY	0.00 (0.00)	0.33 (0.6)	0.07 (0.63)	NA
11	Others	0.53 (5.31)	2.72 (4.91)	0.54 (4.87)	NA
	Term Loans Total	9.99 (100.00)	55.41 (100.00)	**11.08 (100.00)**	**31.61**
	Grand Total	16.73	135.11	**27.02**	**-11.5**

NA - indicates that CAGR calculation was not possible because of irregular allocation of funds to the sector

(Figures in the parenthesis are percent to term loan total)

Source: Potential Linked Credit Plans, NABARD

4.2.10 Credit support to Agricultural development purposes in Wayanad District

The transitional probability matrix of financial allocation to different agricultural purposes was identified using the Markov Chain analysis (Table 20). Table presents the direction of credit flow to the different agricultural sectors in Wayanad

district between 2007-08 to 2017-18. Plantation and Horticulture development was the most stable sector and it was successful in retaining the 29 per cent of its share from the previous years. It has given up about 34.90 per cent of its share to Land Development, 28.10 per cent to Dairy Development and 7.30 per cent to the Minor Irrigation sectors. It has also obtained a share of 69.90 per cent from the Land Development sector and 5.5 per cent share from Minor irrigation. All these sectors are of prime importance in the agricultural economy of the district in the background of climate change.

Apart from Plantation and Horticulture, Dairy Development is the only sector which retained its share from the previous year and it has retained about 14.70 per cent of its share from the previous year. It has given up its share to different sectors like Land Development (18.60), SMY (18.60) and farm mechanization (14.70). The Dairy Development sector has grabbed a share of 28.10 per cent from the Plantation and Horticulture. Plantation and Horticulture as well as dairy development are major sectors that attracted continued attention from the credit institutions.

Table 20. Transitional probability matrix of credit allocation to the different purposes of agriculture in Wayanad District (2007-08 to 2017-18)

Particulars	Minor Irrigation	Land Development	Farm Mechanization	Plantation and Horticulture	Dairy Development	Poultry	SGP	Fisheries	F/WLD	SMY	Others
Minor Irrigation	0.000	0.134	0.016	0.055	0.000	0.668	0.000	0.000	0.007	0.000	0.119
Land Development	0.100	0.000	0.000	0.699	0.000	0.000	0.000	0.000	0.000	0.000	0.201
Farm Mechanization	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000
Plantation and Horticulture	0.073	0.349	0.000	0.297	0.281	0.000	0.000	0.000	0.000	0.000	0.000
Dairy Development	0.042	0.186	0.157	0.000	0.147	0.000	0.139	0.000	0.000	0.186	0.144
Poultry	0.000	0.000	0.000	0.911	0.000	0.000	0.000	0.000	0.004	0.000	0.086
SGP	0.000	0.000	0.000	0.750	0.000	0.000	0.000	0.032	0.000	0.000	0.218
Fisheries	0.000	0.000	0.000	0.520	0.480	0.000	0.000	0.000	0.000	0.000	0.000
F/WLD	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000
SMY	0.000	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.958
Others	0.130	0.000	0.000	0.825	0.000	0.000	0.000	0.035	0.010	0.000	0.000

4.3 Household level investments, economic efficiency and viability of SWC methods

4.3.1 Rainfall Pattern in Wayanad District

As a prelude to establishing the importance of SWC investments in Wayanad, the rainfall pattern of the district is analysed. The district is often highlighted as most vulnerable to climate change. There are several reports of declining rainfall and changes in rainfall pattern (Nair *et al.*, 2014; Ajithkumar and Vysakh, 2018). The district was also declared as drought affected in six years during previous two decades. In order to understand the long run changes in rainfall, data was collected for the district from the RARS, Ambalawayal and the details are presented in the Table 21.

Rainfall varied between 1108.50 mm (2002) and 3093 mm (2018) and the deviation from long term mean (2322 mm) was to the extent of -52.26 per cent and 33.20 per cent respectively. IMD classify the status of drought based on intensity, into three categories, No drought/mild drought (deviation between 0 and 25%), medium (between 25 and 50%) and severe drought (more than 50%). During the period from 1983 to 2019 the District experienced severe drought in one year (2002). There were 10 medium drought years, 23 mild/no drought years and in 3 years there was no drought. Over the long span of 37 years, there was only 3 years with rainfall above long term mean (2322 mm) and were flood affected periods. The rainfall pattern of the district as well as the terrain underlines the importance of the investments in soil and water conservation measures.

Table 21. Annual rainfall pattern and drought situations in Wayanad District (in mm) (1983 to 2019)

Sl No	Year	Rainfall	Deviation in Rainfall	% Deviation	Type of Drought
1	1983	1781.60	-540.40	-23.27	Mild Drought
2	1984	2251.60	-70.40	-3.03	Mild Drought
3	1985	1728.30	-593.70	-25.57	Medium Drought
4	1986	1818.60	-503.40	-21.68	Mild Drought
5	1987	1426.50	-895.50	-38.57	Medium Drought
6	1988	1985.70	-336.30	-14.48	Mild Drought
7	1989	1822.60	-499.40	-21.51	Mild Drought
8	1990	1681.40	-640.60	-27.59	Medium Drought
9	1991	1986.42	-335.58	-14.45	Mild Drought

10	1992	2318.20	-3.80	-0.16	Mild Drought
11	1993	2133.20	-188.80	-8.13	Mild Drought
12	1994	2690.80	368.80	15.88	Normal
13	1995	2317.60	-4.40	-0.19	Mild Drought
14	1996	1982.40	-339.60	-14.63	Mild Drought
15	1997	2151.40	-170.60	-7.35	Mild Drought
16	1998	1728.50	-593.50	-25.56	Medium Drought
17	1999	1558.80	-763.20	-32.87	Medium Drought
18	2000	1743.80	-578.20	-24.90	Mild Drought
19	2001	1446.10	-875.90	-37.72	Mild Drought
20	2002	1108.50	-1213.50	-52.26	Severe Drought
21	2003	1520.60	-801.40	-34.51	Medium Drought
22	2004	1899.80	-422.20	-18.18	Mild Drought
23	2005	2168.20	-153.80	-6.62	Mild Drought
24	2006	2047.80	-274.20	-11.81	Mild Drought
25	2007	2023.20	-298.80	-12.87	Mild Drought
26	2008	1731.00	-591.00	-25.45	Medium Drought
27	2009	2077.40	-244.60	-10.53	Mild Drought
28	2010	1851.80	-470.20	-20.25	Mild Drought
29	2011	2069.40	-252.60	-10.88	Mild Drought
30	2012	1320.80	-1001.20	-43.12	Medium Drought
31	2013	2247.40	-74.60	-3.21	Mild Drought
32	2014	2151.00	-171.00	-7.36	Mild Drought
33	2015	1689.90	-632.10	-27.22	Medium Drought
34	2016	1229.80	-1092.20	-47.04	Medium Drought
35	2017	1780.60	-541.40	-23.32	Mild Drought
36	2018	3093.00	771.00	33.20	Normal
37	2019	2654.00	332.00	14.30	Normal
Long Term Mean		**2322**	**-397.20**	**-17.11**	

Source: Department of Agricultural Meteorology, CoH Vellanikkara

4.3.2 Irrigation pattern in sample farms before the adoption of SWC measures

The net irrigated area in Wayanad is reported as 12,718 ha which forms 8.73 per cent of the Gross Cropped Area (GCA). The major sources of irrigation are lift and minor irrigation (387 ha), rivers and lakes (189 ha), ponds (168 ha) and wells (32 ha) and other sources (11, 942 ha). The gross area under irrigation is reported as 19,679 ha, and was under crops viz., paddy (39.71%), banana (31.01%), vegetables (5.95%), coconut (0.30%), arecanut (0.13%) and betel leaves (0.01%). Paddy and banana (which are mainly grown in low lands) are irrigated from lift irrigation from river and lake. The data shows private wells as irrigating only 32 ha, while number of tube/bore wells are

not reported in official sources. However, there are reports of increasing number of bore wells digging in Wayanad (Richard *et al.*, 2016; Jayasankar and Babu, 2017). Open wells are the major sources of irrigation in the State of Kerala and most often it is used for both domestic purpose and agriculture.

Nearly 75 per cent of the respondents in this study depended on open wells for irrigation. Farm ponds were there for 25 per cent (Table 22). Usually farmers begin irrigation by the month of January and continue till late may *i.e.* till monsoon starts. But 54 per cent of the respondents could irrigate only during January - February (Table 23), while one third could manage for one more month. Only around 11 per cent could irrigate fully during the summer months, as the water was not enough for irrigation.

Table 22. Sources of irrigation in the sample farms before adopting soil and water conservation (SWC) methods

Sl No	**Participation**	**ALT**	**DLT**	**DMS**	**WGDP**	**Total**
1	Open Well	31 (68.89)	33 (82.50)	26 (74.29)	30 (73.17)	120 (74.53)
2	Farm Pond	14 (31.11)	7 (17.50)	9 (25.71)	11 (26.83)	41 (25.47)
3	Grand Total	45 (100.00)	40 (100.00)	35 (100.00)	41 (100.00)	161 (100.00)

(Figures in the parenthesis are percent to total)

Table 23. Irrigation Frequency in sample farms prior to SWC (January - May)

Sl No	**Frequency**	**ALT**		**DLT**		**DMS**		**WGDP**		**Total**	
		Number	**Area (ha)**	**Number**	**Area (ha)**	**Number**	**Area (ha)**	**Number**	**Area (ha)**	**Number**	**Area (ha)**
1	Only January	2 (4.44)	0.40	0 (0.00)	0.00	1 (2.86)	1.00	1 (2.44)	0.60	4 (2.47)	0.60
2	Jan – Feb	26 (57.78)	0.69	24 (58.54)	0.64	19 (54.29)	0.51	19 (46.34)	0.69	88 (54.32)	0.64
3	Jan – Mar	14 (31.11)	0.81	11 (29.27)	0.61	12 (34.29)	0.64	14 (34.15)	0.58	51 (32.10)	0.66
4	Jan – May	3 (6.67)	0.67	5 (12.20)	0.26	3 (8.57)	0.62	7 (17.07)	0.49	18 (11.11)	0.48
5	Total	45 (100.00)	0.52	40 (100.00)	0.35	35 (100.00)	0.32	41 (100.00)	0.30	161 (100.00)	0.37

(Figures in the parenthesis are percent to total)

4.3.3 Soil and water conservation schemes in Wayanad District

The major SWC schemes in the district are implemented under 4 major components *viz.*, Arable Land Treatments (ALT), Drainage Line Treatments (DLT), Drought Mitigation Scheme (DMS) and Western Ghats Development Programme (WGDP). Details of the structures implemented under each scheme is presented in the Table 24. The farmers were free to choose the component, among the technological choices that suit their farm situation.

Table 24. Methods of Soil and Water Conservations under the Schemes approved in the SWC programs by Government of Kerala and Government of India

Sl No	ALT	DLT	DMS	WGDP
1	Earthen bund	Check Dam	Well Recharge	Earthen Bunds
2	Stone pitched contour bunds	Stream Bank Stabilization	Earthen Bunds	Check Dam
3	Trench	Farm Ponds	Logwood Check Dam	Farm Ponds
4	Vegetative Hedges	Coir Geo Textile	Stream Bank Stabilization	Trenches
5	Graded Bunds	Percolation Ponds	Farm Ponds	Stone Pitched Bunds
6	Contour trench	Spring Water Development	Agro-forestry	Planting of trees
7	Staggered Trenches	Well Recharge	Stone Pitched Bunds	Spring Water Development
8	Terrace		Spring Water Development	Irrigation Channels
9	Moisture conservation Pits			
10	Agro. Forestry			

Source: District Soil Conservation Office, Wayanad

4.3.4 Farm level Investment on soil and water conservation

The capital formation in agriculture is often reported as limited and the proportion of public investment is shrinking. (Sunanda, n.d.). Private expenditure on SWC is an investment that yields returns over a period of time. The lagged nature of

the returns often limits the household's decisions to invest due to resource constraints and expectations of early returns.

In the SWC implemented by Government there were several options, based on the subsidy support. Farmers were supposed to pay a share of 10 per cent if the investment is purely private. If the farmers form a group of three or more, subsidy component is only five per cent. The subsidy components also varied with the type of scheme (Table 25).

The average investment for the structures under Arable land treatment Scheme was □ 26,188/ha with the beneficiary share at □ 1964/ha and Government share of □ 24,224/ha. 46 per cent farmers have adopted the structures as a group and have paid only five percent of the total cost *i.e.* □ 1,309/ha. Remaining farmers have adopted the SWC structures on individual basis and have paid 10 per cent of the total cost *i.e.* 2,619/ha.

Total investment under DLT scheme was □ 4,38,048/structure. Nearly 50 per cent (48.89%) of the respondents have adopted the structures individually by paying a share of 10 per cent *i.e.* they have paid an amount of □ 43,805/household, since they have invested on individual basis and remaining amount was compensated by Government. 35.56 per cent of the respondents have adopted the structure as a group (5%) and have paid □ 21,902/household. Going by the responses, from 14 respondents, it appears that they have spent 15 and 25 per cent respectively. However, the scheme does not include this subsidy structure. It is possible that they have overstated the expenditure (intentional or unintentional). Cross verification yielded the same results.

In the Drought Mitigation Scheme (DMS), total investment was □ 2,19,084/structure. In the scheme 50 per cent of the respondents have adopted the structures on individual basis (10 % share) at an average investment of □ 21,908/household. Around 40 per cent of the respondents have paid around five per cent of the premium under the group scheme and have paid around □ 10,954/household. Nine respondents have contributed 15-25 per cent, however the scheme does not include this subsidy structure. It is possible that they have overstated the expenditure. Cross verification yielded the same results.

The average investment under WGDP scheme was 3,13,548/household, where majority opted for individual structures. Around 43.33 per cent respondents who have paid an amount of 31,355/structure as a 10 per cent share. Around 36.17 per cent of the respondents have paid 15,555/structure as five per cent premium. 18 respondents have spent 15 and 25 per cent respectively.

The SWC, on an average attracted an investment of 2,49,217 per household. Overall, nearly 50 per cent (177) of the respondents have adopted SWC structures on individual basis and have paid a premium of 10 per cent at the rate of 24,922/household. About 40 per cent (142) of the respondents have adopted SWC on group basis and have paid a share of five per cent of the cost *i.e.* 12,461/household as premium. Around 11 per cent of the total respondents have opined that they have paid more than 10 per cent *i.e.* 15 per cent and 25 per cent. This can be due to deliberate overstating in the expectation of a refund. Poddar (2016) has reported that beneficiaries of Krishi Bhagya Scheme (KBS) in Karnataka have paid about 10 to 20 per cent of the total cost of the structure and remaining has been borne by Government of Karnataka.

Table 25. Household level investment on SWC structures by respondents (/household)

Sl No	Farmers share (%)	ALT		DLT		DMS		WGDP		Total	
		No	Amount	No	Amount	No	Amount	No	Amount	No	Amount
1	5	41 (45.56)	1309	32 (35.56)	21902	36 (40.00)	10954	33 (36.67)	15677	142 (39.44)	12461
2	10	49 (54.44)	2619	44 (48.89)	43805	45 (50.00)	21908	39 (43.33)	31355	177 (49.17)	24922
3	15		0	12 (13.33)	65707	7 (07.78)	32863	10 (11.11)	47032	29 (8.06)	37383
4	25		0	2 (2.22)	109512	2 (02.22)	54771	8 (8.89)	78387	12 (3.33)	62304
Average		90 (100)	1964	90 (100)	61327	90 (100)	30672	90 (100)	43897	360 (100)	34890
Government Share		**24224**		**376721**		**188412**		**269651**		**214327**	
Total Investment		**26188**		**438048**		**219084**		**313548**		**249217**	

(Figures in the parenthesis are percent to total)

4.3.5 Farm-level economic viability and efficiency of investments

Appraisal of economic sustainability of the implemented schemes is more topical and it plays vital role in designing the general agricultural policies that stabilise agricultural revenue and make farming more feasible and sustainable. Since, soil and water conservation measures are reported to impact farm household welfare through higher production, productivity and farm income (Thomas *et al.*, 2009; Sudha and Sekar 2015). In this section the impact of SWC measures on cropping pattern, productivity, production and farm income along with efficiency of important crops like coffee (Plate 5), pepper (Plate 6), arecanut (Plate 7) and banana (Plate 8) cultivated under SWC structures is discussed.

4.3.5.1 Farm level economic performance in ALT scheme

Impact of each scheme on the cropping pattern, production, productivity and income from major crops is presented in this section.

1. Cropping pattern

In tune with cropping pattern of Wayanad, major crops cultivated by the ALT scheme beneficiaries' coffee, arecanut, pepper, banana, rubber, coconut, ginger, rice, tapioca, tea, turmeric and vegetables (tomato, chilli, yam, cowpea). The cropping pattern of the district has seen the change in favour of crops like rubber, banana and cardamom (Varghese, 2012).

Adoption of SWC structures has given confidence to the respondents to increase area under crops like rubber, banana, cardamom and coffee (Table 31). Highest per cent change in area was observed by rubber (23.32%) followed by banana (22.16%), cardamom (13.30%) and coffee (1.83%).

The post investment farms show substantial increase in are under crops like rubber and banana replacing vegetable and tapioca cultivation. The comparative support (Rubber Board and VFPCK respectively) might have prompted the farmers to opt for these crops once the soil and water situation are better.

Coffee orchard maintained under earthen bund

Coffee orchard maintained under stone pitched bund

Coffee orchard maintained under trenches

Plate 5. Coffee orchards maintained under various SWC structures

Coffee and pepper orchard maintained under earthen bunds

Coffee and pepper orchard maintained under stone pitched bund

A well-maintained pepper orchard under trenches

Plate 6. Pepper orchards maintained under different SWC structures

Arecanut and coffee orchard maintained under earthen bund

Arecanut orchard maintained under stream bank stabilization

Arecanut orchard maintained under farm ponds

Plate 7. Arecanut orchards maintained under various SWC structures

Banana orchard maintained under stream bank stabilization structure

Newly established Banana orchard under check dam structure

Banana orchard maintained under farm ponds

Plate 8. Banana orchards maintained under various SWC structures

2. Productivity of important crops

There was a considerable change in the productivity of crops which was mainly due to the increase in moisture and better management. Highest change in the productivity was observed in coffee which was 45.98 per cent, followed by tapioca (38.50%), arecanut (36.75%), banana (29.88%) and pepper (28.28%).

Increase in the productivity may be attributed to assured irrigation and resultant management reduced soil and water erosion. In the post adoption period distance to water level from ground in open wells has been decreased by 33.57 per cent, 29.22 per cent and 25.70 per cent in *kharif*, *rabi* and *summer* respectively. This additional water availability has ensured irrigation during the off season.

3. Production of important crops

Production level of crops has increased after the adoption of SWC measures in the study area. Banana (58.66 %) and rubber (54.15 %) registered the highest percent change in production during post adoption period which was due to the combined effect of increase in productivity and area. Coffee (48.65 %), cardamom (38.02 %), arecanut (35.79 %) and pepper (27.65 %) also registered higher production mainly due to area effect. Crops like rice and turmeric have witnessed no changes in production because these crops were already cultivated under irrigated condition.

Since, respondents have reduced the area under tapioca and vegetables production of these crops has seen the negative growth in the post adoption period by 43.70 per cent and 51.59 per cent respectively.

4. Gross income

The SWC (ALT) scheme has resulted in an additional income to the farmers which was higher by 33.14 per cent. Of the crops cultivated, banana (nendran) has seen the highest per cent changes in the income *i.e*. 58.66 per cent/farm followed by rubber (54.15%), coffee (48.65%), cardamom (38.02%), arecanut (35.79%), pepper (27.65%), ginger (10.77%) and coconut (9.48%).

Income from crops like rice and turmeric crops has remained the same whereas income from vegetables and tapioca has drastically reduced by 50.11 and 43.70 respectively. This is due to decline in area under these crops and produce price factors. Productivity level of these crops improved.

Increase in the income was mainly due to the changes observed in the productivity of crops which was mainly contributed by the increase in moisture availability and a few critical irrigations that was made possible by the increase in water availability in the wells. There was shift in favour of economically viable crops and the productivity of all the crops have increased.

Table 26. Impact of ALT scheme on agricultural performance (□/farm/year)

(Per cent changes in area, productivity, production (%/farm) and income (%/farm) of major crops)

Sl No	Crop	Area	Productivity	Production	Income
1	Arecanut	-0.70	36.75	35.79	35.79
2	Banana	22.16	29.88	58.66	58.66
3	Cardamom	13.30	21.82	38.02	38.02
4	Coconut (no)	0.00	9.42	9.42	9.42
5	Coffee	1.83	45.98	48.65	48.65
6	Ginger	-9.48	22.38	10.77	10.77
7	Pepper	-0.49	28.28	27.65	27.65
8	Rice	0.00	0.00	0.00	0.00
9	Rubber	23.32	25.00	54.15	54.15
10	Tapioca	-59.35	38.50	-43.70	-43.70
11	Turmeric	0.00	0.00	0.00	0.00
12	Vegetables	-67.82	28.25	-51.59	-50.11
	Total	**0.00**			**33.14**

5. Economics of major crops

To understand the economic performance of the farm in post SWC scenario, the relative economic performance of major crops grown by the respondent farmers were analysed. Coffee, pepper, arecanut and banana which together constituted 87.91 per cent of cropped area of the farmers were considered for the analysis (Table 27).

The annual costs of cultivation of the major crops were estimated, on a per hectare basis, apportioning the SWC investment cost at an annualised rate. The total cost of cultivation at Cost A1 level varied from the lowest □ 68,188/ha in black pepper to □ 1,29,000/ha in banana. Hired labour cost constituted the major share (>50%) in all the crops except banana. The net returns (at Cost C2) was highest in arecanut (□ 3,21,147/ha) farming followed by banana (□ 2,46,804/ha), coffee (□ 1,59,763/ha) and black pepper (□ 1,00,163/ha) (Fig 3). The performance was in the same pattern. However, at cost A1 level the order was arecanut, coffee, black pepper and banana (Fig 4). Despite high profit level efficiency of investment was lower in banana.

Table 27. Economics of important crops cultivated in the sample farms (ALT scheme, □/ha/year)

(for perennial crops the annual maintenance cost alone is presented)

Sl No	Particulars	Coffee		Pepper		Arecanut		Banana	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1	Input cost	29177	38.20	26666	39.12	37538	40.71	73650	57.05
2	Hired Labour Cost	43315	56.70	37940	55.67	50161	54.40	49514	38.36
3	Annualized SWC Cost/ Year	959	1.26	959	1.41	959	1.04	959	0.74
4	Interest on Working Capital (4%)	2935	3.84	2623	3.80	3546	3.85	4965	3.85
5	Cost A1	76386	100.00	68188	100.00	92205	100.00	129088	100.00
6	Cost C1	119305		111108		135124		172007	
8	Cost C2	157034		148837		172853		209736	
9	Gross Return	316800		249000		494000		456540	

10	Net Return (GR-C2)	159763		100163		321147		246804	
11	Net Return (GR-A1)	240411		180812		401795		327452	
12	BC Ratio (GR/C2)	2.02		1.67		2.86		2.18	
13	BC Ratio (GR/A1)	4.15		3.65		5.36		3.54	

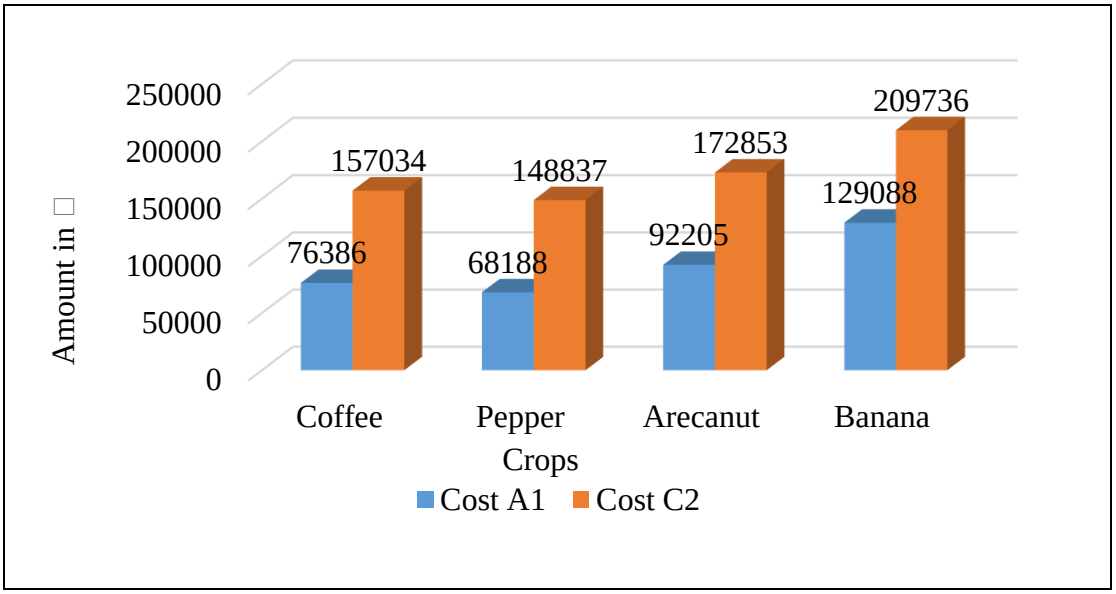

Fig 3. Cost of A and Cost B of important crops cultivated by ALT respondents

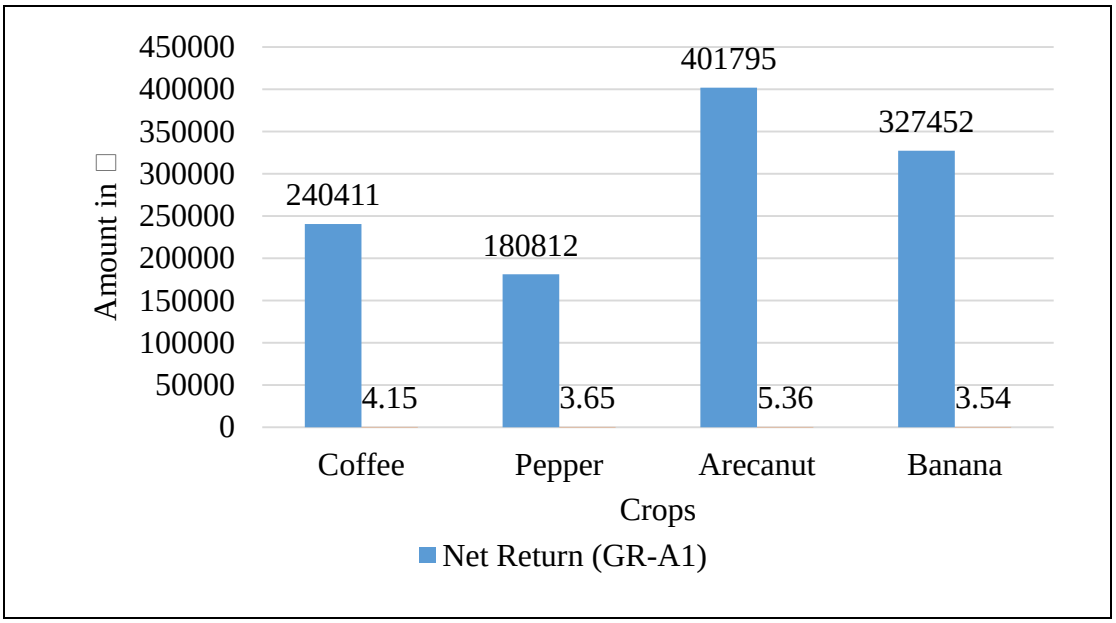

Fig 4: Net returns and BC ratio of important crops by ALT respondents

4.3.5.2 Farm level economic performance of DLT scheme

Drainage lines are the natural channels that carries the rainfall and sediments in watershed area. High runoff and movement of sediment particles are observed in these channels because of the slope and fertile soil is lost due to this. The runoff needs to be arrested to facilitate better crop growth. Hence, structures like check dams, stream bank stabilization, water harvesting structures are constructed in farm were the problems exist. The impact of these structures are presented in this section (Table 28).

1. Cropping Pattern

Cropping pattern of the DLT scheme respondents was also similar to General pattern of the Wayanad District. Major area in the farm was occupied with coffee, arecanut and pepper. There were crops like rubber, banana, ginger, tapioca, cardamom turmeric and vegetable too.

Percentage change in the area of crops was calculated to know the impact of SWC on cropping pattern. Increase in the water availability and decrease in soil erosion has increased the confidence of respondents to shift their cultivation from vegetables and tapioca to ginger, turmeric and banana at the cost of vegetables and tapioca. Of the crops cultivated ginger (197.79%) has observed highest change in the per cent area because of the good returns from the ginger than in the vegetables and tapioca. It was followed by turmeric (50.00%), banana (28.38%) and rubber (10.32%). In post adoption scenario, area under prime crops like arecanut, coffee, and pepper has seen minute changes *viz.*, 3.92 per cent, 1.13 per cent and 0.46 per cent respectively. Area under crops like cardamom, coconut and fodder has not observed any changes and crops like vegetables (-56.11%), tapioca (-49.15%) and rice (-5.88%) has reduced when compared to before adoption of SWC structures.

The prominent changes in ginger and turmeric shows the re-introduction of traditional crops of Wayanad. Banana cultivation gained momentum, especially in paddy lands where assured irrigation is there.

2. Productivity of important crops

In terms of percent change in the productivity of crops, arecanut was the major one with observed 71.99 per cent change in productivity. It was followed by coffee (60.61%) and pepper (49.90%), banana (36.72%) cardamom (36.04%) and remaining crop have observed the change in productivity between 20 per cent and 25.46 per cent. The relative advantages in expansion of cultivated area is not enjoyed in productivity gains in the crops like ginger turmeric and banana, compared to others.

Increase in the productivity of crops was mainly due to the increase in availability of irrigation water and reduction in the soil erosion. Increase in the productivity of banana was mainly due to the reduction in soil erosion, especially at the respondents who have adopted the stream bank stabilization.

3. Production of important crops

It was expected that changes in the irrigation water availability, reduction in the soil erosion and percent change in the area to be contributing to the production. As anticipated, ginger has observed tremendous increase in the production (269.71 %) which the highest. It was followed by turmeric (80.00%), banana (75.52%), arecanut (73.93%), coffee (66.90%), pepper (50.58%), rubber (38.41%) and cardamom (36.04%).

Ginger, turmeric and banana production gained most of the investments mainly due to area effect. Changes in the production level of other crops like arecanut, coffee, pepper rubber and cardamom was mainly due to productivity gains through the irrigation water made available by the SWC structures also due to decrease in the soil erosion. Vegetables (-42.48%) and tapioca (-37.11%) have seen the decrease in production after post adoption period of SWC since, area under these crops has remarkably reduced.

It is to be noted that the production gains in all most of the crops are through productivity gains.

4. Gross income level of respondents

Obviously the income advantage was in favour of ginger, turmeric and banana. Change in income of ginger was 269.71 percent followed by turmeric (80.00%), banana (75.52%), arecanut (73.93%), coffee (66.90%), pepper (50.58), rubber (38.41%) and cardamom (36.04%). Coconut (9.49%) has observed the least change in the income gained and was because it was cultivated only for home consumption and not considered as a commercial one. Hence the management continued to be minimal. There was a decrease in the income obtained by rice (5.88%), tapioca (37.11%) and vegetables (38.55%) because of the decrease in the area under these crops.

Table 28. Impact of DLT scheme on agricultural performance (□/farm/year)

(Per cent changes in area, productivity, production (%/farm) and income (%/farm) of major crops)

Sl No	Crop	Area	Productivity	Production	Income
1	Arecanut	1.13	71.99	73.93	73.93
2	Banana	28.38	36.72	75.52	75.52
3	Cardamom	0.00	36.04	36.04	36.04
4	Coconut	0.00	9.49	9.49	9.49
5	Coffee	3.92	60.61	66.90	66.90
6	Fodder	0.00	0.00	4.88	0.00
7	Ginger	197.79	24.15	269.71	269.71
8	Pepper	0.46	49.90	50.58	50.58
9	Rice	-5.88	0.00	-5.88	-5.88
10	Rubber	10.32	25.46	38.41	38.41
11	Tapioca	-49.15	23.67	-37.11	-37.11
12	Turmeric	50.00	20.00	80.00	80.00
13	Vegetables	-56.11	21.00	-42.48	-38.55
	Total	0.00			**54.49**

5. Economics of major crops

The relative economics post SWC measures with respect to major crops in the farm is presented in the Table 34. The paid out cost of cultivation was highest in banana (□ 1,35,903/ha), followed by arecanut (□ 95,117/ha), coffee (□ 89,899/ha) and black pepper (□ 85,025) (Fig 5.). The costs are higher in all the cases by 3.15 per cent, 17.42 per cent, 24.69 per cent, and 5.27 per cent respectively, compared to ALT scheme, which is partially due to higher SWC investment. The relative net returns are in the same pattern as in ALT scheme but higher by12.49 per cent, 22.61 per cent, 29.16 per cent and 28.09 per cent respectively. The efficiency is highest in arecanut (3.31) farming followed by coffee (2.37), banana (2.32), and black pepper (1.82) (Fig 6.). The cultivation in DLT scheme is economically more efficient than in the farms under ALT scheme.

Table 29. Economics of important crops cultivated in the sample farms (DLT scheme, □/ha/year)

SL No	Particulars	Coffee		Pepper		Arecanut		Banana	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1	Input cost	32358	35.99	33125	38.96	39545	41.58	76928	56.61
2	Labour Cost	51551	57.34	46477	54.66	49761	52.32	51596	37.96
3	Annualized SWC Cost/ Year	2152	2.39	2152	2.53	2152	2.26	2152	1.58
4	Interest on Working Capital	3837	4.27	3270	3.85	3658	3.85	5227	3.85
5	Cost A1	89899	100.00	85025	100.00	95117	100.00	135903	100.00
6	Cost C1	127294		117972		132511		173298	
7	Cost C2	165023		155701		170240		211027	
8	Gross Return	390560		284000		564000		488670	
9	Net Return (GR-C2)	225537		128299		393760		277643	
10	Net Return (GR-A1)	300661		198975		468883		352767	
11	BC Ratio (GR/C2)	2.37		1.82		3.31		2.32	
12	BC Ratio (GR/A1)	4.34		3.34		5.93		3.60	

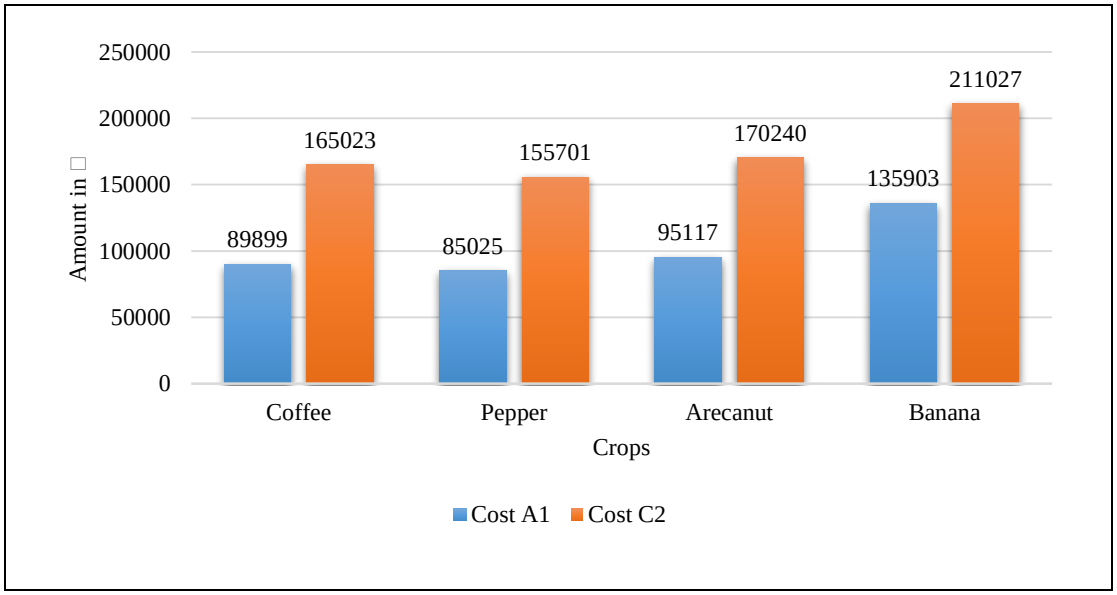

Fig 5. Cost of A and Cost B of important crops cultivated by DLT respondents

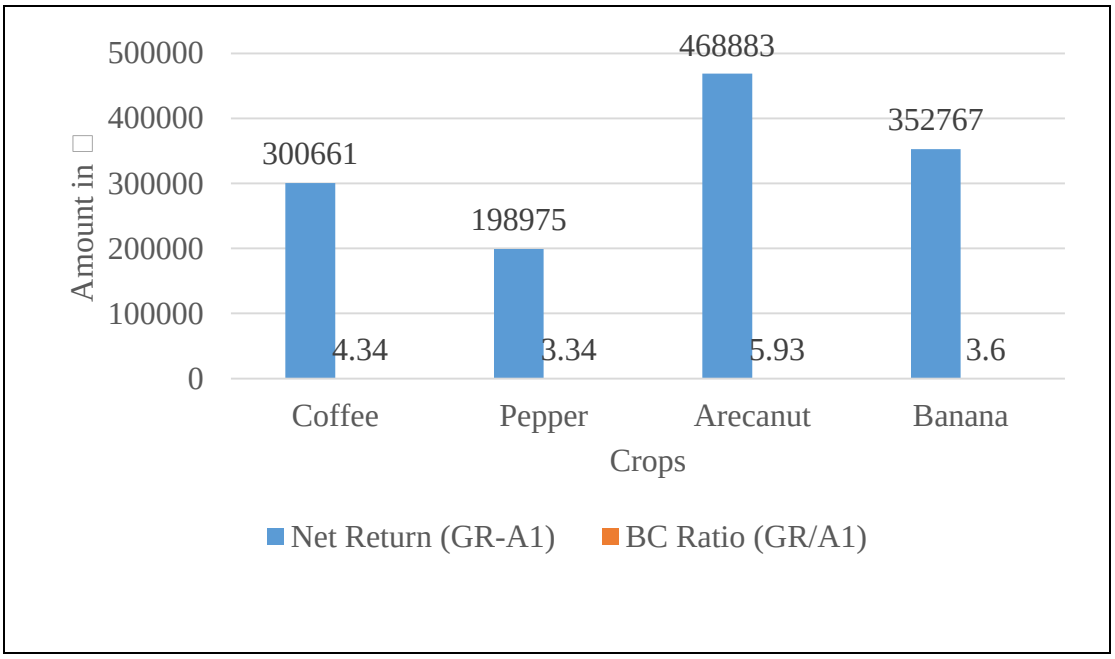

Fig 6: Net returns and BC ratio of important crops by DLT respondents

4.3.5.3 Drought Mitigation Scheme

Drought mitigation schemes was mainly introduced to reduce the impact of severe drought. Well Recharge, Logwood Check Dam, Farm Ponds, Earthen Bunds, Stream Bank Stabilization, Stone Pitched Bunds, Planting of Trees and Spring Water

Development were the structures implemented under scheme. The sample respondents were implementing the well recharge, farm pond and logwood check dam structures. The details of impact are presented in Table 30.

1. Cropping Pattern

Cropping pattern of the DMS scheme respondents was also similar to general cropping pattern of the Wayanad District. Major cultivated area of the respondents was occupied with coffee, arecanut and pepper along with these crops respondents have also cultivated rubber, banana, ginger, tapioca, cardamom turmeric and vegetable.

Of the crops cultivated rubber (106.61%) has observed highest change in the per cent area cultivated after the adoption of SWC structures.

Rubber is not grown as an irrigated crop and if SWC measures are taken the crop can perform well. There was considerable increase in area under banana (72.15%) and ginger (34.62%) especially in farms where ponds were dug. The shift in are to banana/ginger was at the cost of crops like vegetables and tapioca.

2. Productivity of important crops

All the crops gained in productivity levels, coffee has observed 48.93 per cent and stood first among the crops cultivated. It was followed by pepper (46.75%), arecanut (44.84%), ginger (40.74%), tapioca (40.58%) and cardamom (35.15%). Increase in the productivity of crops was mainly due to the increase in moisture and irrigation water availability and reduction in the soil erosion.

3. Production of important crops

Rubber has observed highest gains in production *i.e.* 141.04 per cent, mainly because of the area expansions. It was followed by banana (118.08%), ginger (89.46%), arecanut (47.25%), pepper (46.31%), cardamom (35.15%), coconut (08.24%) and fodder (07.50%).

4. Gross income level of respondents

Rubber, banana and ginger were the crops that performed best in realizing the income. Excepting the tapioca and vegetables all the crops registered an additional income realization, post adoption of SWC measures. The productivity gain in these crops were not enough to offset the area decline and hence the income realization declined. For rice and coconut there were no change. Coconut (9.49%) and fodder (7.50%) has observed the least change in the income gained and was because it was cultivated only for home consumption. There was decrease in the income obtained by tapioca (-8.59%) and vegetables (-43.46%) because of the decrease in the area under these crops.

Table 30. Impact of DMS scheme on agricultural performance (□/farm/year)

(Per cent changes in area, productivity, production (%/farm) and income (%/farm) of major crops)

Sl No	Crop	Area	Productivity	Production	Income
1	Arecanut	1.67	44.84	47.25	47.25
2	Banana	72.15	26.68	118.08	118.08
3	Cardamom	0.00	35.15	35.15	35.15
4	Coconut	0.00	8.24	8.24	8.24
5	Coffee	1.42	48.93	51.04	51.04
6	Fodder	0.00	7.50	7.50	7.50
7	Ginger	34.62	40.74	89.46	89.46
8	Pepper	-0.30	46.75	46.31	46.31
9	Rice	0.00	0.00	0.00	0.00
10	Rubber	106.61	16.67	141.04	141.04
11	Tapioca	-34.97	40.58	-8.59	-8.59
12	Tea	0.00	0.00	0.00	0.00
13	Vegetables	-54.31	25.92	-41.99	-43.46
Total		**0.00**			**45.23**

5. Economics of major crops

The cost of cultivation of major crops in respondent's farms where DMS structure were implemented is presented in Table 31. Banana and coffee cultivation costs were the highest followed by arecanut and pepper. The pattern of net returns (at Cost A1) was in the same pattern (arecanut, banana, coffee and pepper in that order) as that of ALT and DLT farms (Fig 7). Extent of returns was lower level than that of DLT scheme (by 18.98%, 2.77%, 16.04%, 10.83% respectively), but it is higher than that in farms under ALT scheme. The efficiency level is the highest 5.44 in arecanut (Fig 8.), which is higher than that in ALT scheme but lower than that of DLT.

Table 31. Economics of important crops cultivated in the study area (DMS scheme, /ha/year)

SL No	Particulars	Coffee		Pepper		Arecanut		Banana	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1	Input cost	35685	38.20	29495	35.85	33864	38.19	76014	55.30
2	Labour Cost	49860	56.70	47363	57.57	49137	55.42	53893	39.21
3	Annualized SWC Cost/ Year	2252	1.26	2252	2.74	2252	2.54	2252	1.64
4	Interest on Working Capital	3512	3.84	3164	3.85	3410	3.85	5286	3.85
5	Cost A1	91309	100.00	82275	100.00	88663	100.00	137445	100.00
6	Cost C1	129253		119669		126058		176827	
7	Cost C2	166982		157398		163787		214556	
8	Gross Return	316800		261800		482750		480690	
9	Net Return (GR-C2)	159766		104402		318963		266134	
10	Net Return (GR-A1)	240414		179525		394087		343245	
11	BC Ratio (GR/C2)	2.02		1.66		2.95		2.24	
12	BC Ratio (GR/A1)	4.15		3.18		5.44		3.50	

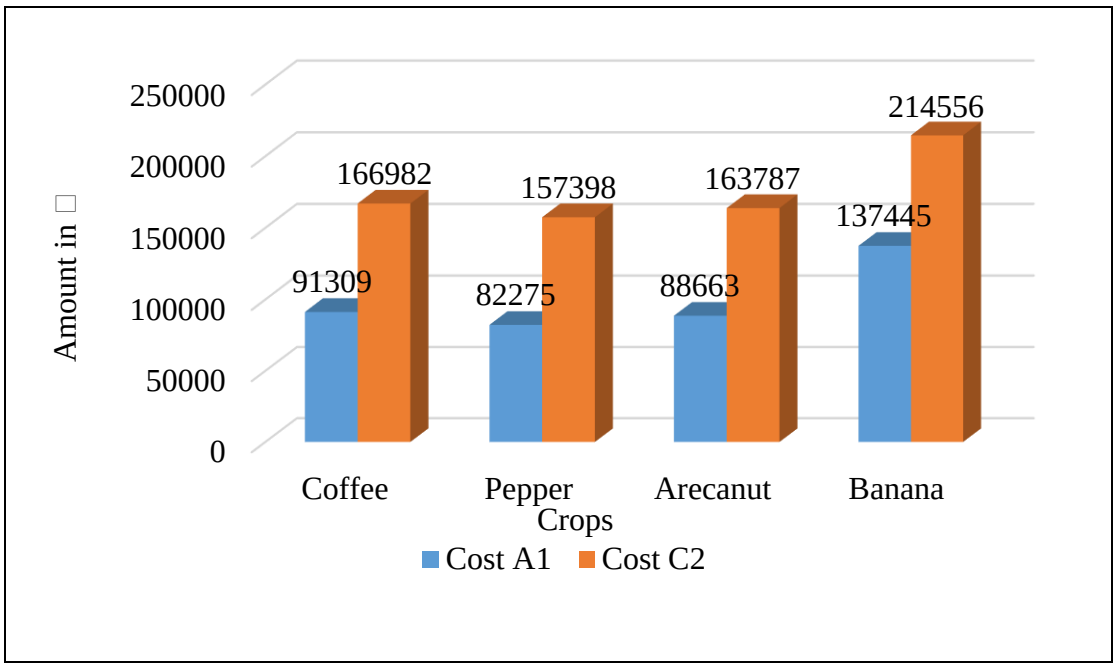

Fig 7. Cost of A and Cost B of important crops cultivated by DMS respondents

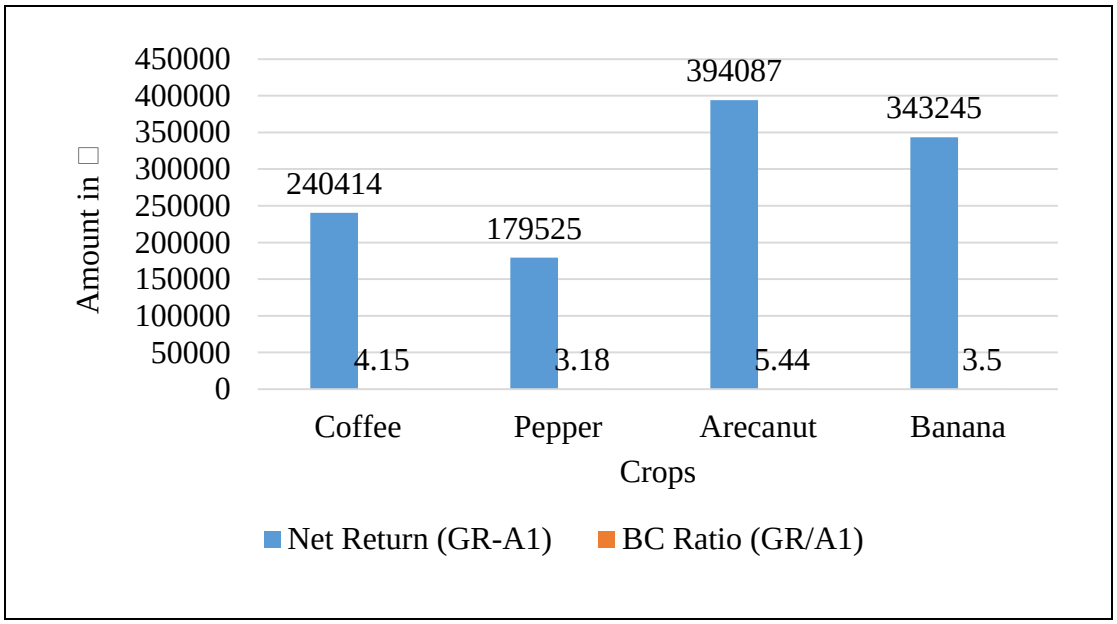

Fig 8: Net returns and BC ratio of important crops cultivated by DMS respondents

4.3.5.4 Wester Ghats Development Programme (WGDP)

Wester Ghats Development Programme is a multi-state programme implemented in Maharashtra, Kerala, Karnataka, Tamil Nadu and Goa. This scheme

was aimed at developing the important areas of the country through strengthening various sectors like agriculture, animal husbandry, forestry and minor irrigation. The respondents in this scheme mainly constructed earthen bunds, check dam and farm ponds (Table 32).

1. Cropping Pattern

Major crops cultivated by the respondents includes coffee, arecanut and pepper along with these crops respondents have also cultivated rubber, banana, ginger, cardamom, tapioca and vegetable.

Of the crops cultivated, ginger area increased by 180.43 per cent post SWC. It was followed by rubber with a change of 140.18 per cent followed by banana (46.00%), pepper (0.47%) and coffee (0.38%). Area under rice, tapioca and vegetables has reduced by 33.33 per cent, 35.36 per cent and 57.89 per cent respectively. The banana area gain may be mainly at the cost of rice area. Ginger is cultivated replacing tapioca and vegetables. Area under crops like arecanut, cardamom, coconut, fodder and tea have seen no change.

2. Productivity of important crops

Excepting rice and tea all the crops registered gains in productivity levels. Coffee registered 63.70 per cent change in productivity and stood first among crops. It was followed by arecanut (51.94%), pepper (47.68%), cardamom (34.14%), tapioca (29.13%) and vegetables (22.85%). Increase in the productivity of crops was mainly due to the increase in moisture and irrigation water availability at the critical times and supported by reduction in the soil erosion problems.

3. Production of important crops

Ginger registered highest change in the production mainly due to area effect (227.08%). Same was the case with rubber and banana. Generally, the production gains in rest of the crops are due to yield effects than area effect.

Coconut and fodder has observed slight change in the production, it was mainly due to farmers were not much critical in identifying the changes of these crops. Vegetables (-49.39%), rice (-33.33%) and tapioca (-16.53) have seen the decrease in production after post adoption period of SWC since, area under these crops has remarkably reduced.

4. Gross income level of respondents

Overall there was an increase in income by 50.05 per cent among the respondents. Of the changes, percent change in income of ginger was 227.08 percent and was highest among other crops. It was followed by rubber (212.23 %), banana (89.73 %), coffee (64.33 %), arecanut (51.94 %), pepper (48.38 %) and cardamom (34.14 %). The income gains in ginger, rubber and coffee mainly due to area increase than productivity gains while rest of the crops gained through yield increase.

Coconut (11.28 %) and fodder (2.22 %) has observed the least change in the income gained and was because it was cultivated only for home consumption. There was a decrease in the income obtained by vegetables (-53.06%), rice (-33.33%) and tapioca (-16.53%) because of the decrease in the area under these crops.

Table 32. Impact of WGDP scheme on agricultural performance

(Per cent changes in area, productivity, production (%/farm) and income (%/farm) of major crops)

Sl No	Crop	Area	Productivity	Production	Income
1	Arecanut	0.00	51.94	51.94	51.94
2	Banana	46.00	29.95	89.73	89.73
3	Cardamom	0.00	34.14	34.14	34.14
4	Coconut	0.00	11.28	11.28	11.28
5	Coffee	0.38	63.70	64.33	64.33
6	Fodder	0.00	2.22	2.22	2.22
7	Ginger	180.43	16.63	227.08	227.08

8	Pepper	0.47	47.68	48.38	48.38
9	Rice	-33.33	0.00	-33.33	-33.33
10	Rubber	140.18	30.00	212.23	212.23
11	Tapioca	-35.36	29.13	-16.53	-16.53
12	Tea	0.00	0.00	0.00	0.00
13	Vegetables	-57.89	22.85	-49.39	-53.06
Total		**0.00**			**50.05**

5. Economics of major crops

Though the cost and returns structures differed with the farms in the rest of the scheme the relative performance with respect costs, net returns (over cost A1), and BC ratio was in the same order (Table 33). The net returns (Cost A1) was highest in arecanut (□ 4,31,953) followed by banana (□ 3,45,530), coffee (□ 3,06,946), and black pepper (□ 1,98,891). The BC ratio, however was in the same order of arecanut (5.56), coffee (4.08), banana (3.53) and black pepper (3.33).

The paid out cost of cultivation was highest in banana (□ 1,36,630/ha), followed by coffee (□ 99,774/ha), arecanut (□ 94,797/ha) and black pepper (□ 85,509/ha) (Fig 9).

The pattern of net returns (at Cost A1) was in the same pattern (arecanut, banana, coffee and pepper in that order) as that of ALT, DLT and DMS farms. But the extent of returns was lower level than that of DLT scheme and higher than DMS and ALT schemes in all the crops except for coffee (coffee returns was higher than all the other schemes). The efficiency level is the highest 5.56 in arecanut (Fig 10), which is higher than that in ALT and DMS schemes but lower than that of DLT.

Table 33. Economics of important crops cultivated in the study area (WGDP scheme, □/ha/year)

SL No	Particulars	Coffee		Pepper		Arecanut		Banana	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1	Input cost	40440	40.53	33136	38.75	37803	39.88	76809	56.22
2	Labour Cost	52722	52.84	46309	54.16	50574	53.35	51792	37.91
3	Annualized SWC Cost/ Year	2774	2.78	2774	3.24	2774	2.93	2774	2.03
4	Interest on Working Capital (4%)	3837	3.85	3289	3.85	3646	3.85	5255	3.85
5	Cost A1	99774	100.00	85509	100.00	94797	100.00	136630	100.00
6	Cost C1	144719		122903		133589		177937	
7	Cost C2	182448		160632		171318		215666	
8	Gross Return	406720		284400		526750		482160	
9	Net Return (GR-C2)	224272		123768		355432		266494	
10	Net Return (GR-A1)	306946		198891		431953		345530	
11	BC Ratio (GR/C2)	2.23		1.77		3.07		2.24	
12	BC Ratio (GR/A1)	4.08		3.33		5.56		3.53	

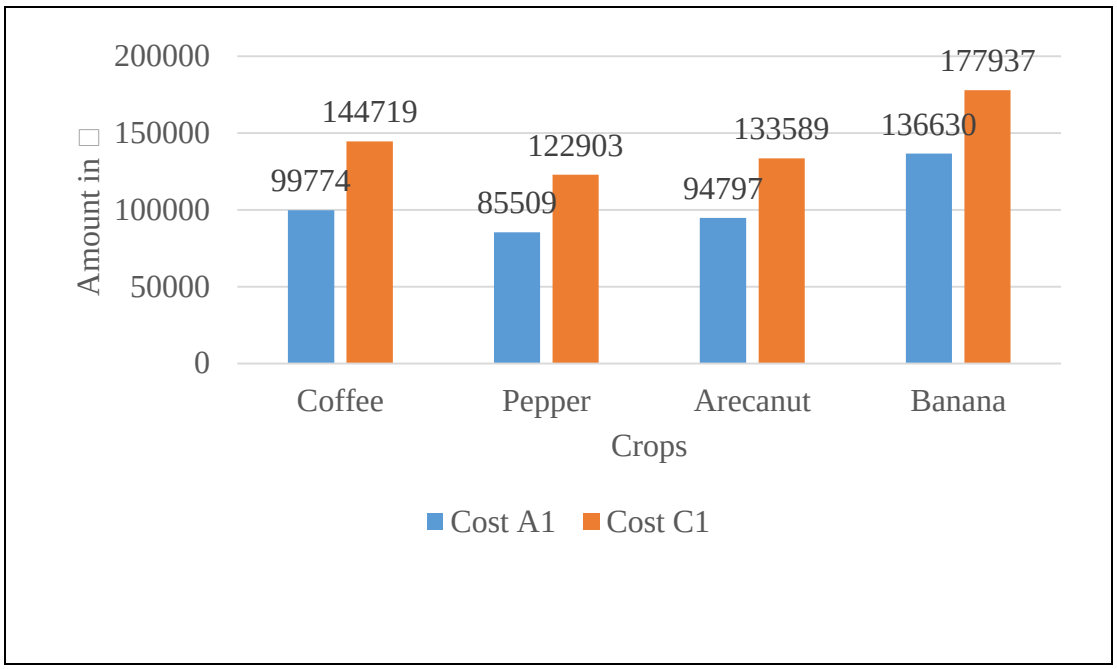

Fig 9. Cost of A and Cost B of important crops cultivated by WGDP respondents

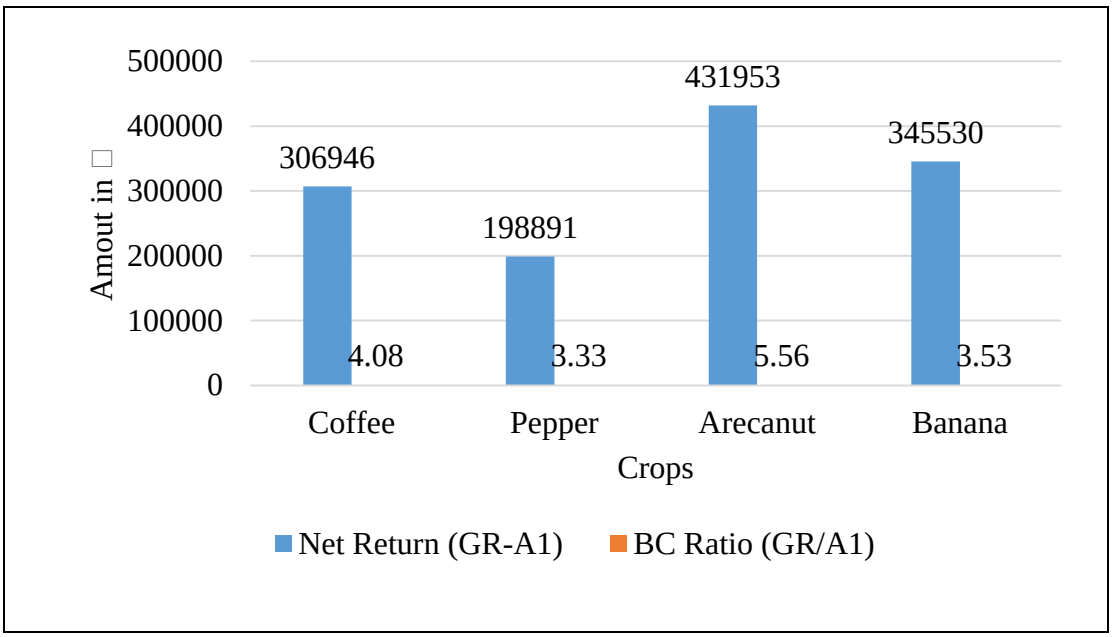

Fig 10: Net returns and BC ratio of important crops by WGDP respondents

4.3.5.5 Impact of SWC structures on agriculture (Pooled data)

1. Cropping Pattern

The investment on SWC measures have facilitated mainly the area expansion of ginger (56.94%), banana (38.53%), rubber (32.71%) and turmeric (31.65%) replacing the vegetables (-57.33%), tapioca (-44.63%) and rice (-5.03%) (Table 34).

The cultivation of ginger and banana to some extent is in paddy fields, replacing the rice cultivation. Though arecanut proved to be the most profitable and efficient one at farmers' perspective (Cost A1) the area increase is only 0.59 per cent.

Black pepper the traditional spice crop of the area has not registered significant increase (0.04%) which is mainly attributed to wide spread pests and diseases attack as well as adverse price factors. Black pepper was the crop that has proved to be least viable and efficient. The decline in vegetable and tapioca farming is to be viewed in the perspective of food safety. Excepting banana, the area expansion is in non-food crops.

2. Productivity of important crops

The significance of SWC measures in Wayanad is revealed by the positive effect on productivity in all the crops. Coffee observed 55.08 per cent of change increase in productivity and stood first among crops cultivated by respondents. It was followed by arecanut (51.29%), pepper (42.59%), tapioca (31.49%), banana (31.24%) and vegetables (25.60%). Increase in the productivity of crops was mainly due to the increase in moisture and irrigation water availability at the critical times and supported by reduction in the soil erosion problems. Despite replacement of tapioca and vegetables, the productivity of these crops have improved. The improvements in productivity of pepper may help the farmers to revive the crop through appropriate SWC measures.

3. Production of important crops

The significant area expansion and productivity gains in ginger, banana, rubber and turmeric has translated into substantial production gains (95.24% in ginger, 81.80%

in banana, 64.77% in rubber, 49.60% in turmeric). The coffee and black pepper production could also gain (58.05%, 42.65%), through productivity improvement, though area expansion was limited. However, the productivity improvements in the vegetable and tapioca cultivation couldn't offset the area loss and the production has declined by 45 per cent and 27 per cent respectively. This is to be viewed seriously as the state is trying to ensure the food security through boosting the food production.

4. Gross income level of respondents

The SWC investments could increase the farm income to the tune of 45.61 per cent, the major increase being from ginger (95.24%), banana (81.80%), rubber (64.77%) and turmeric (49.60%) cultivation. The income from coffee and black pepper has also improved considerably. Obviously, the returns from vegetable and tapioca has declined as these crops registered a decline in production. SWC investments help the farmers improve their farm income by the 45.60 per cent, while impacting the nutritional security.

Table 34. Impact of SWC on agricultural performance (Pooled, □/farm/year)

(Per cent changes in area, productivity, production (%/farm) and income (%/farm) of major crops)

Sl No	Crop	Area	Productivity	Production	Income
1	Arecanut	0.59	51.29	52.19	52.19
2	Banana	38.53	31.24	81.80	81.80
3	Cardamom	3.40	30.82	35.26	35.26
4	Coconut (No)	0.00	9.67	9.67	9.67
5	Coffee	1.92	55.08	58.05	58.05
6	Fodder	0.00	4.88	4.88	4.88
7	Ginger	56.94	24.41	95.24	95.24
8	Pepper	0.04	42.59	42.65	42.65
9	Rice	-5.03	0.00	-5.03	-5.03

10	Rubber	32.71	24.16	64.77	64.77
11	Tapioca	-44.63	31.49	-27.20	-27.20
12	Tea	0.00	0.00	0.00	0.00
13	Turmeric	31.65	13.64	49.60	49.60
14	Vegetables	-57.33	25.60	-44.99	-44.58
Total		**0.00**			**45.61**

5. Economics of major crops

All the major crops in the farm performed well with positive indicators of financial viability and efficiency (Table 35). The relative economic performance was in the order of arecanut, banana, coffee and black pepper (Fig 11). The efficiency of investment as indicated by the BC ratio was in favor of arecanut followed by coffee, banana and black pepper (Fig 12).

Despite comparatively high returns from arecanut and coffee cultivation, the area expansion in these crops very limited. On the contrary the additional area is brought in the case of annual/seasonal crops like ginger, banana and turmeric. Ginger and turmeric have been cultivated in Wayanad traditionally and banana cultivation gained acceptances due to its feasibility for farming in rice fields. The assumed marketing and price advantages also facilitated the spread.

The most popular crop cafeteria of Wayanad, coffee-pepper combination was found to be economically attractive through the productivity gains in these crops. Even though pepper cultivation demanded comparatively low investment, net returns and efficiency was also lowest. Banana cultivation despite highest cost structures occupied second position with respect to net returns (Cost A1).

The farmer choices, while the water availability improve are generally towards economically viable annual/seasonal crops. The shortest duration (ginger) and banana

was favored for cultivation, despite most attractive economic performance from arecanut. Rational farmer choices are generally in favor of early returns, especially in the case of marginal/small farmers, where the major source of household income is from farming.

Rubber being a crop with active institutional support from rubber board, been showing expansion throughout the state.

Ginger and turmeric cultivation has been taken up as a commercial activity in Wayanad since long. The financial attractions that the returns are realised at the shortest duration (10 months) and market access favoured the decision.

Banana (Nendran) variety is considered as one of the most preferred crop, under irrigated condition, which yields returns in 10 months. It is one of the crops that registered continues increase in area across the state.

The impact on productivity gain due to SWC improvements were pronounced in coffee and arecanut followed by pepper and banana. Coffee- pepper intercropped gardens, the prominent agriculture land use system in the district, is thus best benefited. The productivity gains were around 30 per cent for ginger and turmeric.

With remarkable effect on area expansion and reasonable productivity gains the impact on production increase from ginger farming was the highest at 95 per cent, followed by that from banana at 81.80 per cent. Production impact varied from 49.60 in turmeric to 64.77 per cent in rubber. While translating the production gains to income, the same pattern followed.

Table 35. Economics of important crops cultivated in the study area (Pooled, □/ha/year)

SL No	Particulars	Coffee		Pepper		Arecanut		Banana	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1	Input cost	35264	38.17	30548	36.95	37157	39.88	75934	56.11
2	Labour Cost	51051	55.25	46416	56.15	49909	53.56	51672	38.18
3	Annualized SWC Cost/ Year	2526	2.73	2526	3.06	2526	2.71	2526	1.87

4	Interest on Working Capital (4%)	3554	3.85	3180	3.85	3584	3.85	5205	3.85
5	Cost A1	92395	100.00	82671	100.00	93176	100.00	135338	100.00
6	Cost C1	133196		121446		132301		175589	
7	Cost C2	170925		159175		170030		213318	
8	Gross Return	365760		269600		517250		477540	
9	Net Return (GR-C2)	194835		110425		347220		264220	
10	Net Return (GR-A1)	273365		186929		424074		342202	
11	BC Ratio (GR/C2)	2.14		1.69		3.04		2.24	
12	BC Ratio (GR/A1)	3.96		3.26		5.55		3.53	

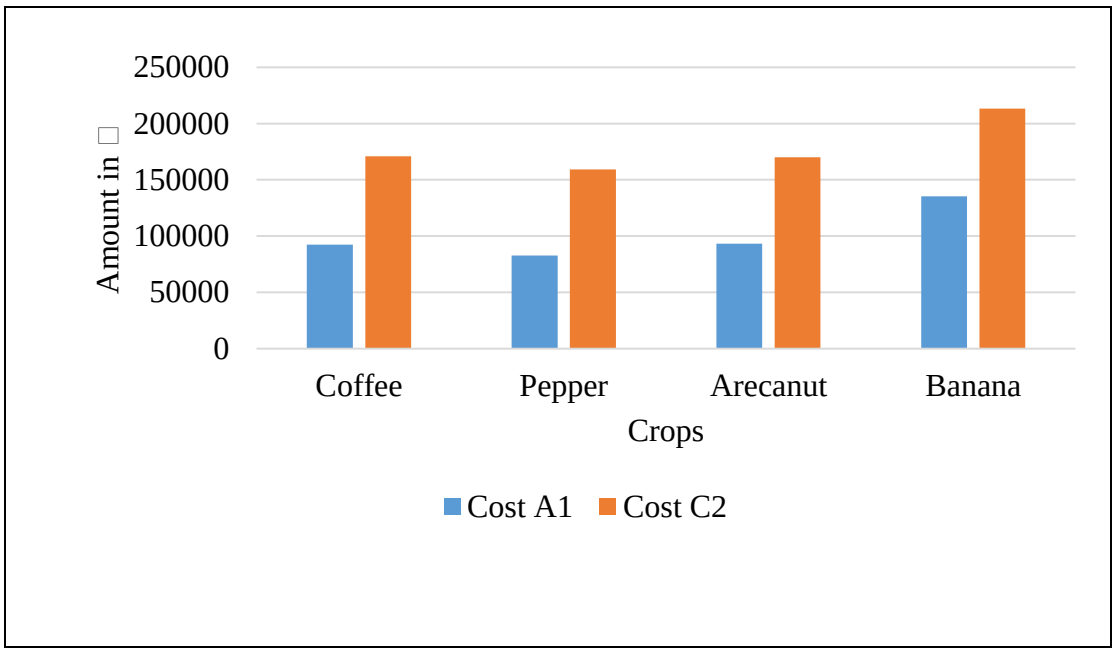

Fig 11. Cost of A and Cost B of important crops (pooled)

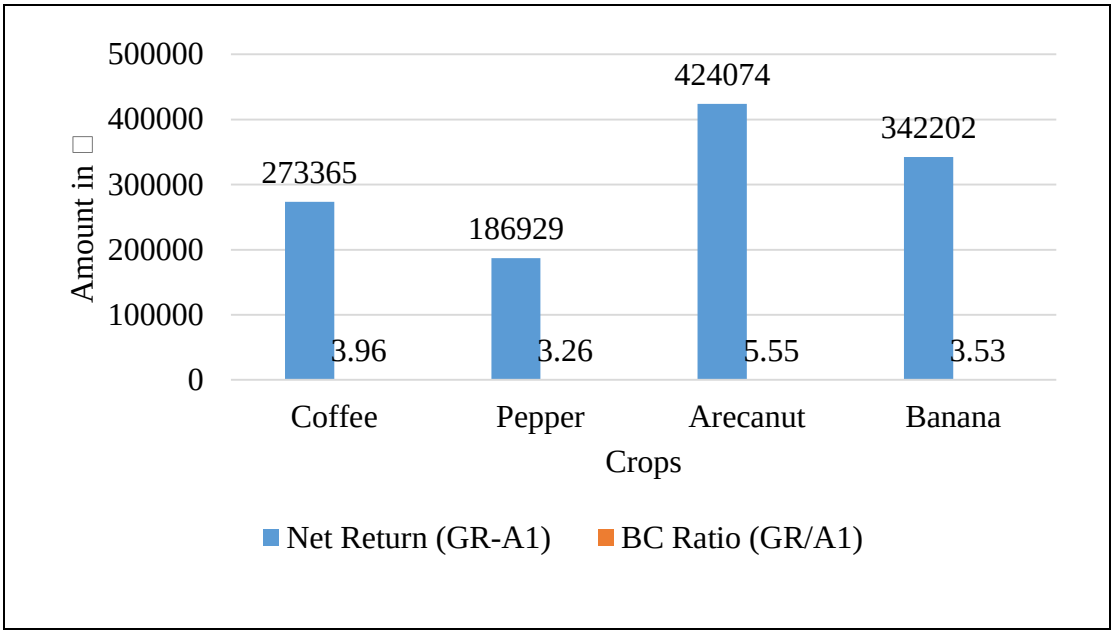

Fig 12: Net returns and BC ratio of important crops (pooled data)

4.3.6 Resource Use Efficiency of crop production in farms with SWC measures

After the SWC structures were built, considerable change was reported in the ground water level which could effect better irrigation. In ALT scheme, respondents could ensure two lifesaving irrigations, though they could not irrigate as per ideal prescriptions.

In an effort to see whether this improved irrigation situation significantly added to the returns from major crops which are irrigated the resource use efficiency analysis was done. Independent variables are the inputs used in the production of respective crops viz., FYM, Lime, Bordeaux Mixture, PPC and number of irrigation. The results confirmed that irrigation has contributed to the returns in arecanut (Table 36), coffee (Table 37), pepper (Table 38). Banana cultivation is generally done where irrigation is assured and the additional gain through banana cultivation is through area expansion, rather than irrigation (Table 39). The soil and water conservation measures thus have proved to improve the resource use efficiency in crop production.

Table 36. Resource use efficiency of crop production under SWC managed farms: Results of Cobb-Douglas production function of coffee cultivation

Particulars	Coefficients	Standard Error	t Stat	MVP: MFC
Intercept	-1.08	0.42	-2.59	2.39
FYM	0.41***	0.03	11.74	0.87
Labour	0.74***	0.12	6.28	0.84
Irrigation	0.16***	0.02	8.32	0.09
Weeding	0.04NS	0.03	1.19	0.15
Lime	0.01NS	0.02	0.49	2.39
R^2	62			
Returns to scale	1.35			

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

Table 37. Resource use efficiency of crop production under SWC managed farms: Results of Cobb-Douglas production function of Pepper cultivation

Particulars	Coefficients	Standard Error	MVP: MFC
Intercept	-0.55	0.18	-
FYM	0.37***	0.02	10.57
Weeding	0.10**	0.05	1.46
Lime	0.02NS	0.04	1.73
Labour	0.68***	0.12	3.93
Irrigation	0.10***	0.02	1.33
R^2	59		
Returns to Scale	1.27		

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

Table 38. Resource use efficiency of crop production under SWC managed farms: Results of Cobb-Douglas production function of Arecanut cultivation

Particulars	*Coefficients*	*Standard Error*	MVP: MFC
Intercept	0.11	0.21	-
FYM	0.35**	0.04	3.47
BM	0.16***	0.02	0.75
Lime	0.06**	0.03	0.67
Labour	0.56***	0.14	0.24
Irrigation	0.11***	0.03	0.86
Weeding	0.02NS	0.05	0.15
R^2	62		
Returns to Scale	1.26		

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

Table 39. Resource use efficiency of crop production under SWC managed farms: Results of Cobb-Douglas production function of banana cultivation

Particulars	*Coefficients*	*Standard Error*	MVP: MFC
Intercept	9.60	1.70	1.99
FYM	0.22***	0.04	0.13
Urea	3.06***	1.04	0.01
DAP	0.15***	0.04	-0.02
Complex	-2.09*	0.78	-0.30
PPC	-0.06**	0.03	1.12
Labours	0.14**	0.06	0.14
Irrigation	0.03NS	0.02	1.99
R^2	71		
Returns to Scale	1.44		

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

4.3.7 Economic Feasibility of Soil and Water Conservation Schemes

Feasibility analysis aims at unveiling the viability of any proposed modifications in the existing project or newly proposed project. The economic viability of SWC investments is estimated to assess the economic worthiness of the investment as it involves substantial part of public money. The analysis was attempted taking the level of investment as the cost and additional revenue as returns. The economic life of respective structures in each scheme was the basis for duration of cash flow. The results are presented in Table 40 and Annexure 2.

The NPW of the investment was positive in all the schemes and averaged at □ 3,02,792/farm. DLT scheme was proved to be the best in terms of NPW. The efficiency in investment as measured by BC ratio was highest in ALT (9.37) which averaged at 2.33, thus confirming the economic efficiency of the investment. IRR averaged at 28 per cent, which is significantly higher than the opportunity cost of capital (interest on fixed investments). ALT scheme performed best. The analysis justifies the social investment of SWC, as it leads to higher production and returns which supports the agricultural profession and welfare of the farmers. Better returns in agriculture can trigger the interest in sector among youth.

Table 40. Economic feasibility analysis of different SWC structures under various schemes

Sl No	Economic Measures	ALT	DLT	DMS	WGDP	Overall
1	Total Cost	28539	465880	238916	333216	265285
2	Gross Returns	429848	2990952	1552257	1595676	1703129
3	Average Economic life (years)	6	27	20	18	18
4	NPW (9%)	241281	609365	204433	148580	302792
5	B:C Ratio	9.37	1.31	1.77	1.39	2.33
6	IRR	>50.00	20.10	27.84	22.15	28.00

4.3.8 Impact of SWC measures on livestock sector

Livestock is an indivisible part of Indian agriculture. It has special role in rainfed areas and is contributing four per cent to the total GDP and 25 per cent to the Agricultural GDP of India (Dash, 2017; Suthar *et al.,* 2019). Livestock plays a major role in agriculture providing mechanical support in farming and provision of cow dung/ urine/ blood meal/ bone meal (Devendra, 2012). Livestock is also contributing to financial security and nutritional security, poverty alleviation, women empowerment and diversification of risk in agriculture particularly in rural areas and dry and areas (Devendra, 2012; Srinivasarao *et al.,* 2013; Dash, 2017; Shanmathy *et al.,* 2018). Prosperity of farmers also depend on the livestock population and it in turn is decided by availability of fodder (Bardhan and Sharma, 2013).

Cow, sheep and goat were the important livestock animals maintained by the respondents in Wayanad, along with the poultry birds. Table 41 represents per cent change in the livestock before and after the adoption of SWC measures. Overall, there was 62.48 per cent increase in number of cows in the post adoption period followed by 30.77 per cent increase of goats, 10.77 per cent increase in the sheep and 51.67 per cent increase in the poultry birds. The households in WGDP scheme (72.57%) maintained the highest number of cows.

Among the different schemes increase in the number of cows (includes both local and cross breed) was highest under WGDP scheme where 73 per cent increase was there. It was followed by the respondents of the ALT scheme (53%), DLT (43%) and least per cent increase was observed by households under DMS scheme (30%).

Sheep were less preferred by the respondents. Overall there was 10.77 per cent increase in the number of sheep/household after the adoption of SWC structures. Among the individual schemes, ALT respondents have taken lead in sheep rearing and there was an increase of 46.01 per cent increase in the number of sheep followed by households under WGDP scheme (19.60%), DMS scheme (7.94%) and DLT (5.84%). The beneficiaries in the ALT and WGDP schemes were provided with the Napier grass (Co3 and Co4) slips to encourage the farmers to go for fodder cultivation and livestock and to diversify their income sources.

The impact of SWC measures on the number, feeding pattern and milk yield of livestock is mainly through better green feed supply. The average number managed by the farmers, increased considerably post investment. 62.48 per cent more of cows, 10.77 per cent more of sheeps, 30.77 per cent of goats and 51.67 per cent of poultry were managed by them. This was possible due to the increase in farm grown feed supply, as evidenced by the increase in consumption of green fodder to the extent of 151.90 per cent. Higher farm income must also have resulted in the supply of purchased feed concentrates which have increased to an average of 30.95 per cent.

Table 41. Percent change in the livestock status in the sample farms (Per household)

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	Cow	52.69	42.95	29.56	72.57	62.48
2	Sheep	46.01	5.84	7.94	19.60	10.77
3	Goat	29.41	5.06	9.09	20.69	30.77
4	Poultry Birds	27.03	94.54	24.07	50.48	51.67

4.3.10.1 Impact of SWC measures on feeding habits of animals

Milk yield in animals is influenced by the age of the animal, green fodder, concentrates and management (Rao, 2017). All the schemes considered in the study were supporting animal husbandry indirectly through providing Napier grass (ALT and WGDP) planting material. Hence, impact of soil and water conservation measures on livestock feeding habit was also studied (Table 42).

The animals were generally fed by dry fodder, green fodder and concentrate feed. Green fodder consumption has increased considerably after the SWC investments, to the extent of 151.90 per cent. It was highest among the animals in ALT farms (225.41%), followed by WGDP farms (184.75%), DLT (101.18%) and DMS farms (16.70%). Correspondingly there was decline in dry fodder consumption. ALT scheme respondents have reduced the dry fodder feeding by 50.67 per cent and was highest

among the schemes, followed by DLT scheme (-40.97%), WGDP (-18.80%) and DMS (-6.85).

Concentrate feeds are essential components in the daily diet of the animals. Overall there was 30.95 per cent increase in the consumption of concentrated feed and it was highest in case of ALT scheme samples (42.42%) followed by the DLT scheme (38.33%), WGDP scheme (18.60%) and DMS scheme (18.18%).

Changes in the feeding pattern (green fodder) was more among farm animals of ALT and WGDP schemes which was mainly due to the supply of planting material supply as part of the project (Napier grass). Consequently, the dry fodder consumption has reduced considerably especially in ALT schemes and DLT schemes.

In WGDP scheme, though the green fodder usage was highest, respondents didn't reduce the dry fodder usage as they were strictly following dietary recommendations given by Veterinary department. The conduct of farmer meetings was more regular in WGDP scheme and the participation was also better. This must have facilitated the better management of farm animals.

Table 42. Percent change in the feeding habit of livestock animals in the study area (Per day)

Sl No	Participation	ALT	DLT	DMS	WGDP	Overall
1	Green Fodder	225.41	101.18	16.70	184.75	151.90
2	Dry Fodder	-50.67	-40.97	-6.85	-18.80	-66.72
3	Concentrated Feed	42.42	38.33	18.18	18.60	30.95

4.3.10.2 Impact of SWC schemes on milking days and milk yield

Adoption of SWC structures have significantly contributed to the fodder cultivation in the study area and the supply of green fodder has increased. Additional farm income has contributed to the purchase of concentrates. Hence, the milk yield has shown an increase (Table 43). Overall, number of milking days have increased by 11.87 per cent. WGDP Scheme has witnessed highest increase of about 16.50 per cent, followed by ALT (11.89%), DLT (10.95%) and DMS (8.47%).

The average increase in milk yield was to the tune of 18.33 per cent. ALT households have observed the highest change *i.e*. 23.40 per cent, followed by DLT scheme (21.36%), WGDP (18.65%) and DMS (9.69%). The highest impact was observed in WGDP scheme, since respondents were feeding green fodder in combination with dry fodder and concentrates based on the suggestions of Department of Animal husbandry, which took up continues knowledge dissemination programmes on livestock. The least impacted scheme DMS scheme (8.47% milking days and 9.69% milk yield) as the scheme is recently introduced and yet to gain momentum. Results obtained were in line with that of Palanisami *et al.* (2009) and Sing *et al.* (n.d.). Soil and water conservation structures implemented under watershed development scheme in Tamil Nadu have contributed to the increase in production of milk by 28 per cent and 50 - 100 per cent respectively. The per cent increase in the milk yield was less in the present study when compared with Sing *et al.* (n.d.), which may be because of differences in the climate and type of milking animals. Response of cross bread animals for green fodder may not be higher in tropical monsoon region when compared to local variety animals in the dry land region.

Table 43. Percent change in the milking days and milk yield level of animals

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	Milking Days (per year)	11.89	10.95	8.47	16.50	11.87
2	Yield (litres/day)	23.40	21.36	9.69	18.65	18.33

4.3.9 Impact of soil and water conservation measures on plant biodiversity

Trees are essential components in tropical home gardens. Wayanad being part of Western Ghats ecosystem, the presence of tree components is more. Hence the study has attempted the effect of soil water conservation on tree population, in two main components *i.e*. fruit crops and forest species (Table 44). The fruit tree planting seems to have increased after SWC and an average 28.74 per cent increase in population was noted. Among the schemes, ALT respondents (32.92%) have shown more interest on planting fruit trees, followed by WGDP (30.31%), DLT (27.78%) and DMS scheme

(21.02). Overall an additional, 6.56 per cent forest trees were planted by the respondents. ALT scheme took lead in forest species planted in the post adoption, followed by WGDP (9.84%) scheme, DMS Scheme (6.30%) and DLT scheme (6.17%) farms.

Table 44. Percent change in the in plant diversity in sample farms

Sl No	Participation	ALT	DLT	DMS	WGDP	Overall
1	Fruits Trees	32.92	27.78	21.02	30.31	28.74
2	Forest Trees	11.11	6.17	6.30	9.84	6.56

4.3.10 Impact of soil and water conservation measures on water level in the open wells

SWC are technological prescriptions to improve the ground water level and the soil moisture condition. To measure the increase in the ground water levels in the sample farms, water level of the open wells in each farm was collected. Water level (meter below ground level) of open wells both before and after the adoption of SWC was collected from each respondent for all three seasons *i.e*. Kharif (monsoon season), rabi and summer season.

. The SWC measures have shown to improve the ground water table, which is reflected as the eater table in open wells (Table 45). Average distance to water in the open wells *i.e.* meter below the ground level (mbgl) was decreased by 30.99 per cent in kharif, 28.69 per cent in rabi and 23.20 per cent in summer. The improvement in water table was more visible in farms under ALT scheme (25.70%) and DLT scheme (23.48%), where the water scarcity was more severe. The gains in water storage was presumably less in summer season.

Results of the study are in compliment with the results obtained by Mahale *et al.* (2003) who conducted research on Priyadarshini watershed of Mahrashtra and there was an increase of 2.13m of ground water level throughout the year in the watershed treated region.

Table 45. Percent change in water level in the open wells of respondents

Sl No	Particulars	ALT	DLT	DMS	WGDP	Overall
1	Kharif	-33.57	-32.48	-31.10	-26.38	-30.99
2	Rabi	-29.22	-28.87	-29.86	-26.63	-28.69
3	Summer	-25.70	-23.48	-21.70	-22.06	-23.20

4.3.11 Impact of soil and water conservation measures on employment pattern

Livelihood support is one of the important aim of watershed programmes and employment is one of the means of supporting it. The improved soil and water conservation situation is expected to generate more of farm employment opportunities through acrage expansion or management improvements. Hence employment pattern of respondents is studied both before and after the implementation of Soil and water conservation measures. Farm employment includes number of days' respondents worked in own farm, employment generated from livestock related activities and labour days which included the number days' respondents worked in other farms.

Overall there was an increase of 20.67 person days/household/year in own farm and 11.23 per cent increase in the employment generated from the livestock (Table 46). There was a reduction in the wage labour days by 15.43%. Since the on farm employment has increased the dependence on paid labour has reduced. WGDP scheme was most benefited scheme because the farmers have shifted to cultivation of crops like Banana, Rubber and ginger which are labour intensive. The obtained results were in support with the Mondal and Loganandhan (2013) who observed that there was a 60 per cent increase in the employment pattern in the treated watershed over the control area. Similar results were also reported by Singh *et al.* (n.d.).

Table 46. Percent change in the employment pattern of respondents

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	Farm Employment	17.75	36.47	8.04	22.16	20.67

2	Employment from livestock rearing	11.88	15.29	3.21	16.50	11.23
3	Paid Work	-23.79	-8.43	0.00	-25.85	-15.43

4.3.12 Impact of soil and water conservation measures on credit availing pattern

Adoption of SWC structures has significantly contributed to the credit requirement of the respondents for crop production activities (Table 47). Respondents have reduced their credit seeking by an average of 12.57 per cent. ALT farmers (-17.16%) followed by WGDP (-13.76%) reduced their credit dependency whereas DLT respondents have increased the credit seeking behaviour and there was no change in DMS respondents.

There was a drastic reduction in the time required to repay the credit. In general time required was reduced by 34.22 per cent, owing to higher farm returns.

Table 47. Percent change in credit availing pattern respondents in the study area

Sl No	Participation	ALT	DLT	DMS	WGDP	Total
1	Loan Availed (□)	-17.16	0.65	0.00	-13.76	-12.57
2	Repayment Time (Years)	-37.03	-35.23	0.00	-34.51	-34.22

4.3.13 Relative preference for the soil and water conservation measures

Respondent's relative preferences for the various SWC technologies were ranked based on their responses. The respondents were given with the list of structures and asked rank from 1 to 'n' (most preferred as 1 and least preferred as n).

4.3.13.1 ALT Scheme

Among the different conservation measures under the ALT scheme, earthen bund was the most preferred one and it was ranked highest with the mean garret score of 70.26 (Table 48). It was followed by stone pitched bunds (54.61) vegetative bunds (54.57), trenches (53.30) and terraces (51.20). These structures were preferred as these

structures had the twin advantages of soil management and increasing the moisture availability. In-situ moisture conservation pits (7) were least preferred as it involved high labour requirement. Agroforestry was ranked 6th, even though the awareness was high, because of the long gestation period and delay in realising the returns. Farmers opted for the investments that yielded immediate returns. Results obtained were in line with Adimassu, *et al.* (2013) whereas Tenge *et al.* (2011) obtained quite contrary results in the High lands of Africa region where farmers preferred terraces over the other methods. It might be due to the slope of the lands *i.e.* African highlands are less steep (500-1000m AMSL; Messerli, *et al.,* 1988) compared to Wayanad Hilly areas (700 and 2100m AMSL; CGWB, 2013). Earthen bunds over the terraces were preferred mainly to prevent landslides. The massive damage due to landslides in yester years might have prompted the farmers for the choice. Moreover, terracing needs higher investments than earthen bunds and it is difficult to implement it in the existing cropped areas.

Table 48. Relative preference for the soil and water conservation methods under ALT scheme

Sl No	Particulars	Total Score	Mean Score	Rank
1	Earthen Bunds	6323	70.26	1
2	Stone Pitched Bunds	4915	54.61	2
3	Vegetative Hedges	4911	54.57	3
4	Trenches	4797	53.30	4
5	Terraces	4608	51.20	5
6	Agro- forestry	3127	34.74	6
7	Moisture Conservation Pits	2955	32.83	7

4.3.13.2 DLT Scheme

Technical structures in Drainage Line Treatments scheme were check dam, streambank stabilization, farm ponds, coir geotextile, percolation ponds, spring water development and well recharge (Table 49). Stream Bank Stabilization (SBS) was most preferred by the respondents and it was ranked first with a mean garret score of 68.40.

SBS was followed by farm ponds (66.42), Check dams (57.26), spring water development (47.24), well recharge (43.04), coir geo textiles (35.78) and percolation ponds (32.14). SBS was preferred as it proved very effective in stopping the gully erosions. Farmers were experiencing land erosion along the sides of streams which resulted in cropped area. SBS also contributed to increasing the water availability in the farms. Structures like Coir Geo Textile were least preferred because of their low awareness and lack of demonstrations in the neighbourhood.

Table 49. Relative preference for the water conservation structures under DLT scheme

Sl No	Particulars	Total Score	Mean Score	Rank
1	Stream Bank Stabilization	6156	68.40	1
2	Farm Ponds	5978	66.42	2
3	Check Dam	5153	57.26	3
4	Spring Water Development	4252	47.24	4
5	Well Recharge	3874	43.04	5
6	Coir Geo Textile	3220	35.78	6
7	Percolation Ponds	2893	32.14	7

4.3.13.3 DMS Scheme

Among the structure listed under the Drought Mitigation Scheme, well recharge structure (through roof top water harvesting) was the most preferred one with mean garret score of 68.64 (Table 50). It was followed by logwood check dam (61.32), farm ponds (53.73), earthen bunds (52.86) and stream bank stabilization (47.70). Spring water development (29.68) structures were least preferred. Well recharge, check dam and farm ponds were showing satisfactory results than other structures. Hence, farmers preferred well recharge under the Drought Mitigation scheme to ensure water availability for domestic and irrigation purpose.

Table 50. Relative preference for the soil and water conservation structures of DMS scheme

Sl No	Particulars	Total Score	Mean Score	Ranking
1	Well Recharge	6178	68.64	1
2	Logwood Check Dam	5519	61.32	2
3	Farm Ponds	4836	53.73	3
4	Earthen Bunds	4757	52.86	4
5	Stream Bank Stabilization	4293	47.70	5
6	Stone Pitched Bunds	2997	33.30	6
7	Planting of Trees	2981	33.12	7
8	Spring Water Development	2671	29.68	8

4.3.13.4 WGDP Scheme

Among the structures under WGDP, respondents preferred earthen bunds as the most preferred one with the mean garret score of 71.20 (Table 51). It was followed by the stone pitched bunds (64.00), trenches (54.71) and farm ponds (50.32). Farmers preferred more of earthen bunds and stone pitched bunds to arrest the soil erosion which is a major problem and these conservation measures were comparatively cost effective also. Mechanisms like check dam and farm ponds needed higher investment and there are apprehensions that farm ponds will be taken over by village panchayats and make it as a public property. The farmer will be losing the ownership in that case. Hence respondents prefer to adopt earthen bunds and stone pitched bunds, that ensured private property rights. Whereas this scheme has taken efforts to implement more of check dams and farm ponds (respondents preference is less) to stop the gully erosions and to increase the water availability in the area hence even though farmers preferred to adopt stone pitched bunds and trenches, they were provided with check dams and farm ponds.

Table 51. Relative preference for the soil and water conservation structures of WGDP scheme

Sl No	Particulars	Total Score	Mean Score	Ranking
1	Earthen Bunds	6408	71.20	1
2	Stone Pitched Bunds	5760	64.00	2
3	Trenches	4924	54.71	3
4	Farm Ponds	4529	50.32	4
5	Check Dam	4227	46.97	5
6	Planting of trees	2967	32.97	6
7	Spring Water Development	2702	30.02	7
8	Irrigation Channels	2432	27.02	8

4.3.14 Factors influencing the adoption of soil and water conservation measures

The decision to adopt SWC in any farm is decided by demographic, social, economic and institutional factors. Study attempted to identify such influential factors that were impacting the adoption decision of respondents. The factors considered are age, education, occupation, family size, number of literate persons in the family, organization membership, social media contacts, land holding size, irrigation status before the SWC investment and knowledge on soil erosion. The analysis was done separately for the four schemes and for the pooled data (Table 52) using ordered probit method in IBM SPSS Software 22.

Age and education levels of the respondents, family size and number of literate persons in the family and knowledge in soil erosion influenced the decisions to adopt the SWC in all the cases irrespective of the scheme. Organizational membership also influenced the decisions making, except in the case of WGDP scheme.

Age of the respondents as proxy for the experience and educational level, naturally exert a profound influence on decision making as it help in identifying the

problem, its impacts and possible remedies. Family size is seen to favour the investment as it is indirectly increasing the demand for domestic water supply. It is also possible that number of earning members are also more in such cases. As number of educated persons are more, higher knowledge and exposure may be influencing scientific decision making. There can be instances wherein they also contribute to investment, if they are earning members. Organizational membership is capable of exerting the demonstration effect, knowledge build-up and peer group pressure, thus facilitating the adoption. However, the effect is not strong enough among the DLT group. This may be due to the flows in organizing the group meeting or poor participation. The knowledge on the ill effects of soil erosion, naturally exerts a positive effect on SWC adoption. Irrigated area is not a major factor in decision making. More than irrigation, it may be the drinking water availability and prevention of soil erosion that are impacting the decision. Sudha and Sekar (2015) identified age, education, experience, family size and farm size as the significantly contributing factors for the adoption of SWC structures in the Hilly zone of South India. Moges and Taye (2017) identified education, land holding, ownership, extension contacts as the important factors in adopting the SWC structures in Ethiopia.

Table 52. Factors influencing the adoption of soil and water conservation measures

Sl No	Particulars	ALT	DLT	DMS	WGDP	Pooled
1	Age	0.025***	0.051**	0.027***	0.043**	0.027***
2	Education	0.496***	0.848***	0.421***	0.826***	0.421***
3	Occupation	-0.201	-0.216	-0.097	-0.133	-0.097
4	Family size	0.174***	0.304***	0.164***	0.216**	0.164***
5	Number of Literates in the Family	0.395***	0.462**	0.376***	0.510**	0.376***
6	Organizational Membership	0.032*	0.278*	0.124*	0.155	0.124**
7	Total Land Holding	-0.174	-0.007	0.099	0.002	0.099
8	Area Under Irrigation Before adoption	0.026	0.171	-0.013	0.199	-0.013
9	Knowledge on Soil Erosion	1.678***	2.960**	1.921***	1.988*	1.921***

*** indicates the significance at 1%, ** indicates significance at 5% and * indicates significance @ 10%

4.4 Farmers' perceptions on effectiveness of SWC measures

Perception is the ability of a person to see, listen and to become aware of something new and is the way in which something is viewed, assumed or inferred. According to Daniel (2011) "Perception is the organization, identification, and interpretation of information in order to represent and understand the presented sensory information or environment". Farmers views about a new technology plays a major role in making the decision for adopting the new technology. Hence, the perception of respondents on impact of SWC measures, usefulness, sources of information on agriculture/SWC *etc.* were collected and are presented from Table 53 to 61.

4.4.1 Opinions of the farmers on usefulness of the SWC measures

The benefits of the SWC measures were listed based on the literature review and discussion with experts. Farmers were asked to respond to the statements and details are as follows (Table 53).

69 per cent respondents were of the opinion that SWC measures were successful in decreasing the soil erosion on their fields. Among the schemes considered ALT scheme (81%) and WGDP scheme (78%) were more popular among the respondents for conserving the soil and water. Structures under DLT scheme (62%) and DMS scheme (55%) were not successful as that of ALT and WGDP.

Around 62 per cent of the respondents have acknowledged the improvements in ground water level due to SWC measures. Increase in the ground water was highest in DMS scheme because all the mechanisms implemented were for the water conservation which in turn supported ground water level, especially Rooftop water harvesting method. Respondents of DLT scheme (55%) less number of people have opined that there was an increase in the ground water level because beneficiaries were distributed in different altitudes from the structures.

About 76 per cent of the respondents have told that they have noticed the increase in the yield levels. Most farmers (89 per cent) of the WGDP scheme endorsed the statement while there was slight variation among different schemes. 62 per cent of

the respondents have felt that there was an increase in the fodder availability. Majority respondents of ALT and DMS schemes were supporting the statement.

About 70 per cent of the farmers have opined that there was an increase in the on farm employment opportunities because of the adoption of SWC. Results obtained by individual schemes showed that WGDP scheme (79%) has highest number of respondents who accepted that there was increase in the employment and DMS respondents were lower (61%).

Respondents of ALT scheme have opined that fodder availability (87%), decrease in soil and water erosion (81%), increase in the yield (72%) and increase farm employment (71%) were the major benefits of the SWC measures. The respondents of DMS perceived that benefits received by them were lesser when compared with other schemes because it was recently launched scheme and it has not yet stated to yield the proper benefits.

Table 53. Opinion about the usefulness of the soil water conservation structures by the respondents (in percentage)

Sl No	Particulars	ALT	DLT	DMS	WGDP	Total
1	Decreased soil and water erosion	81.00	62.00	55.00	78.00	69.00
2	Increase in ground water level	63.00	55.00	71.00	57.00	62.00
3	Increase in yield	72.00	81.00	62.00	89.00	76.00
4	Increase in the availability of fodder	87.00	54.00	42.00	64.00	62.00
5	Increase in farm employment	71.00	68.00	61.00	79.00	70.00

4.4.2 Farmers opinions about the impact of SWC measures on different farming aspects

Farmers were asked about their opinion on the effects of SWC on the farm operations such as cropping pattern, level of inputs used, improved planting (Table 54). Around 86 per cent of the respondents in the study have accepted that there was a change in the cropping pattern after the adoption of SWC measures. The respondents

of DLT scheme (96.00%) and WGDP schemes (93.00%) have endorsed the positive changes in the cropping pattern which was due to increase in the water availability. The cropping pattern was shifted from vegetables to Banana or cash crops like ginger or perennial crops like rubber and cropping intensity has increased. More respondents in DLT (96%), WGDP scheme (93%), and ALT scheme (71%) have endorsed the positive change in the cropping pattern and cropping intensity. Only 32 per cent of the people has reported change in farms in DMS scheme as it is mostly implemented in the existing cropping areas and was a new scheme, respondents yet to realize the appropriate results.

The changes in management practices in the farms as reflected in the input use was assessed based on their responses. 37 per cent of the respondents have improved their input use pattern which was more in DLT scheme *i.e.* 52 per cent of the respondents in DLT scheme have used the higher inputs.

75 per cent of the respondents have increased the planting of perennial crops like coffee, pepper and arecanut after the adoption of SWC measures. Planting was more in ALT scheme (91%) whereas in DLT scheme it was only 62 per cent.

The adoption of water saving technologies are rather low, despite the scarcity situations. Only 14 per cent of the respondents have opined on establishing water saving methods like drip irrigation and sprinkler irrigations. Even though water scarcity is increasing over the time respondents were not aware of droughts since, they thought that the drought could occur only in the dryland regions but not in the humid region like Wayanad.

The adoption of SWC measures are not expected to impact the harvesting methods (04 %) and post-harvest technologies (07 %). Most of the respondents were not aware of farm level post-harvest technologies.

Table 54. Opinions of the farmers on impact of soil and water conservation structures on different cropping aspects (in percentage)

Sl No	Impacts	ALT	DLT	DMS	WGDP	Total
1	Change in cropping pattern	73.00	96.00	32.00	93.00	86.00
2	Change in the input level used	26.00	52.00	18.00	43.00	37.00

3	Improved replanting	91.00	62.00	9.00	79.00	75.00
4	Adoption of water saving methods (micro irrigation)	9.00	12.00	8.00	16.00	14.00
5	Change in the Harvesting methods	0.00	3.00	0.00	6.00	4.00
6	Post-harvest technologies adopted	0.00	9.00	0.00	7.00	7.00

4.4.3 Sources of technical information related to soil and water conservation structures

Respondents were depending on the various sources for the information on soil and conservation in the study area. Data on the information sources were collected and depicted in the Table 55. Respondents were depending equally on the Government offices (24%) and Village watershed committees (24%) for the information. These sources of information were also supported by NEWS papers/periodicals (08%) and Neighbours (06%). The dependency was more on the sources like Watershed committee and government offices because they were the implementing agencies.

Table 55. Sources of technical information related to soil and water conservation structures (in percentage)

Sl No	Source	ALT	DLT	DMS	WGDP	Total
1	Neighbours	8.00	7.00	4.00	5.00	6.00
2	Government Office	26.00	25.00	22.00	25.00	24.00
3	Watershed committee	22.00	25.00	21.00	29.00	24.00
4	NEWS Paper/ Periodicals	9.00	7.00	8.00	9.00	8.00

4.4.4 Sources of agricultural related information

Major sources of agrirelated information are Krishi Bhavans, Agricultural Universities, neighbours or print and other mass media (Table 56). The respondents were asked to state the source of information on SWC. 26 percent of the respondents were in touch with RARS and KVK(KAU) for the information, which was followed by Krishi Bhavans (25%) NEWS papers (09%) and the neighbours or friends (11%). Farmers of Sultan Batteri *i.e.* in and around Amabalawayal were only visiting the ARS

and KVK (26%). Farmers generally visit the Krishi Bhavans mainly for agri inputs and subsidy payments and seek technical information during that visits.

Table 56. Sources of technical information related to farming activities (in percentage)

Sl No	Source	ALT	DLT	DMS	WGDP	Total
1	Neighbours	10.00	8.00	15.00	9.00	11.00
2	Krishi Bhavan	30.00	22.00	21.00	26.00	25.00
3	NEWS Paper	10.00	9.00	7.00	9.00	9.00
4	ARS/KVK/SAU	27.00	25.00	22.00	28.00	26.00

4.4.5 Constraints faced by the respondents

Respondents have faced many constraints while adopting the soil and water conservation measures and after the adopting the structures. Constraints faced by respondents are listed in the Table 57. The major constraint was reported as limited knowledge about the SWC structures. Small land holding size (2) was another constraint faced by the respondents especially in the schemes which consisted of farm ponds. Limitations like lack of capital for the investment (3), lack of labour available for construction works (4), lack of extension support (5) and difficulty in availing the subsidy (6) were also reported by the respondent farmers. Results of individual schemes were also similar to the overall results except in WGDP scheme which has slight variation in the result. During the post investment period, no major constraints were reported. Around 15 farmers have said that in case of earthen bunds, stone pitched bunds and trenches the row spacing is considered harmful to the pepper wines as it is believed to cause quick wilt disease.

Table 57. Constraints faced by respondents while adopting the structures (Ranking)

SL No	Particulars	ALT	DLT	DMS	WGDP	Overall
A	**Constraints faced while adopting**					
1	Limited knowledge about the SWC structures	1	1	1	1	1
2	Required huge investment	2	3	2	3	3

3	Difficult to adopt because of the smaller land holding	3	2	3	2	2
4	Shortage labours	4	4	4	5	4
5	No extension support service	5	5	5	4	5
6	Difficulty in availing subsidy	6	6	6	6	6

4.4.6 Externalities of SWC measures: Effect on the neighboring Farms

Externalities are the consequences of the activities of any individual on the other individuals of the same environment or ecology and are not compensated. Baumol and Oates (1998) and Sundqvist (2004) defines externality as "Un-priced, unintentional and uncompensated side effect of one agents action, that directly affects the welfare of another". The impacts of SWC investments are not limited to the investor alone. The public gains of SWC measures are manifested mainly as improvements in ground water table.

81 percent neighbouring farmers opined that implementation of SWC measures in the neighbouring farm has helped them by increasing the soil moisture (Table 58). Opinions of the respondents from different schemes were similar except the DMS scheme (67%) which was less. The well recharge method of water conservation naturally does not affect considerable effect to the neighbouring farms.

About 75 per cent of the farmers (downstream) have opined that the silt accumulation has reduced in their field since movement of silt was trapped by the SWC measures adopted by their neighbouring upstream farmers. The effect was more under the ALT (81%) and WGDP (80%) schemes since structures adopted in the scheme were mostly suitable for avoiding the soil runoff. Hence, neighbours of ALT and WGDP scheme has benefited more than the other schemes. Only 58 per cent of the neighbours have said DMS scheme helped them by stopping silt accumulation and it was lowest among the DMS schemes since, well recharge method of water conservation in DMS has no role in soil conservation.

About 40 per cent of the neighbours stated that adoption of soil and water conservation by their neighbours have helped to achieve increased yield in their farms. About 33 per cent of the neighbours have opined generation of higher employment in their farm.

About only 44 per cent of the neighbours have felt that the demonstration effect has motivated them to adopt SWC measures in future. DMS scheme was most preferred because the scheme has implemented structures with more directly visible impacts viz., rooftop mechanisms where roof water harvested was diverted into open wells, which made the open wells to even overflow in rainy season.

Table 58. Opinion on benefits received by the neighbors from the soil and water conservation measures (in percentage)

Sl No	External Effects	ALT	DLT	DMS	WGDP	Total
1	Increase in moisture level	85.00	86.00	67.00	86.00	81.00
2	Decrease in silt accumulation	81.00	79.00	58.00	80.00	75.00
3	Increase in water level	69.00	81.00	85.00	74.00	77.00
4	Yield increase	46.00	40.00	26.00	39.00	40.00
5	Increase in farm employment	34.00	30.00	26.00	30.00	33.00
6	Motivated to adopt SWC measures	46.00	37.00	50.00	43.00	44.00

4.4.7 Contingent valuation method (CVM)

Contingent Valuation Methods (CVM) is the most widely used methods for the estimation of use and non-use values. It is based either directly or indirectly on the estimation of Willingness to Pay (WTP) for the services received by the ecosystem. WTP is the maximum amount a person is prepared to pay for the given quality of goods or services (Kalish and Nelson, 1991; Kohli and Mahajan, 1991). Methodology for determining the WTP for Soil and Water Conservation Measures was adopted from Gulati and Rai (2015) with slight modifications according to the requirements of the study and answers of respondents were compiled and presented in the Table 59.

On an average 83 per cent of the respondents were ready to pay for the adoption of soil and water conservation measures *i.e*. 300 respondents out of 360 were ready to pay. Respondents were ready to pay about 21.37 per cent of the total cost expended for implementing SWC structures. Respondents were ready to pay since, there was an increase in the yield levels, reduction in the soil erosion (Table 60). The 17 per cent of the respondent were not ready to pay since, they were felt that implementation of SWC measures was the duty of Governments (Table 61).

Among the Schemes considered results were similar in all the schemes except in the DMS scheme since, it was newly implemented scheme and was not yet started yielding the complete benefits hence per cent of WTP was lesser in the scheme. Respondents ready to pay were highest for the ALT scheme and WGDP scheme because they were the one who got complete benefits and structure were implemented effectively.

Respondents were asked to indicate the percent of share they were ready to bear in the total cost, on an average farmers were to pay around 21 per cent in the total cost. Among the schemes implemented respondents of DLT scheme were ready to pay more *i.e*. 25 per cent. It was followed by WGDP scheme (22.41%) and ALT scheme (19.74%). Respondents of DLT and WGDP scheme were ready to pay more, because benefits derived from the adoption of SWC were more visible in these schemes *i.e.* water availability, cropping pattern fodder and *etc.*

Most of the respondents were ready to pay in a single instalment (79.00 %) and about 21.00 per cent of them were said that they would like to pay in two instalments. Respondents who wanted to pay in two instalments were mostly from the DLT scheme and WGDP scheme because the initial expenditure was high under these schemes.

Table 59. Willingness To Pay (WTP) for the soil and water conservation measures

Particulars	Frequency	ALT	DLT	DMS	WGDP	Overall
Numbers	No	14 (15.56)	16 (17.78)	19 (21.11)	11 (12.22)	60 (16.67)
	Yes	76 (84.44)	74 (82.22)	71 (78.89)	79 (87.78)	300 (83.33)

	Total	90 (100.00)	90 (100.00)	90 (100.00)	90 (100.00)	360 (100.00)
Instalment	Single	66 (86.84)	53 (71.62)	59 (83.10)	59 (74.68)	237 (79.00)
	Two	10 (13.16)	21 (28.38)	12 (16.90)	20 (25.32)	63 (21.00)
	Total	76 (100.00)	74 (100.00)	71 (100.00)	79 (100.00)	300 (100.00)
Percentage of WTP		19.74	24.99	18.21	22.41	21.37

4.4.7.1 Reasons for willingness to pay for SWC measures

Respondents who were ready to pay were asked to tell what made them to be ready to pay more for adoption soil and water conservation measures and reasons were enlisted in the Table 60.

About 88 per cent of the respondents were said that they were ready to pay because there was an increase in the soil moisture or water availability in the farm. About 69 per cent of the respondents were accepted that they were ready to pay because they felt that soil and water conservation as their responsibility. About 68 per cent of the respondents were ready to pay because they got increase in the productivity and 65 per cent of the respondents said that amount was affordable hence they were ready to pay. Similar results obtained across different schemes.

Table 60. Reasons for willingness to pay for the soil and water conservation activities (in percentage)

Sl No	Reasons	ALT	DLT	DMS	WGDP	Total
1	Increased in soil moisture/ Water availability	87.00	89.00	87.00	88.00	88.00
2	Helps in achieving the higher productivity	62.00	71.00	62.00	78.00	68.00
3	Soil and water conservation are responsibility	69.00	71.00	63.00	73.00	69.00
4	Amount is affordable	60.00	63.00	65.00	73.00	65.00

Summary

5. SUMMARY

Climate change is expected to increase stress on water resources which impacts the agricultural production and farmers' livelihoods. High latitude and tropical regions are more vulnerable to climate changes where warming up of these regions is taking place at the faster rate along with the increased number of droughts and temperature effects. Wayanad is one such district in Kerala with the altitude ranging between 700 to 2100 meters and is declared as one of the hot spots of climate change in the State. Soil and water conservation(SWC) measures assumes significance in such situations where the gradient, land use and rainfall factors facilitate top soil loss and is considered as one of the major adaptation strategy to address the problem. The state efforts to propagate the soil and water conservation measures in the district was initiated during 1993. The major schemes are Arable Land Treatment (ALT), Drainage Line Treatment (DLT), Drought Mitigation Scheme (DMS) and Western Ghats Development Scheme (WGDP). This study was taken up to understand various dimensions of SWC measures implemented in Wayanad. The specific objectives were

1. to analyse the institutional credit flow towards soil and water conservation investments in Kerala
2. to assess the household level investment on soil and water conservation
3. to assess the farm level economic viability and efficiency of such investments
4. to understand the local preferences for soil/water conservation methods, and
5. to understand the farmers' perceptions on effectiveness of conservation measures

The SWC activities in Wayanad District was implemented under four major schemes viz., Arable land treatment, Drainage line treatments, Drought Mitigation and Western Ghats Development Project. The study was based on both Primary data and secondary data. Secondary data on institutional credit support to SWC activities was compiled from various official/published sources.

The samples for the primary data were identified based on the multistage random sampling method, from the sampling frame of farmers who have adopted the SWC measures, sourced from Dept. of Soil and Water Conservation, GoK and NGO's. Among the various structures implemented under each scheme, 3 important structures from each scheme were selected based on the number of structures implemented. 30 beneficiaries (10 beneficiaries * 3 structures) were selected from each scheme and 120 beneficiaries (30 * 4 schemes) from each taluk, thus making a total sample of 360 farmers (30 beneficiaries * 4 schemes * 3 taluks) (Fig 2). One neighboring farmer to the respondent was interviewed to the find out externalities received by the adjacent farmers because of the adoption of SWC structures. The data was collected through personal interview method employing structured pretested interview schedule, during Feb-March 2019. The analysis was done using appropriate statistical tools. Major findings are:

- The institutional credit support to agriculture sector in Kerala was 67,089 crores (2017-18) which grows at 15.11 per cent per annum during the period 2006-07 and 2017-18. Commercial Banks, State Co-op. Banks, KSCARD's and Regional Rural Banks were the major agencies involved. Nearly three fourth of the total amount is disbursed as crop loans and rest as term loans (2017-18). Growth rate of the term loans (20.22%) was higher than crop loans (13.43%) and total credit lending rate (15.11%). Higher growth rate in the term loans indicates the increasing importance towards capital formation in agriculture
- NABARD refinance to agriculture was 10,024.29 crores (17-18) in which Regional Rural Banks enjoyed one third share, followed by Commercial Banks (27.58 %) and State Co-operative Banks (26.72 %). KSCARDB's received only 12.42 per cent though they are the prime agency intended to supply long term credit to agriculture.
- The refinance support to agriculture increased at the rate of 17.87 per cent and that to commercial bank was increasing at the fastest rate of 21.63 per cent, followed by Regional Rural Banks (20.32%) and KSCARDB's (14. 06%). With a higher share of 33 per cent and faster growth in refinance support RRB's are reflecting their active presence in agriculture finance in the state, though co-operatives together (SCB and PCARDB's) accounted for 40 per cent share.

- In the purpose wise refinance, Non-Farm Sector was enjoying nearly two thirds of the refinance support (61.43 %) and in Farm sector, Plantation and Horticulture (12.06%), Land development (10.31%) and minor irrigation (5.18%) activities were the major ones. Sheep Goat and Piggery (SGP) sector has been retaining the maximum (87%) share over the years, followed by NFS (68%), fisheries (66%) and SG/MY (65%).
- Institutional credit flow to the agricultural sector in Wayanad has seen a growth rate of 18.97 per cent and in 2017-18 the district received 2469.89 crores. Major share of credit support was from commercial banks (51.83), followed by Co-operative banks (27.79 %) and RRB's (19.70%). Of the total credit supply 86.40 per cent was distributed as crop loans whereas growth rate in Short Term Loan (STL) is lower than the Term Loan (TL). It is a welcome sign, considering the importance of capital formation in agriculture in Wayanad.
- Commercial Bank financing to agriculture was growing at the rate of 24.20 per cent per annum, mainly for crop production loans (STL) (88.93 %). Co-operative banks (PACS/SCBs) have disbursed 686.49 crores for crop production purpose which increased at 11.69 per cent per annum. RRB's distributed 486.48 crores. The growth is term loans was at a high 57.70 per cent. PCARDB has disbursed 16.73 crores mainly as investment loan to the agricultural sector growing at the rate of 31.61 per cent per annum.
- The Soil and Water Conservation (SWC) programme in Wayanad assumes significance in view of the climate change impacts, the district being highlighted as the hot spot of climate change. Rainfall analysis of the district for 37 years (1983 to 2019), revealed that in only in three years there was above normal rainfall. One year was severely drought affected, 10 years were medium drought affected and 23 years were mild/no drought years
- The micro level study on SWC was done based on 360 numbers of sample respondents. In the post classification, Marginal Farmers (62.22%) were high followed by 36.39 per cent small farmers and 1.39 per cent medium/large farmers. Average holding size of the respondents was 0.94 ha.
- Most of the respondents were middle aged (58.33 %) and the average age of the respondents was 52.91 years. One third respondents completed the 10th

standard education (30 %). The households were mainly nuclear families (86.11 %) Agriculture was the main source of income for 73.89 respondents.

- Though, an average 60 per cent respondents were members in social groups, the participation rate was limited. They were not very active in social media and WhatsApp was the most used one (22.13%).
- Nearly 75 per cent of the respondents depended on open wells for irrigation and 25 per cent on farm ponds. Usually farmers begin irrigation by the month of January and continue till late may *i.e*. till monsoon starts but majority (54 per cent) of them could irrigate only during January – February.
- The SWC measures in the district were implemented under four major schemes viz., Arable Land Treatments (ALT), Drainage Line Treatments (DLT), Drought Mitigation Scheme (DMS) and Western Ghats Development Programme (WGDP).
- Average investment on the structures under Arable land treatment Scheme was 26,188/ha, in DLT scheme it was 4,38,048/structure, in DMS 2,19,084/structure and in WGDP 3,13,548/structure. On an average, the SWC amounted to 3,49,217/structure.
- The SWC, on an average attracted an investment of 2,49,217 per household. Overall, nearly 50 per cent (177) of the respondents have adopted SWC structures on individual basis and have paid a share of 10 per cent at the rate of 24,922/household. About 40 per cent (142) of the respondents have adopted SWC on group basis and have paid a share of five per cent of the cost *i.e*. 12,461/household. Around 11 per cent stated that they have paid more than 10 per cent
- Impact of SWC measures on cropping pattern, productivity, production and farm income were assessed comparing it with the situation before the investment. The SWC measures have facilitated mainly the area expansion of ginger (56.94%), banana (38.53%), rubber (32.71%) and turmeric (31.65%) replacing vegetables (-57.33%), tapioca (-44.63%) and rice (-5. 03%). Black pepper the traditional spice crop of the area has not registered significant increase (0.04%) Excepting banana, the area expansion is in non-food crops.

- The significance of SWC measures is evident through the positive effect on productivity in all the crops. Coffee observed 55.08 per cent increase followed by arecanut (51.29%), pepper (42.59%), tapioca (31.49%), banana (31.24%) and vegetables (25.60%). Increase in the productivity of crops was mainly due to the increase in moisture and irrigation water availability at the critical times and supported by reduction in the soil erosion problems. Despite replacement of tapioca and vegetables, the productivity of these crops have improved. The improvements in productivity of pepper may help the farmers to revive the crop through appropriate SWC measures.
- The significant area expansion and productivity gains in ginger, banana, rubber and turmeric has translated into substantial production gains (95.24% in ginger, 81.80% in banana, 64.77% in rubber, 49.60% in turmeric). The coffee and black pepper production could also gain (58.05%, 42.65%), through productivity improvement, though area expansion was limited. However, the productivity improvements in the vegetable and tapioca cultivation couldn't offset the area loss and the production has declined by 45 per cent and 27 per cent respectively. This is to be viewed seriously as the state is trying to ensure the food security through boosting the food production.
- The production gains could be translated to higher farm income to the tune of 45.61 per cent, the major increase being from ginger (95.24%), banana (81.80%), rubber (64.77%) and turmeric (49.60%) cultivation. The income from coffee and black pepper has also improved considerably. Obviously, the returns from vegetable and tapioca has declined as these crops registered a decline in production. SWC investments help the farmers improve their farm income by the 45.60 per cent. There was little variation on these aspects, among the schemes.
- The estimation of costs and returns of major crops, under different SWC investment schemes were done. All the major crops (coffee, pepper, arecanut and banana) performed well with positive indicators of financial viability and efficiency. The relative economic performance with respect to net returns was in the order of arecanut (□ 4,24,074/ha), banana (□ 3,42,202), coffee (□ 2,73,365/ha) and black pepper (□ 1,86,929/ha). The efficiency of investment as indicated by the BC ratio was in favor of arecanut (5.55) followed by coffee

(3.96), banana (3.53) and black pepper (3.26). Despite comparatively high returns from arecanut (□ 4,24,074/ha) and coffee cultivation (□ 2,73,365/ha), the area expansion in these crops were very limited. Banana cultivation despite highest cost structures occupied second position with respect to net returns (Cost A1). The farmer choices, while the water availability improve are generally towards economically viable annual/seasonal crops. Banana (Nendran) variety is considered as one of the most preferred crop, under irrigated condition, which yields returns in 10 months.

- SWC is expected to improve the water availability and irrigation. Resource use efficiency analysis was done to assess whether it has contributed significantly to the returns. The results confirmed that irrigation has significantly contributed to the returns in arecanut, coffee and pepper. Banana Cultivation is generally done where irrigation is assured and the additional gain through banana cultivation is through area expansion, rather than irrigation.
- The economic viability of SWC investments is estimated to assess the economic worthiness of the investment as it involves substantial part of public money. The analysis was attempted taking the level of SWC investment as the cost and additional revenue as returns. The economic life of respective structures in each scheme was the basis for duration of cash flow. The NPW of the investment was positive in all the schemes and averaged at □ 3,02,792/farm. DLT scheme was proved to be the best in terms of NPW. The efficiency in investment as measured by BC ratio was highest in ALT (9.37) which averaged at 2.33, thus confirming the economic efficiency of the investment. IRR averaged at 28 per cent, which is significantly higher than the opportunity cost of capital (interest on fixed investments). ALT scheme performed best. The analysis justifies the social investment of SWC, as it leads to higher production and returns which supports the agricultural profession and welfare of the farmers. Better returns in agriculture can trigger the interest in sector among youth.
- The impacts of SWC measures on farm diversification was assessed through the increase in livestock population. There was 62.48 per cent increase in number of cows in the post adoption period followed by 30.77 per cent increase of goats, 10.77 per cent increase in the sheep and 51.67 per cent increase in the poultry birds. The households in WGDP scheme (72.57%) maintained the highest

number of cows. This was possible due to the increase in farm grown feed supply, as evidenced by the increase in consumption of green fodder to the extent of 151.90 per cent. Higher farm income must also have resulted in the supply of purchased feed concentrates which have increased to an average of 30.95 per cent. This was reflected in the increased (11.87 %) number of milking days and milk yield (18.33 %).

- The tree diversity (fruit trees and forest species) in the farms have also improved at an average 28.74 per cent and 6.56 per cent respectively.
- There was improvement in ground water level. The depth of water table from ground in kharif was decreased by 30.99 per cent and in rabi by 28.69 per cent and in summer by 23.20 per cent.
- There was an increase of 20.67 human days/household/year in the employment generated from the own farm and 11.23 per cent increase in the employment generated from the livestock management.
- Respondents have reduced their credit seeking by an average of 12.57 per cent and among the schemes, credit seeking behaviour was reduced at ALT farmers (-17.16%) followed by WGDP (-13.76%).
- Among the different conservation measures under the ALT, earthen bund was the most preferred one and it was ranked highest with the mean garret score of 70.26. It was followed by stone pitched bunds (54.61) vegetative bunds (54.57), trenches (53.3) and terraces (51.20).
- In DLT scheme, Stream Bank Stabilization (SBS) was most preferred by the respondents and it was ranked first with a mean garret score of 68.40. SBS was followed by farm ponds (66.42), Check dams (57.26), spring water development (47.24), well recharge (43.04), coir geo textiles (35.78) and percolation ponds (32.14).
- Among the structure listed under the Drought Mitigation Scheme, well recharge structure (through roof top water harvesting) was the most preferred one with mean garret score of 68.64. It was followed by logwood check dam (61.32), farm ponds (53.73), earthen bunds (52.86) and stream bank stabilization (47.70).

- Under WGDP scheme, respondents preferred earthen bunds as the most preferred one with the mean garret score of 71.20. It was followed by the stone pitched bunds (64.00), trenches (54.71) and farm ponds (50.32).
- The decision to adopt SWC in any farm is decided by demographic, social, economic and institutional factors. Age, education levels, family size and number of literate persons in the family knowledge about soil erosion influenced the decision to adopt the SWC, in all the cases irrespective of the scheme. Organizational membership also influenced the decisions making except in the case of WGDP scheme.
- SWC measures have also benefitted the neighbouring farms, through the positive externalities. Neighbours of the respondents have opined that, there was an increasing the moisture (86 % neighbours), reduced silt accumulation (75 %) and increased yield (40 %) and employment level (33 %). About only 44 per cent of the neighbours have felt that adoption of SWC measures have motivated them to adopt SWC measures in future.
- About 69 per cent of the respondents have opined that the SWC measures adopted by them were successful in decreasing the soil and erosion on their fields. Among the schemes considered ALT scheme (81%) and WGDP scheme (78%) were more popular among the respondents for reducing the soil and water erosion. The improvements in water table has also been acknowledged.76 per cent respondents have noticed the increase in the yield levels. 62 per cent of the respondents have felt that there was an increase in the fodder availability after the adoption of soil and water conservation measures.70 per cent of the farmers have opined that there was an increase in the on farm employment opportunities. 86 per cent respondents stated change in the cropping pattern and 37 per cent have effected changes in input use pattern. 75 per cent of the respondents have increased the intensity of replanting of perennial crops like coffee, pepper and arecanut. However, only 14 per cent have said to be adopted the water saving methods like drip irrigation and sprinkler irrigations.
- The major source of information on SWC measures were Government offices (24%) and Village watershed committee (24%) followed by NEWS papers/periodicals (08%) and Neighbours (06%).

- Limited knowledge about the SWC structures was reported as the major constraint in the adoption of SWC. Smaller land holding was a constraint especially in schemes which consisted farm ponds. Other constraints include lack of investment source (3), lack of labour available for construction works (4), lack of extension support (5) and difficulty in availing the subsidy (6).
- Respondents were ready to pay about 21.37 per cent of the total cost expended for implementing SWC structures. Most of the respondents were ready to pay in a single instalment (79.00 %) and about 21.00 per cent of them said that they would like to pay in two instalments.
- About 88 per cent of the respondents were ready to pay because there was an increase in the soil moisture. About 69 per cent of the respondents were ready to pay because they felt that soil and water conservation as their responsibility. About 68 per cent experienced increase in the productivity and 65 per cent were of the opinion that the amount was affordable to them.

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Annexures

ANNEXURES

Annexure 1: Survey Questionnaire

KERALA AGRICULTURAL UNIVERSITY, THRISSUR
_____COLLEGE OF AGRICULTURE, VELLANIKKARA_____

"Interview schedule"

on

"Analysis of soil and water conservation investments in Kerala and farm level financial gains"

Disclaimer: This information is gathered for the purpose of research work of the PhD programme in KAU and the data will be used only for the said purpose.

Schedule No._____
Date._____
Village:_____ Block_____ District: Wayanad

1. GENERAL INFORMATION

2. Name: _____ Age: _____Education: _____
3. Village: _____ Taluk: _____ District: _____
4. Family type: Nucleus/ Joint
5. Occupation: Main: _____Subsidiary: _____
6. Association with Social organization: VP/NGO/SHG/Water use groups/ZP/TP
7. Community: General/SC/ST/CatI/OBC
8. Annual Family income:

Main Occupation. _____Subsidiary Occupation. _____Total. _____

1.1. Family composition: Number of Family members: _____ Male: _____Female: _____

Sl. No	Name	Sex	Age	Education	Occupation	Approx. Income/ Month
1						
2						
3						
4						
5						

1.2 Land Holdings:

Area: Acre **Type of Soil**: _____

Sl No	Particulars	Total	Rain fed	Irrigated	Net cultivated area
1	Owned				
2	Leased in*				
3	Leased out*				
4	Permanent fallow				
5	Total				

*If Leased in rent paid (Rs/ac/yr): _____If leased out, rent received (Rs/ac/yr): _____ Value of land (Rs/ac):

Dry land_____ Wetland: _____ Fallow land_____

1.3 Sources of Irrigation

Sl No	Sources	Area irrigated (Ha)		
		Kharif	Rabi	Summer
1	Open Well			
2	Bore well			
3	Canal			
4	Tank			
5	Farm pond			
6	Other			

1.4 Social Participation

Sl. No.	Organization	Member/ Office bearer	Extent of participation		
			Regular	Occasional	Never
1	Gram Sabha				
2	Taluk Panchayat				
3	Zilla Panchayath				
4	Farmers union				
5	Youth club				
6	Cooperative society				
7	Watershed Committee				
8	Self-help groups				
9	Any other (specify)				

1.5 Social Media Participation

Sl. No.	Organization	Access Through	Extent of participation		
			Regular	Occasional	Never
1	Gmail				
2	Facebook				
3	What's App				
4	Facebook Messenger				
5	Skype				
6	Instagram				
7	YouTube				
8	LinkedIn				
9	Viber				
10	Snapchat				
11	Telegram				
12	Tinder				

1.6 Awareness on the problems of Soil erosion/ill effects of not adopting the SWC Measures

	Particulars	Awareness

Sl. No		Low	Medium	High
1	Removes of top fertile soil			
2	Formation of soil cakes/Soil compaction			
3	Leads to loss of nutrients			
4	Reduced organic matter			
5	Poor Drainage/infiltration			
6	Affects the Plant growth			
7	Soil acidity			
8	Long term erosion			
9	Siltation of reservoirs in ponds/water sources			
10	Flooding of down streams			
11	Hindrance for tillage operation			
12	Reduce land value			

1.7 Preference for SWC measures for adoption in the field

Sl. No	Particulars	Rank
1	Contour bunding	
2	Deep ploughing	
3	Farm pond	
4	Field bund (Mtr)	
5	Inter cultivation	
6	Levelling	
7	Rubble filled check	
8	Stubble mulching	
9	Vegetative barrier	
10	Waste weir	

1.8 Soil and Water Conservation Measures adopted

Sl. No	Particulars	Unit (Size/ Length)	Economic life (Years)	Establishment			Annual Maintenance			Functional or Non-functional	Reason
				Year	Area	Cost	Year	Area	Cost		
1	Field bund (Mtr)										
2	Stubble mulching										
3	Inter cultivation										
4	Waste weir										
5	Levelling										
6	Vegetative barrier										
7	Deep ploughing										
8	Rubble filled check										
9	Farm pond										
10	Contour bunding										

1.09 Sources and expenditure of SWC measures implementation

Sl. No.	SWC Measures	Total Amount	Own	Govt. Scheme/ Subsidy
1	Contour bunding			
2	Deep ploughing			
3	Farm pond			
4	Field bund (Mtr)			
5	Inter cultivation			
6	Levelling			
7	Rubble filled check			
8	Stubble mulching			

1.10 Classification of own funds used for the adoption of SWC measures

Sl No	SWC Measures	Savings		Loan	
		Farm	Non-farm	Formal	Informal (Friends and relatives)
1	Contour bunding				
2	Deep ploughing				
3	Farm pond				
4	Field bund (Mtr)				
5	Inter cultivation				
6	Levelling				
7	Rubble filled check				
8	Stubble mulching				
9	Vegetative barrier				
10	Waste weir				

1.11 Expenditure on Annual Maintenance

Sl No	SWC Measures	Frequency				Amount
		6 Months	One Year	2 Years	3 Years	
1	Contour bunding					
2	Deep ploughing					
3	Farm pond					
4	Field bund (Mtr)					
5	Inter cultivation					
6	Levelling					
7	Rubble filled check					
8	Stubble mulching					
9	Vegetative barrier					
10	Waste weir					

1.12 Motivation to adopt the SWC measures in the land

Sl. No.	Factors	Rank
1	Increase in yield	
2	Increase in the profit margin	
3	It needs lesser labour	
4	Avail free inputs/subsidy	
5	Increases the quality of crop	
6	Increase in the on-farm employment	
7	Needs lesser inputs	
8	Helps in learning/adoption new technology	
9	It increases the standard of living	

1.13 Perception or Knowledge level of the farmers on SWC measures and Level of Adoption

Sl. No	Particulars	Awareness/Knowledge		
		Low	Medium	High
1	Contour bunding			
2	Deep ploughing			
3	Farm pond			
4	Field bund (Mtr)			
5	Inter cultivation			
6	Levelling			
7	Rubble filled check			
8	Stubble mulching			
9	Vegetative barrier			
10	Waste weir			

1.14 Willingness to pay for adopting the SWC conservation measures

Sl No	SWC Measures	Base Amount	Base Price only	<10%	10-25%	25%<
1	Contour bunding					
2	Deep ploughing					
3	Farm pond					
4	Field bund (Mtr)					
5	Inter cultivation					
6	Levelling					
7	Rubble filled check					
8	Stubble mulching					
9	Vegetative barrier					
10	Waste weir					

2. Farm level economic viability of Soil and Water Conservation Measures

2.1. Cropping Pattern and Yield Levels

Sl. No.	Season/Crop	Area		Yield		By-product		Marketed Price	
		Before	After	Before	After	Before	After	Before	After
1	**Kharif**								
i									
ii									
iii									
iv									
v									
vi									
2	**Rabi**								
i									
ii									
iii									
iv									
v									
3	**Summer**								
i									
ii									
iii									
iv									
v									
4	**Perennial Crops**								
i									
ii									
iii									
iv									
v									

2.2 Input Use pattern of the respondents

Sl. No		Quantity	Price
1	FYM (Cart Load)		
2	Seed Material		
3	Seed Treatment Chemicals		
a			
b			
c			
d			
4	Fertilizers		
a			
b			
c			
d			

e			
5	PPC		
a			
b			
c			
d			
6	Others		

2.3 Labour Utilization pattern

Labour Rates (/day): Men____ Women____ Bullock Pair (/day) _____Machine (/hr) ____

Sl No	Particulars	Human Labour		Bullock Labour	Machine labour
		Male	Female		
1	Hired				
2	Family/Own				

2.4 Sources of credit availed

Sl. No	Details	After				Before			
		Amount	Interest Rate	Amount repaid	Due amount	Amount	Interest Rate	Amount repaid	Due amount
1	Formal								
i	Bank								
ii	RRB								
iii	Co-operatives								
2	Informal								
i	Money								
ii	Friends								
iii	Relatives								

2.5 No of Animal and Milk Yield

Sl. No.	Animals	Before				After			
		No	Days	Yield	Price	No	Days	Yield	Price
1	Cow								
2	Buffalo								
3	Cross breed								

4	Bullock								
5	Sheep								
6	Goat								
7	Poultry Birds								
Total									

2.6 Fodder Situation of farmers who adopted SWC measures

Sl. No	Types of fodder	Before			After		
		Qty	Price/unit	Value	Qty	Price/unit	Value
1	Green fodder						
2	Dry fodder						
3	Concentrated feed						
4	Other						

2.7 Biodiversity

Sl No	Particulars	Number		Yield	
		Before	After	Before	After
1	Trees				
	Plantation				
	Fruit				
	Fodder				
	other				
2	Pasture				
3	Flower/Ornamentals				

2.8 Water availability

Sl No	Particulars	No of Months	No of Irrigations per Acre
1	Kharif		
2	Rabi		
3	Summer		

2.9 Income

Sl No	Particulars	Before		After	
		Agriculture	Animal Husbandry	Agriculture	Animal Husbandry
1	Farm				
2	Non-Farm				

2.10 Employment

Sl No	Particulars	Before		After	
		Men	Women	Men	Women
1	Farm				
2	Non-Farm				

3. Farmers' perceptions on effectiveness of conservation measures

3.1 Opinions about the benefits of the SWC measures

Sl. No	Benefits	Strongly Disagree	Dis-agree	Neutral	Agree	Strongly Disagree
Farm Benefits						
1	Decrease in Soil and water erosion					
2	Increased soil moisture and water availability					
3	Decrease in the flow of rainwater and Increase in infiltration					
4	Increase in the Ground water availability					
5	helps to drain out surplus rainwater					
6	Change in Cropping Pattern and Cropping Intensity					
7	Increased yield					
8	Increase in fodder availability					
9	Increase in employment					
10	Helped in raising perennials/tree species					
11	Better utilization of leisure time					
12	Improvement of Environment					
13	Increased income over previous years					
Social Benefits						
14	Increase in the family savings					
15	Improvement in family living conditions					
16	Material possession increased					
17	Increased organizational participation					
18	Increased number of outside contacts					
19	Availed Govt. subsidy/loan					
20	Consulted by other farmers for Agriculture purpose					

3.2 Attitude towards the SWC measures

Sl. No	Benefits	Strongly Disagree	Dis agree	Neutral	Agree	Strongly Disagree
1	Adoption of SWC practices is real boon to the farmers of rain-fed area					
2	Investing money for soil and water conservation in dryland is wastage					
3	SWC measures increases farmers' awareness on scientific dry farming					
4	SWC technologies are beyond capacity of small and marginal dryland farmers					

5	SWC practices are suitable to the farmers of all levels of economic conditions					
6	SWC activities loss-making against cost of investment to the farmers					
7	SWC technologies support dryland farmers to improve degraded soil					
8	SWC programme is irrelevant to accomplish needs of majority of the farmers of dryland area					
9	Watershed development programme is systematic approach to manage land using water professionally					
10	Demonstrated watershed management technology does not motivate farmers' level of adoption					
11	Adoption of SWC technology supports to boost crop yield in rain-fed farming					
12	Watershed development programme is more government friendly than farmers' friendly approach					
13	I feel encouraging in adopting scientific watershed management technology					
14	Watershed management practices are impracticable for farmers to adopt in local situations					
15	Watershed development programme also helps in harmonizing other farmers' related departments of government					
16	Watershed development programme personnel are unprofessional to convince farmers to gain benefits of programme					
17	Adoption of SWC practices is real boon to the farmers of rain-fed area					

3.3 Sources of Technological Knowledge to the farmers

Sl. No.	Organization	Member/ Office bearer	Extent of participation		
			Regular	Occasional	Never
1	Gram Sabha				
2	Agriculture/Soil Survey Department				
3	NEWS Paper / Radio				
4	SAU/ Agricultural Research Station				
5	Govt. Office (TP/ZP/any other)				
6	Youth club				
7	Farmers union /Cooperative societies				
8	Watershed Committee				
9	Self-help groups				
10	Internet				
11	Friends/Relatives/ Neighbour farmers				

3.4 Information access by the SWC beneficiaries

Sl. No.	**Organization**	**Ranking**	**Access to the information**		
			Regular	**Occasional**	**Never**
1	Friends/Relatives/ Neighbour farmers				

2	Gram Sabha				
3	Agriculture/Soil Survey Department				
4	Farmers union /Cooperative societies				
5	Watershed Committee				
6	Govt. Office (TP/ZP/any other)				
7	Print Media (NEWS Paper//Agriculture Journals)				
8	Radio				
9	Internet				

3.5 Constraints faced by the farmers

Sl. No	Constraints	Ranking
Before/while Adoption		
1	Not aware of technology	
2	Technology not suitable	
3	Heavy investment and Lack of credit availability	
4	Fragmented land holdings	
5	High labour requirement and Long gestation period	
6	Improper extension support service	
7	Increase in farm pond sedimentation	
8	Difficulties in availing subsidy	
After Adoption		
1	Time consuming operation	
2	Productive land goes under the construction of farm pond	
3	Rate of evapo-transpiration is high in the area	
4	Soil bunds harbour mole-rats/weeds	
5	Bunds needs much land which will be waste further	
6	Bunds hinder ox-ploughing and affects cultural operations	
7	Water stagnates near bunded area	
8	Fragmentation of land into unconventional shape and size	
9	Lack of co-operation by neighbour farmers	
10	Disturbances' of wild animals	

Annexure 2: Factors influencing the adoption of SWC measures under different schemes

2.1 ALT Scheme

Sl No	Particulars	Estimate	Std. Error	Wald Statistic
1	Age	.025***	.014	3.06
2	Education	.496***	.133	13.97
3	Occupation	-.201	.160	1.58
4	Family size	.174***	.089	3.81
5	Number of Literates in the Family	.395***	.129	9.34
6	Organizational Membership	.032*	.103	0.10
7	Total Land Holding	-.174	.132	1.75
8	Area Under Irrigation Before adoption	.026	.092	0.08
9	Knowledge on Soil Erosion	1.678***	.987	2.89

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

2.2 DLT Scheme

Sl No	Particulars	Estimate	Std. Error	Wald Statistic
1	Age	.051**	.022	5.39
2	Education	.848***	.253	11.28
3	Occupation	-.216	.247	0.76
4	Family size	.304***	.117	6.75
5	Number of Literates in the Family	.462**	.235	3.86
6	Organizational Membership	.278*	.155	3.23
7	Total Land Holding	-.007	.270	0.00
8	Area under irrigation before adoption	.171	.178	0.92
9	Knowledge on Soil Erosion	2.960**	1.342	4.86

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

2.3 DMS Scheme

Sl No	Particulars	Estimate	Std. Error	Wald Statistic
1	Age	.027***	.006	20.01
2	Education	.421***	.060	48.75
3	Occupation	-.097	.066	2.17
4	Family size	.164***	.033	24.71
5	Number of Literates in the Family	.376***	.061	37.72
6	Organizational Membership	.124*	.048	6.56
7	Total Land Holding	.099	.067	2.16
8	Area under irrigation before adoption	-.013	.044	0.09
9	Knowledge on Soil Erosion	1.921***	.469	16.80

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

2.4 WGDP Scheme

Sl No	Particulars	Estimate	Std. Error	Wald Statistic
1	Age	.043**	.019	5.00
2	Education	.826***	.240	11.87
3	Occupation	-.133	.242	0.30
4	Family size	.216**	.106	4.18
5	Number of literates in the Family	.510**	.246	4.31
6	Organizational Membership	.155	.148	1.11
7	Social Media Contacts	-.076	.137	0.31
8	Total Land Holding	.002	.273	0.00
9	Area Under Irrigation Before adoption	.199	.177	1.28
10	Knowledge on Soil Erosion	1.988*	1.074	3.43

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

2.5 Pooled Data

Sl No	Particulars	Estimate	Std. Error	Wald Statistic
1	Age	.027***	.006	20.01
2	Education	.421***	.060	48.75
3	Occupation	-.097	.066	2.17
4	Family size	.164***	.033	24.71
5	Number of Literates in the Family	.376***	.061	37.72
6	Organizational Membership	.124**	.048	6.56
7	Social Media Contacts	-.015	.047	0.11
8	Total Land Holding	.099	.067	2.16
9	Area Under Irrigation Before adoption	-.013	.044	0.09
10	Knowledge on Soil Erosion	1.921***	.469	16.80

*** indicates the significance at 1%, ** indicates significance at 5% level and * indicates significance @ 10%

Annexure 3: Economic Feasibility Analysis of SWC schemes

3.1 ALT scheme (□/farm)

Sl No	Year	Cost/Cash Outflow	Returns/Cash Inflow	Net Cash flow	Discount factor @ 9%	Present Value	Discount factor @ 174 %	Present Value
1	0	26188		-26188	1.00	-26188	1.00	-26188
2	1		36582	36582	0.88	32373	0.36	13351
3	2		54073	54073	0.78	42347	0.13	7202
4	3		68066	65715	0.69	45544	0.05	3195
5	4		83643	83643	0.61	51300	0.02	1484
6	5		93742	93742	0.54	50879	0.01	607
7	6		93742	93742	0.48	45026	0.00	222
		NPW				241281		-128
		IRR				174.09		
		B:C				9.37		
		PI				9.21		

3.2 DLT scheme (□/farm)

Sl No	Year	Cost/Cash Outflow	Returns/ Cash Inflow	Net Cash flow	Discount factor @ 9 %	Present Value	Discount factor @ 20.10%	Present Value
1	0	438048		-438048	1.00	-438048	1.00	-438048
2	1		44504	44504	0.87	38699	0.83	37056
3	2		60488	60488	0.76	45737	0.69	41935
4	3		71981	71981	0.66	47329	0.58	41552
5	4		85926	85926	0.57	49128	0.48	41300
6	5		118611	118611	0.50	58970	0.40	47469
7	6		118611	111653	0.43	48271	0.33	37206
8	7		118611	118611	0.38	44590	0.28	32910
9	8		118611	118611	0.33	38774	0.23	27402
10	9		118611	118611	0.28	33717	0.19	22816
11	10		118611	118611	0.25	29319	0.16	18997
12	11		118611	111653	0.21	23999	0.13	14890
13	12		118611	118611	0.19	22169	0.11	13171
14	13		118611	118611	0.16	19278	0.09	10966
15	14		118611	118611	0.14	16763	0.08	9131
16	15		118611	118611	0.12	14577	0.06	7603
17	16		118611	118611	0.11	12675	0.05	6330
18	17		118611	111653	0.09	10375	0.04	4962
19	18		118611	118611	0.08	9584	0.04	4389
20	19		118611	118611	0.07	8334	0.03	3654
21	20		118611	118611	0.06	7247	0.03	3043
22	21		118611	118611	0.05	6302	0.02	2533
23	22		118611	111653	0.05	5158	0.02	1986
24	23		118611	118611	0.04	4765	0.01	1756
25	24		118611	118611	0.03	4144	0.01	1462
26	25		118611	118611	0.03	3603	0.01	1218
27	26		118611	118611	0.03	3133	0.01	1014
28	27		118611	118611	0.02	2724	0.01	844
	NPW/NPV					**609365.17**		-452.85
	IRR					**20.10**		
	B:C					**1.31**		

3.3 DMS scheme (□/farm)

Sl No	Year	Cost/ Cash Outflow	Returns/ Cash Inflow	Net Cash flow	Discount factor @ 9 %	Present Value	Discount factor @ 27.8 %	Present Value
1	0	219084		-219084	1.00	-219084	1.00	-219084
2	1		38147	38147	0.87	33171	0.78	29849
3	2		47934	47934	0.76	36245	0.61	29348
4	3		55662	55662	0.66	36599	0.48	26667
5	4		64898	59940	0.57	34271	0.37	22470
6	5		84101	84101	0.50	41813	0.29	24669
7	6		84101	84101	0.43	36359	0.23	19303
8	7		84101	84101	0.38	31617	0.18	15104
9	8		84101	79143	0.33	25872	0.14	11122
10	9		84101	84101	0.28	23907	0.11	9247
11	10		84101	84101	0.25	20788	0.09	7236
12	11		84101	84101	0.21	18077	0.07	5662
13	12		84101	79143	0.19	14792	0.05	4169
14	13		84101	84101	0.16	13669	0.04	3467
15	14		84101	84101	0.14	11886	0.03	2712
16	15		84101	84101	0.12	10336	0.03	2122
17	16		84101	79143	0.11	8458	0.02	1563
18	17		84101	84101	0.09	7815	0.02	1299
19	18		84101	84101	0.08	6796	0.01	1017
20	19		84101	84101	0.07	5909	0.01	796
21	20		84101	84101	0.06	5139	0.01	623
	NPW/NPV					**204433**		-641
	IRR					**27.84**		
	B:C					**1.77**		

3.4 WGDP scheme (□/farm)

Sl No	Year	Cost/ Cash Outflow	Returns/ Cash Inflow	Net Cash flow	Discount factor @ 9 %	Present Value	Discount factor @ 21.85 %	Present Value
1	0	313548		-313548	1.00	-313548	1.00	-313548
2	1		34063	34063	0.87	29620	0.82	27955
3	2		47497	47497	0.76	35914	0.67	31990
4	3		57990	57990	0.66	38129	0.55	32054
5	4		70574	70574	0.57	40351	0.45	32014
6	5		98968	92411	0.50	45945	0.37	34403
7	6		98968	98968	0.43	42786	0.31	30237
8	7		98968	98968	0.38	37206	0.25	24815
9	8		98968	98968	0.33	32353	0.21	20365
10	9		98968	98968	0.28	28133	0.17	16713
11	10		98968	92411	0.25	22843	0.14	12808
12	11		98968	98968	0.21	21272	0.11	11257
13	12		98968	98968	0.19	18498	0.09	9238
14	13		98968	98968	0.16	16085	0.08	7582
15	14		98968	92411	0.14	13060	0.06	5810
16	15		98968	98968	0.12	12163	0.05	5106
17	16		98968	98968	0.11	10576	0.04	4191
18	17		98968	98968	0.09	9197	0.03	3439
19	18		98968	98968	0.08	7997	0.03	2822
	NPW/NPV					**148580**		-749
	IRR					**22.15**		
	B:C					**1.39**		

3.5 Pooled Data (□/farm)

Sl No	Year	Cost/Cash Outflow	Returns/ Cash Inflow	Net Cash flow	Discount factor @ 9%	Present Value	Discount factor @ 28 %	Present Value
1	1	249217	0	- 249217	0.8929	- 222515.18	0.7874	- 196233.86
2	2		38089	38088.93	0.7972	30364.26	0.6200	23615.18
3	3		52216	52216.48	0.7118	37166.66	0.4882	25491.56
4	4		63115	63114.87	0.6355	40110.64	0.3844	24261.45
5	5		75914	75914.42	0.5674	43075.88	0.3027	22977.65
6	6		98253	92897.52	0.5066	47064.78	0.2383	22140.21
7	7		98253	98253.41	0.4523	44444.85	0.1877	18438.33
8	8		98253	98253.41	0.4039	39682.90	0.1478	14518.37
9	9		98253	98253.41	0.3606	35431.16	0.1164	11431.79
10	10		98253	98253.41	0.3220	31634.97	0.0916	9001.41
11	11		98253	92897.52	0.2875	26705.82	0.0721	6701.36
12	12		98253	98253.41	0.2567	25219.20	0.0568	5580.88
13	13		98253	98253.41	0.2292	22517.15	0.0447	4394.40
14	14		98253	98253.41	0.2046	20104.59	0.0352	3460.15
15	15		98253	98253.41	0.1827	17950.53	0.0277	2724.53
16	16		98253	92897.52	0.1631	15153.60	0.0218	2028.36
17	17		98253	98253.41	0.1456	14310.05	0.0172	1689.21
18	18		98253	98253.41	0.1300	12776.83	0.0135	1330.09
19	19		98253	98253.41	0.1161	11407.89	0.0107	1047.31
20	20		98253	98253.41	0.1037	10185.61	0.0084	824.66
		NPW	302792.21					
		B:C Ratio	2.33					
		IRR	28%					
		PI	2.95					

Abstract

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By

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ABSTRACT OF THE THESIS

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2020

ANALYSIS OF SOIL AND WATER CONSERVATION INVESTMENTS IN KERALA AND FARM LEVEL FINANCIAL GAINS

Abstract

Climate change is expected to increase stress on water resources which impacts the agricultural production and farmers' livelihoods. Tropical high range regions like Wayanad are more vulnerable to climate change because of the *faster rate of temperature increase and irregular rainfall pattern.* Soil and Water Conservation (SWC) measures assumes significance in such situations in which the gradient, land use and rainfall factors trigger top soil loss. The SWC measures in Wayanad is promoted through four major schemes which are heavily subsidised by the State and Central Governments. This study was taken up with the specific objectives *viz.,* to analyse the institutional credit flow towards soil and water conservation investments in Kerala, to assess the household level investment on soil and water conservation, understand the local preferences for soil/water conservation methods, assess the farm level economic viability and finally efficiency of such investments and understand the farmers' perceptions on effectiveness of conservation measures. The study was based on both primary data and secondary data. Secondary data on institutional credit support, refinance and rainfall pattern was compiled from various issues of Economic Review, Government of Kerala; Annual Reports and potential linked credit plan documents of NABARD. The samples for the primary data were identified based on the multistage random sampling method. The major interventions in SWC are implemented through four schemes *viz.* Arable Land Treatment (ALT), Drainage Line Treatment (DLT), Drought Mitigation Scheme (DMS) and Western Ghats Development Scheme (WGDP). Total sample of 360 farmers (30 beneficiaries x 4 schemes x 3 taluks) were identified from the list of beneficiaries collected from the Department of Soil and Water Conservation. One neighboring farmer each to the sample farm was also interviewed. The data was collected through personal interview method employing a structured and pretested interview schedule. The analysis was done using appropriate statistical tools. The major findings of the study are as follows:

Institutional credit support to agriculture in Kerala was □ 67,089 crore during 2017-18, wherein crop loans constituted major share (72%). The Commercial banks were leading with 65 per cent share. NABARD refinance support to agriculture amounted to □ 10024.29 crores. There has been an increasing preference for Non-Farm Sector, which enjoyed two third of total refinance support. Among the major

institutions, RRB's enjoyed the highest share of 33 per cent. In the farm sector, plantation and horticulture sector (31.26%) remained the prime sector in refinance support during the period 1990-91 to 2017-18. The institutional credit support to Wayanad agriculture was □ 2469.89 crores (2017-18) which registered a Compound Annual Growth Rate (CAGR) of 18.97 per cent (2007-08 to 2017-18). Though crop loans constituted for 86 per cent of the total credit, the CAGR of term loans was faster (22.77%). Commercial banks were the main provider of credit and plantation and horticulture sector and dairy development sectors were given priority in lending. Considered as the hot spot of climate change in Kerala, the district was regularly facing drought situation and water scarcity was reported as one of the major problems. The irrigated agriculture in the district (44.72% of the respondents) was mainly depending on open wells and facing challenges as the water was enough to irrigate only during 2-3 months. Most of the respondents were middle aged, literate and marginal farmers.

The SWC, on an average attracted an investment of □ 2,49,217 per household. Overall, nearly 50 per cent (177) of the respondents have adopted SWC structures on individual basis and have paid a share of 10 per cent at the rate of □ 24,922/household. About 40 per cent of the respondents adopted on group basis paying a share of five per cent. However, none of the respondents bothered to undertake the annual maintenance of the SWC structures. Impact of SWC measures on cropping pattern, productivity, production and farm income were assessed by comparing it with the situation before the investment. The SWC measures have facilitated the area expansion of ginger (56.94%), banana (38.53%), rubber (32.71%) and turmeric (31.65%). The significance of SWC measures was evident through the positive effect on productivity in all the crops. The significant area expansion and productivity gains in ginger, banana, rubber and turmeric has translated into substantial production gains (95.24% in ginger, 81.80% in banana, 64.77% in rubber, 49.60% in turmeric). The farm income increased to the tune of 45.61 per cent, the major increase being from ginger (95.24%), banana (81.80%), rubber (64.77%) and turmeric (49.60%) cultivation.

All the major crops (coffee, pepper, arecanut and banana) performed well with positive indicators of financial viability and efficiency. The relative economic performance with respect to net returns was in the order of arecanut (□ 4,24,074/ha), banana (□ 3,42,202), coffee (□ 2,73,365/ha) and black pepper (□ 1,86,929/ha). The efficiency of investment as indicated by the BC ratio was in favour of arecanut (5.55) followed by coffee (3.96), banana (3.53) and black pepper (3.26). SWC is expected to improve the water availability and irrigation. Resource use efficiency analysis was done

to assess whether it has contributed significantly to the returns. The results confirmed that irrigation has significantly contributed to the returns in arecanut, coffee and pepper.

The economic viability of SWC investments was estimated to assess the economic worthiness of the investment as it involves substantial part of public money. The NPW of the investment was positive in all the schemes and averaged at □ 3,02,792/farm. DLT scheme was proven to be the best in terms of NPW. The efficiency in investment as measured by the BC ratio was highest in ALT (9.37) which averaged at 2.33, thus confirming the economic efficiency of the investment. IRR averaged at 28 per cent, which is significantly higher than the opportunity cost of capital (interest on fixed investments). The analysis justifies the social investment of SWC, as it leads to higher production and returns which supports the agricultural profession and welfare of the farmers.

The impact of SWC measures on farm enterprise diversification, tree diversity, employment generation and ground water level were also found to be positive and helped in improving farm income. The positive externalities of SWC measures were acknowledged by the neighbouring farmers and they were reported to be motivated to adopt the same. However, the adoption of water saving technologies were found to be rather low.

The decision to adopt SWC in any farm is decided by demographic, social, economic and institutional factors. Age, education levels, family size and number of literate persons in the family and knowledge on soil erosion influenced the decision to adopt the SWC, in all the cases irrespective of the scheme. Organizational membership also influenced the decisions making except in the case of WGDP scheme.

The institutional credit delivery and refinance support in Kerala need to give more focus towards capital formation investments through LT credit support. The analysis justifies the public allocation and investment in SWC measures in farm holdings. The quantified positive impacts and externalities of SWC schemes can be used in educational and awareness creation programmes for wider implementation of the schemes. The design of the project has to be widened to ensure post investment monitoring to ensure scientific management and maintenance of the structures as well as adoption of water saving technologies.