National Research Journal of Business Economics
Volume-5, Issue-2, Year-2018 **ISSN: 2349-2015**

CHANGE IN CROPPING PATTERN FROM PADDY TO GINGER AND ITS IMPLICATIONS ON KODAGU'S ECONOMY

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Environmental problems are really social problems they begin with the people with the cause, and end with people as victims.[1] **Sir Edmund Hillary**

ABSTRACT

Sustainable agriculture is the need of the hour. Before the advent of coffee plantation in Kodagu district of Karnataka state in India, in the latter half of the 19th century, agriculture was the major source of livelihood for the population with paddy being the staple crop. It is said that there was time when Kodaguproduced surplus paddy even for exports and sometimes the excess was never utilized and hence waswasted due to lack of transport and marketing facilities. Farmers could not even winnow and store the paddy.[2] However, things changed with the increase in population. The area under cultivation of coffeeexpanded at the cost of deforestation, which in turn is costing heavily now in the form of reduced numberof rainy days, erratic and untimely rainfall leading to seasonal water scarcity. Besides, the advent of ginger cultivation in the recent years has led to further deforestation and conversion of paddy fields into ginger growing beds. In the process of ginger cultivation the water which otherwise used to get collected in the paddy fields is drained out to save the ginger rhizomes from rotting. This has affected the percolation process and led to decline in the water table. The ramification is, drying of wells and farmponds in the surrounding area. Hence, the crop budgeting of paddy and ginger is calculated to find out the reasons for the shift in the cropping pattern, its implications on income and employment. Besides,this change in cropping pattern has further led to shift to banana and areca nut plantation leaving a negative impact on water availability in the study area. Migrants from Kerala, who are well

versed in ginger cultivation, lease the land and convert the paddy field to ginger cultivation.

Key words: Cropping pattern, Environment, Ginger Paddy, Sustainable agriculture

INTRODUCTION

Sustainable agriculture is that form of farming, which produces sufficient food and other crops to meet the requirements of the present without harming the ecological assets and the productivity of life supporting system of the future generation. A new strategy for sustainable development is outlined by the World Conservation Union, in *Caring for the Earth*, as improving the quality of human life by living within the carrying capacity of supporting ecosystem. Reaching the goal of sustainable development requires simultaneous progress along the critical and interacting dimensions - economic, human, environmental and technological, where actions in one area can reinforce goals in another. What we need to sustain is human life to which, the whole of development effort is addressed. An effort has been made to link environment and development. Agricultural production must further be boosted to feed the teeming population. Shortage of food supply is a major impediment to the pursuit of development, while population growth magnifies the problems. Hence, this paper highlights the causes and consequences of change in cropping pattern from food crop to cash crop on the economy of Kodagu district in Karnataka state and its environment. Kodagu has a highly dynamic history of land use and cropping pattern changes. The agricultural sector in the district has changed significantly in terms of land ownership, cropping pattern, cultivation techniques and cropping in- tensity[3]. Cropping pattern is a dynamic concept concerned with the extent to which arable land categories can be utilized[4-6]. A cropping pattern refers to the proportional area under different crops at a point in time. The farm front of Kodagu is distinguished by an incredibly diverse biophysical resource base and agro-climatic endowments that offer a wide range of options for cultivating various crops. Apart from these, farmers are highly influenced by changes in technological, economic, institutional and policy-induced factors.[7,8] In particular, land-use experts have observed a shift towards monoculture and traditional cash crop agro forestry at the cost of diversified homegardens.[9–11] Exorbitant land prices have also altered the land-use pattern in the district. [12,13] These changes have affected the

cropping pattern as well. A sizable decline in area under field crops like paddy and an increase in area under ginger are noticed in the district. Thomas[14] pointed out that the shortage of farm labourers, rapid in- crease in wages and absentee landowners have also favoured the shift in cropping pattern. According to Guillerme *et al*.[15] crop choice by the farmers depends on factors like topography, soil type, irrigation facilities, crop profitability and Government policy decisions. The determinants of cropping pattern changes in the state are the anticipated price of the crop, price of the competing crop, anticipated yield, differences in the climate, soil, vegetation, irrigation facilities and cost of cultivation[16,17]. The climate, soil and land characteristics of a region heavily influence its agricultural productivity and agro-biodiversity. Agricultural diversification is an important mechanism for economic growth. Crop diversification refers to the shift from the production of one crop to several crops in a region. It enhances the cropping intensity and productivity growth of the crops. The levels of crop diversification vary for different regions due to varied agro-climatic conditions and resource endowments of the cultivators. The growth of the agricultural sector acts as a catalyst for the growth of the other sectors. In the context of Kodagu's agriculture, several studies were conducted on agricultural trends such as land-use changes and dynamics of cropping pattern[18-27]. As a result of the diversion of labour, the paddy farmers were forced to reduce the crop acreage or leave their land fallow. This is in agreement with the findings of Harish *et al*[28] . Shift from paddy to ginger cultivation has led to water shortage and depletion of ground water in Kodagu since water is drained out of the ginger bed to arrest rhizome rot. Hence this paper intends to create awareness among the people to adopt strategies towards sustainable water use and its management since water is a fixed resource and an inescapable necessity; and importance of growing paddy, before it is too late to act upon to attain sustainable development for which, the entire economic activities are addressed. Since cropping pattern can affect the entire agrarian economy of the state, studies on the changes in cropping pattern and crop diversification and its impact on the environment are the need of the hour. The present study analyses the cropping pattern changes and its impact on availability of water. The constraints faced by the respondents in the study areas in crop production and marketing are also analysed.

SCOPE AND METHODOLOGY

The study covers 2 taluks out of three viz. Madikeri and Virajpet since paddy is grown extensively in these two taluks. The primary survey is done through questionnaire schedule covering 118 randomlyselected farmers covering 9838.7 acres of which 889.2 acres are of paddy fields. Out of 453 acres of ginger cultivation, 341.5 acres were paddy fields which are converted to ginger cultivation and only 21 acres were cultivated by local people (respondents). The rest of the land was leased out for ginger cultivation to outsiders usually from neighboring states of Kerala and Tamil Nadu. Apart from this, 13.5 acres are in newly planted coffee plots, and 98 acres are from uncultivated land which is brought under ginger cultivation by clearing the vegetation cover enforcing further expansion of plantation bydeforestation. The paper is both analytical and descriptive using the primary and secondary data. To deal with the objective of the study and its relative hypothesis viz., tables are used to support the analysis. Economic tools like crop budgeting (economics of crops and partial budgeting techniques are employed to compare the cost of production and returns under two different situations viz., paddy and ginger. To summarize the paper SWOT analysis is adopted. It is an acronym with stands for strength, weakness, opportunity and threats.

Objectives and Hypotheses:

Objectives	Hypotheses
To analyze the economic and environmentalfactors inducing economic scarcity of water.	1. Change in market forces (price) has led to shift in cropping pattern (from paddy to ginger) inducing water scarcity.
To analyze the economic and environmental implications of change in cropping pattern on water availability, employment and income	2. Change in cropping pattern from paddy to ginger increases the income and employment but, aggravates water scarcity and degrades soil fertility.

RESULTS AND DISCUSSIONS

For the last two decades, Kodagu district has been witnessing changes in the cropping

pattern. The major shift is from paddy to ginger cultivation and the recent trend is still disheartening. Due to the ban on the cultivation of ginger in the neighboring state Kerala, ginger cultivators have migrated to Kodagu inlarge members to raise the crop with a high profit motive.

The trend in the cropping pattern (Vide Table 1) clearly indicates the positive growth for coffee and ginger cultivation but, a negative trend for paddy cultivation. The area under coffee plantation has been steadily increasing every year. It has increased by 51.4 per cent in Madikeri and by 3.1 per cent in Virajpet between 2000 and 2017. This increase of more than double has been at the cost of deforestation as to expand the plantation. Ginger, being a cash crop, has replaced paddy cultivationsince 2000. There is a declining trend in paddy cultivation, by -18.3 per cent in Madikeri -14.8 per centin Virajpet and -21.5 per cent in Somwarpet from 2000 to 2017 since the advent of ginger cultivation.This has led to shortage of food grain. Ginger cultivation has increased by 4011 per cent in Madikeri, 4067 per cent in Virajpet and 7281 per cent in Somwarpet during the same period. This has its own significance in altering the water availability. Though ginger can fetch the grower monetary benefits, it has negative impact on water percolation and fertility of the soil. To protect the rhizome from rotting, the paddy fields are converted to high beds to help draining of water out of the fields.No effort is being made to store this water. This has lead to poor ground water recharge, where as paddy fields facilitated ground water recharge, by capturing water. Thus paddy fields are more a water harvesting structure than paddy cultivation.[3] Besides creating water scarcity, the use of chemical fertilizers mixed with high dose of salt (to arrest rhizome rot), the soil gets burnt leading theland not fit for cultivation for at least two years. During this period, the land is neither ploughed nor leveled. Hence, the process of percolation is reduced due to continued draining of rainwater from the fields. This also leads to scarcity of water as hypothesized. Due to increased application of chemical fertilizers and salt, the land becomes unfertile for the next crop. Hence, ginger is grown only once on a particular plot of land and ginger growers keep shifting their cultivation to new plots each time increasing the area.

Table 1: Cropping Pattern in Kodagu (2000-2017) (in hectares)

YEAR	TALUKS								
	MADIKERI			VIRAJPET			SOMWARPET		
	COFFEE	PADDY	GINGER	COFFEE	PADDY	GINGER	COFFEE	PADDY	GINGER
2000	13605	10260	18	23332	12221	33	34495	21076	21
2001	15669	10488	22	23382	12560	33	34579	22059	23
2002	15681	9253	28	23392	8149	33	34579	17937	23
2003	15715	10061	25	23392	11845	28	34630	22392	35
2004	15760	10337	28	23497	12844	29	34800	22384	19
2005	15900	10399	26	23510	12252	29	34862	22618	22
2006	16270	9949	22	23600	12222	28	35112	22545	20
2007	16365	9856	14	23608	12586	34	35125	22647	25
2008	16441	9842	25	23620	12450	56	35170	22568	60
2009	17277	9891	25	23633	11930	326	35300	22430	280
2010	17327	9396	76	23708	9644	320	35445	21743	256
2011	17418	9156	60	23910	10469	300	35715	19596	270
2012	17430	9507	45	23920	10615	200	35745	20210	200
2013	17450	9507	51	23920	10615	350	36010	20210	250
2014	18978	9338	772	23950	11870	1400	38010	19428	1500
2015	20539	8098	990	23980	11207	1200	38100	17650	2010
2016	20540	7899	860	24020	11600	1100	38160	16765	1600
2017	20600	8384	740	24050	10413	1375	38180	16550	1550
% Δ*	**51.4**	**-18.3**	**4011**	**3.1**	**-14.8**	**4067**	**10.68**	**-21.5**	**7281**

Note: *denotes the percentage change in cropping pattern over the years.

Percentage change from 2000 to 2017 (%Δ) is calculated (for 16 years) by taking 2000 as base year.

Source: Compiled from the **Yearly District Statistical View of Kodagu**, Zilla Panchayat, Madikeri[4]

Cultivation of paddy, the traditional staple crop, both for subsistence and commercial purpose is less preferred for cultivation because **ginger has emerged to be more remunerative than paddy**. Paddy has been facing a threat due to high factor price and reduced product price as the former is moreremunerative and less cumbersome. This is analyzed in the Table 2.

Table 2: Economics of Paddy and Ginger - A Comparison (in Rupees)

Sl. No	PARAMETERS	PADDY		GINGER		
		Cost of Variables	Average Cost	Cost of Variables	Average Cost	Additional cost and income of ginger over paddy (difference)
	FACTOR PRICE					
1	Cost of human labour	2516850	**2,830.5**	250130	11911	9080.5
2	Cost of Draft Power *	1871467	2105	0	0	-2104.7
3	Cost of seed material	355810	400	167000	7952.4	7552.3
4	Cost of Manure	971250	1092	56400	2686	1593.7
5	Cost of fertilizersand plant protection	688297	774	63430	3021	2246.9
6	Transportation cost	0	0	6780	325	325
Total Expenditure		6403674	**7202**	543740	**25895**	**18693.4**
	PRODUCT PRICE					
1	Price of Main product	12382350	**13925**	1191600	56743	42814
2	Price of By products	736565	**828**	0	0	-828
Gross income		**13118915**	**14754**	**1191600**	**56743**	**41990**
Net income		**6715241**	**7552**	**647860**	**30848**	**23298**

Leased out amount per acre	**1035000**	**9383*1**	**4769000**	**11,039*2**	**1656**
Total area in acres	**889.2**		**21**		

Note: * Bullock and other farm machineries.

*1 is calculated for 110.3 acres which has been leased out for paddy cultivation

*2 is calculated for 432 acres of land which has been leased out for ginger cultivation

Source: Tabulated from the primary data collected through the Questionnaire Schedule

Table 2 presents the result of the survey on the economics of paddy and ginger (crop budget) in the study area. The average values are derived by dividing the total variable cost by the area under each crop.

For example for paddy,

Total human labour cost (Rs.)

———————————— **=Average Cost of Human Labour per Acre**

Total paddy area (acres)

Rs. 2,516,850

——————— = **Rs. 2,830.5** is the average cost of human labour per acre

889.2 acres.

In deriving the gross income, price of by-product (hay) and price of main products (paddy or ginger) are added up and net income is derived by deducting total expenditure from the gross income. Out of **453 acres** of ginger cultivation, **only 21 acres** were cultivated by local people (respondents). The rest of the land was leased out for ginger cultivation to outsiders usually from neighboring states ofKerala and Tamil Nadu.

Leased out amount per acre is obtained by the following method.

Total leased amount (in Rs.)

———————————— **=Average Leased Value (in Rs.) per Acre**

Total area leased out (acres)

For example for Ginger,

Rs. 4,769,000

——————— = **Rs. 11,039** is leased out amount per acre per year432 acre

It appears from comparative results that ginger cultivation is not cost effective than paddy. Because, ifginger could earn more returns at same cost as paddy or same returns at lesser cost than paddy it couldhave been cost effective but, amidst high investment there is high return, as high as thrice the paddy production cost and income. It is further clear from the table that the paddy cultivation compared to ginger has low risk factor, low investment and low profit amidst cumbersome process of production. Whereas ginger is a gamble, as it not only demands greater investment but yields greater profit at high risk of crop failure due to diseases discussed before. Therefore, paddy growers seem to be attracted tolease out their paddy fields to ginger cultivation, as the lease amount is higher than returns from paddycultivation (Rs. 11,040 against Rs. 9,383.5). The only advantage that the paddy growers have is that,they get by-products like hay for cattle and domestic consumption of rice is taken care of, where as inginger, there are no by-products and if the crop fails, it is a total loss. Out of 453 acres of ginger cultivation, 341.5 acres are the paddy fields that are converted. Of which, 110.3 acres were brought back under paddy cultivation only after leaving the field (fallow) uncultivated for two years. Because, thefertility would be totally lost after ginger cultivation, due to application of salt to the field to arrest rhizome rot. Besides, the cost of bringing the paddy fields back to the original shape is high accordingto the respondents. The rest of 231.2 acres was converted to banana and areca nut plantation. This does not help the replenishment of groundwater, which is leading to water scarcity. This scarcity is reflectedin bore-well failures, deepening of wells, drying up of farm ponds in the study area. Ginger cultivation is not only spreading in the paddy fields but also taken up by clearing uncultivated vegetative land since they are more fertile.

Further, ginger cultivation in the paddy fields has affected the ground water recharge, since the fields are not ploughed for paddy cultivation and percolation is reduced. As more and more paddy fields come under ginger cultivation, trenches are dug (drains the water out) to arrest rhizome rot in ginger. Drained out water from the paddy field is not stored or collected to use it for other purposes. This has aggravated the water scarcity in the study area. This is again reflected in dried up wells, ponds, and borewells, which is mainly intensified due to ginger cultivation in the paddy fields. Apart from this, out of 453 acres of ginger cultivation, 13.5 acres are in newly planted coffee plots, and 98

acres are from uncultivated land which is brought under ginger cultivation by clearing the vegetation cover. Thus, it has enforced further expansion of by deforestation. The water loss due to ginger cultivation is to the tune of water drained out of paddy field for the duration of total number of months under paddy cultivation. Hence, it is calculated as, (inches of rainfall x totalpaddy area converted to ginger x number of months under paddy cultivation) =

Total inches of waterloss due to ginger cultivation

Total inches of water loss due to ginger cultivation
— = **Total Acre-Inch of Water Lost**
Total area converted from paddy to ginger cultivation

For example in the study area,

2 inches X 341.5 acres X 6 months = **4,098 inches** of water loss due to ginger cultivation

4,098 inches
— — — — — = **12acre-inches** of water loss due to ginger cultivation in the paddy field
341.5 acres

The entire acreage of paddy field which is converted to ginger cultivation loses the recharging capacity of the groundwater. During monsoon, rainwater is stored in the paddy fields to maintain 2 inches of standing water required for paddy cultivation. This is used to act as a ground water recharge structure. Since the adoption of ginger cultivation, the water is drained out of the paddy field without storing. This has affected the percolating process for 6-7 months (duration of paddy cultivation for two crops). In the study area, a minimum of 12 acre-inches of water is lost due to draining out the water from the paddy fields without storing. This has affected the water level in the farm ponds, dug in the paddy fields forthe purpose of sprinkler irrigation to Robusta coffee plantation.

According to the hypotheses, the shift in cropping pattern from paddy to ginger is certainly dueto the high product price of ginger and high price of leasing compared to paddy. The **difference of net income** from paddy and ginger is as high as **Rs.23,298** per acre (Vide Table 2). This difference hasencouraged the farmers to shift from paddy to

ginger, which could fetch them higher profits. The leasing price difference of Rs. 1,656 per acre also have motivated the farmers to lease the paddy fieldsfor ginger cultivation. In spite of higher returns by self cultivation, farmers chose to lease out the land for lesser price because, cultivation of ginger is more than a gamble due to diseases associated with it. Apart from this, the farmers could save the investment, time and strain due to cumbersome work in thepaddy fields.

The landlords are persuaded to lease out their vegetative virgin land (not cultivated even once) for ginger cultivation which in turn helps the landlords to take up coffee plantation after the lease period or simultaneously. Landlords are benefited to the extent of clearing of vegetation and preparing the landfor plantation along with the lease money. But, landlords have failed to take notice of the fact that **ginger cultivation leaves the soil unfertile and reduce the water bearing capacity of the soil.** Ginger cultivation is also taken up in the new coffee plantation areas. The coffee plants need continuous nourishment for 4 to 5 years until they bear the yield. During this period, planters lease out their plantation for ginger cultivation since manuring and watering for ginger would take care of the coffee plants too. But, application of high doses of chemical fertilizers and salt has a negative impact on the fertility of the soil which has gone unnoticed. This further affects the coffee plants too. When enquired, farmers did admit that, cultivating ginger is more than a gamble. They earn higher profits amidst high risk of diseases and unassured markets. However, according to a large number of respondents, the shift towards ginger cultivation is mainly due to higher profits compared to paddy, noresponsibility of maintaining of farm due to leasing and also due to existence of labour problem.

According to the respondents, several factors influence them to shift the cropping pattern. Working for long hours in the slush in the paddy field is cumbersome. The farmers have to cook food for the laborers during transplanting and harvesting period. Apart from this, wages have increased considerably. Farmers, who have the paddy fields, beside the rivers and streams, face two types of problems in two different seasons. During monsoon, **swollen rivers flood** the low lying paddy fields and ruin the crops. In summer, when the level of water in the river goes down, it sucks the water from the nearby paddy fields. Hence, farmers cannot grow paddy more than once a year.

Therefore, they have opted to shift to ginger cultivation and later the same land is converted to banana / areca nut plantation. **Elephant menace** is another grave problem faced by the farmers forcing them to shift the crop from paddy to areca nut and before that, ginger is grown at least once. It is the same practice while paddy fields are converted for banana cultivation. These are some of the reasons which indirectly affect the availability of water at present and in the future. Another most important aspect to be noted is, the conversion of paddy fields into farm ponds, reducing the paddy grown area. **284.66 lakh cubic feet of farm ponds are constructed in the paddy fields** in the study area to facilitate sprinkler irrigation for coffee plantation during its critical growth period of blossom and berry, for 15 to 20 days in a year. This is due to change in rainfall pattern leading to seasonal scarcity of water in the months of late February and early March. Just to provide 50 mm of shower for blossom in February and 25 mm of shower for back up in the month of March, without which the Robusta coffee yield, which is the mainstay of Kodagu's economy, fails. This extra cost which is incurred to provide sprinkler irrigation as a mechanism, to combat the seasonal scarcity of water has led to the economic scarcity of water. That is when is incurred to make good of the unavailability of water. Being a water sumptuous district with places receiving highest rainfall in the country and before entering into physical scarcity of water Kodagu is experiencing economic scarcity of water due to seasonal failure of rainfall which was otherwise normal before 1970's.

Thus, the change in cropping pattern from paddy to ginger is found to have the implication on increase in income, employment, and in turn water scarcity along with soil degradation, as hypothesized. This is analyzed in the Table 3, where the capacity of paddy and ginger to generate income and provide employment, (by the production of respective crops in a year) in the study area.

Table 3: Income and Employment Generation under existing Cropping Pattern
(per acre)

Sl.No	CROPS	INCOME (in rupees)	EMPLOYMENT (man days)
1	**Paddy**	7,552	48
2	**Ginger**	30,848	199

Source: Tabulated from the primary data, Table 2, for paddy and ginger

Average employment per acre is calculated as,

$$\frac{\text{Average cost on labour (in Rs.)}}{\text{Rs. 60}} = \text{Average Employment in Man days (per acre per year)}$$

The income generated through paddy cultivation for one season of seven months is Rs.7,552 per acre.The employment generated is to the tune of 48 man days per acre in paddy at the rate of Rs. 60. This includes all the work in the paddy field like: ploughing, building proper ridges for the standing water,sowing seedlings *(bith)*, the process of transplanting through the Process of removing seedlings from seed beds, making bundles of seedlings,transplanting, *(aage, nere and naati)* spraying of pesticides, weeding and harvesting, bagging, loading for transportation and storing the paddy in (*thuiah*) paddy storing structure made out of slit bamboo for the domestic use till the next harvest. Words in the parentheses are Synonymous in the native language, Kodava.

Local labour and labour from outside the district who normally migrate during harvest get employment.It provides 199 man days of employment, which is four times more than paddy (the duration of crop and harvest is three months more than that of paddy). Land preparation takes more labour which includespreparing of raised beds and give proper drainage. There is continuous work to maintain the beds weedfree till the harvest.

The disadvantage in the production of ginger is that, the growers cannot wait for a better price, once the crop has come to harvest. Because the crop losses its weight if kept after harvesting, and cannot delaythe harvest since it becomes hallow. In case if it is attacked by any disease like rhizome rot, then thecomplete crop is a failure. Therefore, majority of the farmers lease their land for ginger cultivation without wanting to the risk (out of 453 acres of ginger cultivation 432 acres is leased out as shown inthe Vide Table 2).

In spite of this, few farmers in the study area (to the tune of 21 acres) (Vide Table 2), chose to cultivate ginger and **gamble** due to its higher returns. **Besides, the production cost is four times higher thanthat of paddy and the risk factor is to the tune of total investment** (having no by product). Therefore,they intend not to leave the field uncultivated for two years, without having a thought about groundwater recharge as discussed before. Thus,

local employment is lost for 3 years i.e., without having paddy work for one year and by not cultivating anything on the same land for another 2 years. Besides, ginger growers from outside the district / state usually employ their own labour force from their own place /outside and keep on shifting the cultivation area.

The following chart 1 summarizes the analysis on the Economic and Environmental Implications of Water Scarcity on Cropping Pattern, Employment and Income

Chart 1: SWOT Analysis on the Economic and Environmental Implications of Water Scarcity on Cropping Pattern, Employment and Income

Hypothetical Characteristics	STRENGTHS	WEAKNESSES	OPPOR-TUNITIES	THREATS
1. Change in cropping pattern from paddy to ginger increases the income, employment but aggravates water scarcity and degrades soil resources.	*Increases income *Increases employment *Earns foreign exchange *Relief from cumbersome paddy work	*Investment on ginger is a gambledue to high risk ofdisease (rhizome rot) *No by-products in ginger *Increased use of fertilizer & pesticide ***Local employment** is lostdue to leasing out the land to the outside investors, who employ their own labours *No crop rotation followed *Land left uncultivated for twoyears for rejuvenation *Employment lost for two years	*To halt conversion of paddy fields to ginger	*Water scarcity *Shortage of foodcrops *Water pollution *Soil degradation due to decline in the activities of soil micro flora *Unproductiveland *Ground water depletion due tolack of recharge from the fields.

2. Paddy is grown twice a year only in areas where there is conjunctive use of rain water and perennial stream (fetching more income and employment)	*More income *More employment *Food security *Optimum utilization of water resources	*Profits re-invested for the 2nd crop *Increased application of fertilizer due to increased cropping intensity *Cumbersome work	Nil	*Early occurrence of diminishing returns to scale *Insufficient water to adopt coping mechanism for critical growth period of coffee
3. Due to water scarcity profitability from plantation is reduced.	Nil	*Higher investment *Profit is re- invested *Burden of debt *Profit is reduced *Water is a fixed resource	*Rainwater harvesting *Watershed management	*Re-investment cycle perpetuates

1. **Income** = *f* **(**employment opportunities**)**
2. **Employment =** *f* **(**investment on coping mechanism, change in crop pattern from paddy toginger**)**
3. **Profit =** *f* **(**water**)**

Recommendations and conclusion

Following are the recommendation to mitigate the problems

- Legal ban on further deforestation with immediate effect.
- Steps towards afforestation.
- Insurance to crops to be made compulsory (especially paddy and ginger).
- Paddy cultivation to be encouraged.
- Ginger cultivation to be limited to some areas with organic farming methods to restore the lostfertility of land.
- Water drained from the ginger field is to be stored.
- Compulsory steps to be taken towards percolation and storing of rain water. Adequate creditfacility is to be provided for rain water harvesting structures at low interest rates.
- Spreading water literacy amongst the masses by creating awareness among people regarding the problem and scarcity and intensity of waterproblems

immediately

- Permission to rig bore-wells to be linked to rain water harvesting (extraction of groundwatershould be regulated with respect to recharge).
- The possibility of adopting co-operative water management is to be looked into with communityand people's participation at large.
- Policy changes in all sectors with respect to their development and to their impacts on othersectors' development to be made possible.
- Strong leadership and continued efforts of people are necessary to bring in fundamental changesin the policies and practices.

Ginger (*Zingiber officinale* Roscoe) and turmeric (*Curcuma longa* L.) consumption in the United States (U.S.) is rising partly due to an increased consumer interest in their medicinal properties [29]. Both crops are described as "superfoods" due to the high concentration of bioactive compounds and phytochemicals in their rhizomes. Ginger has more than 400 health-related compounds, including paradols, terpenoids, shogaols, and gingerols. Over 230 compounds have been identified in turmeric, including various phenolics and terpenoids (curcuminoids) [30] with antiviral, antibacterial, antidiabetic, antioxidant, and anti-inflammatory properties [31]. The unique flavor, color, and preser- vative characteristics of these rhizomes also make them attractive supplements for food and beverage uses.[32] Currently, commercial production is primarily limited to Asian and South American countries, and a few small-scale farms in Hawaii and the southern U.S. [33]

ACKNOWLEDGEMENTS: I thank the respondents of Madikeri and Virajpet taluk of Kodagu district, Karnataka state, India, for their cooperation and support in providing the requisite information for this study.

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