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Impact of Long Term Dry Land Based Integrated Farming System on Resource Usage, Sustainability and Profitability of Small Holding Farmers of Semiarid Climate Condition of Karnataka

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ABSTRACT

In India 60% dry land agriculture area exemplifies the arid and semi-arid regions and they play a dominant and crucial role in providing 45% of food grains and feed for human and livestock, but it's not enough to meet the increasing world population. It creates a tremendous potential untapped for the upgradation of agriculture through innovative form of blending crop with livestock farming system which stabilize the food production intern makes agriculture more profitable and sustainable. A field study was conducted during 2015–20 to study the impact of dry land based integrated crop livestock system (DCLS) for profitability, carbon emission and sustainability under dry condition. Profit was improved by 55.5% in crop, horticulture and livestock integrated farming system over conventional cropping system. The model size is 3972 m^2 which contributed a net profit of $ 599/year and generated employment of 176 man days/acre/year. In DCLS, the recyclable farm waste material produced 6.35 tons which was converted into organic manures of 2.97 tons, their re-usage within the system with its fertilizer's cost of $ 38.05 per year with its form it was a sustainable model for dry situations with less carbon-emitting and profitable model.

Keywords Dry land, Energy, Employment, Integrated farming system, Resource recycling.

INTRODUCTION

Dry land agriculture is the backbone of Indian agriculture which shares major portion to Indian economy and occupy 68% of the total net sown area (136.8 m ha) and spread over 177 districts (Vairavan *et al.* 2000). The analysis showed that 7100 km^3 of water is obligatory for food production in both dry land and irrigated situation especially, the dry land requires 5500 km^3 of water per year (Weels 2011).

With uncertain climatic condition which is supporting 90% farming activities under dry land situation. Similarly, area where rainfall is 250–300 mm, the mixed farming encompassing agroforestry system, mixed cropping, livestock and pasture management are main livelihood optional farming and also where rainfall is more than 300 mm crops and cropping system diversification, agroforestry

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Table 1. Dryland integrated farming system model component wise area and per cent.

Crop components	Area (m^2)	Per cent
Ragi + Fieldbean (4:2)	500	12.59
Maize + Pigeon pea (8:2)	1000	25.18
Minor millet (navane)	600	15.11
Groundnut	253	6.37
Horticulture unit (vegetables)	753	18.96
Fodder block	250	6.29
Boundary plantations (castor and curry leaf)	268	6.75
Animal components dairy shed and sheep shed (cow- 2 no's and sheep- 5 no's)	66	1.66
Farm pond (10 × 10 × 3 m^3)	300	7.55
Total	3972	100

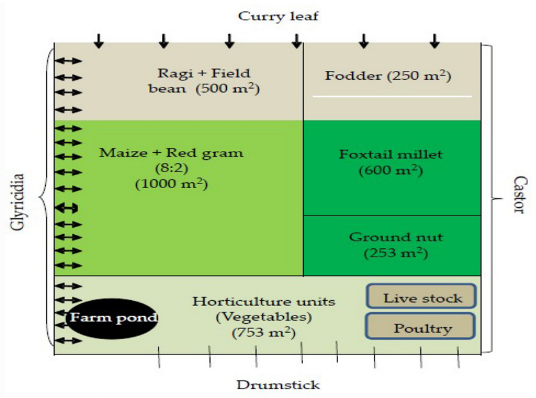

Fig. 1. Plan of layout for dry land based IFS model (< 1.0 Acers).

and livestock rearing are subsistence farming was suggested by Bhati and Joshi (2007). The soils in dry land characterized as low in organic carbon, heavy in texture, low fertility, less water retention capacity and high erodibility are the major edaphic factor that limits the crop production. Cropping in arid and semi-arid region have many emerging challenges like climate change leading to frequent droughts, depleting groundwater, infructuous investments on wells, imperfect markets and lack of competitiveness of dry land agriculture (Gill *et al.* 2009).

DCLS includes all these good agricultural practices and reduces erosion and increases organic matter in the soil surface (Paramesh *et al*. 2014). So, in this regard, the study was conducted to identify a technically feasible, economically viable and eco-friendly integrated dry land crop-livestock system by integrating cropping with allied enterprises.

MATERIALS AND METHODS

Experimental site

The study was undertaken as a part of All India Coordinated Research Project on integrated farming system, which was initiated in 2015 under semi-arid tropic situation of lowland ecology at Agricultural and Horticultural Research Station, Kathalagere, with the Assistance from ICAR- Indian institute of farming system research, Modipuram (UP) under Bhadra command area of Davanagere, Karnataka, India (13°21 N latitude and 76°15[1] E longitudes at an elevation of 561.6 m above the MSL). The present study was carried out during 2015 to 2020, The soils are classified under Alfisols (Sandy clay loam in texture). The soils are acidic to neutral in reaction (6.6) and low to medium in fertility. The organic carbon ranges between 0.52 to 0.61%, available P varies from 12.00 to 26.50 kg ha^{-1} and available K varies from 176.00 to 237.02 kg ha^{-1}.

Farming and cropping system

Less than one acre of dry land based integrated farming system model with a total area of 0.39 ha which includes agriculture crops like Maize, Pigeon pea, Ragi, Groundnut and Foxtail millet and Horticulture crops like Field bean, Cluster bean, Okra (Bhendi), Ridge gourd along with dairy, forage crop such as multi-cut sorghum and border planting of caster. The crop was sown during *kharif* season along with vegetable crops (Table 1) and (Fig. 1). All the crops were sown during July with proper spacing and harvested in November.

Maize equivalent yield

Maize equivalent yield (MEY) was determined by converting the economic yield of agriculture crops, horticulture crops, milk yield and meat production on the basis of their marketable price prevailing during the period for each crop, including maize and expressed in kg per unit area.

$$\text{MEY (kg)} = \frac{\text{Yield of component crops (kg)} \times \text{Price of component crops (S/kg)}}{\text{Price of maize (S/kg)}}$$

Economic analysis

Cost of cultivation and gross return were computed form all the enterprises by taking into market rates of inputs and outputs at Agriculture Produce Market Committee, Davanagere.

Net returns (*S/ha*) = (*Gross returns* (*S/ha*)–*Cost of Cultivation* (*S/ha*)

$$\text{Benefit cost ratio} = \frac{\text{Gross returns (S/ha)}}{\text{Cost of cultivation (S/ha)}}$$

Employment generation

Employment generation was calculated for various components of the integrated crop-livestock system. Farm Family member engaged in various activities throughout year with eight working hr is considered as a 1 man-day by using formula (Anup *et al.* 2021).

$$\textit{Man days (man days)} = \frac{\textit{Working hours}}{8}$$

Greenhouse gas emission

To identify the sources and sink of greenhouse gases viz., methane, nitrous oxide and carbon di oxide in the existing DCLS model of southern transitional zone of Karnataka, work has been initiated the model consist of different cropping system as maize + pigeon pea (1000 m^2), foxtail millet (600 m^2), *ragi* + field bean (500 m^2), groundnut (250 m^2), sheep (4+1), dairy (1+1), fodder unit (250 m^2), horticulture crops (753 m^2), vermicompost (1 no) also maintained in the boarder castor and curry leaf were established.

The greenhouse gas emission from different components of the IFS model predicted using the excel tool released by the Indian institute of farming system research, Modipuram. Meerut, Uttar Pradesh using the IPCC guidelines. The data are worked out based on already available predicted value fertilizers usage. Machinery usages and chemical usage for different cropping sequence and other component was converted into carbon di oxide equivalent between components for easy comparison

$$\text{Emission} = \text{E} \times \text{EF}$$

Where emission = Annual emission in units of kg of CO_2 eq. per farm
A = Activity data (kg of N used, liters of fuel used.)
EF -Emission factor = IP
CC default emission factors of country specific emission factors.

Soil carbon stock determination

Samples were collected at 15 cm interval from 0–105 cm depth of soil, from all the components of DCLS model, for soil organic carbon estimation a specific volume of soil samples were collected, air-dried, crushed and sieved through 2 mm diameter sieve. 5 grams of the sieved soil was used for SOC determination. Whereas core sampling method was used for BD estimation.

$$\text{BD (g/cc)} = \frac{\text{Mass of oven dry soil (g)}}{\text{Total volume of soil (cc)}}$$

Based on the soil analyzed data, considering soil organic carbon concentration, bulk density (BD) and soil depth (Manjunath *et al.* 2012) soil organic carbon was estimated using the following formula.

$$\text{Carbon (Mg C/ha)} = \frac{\text{Soil organic carbon (g/kg)} \times \text{Soil bulk density (mg/m}^3\text{)} \times \text{Depth of soil (cm)} \times 10}{100}$$

Analysis of soil

Soil samples were collected at 0–30 cm depth from the field after the completion of each cropping sequence. Soil pH determined through glass electrode by pH meter and EC through conductivity bridge as per the method by using a soil water suspension at ratio of 1:2.5 (Sparks 1996). The soil organic carbon was determined by wet digestion method (Sparks 1996) and expressed in percentage. Soil available

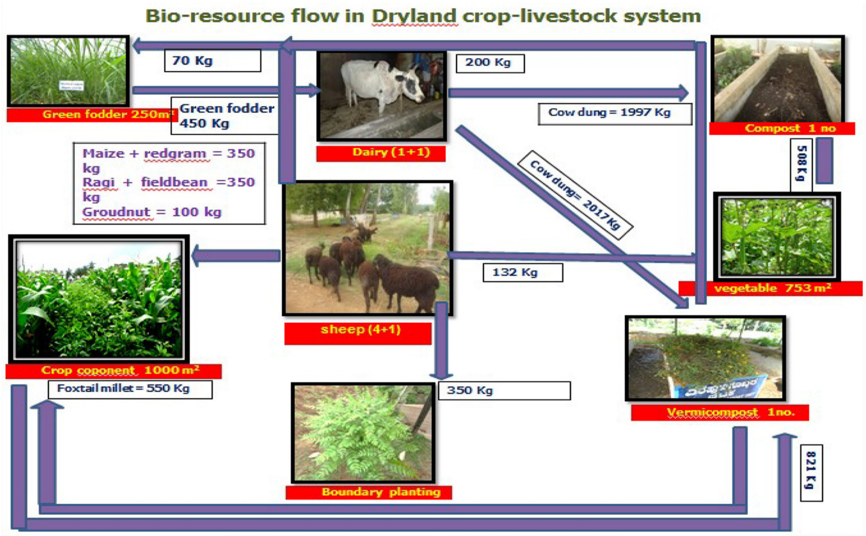

Fig. 2. Bio resource flow in dryland crop livestock system.

nitrogen (Sharawat and Buford 1982), phosphorus and potassium was estimated as per standard method explained by Sparks (1996) and expressed in kg/ha.

Table 2. Influence of DCLS dry land integrated farming system on productivity and profitability of different component (mean of 2015- 2020). Note : 1 dollar =74.29 rupee, Sustainability indices of IFS.

Components	Area (m^2)	Maize equivalent yield (MEY) (kg/unit area)	Cost of cultivation (Rs/ year)	Net returns ($/year)	B:C ratio
Crop unit					
Maize + Pigeon pea (8:2)	1,000	480	79.2	95.8	2.82
Ragi + Fieldbean	500	220	34.4	31.3	2.02
Groundnut	253	107	12.0	16.9	2.46
Foxtail millet	600	213	27.6	64.0	4.05
Fodder	250	170	10.1	-	-
Horticulture unit					
Okra (bhendi)	250	65	12.4	8.0	1.97
Clusterbean	250	42	9.4	6.7	2.22
Ridge gourd	253	40	10.1	3.8	1.65
Border (castor)	268	185	13.7	43.6	5.76
Animal component					
Dairy (2 no's)	66	1079	70.7	215.9	4.75
Sheep (5 no's)		621	61.3	113.2	4.00
Total	3657	3222	340.9	599.2	3.17
	Mean				

Sustainable yield index 0.48 Sustainable value index 0.64
System economic efficiency 128

Microbial analysis

The rhizosphere soil samples were collected from experimental plot before initiation of experiment and during experiment and it was analyzed for different soil micro-organisms viz., total bacteria, total fungi, total actinomycetes population using standard dilution plate count technique.

Data analysis

The data obtained were tabulated and necessary graphs and tables were prepared with the mean and standard deviation (SD) values using MS excel program. The data on production, productivity and income presented in this manuscript are the average of four years i.e., 2015 to 2020.

RESULTS AND DISCUSSION

Maize equivalent yield and sustainability indices

Depending on agro-climatic condition and rainfall pattern of the situation the possible dry land base cropping system with livestock integration reduce the risk of crop failure under varied rainfall other than crop activities which are support farms livelihood se-

Table 3. Influence of DCLS dry land integrated farming system on recycling of farm waste of different components (Mean of 2015 - 2020). Note : Vale of each unit = 0.0269 $.

Components	Area (m^2)	Quantity of waste produced (kg/lit/ no.)	Total value of recycled product $
Crop unit			
Maize + Pigeon pea (8:2)	1000	366	9.8
Ragi + Fieldbean	500	240	6.5
Groundnut	253	15	0.6
Foxtail millet	600	200	8.1
Horticulture unit			
Okra (bhendi)	250	508	13.7
Clusterbean	250		
Ridge gourd	253		
Animal component			
Dairy (2 no's)	66	4015	9.5
Sheep (5 no's)		1012	40.8
Total	3657	6356	86.2

curity. Similarly, in DCLS integrated farming system (Table 2) crop component such as maize + pigeon pea produced maximum MEY (480 kg) which was followed by ragi+ field bean intercropping system. In Horticulture system vegetable crops of okra recorded maximum MEY (65 kg) then cluster bean. However, in livestock system dairy and sheep rearing gave stability to the dry land system productivity. The

Table 4. Influence of DCLS dry land integrated farming system on quantity of manures production and its nutrient content (Mean of 2015 – 2020).

Recyclable farm waste	Quantity (kg)	Nutrient content (%) and total recyclable nutrients (kg) N (kg)	P (kg)	K (kg)	Quantity of fertilizers (kg)	In terms of rupees $
Sheep dropping	1012	2.28	0.74	1.66	110.79	8.03
		23.07	7.49	16.8	(Urea)	
Vermicompost	1280	1.57	1.28	1.16	222.31	14.28
		20.1	16.38	14.85	(SSP)	
Compost	680	1.16	1.72	0.64	59.76	15.73
		7.89	11.7	4.35	(MoP)	
Total	2972	51.06	35.57	36.00	-	38.05

Table 5. Influence of DCLS dry land integrated farming system on employment generated in different components (Mean of 2015 - 2020).

Components	Area (m^2)	Employment generated
Crop unit		
Maize + Pigeon pea (8:2)	1,000	30
Ragi + Fieldbean	500	13
Groundnut	253	6
Foxtail millet	600	17
Fodder	250	3
Horticulture unit		
Okra (bhendi)	250	3
Clusterbean	250	2
Ridge gourd	253	2
Border (castor)	268	11
Animal component		
Dairy (2 no's)	66	57
Sheep (5 no's)		31
Total	3657	176

sustainability index for dry land integrated farming system was calculated and presented in Table 2. The total sustainability yield index of dry land integrated farming system model was 0.48, sustainable value

Table 6. Carbon sequestration in various components of DCLS dry land integrated farming system (Mean of 2015 to 2020).

Components	Area (m^2)	Bulk density (mg/m^3)	Soil organic carbon (g/kg)	Initial carbon stock (mg C/ha)	Carbon stock (mg C/ha)	% Increases in carbon sequestration over initial value
Crop unit						
Maize + Pigeon pea (8:2)	1,000	1.31	4.43	8.70	8.03	8.24
Ragi + Fieldbean	500	1.28	4.49	8.68	8.02	8.19
Groundnut	253	1.31	4.29	8.44	7.80	8.16
Foxtail millet	600	1.28	4.37	8.30	7.68	8.07
Fodder	250	1.30	4.30	8.40	7.76	8.14
Horticulture unit						
Okra (bhendi)	250	1.33	4.21	8.36	7.73	8.11
Clusterbean	250					
Ridge gourd	253					
Total	3657	1.30	4.35	8.48	7.84	8.15

Table 7. Net GHG emissions in dryland IFS model (CO_2-e in kg).

Sl. No.	Components	CO_2-e in kg
Carbon source		
1	Cropping system	
	Maize + Pigeon pea (8:2) cropping system	323.2
	Ragi + Fieldbean (4:2) cropping system	161.3
	Minor millet (Navane)	144.2
	Groundnut	148.5
2	Vegetable unit	
	Cluster bean and bhendi	156.8
3	Boundary plantation (Castor and Curry leaf)	4.0
4	Dairy (2+1)	1677.1
	Fodder crops	30.2
	Sheep	226.8
	Energy used for household	167.0
1	Agro-forestry	63.1
2	Total bio-mass/compost added	4856.1
	Total carbon Source	3039.1
	Total carbon sink	4919.2
	GHG- IFS	-1880.1

index 0.64 and sustainable economic efficiency was 128.

Profitability

Suitable combination of enterprises under dry land situation gave important as management and economic standpoint help to measure profitability using cost and return of the investment in the DCLS dry land integrated system. Similarly, livestock system of dairy and sheep rearing contributed 54% to the net return (Table 2). Among cropping activities maize + pigeon pea intercropping system shared 15% ($95.8) to the total net profit of the DCLS farm family followed by foxtail millet. However, horticulture components (vegetable crops okra and cluster bean) contributed 3% of total income.

In DCLS blending of vegetable, food crop, animal component and vermicompost resulted in higher profit due to mixing of various proposition of income generative enterprises and use of recycled products within the system than cropping alone as reviewed by various workers Channabasavanna *et al.* (2009) and Shivani *et al.* (2010) observed that loss of nutrient from the field as those crops removed were returned in the form of cattle manure in integrated farming

Table 8. Influence of DCLS dry land integrated farming system on soil properties and available nutrients (Mean of 2015 to 2020).

Treatments	pH (1:2)	EC (1:2)	OC (%)	Av. P (kg/ha)	Av K (kg/ha)
Maize + Pigeon pea	6.75	0.19	0.58	26.87	241.68
Ragi +Field bean	6.78	0.18	0.56	25.79	249.16
Groundnut	6.76	0.18	0.54	24.20	252.92
Foxtail millet	6.79	0.18	0.55	24.39	251.88
Fodder	6.71	0.20	0.56	25.29	250.71
Vegetable	6.73	0.17	0.54	24.31	241.22
Mean	6.75	0.18	0.56	25.14	247.93
Initial status	6.67	0.21	0.51	21.67	235.87

system by recycling of goat manure, and modified form of cattle waste to cropping there by minimize the investment on external source of nutrient and enhance the profitability. Basavanneppa and Gaddi (2017) proposed that inclusion of dairy animal to existing cropping patterns improves the income (net return) and employment sustainability, milk yield was sustained in cow when integrated with the crop component sorghum and cowpea raised at 2:1. Kumar *et al.* (2017) reported that goat and sheep provided the most valuable source of income in the semiarid tropics and the sale of goat contributed 30.0% of total farm income in India.

On farm bio-resource recycling

Integration of cropping activities along with vegetable, dairy, sheep and vermicompost by reorientation of agriculture with utilization of output of one as a valuable input for other enterprises (Fig. 2) which was reduces dependency on external or market purchased input especially chemical fertilizers. Similarly, various farm of waste generated in the DCLS dry IFS system its volume would be 6356 kg/Lit/No and its value in terms of $ 86.2 and recyclable manures generated from waste was 2972 kg with nutrients composition of 51.06 kg of nitrogen, 35.57 kg of phosphorus and 36 kg of potassium respectively and its equivalent to 38.05 dollar of chemical fertilizer (Tables 3 and 4).

Employment generation

Dry land situation where the farm families remain

Table 9. Microbial population as influenced by various components of DCLS dry land integrated farming system (Mean of 2015- 2020).

Treatments	Fungi	Bacteria	Actino-mycetes
	10^3 CFU (g^{-1} soil)	10^6 CFU (g^{-1} soil)	10^3 CFU (g^{-1} soil)
Maize + Pigeon pea cropping system	36.4	74.6	27.4
Ragi + Field bean	32.2	70.9	26.0
Groundnut	28.2	69.4	26.1
Foxtail millet	30.9	64.7	23.7
Fodder	32.5	74.3	25.6
Vegetable	24.7	57.6	17.6
Mean	30.8	68.6	24.4
Initial status	20.0	52.0	10.0

unemployed for two thirds of the year as cropping activities occupies only a part of the year (*kharif* season). Inter linking enterprises in the DCLS integrated farming system increase the scope for employment in the system. Similarly, in DCLS dry integrated farming system generate 176 man days per annum in which more employment generative activities were blend (Cropping +sheep rearing +dairy + horticulture +vermicomposting) to create more working hr in each activity. Crop activities shared 66 man days which was 33.3% less than animal activities due to grazing of animal, milking and shade cleaning requires more man power (Table 5). Combining of cropping with other enterprises in DCLS would increase the labor requirement and thus provide the scope to increases the employment opportunities for family labors round-the-year without giving much relaxation during lean season as in traditional agriculture (Ravisankar *et al.* 2007). Similarly, under dry land conditions, rearing of sheep or goat generated more employment opportunities than traditional cropping system (Jayanthi *et al.* 2009). The diversified nature of enterprises in integrated farming system provide a lot of employment opportunities and keeps the farmers and their family members engaged in farm work all around the year and helps them in improving their socio-economic condition. (Kumar *et al.* 2011, Mynavathi and Jayanthi 2015).

Carbon sequestration and greenhouse gas emission

Long term use of organic source of nutrients like compost and vermicompost and *in situ* green manure prepared by utilizing farm waste, animal waste, on farm crop residue incorporation to crops which had high potential to store carbon to the DCLS field, which acts as a store house for soil organic carbon, resulted in 8.15% (Table 6). The DCLS integrated farming system has showed negative trend with respect to greenhouse gas emission (-1880.1 CO_2-e in kg). The total carbon sink for GHG emission noticed in DCLS dry land IFS model was 4919.2 CO_2-e in kg which is higher than the source (3039.1 CO_2-e in kg), depicted in Table 7.

Integrated farming system provides excellent opportunity for residue recycling which in turn enhances not only soil organic carbon but also diminish emission of GHG by reducing use of mineral fertilizers, in IFS one more scope for maintaining greenery vegetation like forest trees and horticulture crops grown on farm and also around the farm boundaries which sinks the greenhouse gases. Crop (field crop and vegetable) and boarder plantation of castor, drumstick and curry leaf with livestock blending has both complementary and synergistic interaction in terms of effective utilization of carbon source for photosynthesis in the system. Higher vegetative cover which sink the more carbon and also low external input use in the system in turn make the system eco-friendly as revealed by Robertson and Grace (2003), Lal (2004) Petersen *et al.* (2005), Smith *et al.* (2008).

Soil fertility and microbial activity

DCLS which is an interrelated and interlocking production system, that encourage addition of a lot of organic sources of nutrients in the system by resource recycling it might provide a good substrate for the growth of the beneficial micro-organisms which in turn resulted in rapid mineralization and solubilization of nutrients that improves nutrient availability to the crops and also favorable nutritional balance and beneficial effects like increased organic carbon by 9%, 16.01% available phosphorus and 5% available potassium in the soil against initial (Table 8). Combination of cropping system with the livestock enterprises in DCLS has produced enormous quantity of organic manures and added to the soil in crop growing season on regular basis over the period which

Table 10. Influence of AHLF integrated farming system on nutrient budgeting (Pool of 2015 -2020).

Components	Particulars	N	P	K	Nutrient saving in terms of $
Maize + Redgram					
(1000 m^2)	Rec. dose of fertilizers as per PoP	17.5	7.2	6.2	8.1
	Nutrient added through resource recycling (sheep litter 350 kg)	10.1	2.4	6.2	5.2
	Nutrient added through fertilizers	7.4	4.8	0.0	2.9
Multi cut sorghum	Rec. dose of fertilizers as per PoP	6.3	3.0	2.8	3.3
(250 m^2)	Nutrient added through resource recycling (sheep litter 70 kg)	2.0	0.5	1.3	1.1
	Nutrient added through resource recycling (vermicompost 200 kg)	4.2	1.1	1.5	2.1
	Nutrient added through fertilizers	0.0	7.0	51.0	0.2
Foxtail millet (500 m^2)	Rec. dose of fertilizers as per PoP	5.6	2.0	2.8	3.0
	Nutrient added through resource recycling (vermin compost 550 kg)	5.6	1.5	2.7	2.6
	Nutrient added through fertilizers	0.0	0.5	0.0	0.4
Ragi + Fieldbean (500 m^2)	Rec. dose of fertilizers as per PoP	10.0	4.7	6.2	6.1
	Nutrient added through resource recycling (sheep litter 350 kg)	10.0	2.4	6.2	5.2
	Nutrient added through fertilizers	0.0	2.3	0.0	0.9
Groundnut (250 m^2)	Rec. dose of fertilizers as per PoP	2.5	1.8	1.6	1.8
	Nutrient added through resource recycling (sheep litter 100 kg)	2.5	0.7	1.6	1.4
	Nutrient added through fertilizers	0.0	1.1	0.0	0.4
Horticulture (753 m^2)	Rec. dose of fertilizers as per PoP	3.8	3.2	3.3	3.2
	Nutrient added through resource recycling (sheep litter 132 kg)	3.8	1.0	2.4	2.0
	Nutrient added through fertilizers	0.0	2.2	0.9	1.2
Castor + Curry leaf	Rec. dose of fertilizers as per PoP	2.7	1.6	1.3	1.3
	Nutrient added through resource recycling (sheep litter 350 kg)	2.5	0.8	1.3	1.2
	Nutrient added through fertilizers	0.2	0.8	0.0	0.03
	Total amount nutrient saved by recycling of dollar				20.9

in turn enhanced the number of microbial population (by 54.1% fungi, 31.88% bacteria and 44% actinomycetes) in compare with initial value (Table 9).

Nutrient budgeting

Field and vegetable crops under dry situation and their nutrient requirement were very high so using only chemical fertilizer in the system contributes higher cost of production and environmental hazards. In DCLS integration or proper blending of field + vegetable crops with animal components and regulated mechanism of natural resources usage into farming activities in which off-farm and on farm waste utilized effectively for sustain farm income and productivity. The total amount of fertilizer required for 3972 m^2 of DCLS integrated farming system including field + vegetable crops the fertilizer recommendation was 48.3:23.6:24.2 kg of NPK its cost $ 26.8. But resource recycling in the form of vermicompost and compost shared 41.1:10.2:24 kg of NPK to the total fertilizer cost $ 20.9 was saved and which account 28.8% reduction in cost of production (Table 10).

In present DCLS integrated farming system the by-product of livestock and crop residue used to produce compost and vermicompost and these organic sources added to crop stand which enhance the organic content and microbial activity in the same which reduces the usage of chemical fertilizers and minimizes the spending's on it there by make farming more sustainable one. Mynavathi and Jayanthi (2015) stated that pair of drought cattle produce 12 tonnes of manures was diverted to resource recycling processes in a crop-livestock integrated system contributing to enhance the soil fertility and organic enrichment of soil in dry land and rainfed environments. Vairavan *et al.* (2000), Kumar *et al.* (2017) similar results were notice that integrated farming system produced 462.50 kg of organic manures being recycled by farm waste from different components which was reduced 18-20% fertilizers cost. The integrated system had natural regulatory system which includes on and off farm waste was effectively utilized for production of organic manures their by the production cost beard by fertilizers was reduced to a greater extent (Jayanthi *et al.* 2009).The shoot up in microbial biomass within the DCLS model was attributed to the effective recycling of the farm wastes which add lots of organic carbon available from crop and animal by-products which act as a carbon and energy source for microbes and their quick build-up in the soil Kiran *et al*. (2015). Higher microbial population registered in integrated farming system by the application of organics source of nutrient in the system as revealed by Mallesha *et al.* (2017). Similarly, in integrated farming system surplus manure produced from different sources which safeguards the soil health as reported by Desai (2013), Basavanneppa and Gaddi (2017), Vinodakumar *et al.* (2017), Channabasavanna *et al.* (2009).

CONCLUSION

In India major cultivated area comes under dry land farming where rainfall is limiting factor for crop production and variation in rainfall the crop failure is more common. The re-orientation of agriculture system in dryland farming is proper composition of agriculture crop with subsidiary enterprises like dryland Horticulture, Livestock. Perennial forest trees and water harvesting structure make farming more profitable under aberrant weather condition a promising one which system more sustainable. Semiarid climatic condition the annual rainy days it might be 60 - 64 days with average precipitation in the crop growing period was 578.9 mm and temperature ranging from 20.6°C to 33.9°C it is ideal to adopt integrated for small holding farmers for enhances the productivity and profitability and also to meets the nutritional requirement of the farm family. This system is a diversified in nature with more working force involved which in turn generate more employment and income generative activities throughout the year. Under DCLS farming system nutrient utilized efficiently, out of 26.8 dollar spending on fertilizer 20.9 dollar has been saved by proper resource recycling which improves carbon stock in the system and it is a eco-safety with minimum GHG emission.

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