Mysore J. Agric. Sci., 60 (2) : 1-10 (2026)

Impact of Crop Residue Mulching and Diversified Cropping Systems on Soil Carbon Dynamics in *Alfisols*

AISHWARYA GOLSHETTI[1], S. B. YOGANANDA[2], M. A. ANANTHAKUMAR[3], M. N. THIMMEGOWDA[4] AND P. THIMMEGOWDA[5]

[1&2]Department of Agronomy, [3]Department of Soil Science & Agricultural Chemistry & Water Technology Centre, College of Agriculture, [5]Zonal Agricultural Research Station, V. C. Farm, Mandya - 571 405

[4]Department of Agrometerology, College of Agriculture, UAS, GKVK, Bengaluru - 560 065

e-Mail : bharatiashwa1976@gmail.com

AUTHORS CONTRIBUTION

AISHWARYA GOLSHETTI :
Conceptualization & design, data analysis & curation and editing

S. B. YOGANANDA :
Supervision, manuscript prepration and design

M. A. ANANTHAKUMAR ;
M. N. THIMMEGOWDA AND
P. THIMMEGOWDA :
Critical feedback and helped to shape the research

Corresponding Author :
AISHWARYA GOLSHETTI

Received : November 2025
Accepted : March 2026

ABSTRACT

The study evaluated the impact of crop residue mulching combined with diversified cropping systems on maize equivalent yield, plant carbon sequestration, soil organic carbon content, and total soil carbon stock in *Alfisol* soils of the Bankanahalli micro-watershed during the 2024 summer-*kharif-rabi* seasons. *Alfisol* A split-plot design was used with mulching (M_1) and non-mulching (M_2) as main plots and six cropping system treatments as subplots, integrating maize, dhaincha, greengram and field bean. Results demonstrated that mulching significantly increased maize equivalent yield from 7.24 t/ha (M_2) to 7.79 t/ha (M_1), a 7.6% enhancement. The Dhaincha-Maize+Greengram system recorded the highest maize equivalent yield (8.04 t/ha), outperforming Greengram–Maize (6.94 t/ha). Plant carbon sequestration was higher in mulched plots (5.44 Mg/ha) than non-mulched (4.15 Mg/ha), with Dhaincha-based systems showing maximum carbon storage (6.35 Mg/ha). Soil organic carbon content and total soil carbon stock also improved with mulching and legume intercropping, with the highest values recorded in mulched Dhaincha-Maize+Greengram (0.63% and 9.92 t/ha, respectively) and lowest in non-mulched Greengram-Maize (0.42% and 6.61 t/ha). Interaction between mulching and cropping systems showed the highest productivity in mulched Dhaincha-Maize+Greengram (8.65 t/ha).The significance of this study lies in demonstrating how integrated crop residue mulching and legume-based diversified cropping can substantially improve crop productivity and enhance soil carbon dynamics in *Alfisol* soils. These management practices improve soil moisture conservation, nutrient cycling, and biological nitrogen fixation, which are essential for sustainable agriculture in tropical rainfed systems. By improving soil structure, fertility, and carbon sequestration, the studied approach offers a valuable strategy for mitigating land degradation and supporting climate-resilient food production in resource-poor environments.

Keywords : Cropping Systems, Dhiancha, Field bean, Greengram, Maize carbon sequestration

CROPPING systems are fundamental to agricultural productivity and sustainable land management. Incorporation of diverse crops, particularly leguminous green manure crops like Dhaincha and Greengram, enriches soil nitrogen through biological fixation, improving nutrient cycling and soil fertility. Green manuring boosts soil organic matter (SOM), enhances microbial activity and sustains crop yields. Conservation agriculture (CA) integrates minimum soil disturbance, crop residue retention and crop diversification to promote healthy soils. Mulching, a vital CA practice, involves covering soil with organic residues, reducing water evaporation, moderating soil temperature, suppressing weeds and adding organic carbon. Together, these practices improve soil structure, increase water-holding capacity and elevate soil organic carbon (SOC) (Lal, 2004, Sahu *et al.,* 2021, Singh & Patel, 2023 and Yadav, Choudhary, & Singh, 2017).

However, soils in watershed areas, especially *Alfisols*, face severe degradation due to intensive cultivation, erosion, nutrient depletion, and loss of organic matter. In India*, Alfisols* soils have shown alarming declines in soil organic carbon-up to 47 per cent under cultivation compared to forest soils-and experience significant topsoil erosion, reducing soil depth and fertility (Aulakh, 2015, Garg *et al.,* 2021 and Sahu *et al.,* 2021). This degradation undermines water retention and crop productivity, posing a threat to food security in rainfed systems. Continuous residue removal and improper land management accelerate soil degradation, making conservation practices crucial (Garg *et al.,* 2021).

Integrating crop residue mulching with legume-based cropping systems provides an effective approach to restore soil carbon and improve moisture dynamics in *Alfisols*. Mulching preserves soil moisture by reducing evaporation, while legumes enhance nitrogen inputs, stimulating biomass production and organic carbon incorporation. This synergy improves soil physical and chemical properties and enhances resilience to climatic stresses. With this background, the study was aimed at evaluating the impact of crop residue mulching combined with diversified legume-based cropping systems on maize equivalent yield and crop growth parameters and assessing the influence of these practices on plant carbon sequestration and soil organic carbon content in *Alfisols* soils.

Material and Methods

Experimental Site

The soil at the study location was classified as *Alfisols*, exhibiting distinct physico-chemical characteristics typical of this soil order. *Alfisol*s generally have moderate to high base saturation due to the presence of essential nutrient cations such as calcium, magnesium, potassium and sodium, contributing to their comparatively good fertility among tropical soils. The soil texture generally features a lighter, more porous surface horizon underlain by a clay-enriched subsoil, known as an argillic horizon, which aids in water retention and nutrient availability. Organic carbon content is typically low in *Alfisol*s but can be enhanced through organic amendments like crop residue mulching and green manure cultivation. These soils possess moderate bulk density and porosity, facilitating effective root penetration and water-holding capacity essential for rainfed agriculture but remain susceptible to degradation by erosion and intensive management. Thus, the *Alfisols* at this site represents a fertile yet vulnerable soil system where integrated management practices focusing on mulching and legume-based cropping can sustainably improve soil organic carbon and overall soil health.

The bulk density observed, 1.03 g cc-1 was estimated using a core sampler, and the organic carbon status found was very low (<0.5 %) as determined by wet oxidation method following Walkley and Black 1934 all the other estimates were determined following the standard protocols.

Experiment Details

The study was conducted involving 2 main plots and 6 subplots, by adapting the split plot design involving 3 crops in the cropping system as subplots and crop residue mulching and non-mulching as main plots.

Maize equivalent yield

Maize Equivalent Yield (MEY) is a comparative measure used to evaluate the productivity of intercropping systems by converting the yields of all component crops into an equivalent yield of maize based on their respective market prices. This metric provides a standardized basis to assess the overall performance and economic value of diverse cropping combinations, facilitating a fair comparison across different intercropping practices. The formula to calculate MEY is typically takes the form formulated according to Sharma, 2024.

TABLE 1
Treatment details

Treatment	Summer	*Kharif*	*Rabi*
M1S1	Dhaincha	Maize	
M1S2	Dhaincha	Maize+ Greengram	
M1S3		Maize + Greengram	
M1S4		Green gram	Maize
M1S5		Maize	Field bean
M1S6		Maize + Greengram	Field bean
M2S1	Dhaincha	Maize	
M2S2	Dhaincha	Maize + Greengram	
M2S3		Maize + Greengram	
M2S4		Green gram	Maize
M2S5		Maize	Field bean
M2S6		Maize + Greengram	Field bean

$$MEY = Y_a + \frac{Y_b \times P_b}{P_a} + \frac{(Y_c * P_c)}{P_a}$$

Where,

Ya = Maize grain yield (kg/ha),

Yb = Yield of intercrop (kg/ha),

Yc = Yield of sequential crop (kg/ha),

Pa = Price of maize,

Pb = Price of intercrop,

Pc = Price of sequential crop

Plant Carbon Sequestration

For calculation of plant carbon sequestration we have followed AOAC International (2016) method of ash content determination by burning the accumulated dry matter in muffle furnace at 600Ú C using silicon crucibles (Fig. 1) through which the carbon sequestration was calculated as follows (steps a-d)

The ash content was measured using the formula a. and expressed in percentage. After which the volatile solids was calculated using formula b. later by using a and b the carbon content was calculated and expressed in percentage as depicted in c. later on the plant carbon was calculated using a, b and c. and depicted in d.

a. Ash content (%) = $((M_3 - M_1) / (M_2 - M_1)) \times 100$

Where,

M_1 = Mass of empty crucible

M_2 = Mass of crucible + sample (before heating)

M_3 = Mass of crucible + ash (after heating)

b. Volatile solids (%) = 100- Ash content (%)

c. Carbon content (%) = Volatile solids*(55/100)

For most biological materials the carbon content is between 45 to 60 percent of the volatile solids fraction. Assuming 55 percent (Adams *et al*., 1951, Richard T (retrieved on august 25, 2025)

d. Plant carbon sequestration = Carbon content (%) * dry weight (g) * plant population

e. For calculation of carbon stock by following Zeng *et al.* 2021 & expressed in t/ha by following formula

Fig. 1 : The left-over ash after the incineration

Carbon stock = Organic carbon (g/kg) * BD (g/cc)* depth (cm)* 10,

Organic carbon (%) determined through Walkley and Black (1934), Bulk density by core sampler method, at a depth of 15 cm.

Statistics

The data collected at various crop growth stages were compiled and statistically analyzed using the analysis of variance (ANOVA) procedure described by Gomez and Gomez (1984). An 'F' test was performed at the 5% probability level, and wherever the test showed significance, the critical difference (CD) was computed. The mean values corresponding to main plot, subplot, and their interactions were further compared through Duncan's Multiple Range Test (DMRT), employing the respective error mean sum of squares and associated degrees of freedom.

Results and Discussion

This section presents key findings on soil properties, crop yield, and carbon dynamics from the study. The results are interpreted to understand the effects of mulching and intercropping on soil health and productivity. The discussion links these findings to existing research and highlights their significance for sustainable agriculture.

Table 2

The combined SPAD, Green Seeker and Dry Matter Accumulation grams per plant as influenced by the mulching and cropping system.

Treatment	SPAD value		Green seeker value		DMA (g/plant)
	30 DAS	30 DAS	30 DAS	30 DAS	At harvest
Mainplot					
M_1	41.0 [a]	39.9 [a]	0.55 [a]	0.52 [a]	120.9 [a]
M_2	36.1 [a]	32.4 [b]	0.47 [a]	0.37 [b]	86.5 [b]
S.Em. ±	1.1	0.6	0.01	0.02	0.5
Subplot					
S_1	36.9 [a]	34.1 [bc]	0.48 [a]	0.4 [bc]	90.9 [cd]
S_2	40.9 [a]	40.3 [a]	0.56 [a]	0.49 [a]	119.3 [a]
S_3	38.8 [a]	36.1 [abc]	0.50 [a]	0.47 [a]	109.5 [b]

Continued....

Table 2 Continued....

Treatment	SPAD value		Green seeker value		DMA (g/plant)
	30 DAS	30 DAS	30 DAS	30 DAS	At harvest
S_4	36.3 [a]	32.5 [c]	0.48 [a]	0.39 [c]	88.5 [d]
S_5	38.0 [a]	35.5 [abc]	0.50 [a]	0.45 [ab]	99.0 [c]
S_6	40.3 [a]	38.7 [ab]	0.54 [a]	0.48 [a]	114.8 [ab]
S.Em. ±	2.2	1.1	0.03	0.01	2.1
INTERACTION					
M_1S_1	39.7 [a]	36.7 [cde]	0.52 [a]	0.46 [cd]	108.7 [c]
M_1S_2	43.7 [a]	45.2 [a]	0.61 [a]	0.57 [a]	140.2 [a]
M_1S_3	40.5 [a]	39.9 [bc]	0.54 [a]	0.55 [ab]	125.1 [b]
M_1S_4	38.9 [a]	36.6 [cde]	0.52 [a]	0.45 [de]	105.8 [cd]
M_1S_5	40.8 [a]	38.6 [bcd]	0.53 [a]	0.51 [bc]	110.3 [c]
M_1S_6	42.4 [a]	42.8 [ab]	0.58 [a]	0.57 [a]	135.1 [a]
M_2S_1	34.1 [a]	31.5 [fg]	0.45 [a]	0.34 [gh]	73.1 [g]
M_2S_2	38.2 [a]	35.4 [cdef]	0.51 [a]	0.4 [ef]	98.3 [de]
M_2S_3	37.0 [a]	32.4 [efg]	0.47 [a]	0.39 [fg]	93.8 [ef]
M_2S_4	33.8 [a]	28.4 [g]	0.45 [a]	0.32 [h]	71.3 [g]
M_2S_5	35.2 [a]	32.3 [efg]	0.47 [a]	0.38 [fgh]	87.7 [f]
M_2S_6	38.1 [a]	34.7 [def]	0.50 [a]	0.4 [ef]	94.5 [ef]
S.Em. ±	3.11	1.53	0.04	0.02	2.9

Note : Means followed by the same letter are not significantly different at the 5% level by DMRT

SPAD and Green Seeker values showed no difference between mulched (M_1) and non-mulched (M_2) plots at 30 DAS, but at 60 DAS, mulched plots recorded significantly higher values, with cropping systems involving green manure and intercropping showing similar improvements. This is likely due to the combined effects of mulch conserving moisture and companion crops fixing atmospheric nitrogen, thus enhancing nutrient availability during critical growth stages (Kumar *et al.,* 2021, Singh & Patel, 2023 and Bhayal *et al.,* 2018).

Dry matter accumulation at harvest was greater in mulched plots (M_1) compared to non-mulched (M_2), and higher biomass was observed in intercropped systems with incorporated green manures versus sole crops. The interaction effects showed that mulched plots with Dhaincha and intercropping maize and greengram (M_1S_2) accumulated the most dry matter, attributed to reduced water evaporation, weed suppression, and improved nutrient cycling through mulching and green manure incorporation similar observation were made by Wang *et al.,* 2024 and Miller & Lee, 2024. The interaction effects showed that mulched plots with Dhaincha and intercropping maize and greengram accumulated the most dry matter, attributed to reduced water evaporation, weed suppression, and improved nutrient cycling through mulching and green manure incorporation and also improved soil fertility, better nutrient availability, and enhanced plant growth conditions were promoted by organic matter addition and nitrogen fixation from the green manure (Kalyan Murthy *et al.,* 2025).

Combined leaf area and leaf area index (Table 3) did not differ significantly between mulch treatments at 30 DAS, though non mulched (M_2) showed numerically higher values. At 60 DAS,

Table 3

Combined leaf area (per m²) and leaf area index as influenced by the mulching and cropping system

Treatment	Combined leaf area/ m²		Combined leaf area index	
	30 DAS	60 DAS	30 DAS	60 DAS
Main plot				
M_1	0.440 [a]	0.92 [a]	7.34 [a]	12.32 [a]
M_2	0.457 [a]	0.85 [b]	7.72 [a]	11.88 [b]
S.Em. ±	0.013	0.004	0.31	0.06
Sub Plot				
S_1	0.28 [e]	0.53 [e]	1.54 [d]	2.94 [e]
S_2	0.41 [c]	1.00 [b]	5.85 [c]	12.98 [b]
S_3	0.32 [de]	0.86 [c]	4.57 [cd]	11.88 [c]
S_4	0.39 [cd]	0.88 [c]	5.72 [c]	12.34 [bc]
S_5	0.54 [b]	0.75 [d]	10.46 [b]	5.57 [d]
S_6	0.74 [a]	1.26 [a]	17.03 [a]	21.36 [a]
S.Em. ±	0.02	0.02	0.65	0.25
Interaction				
M_1S_1	0.26 [a]	0.53 [f]	1.45 [a]	2.97 [e]
M_1S_2	0.42 [a]	1.03 [b]	5.87 [a]	13.28 [b]
M_1S_3	0.28 [a]	1.02 [bc]	3.84 [a]	12.99 [bc]
M_1S_4	0.42 [a]	0.94 [c]	5.78 [a]	12.62 [bc]
M_1S_5	0.51 [a]	0.68 [e]	9.65 [a]	10.24 [d]
M_1S_6	0.75 [a]	1.29 [a]	17.43 [a]	21.87 [a]
M_2S_1	0.29 [a]	0.52 [f]	1.63 [a]	2.91 [e]
M_2S_2	0.40 [a]	0.98 [bc]	5.83 [a]	12.69 [bc]
M_2S_3	0.37 [a]	0.70 [e]	5.30 [a]	10.77 [d]
M_2S_4	0.36 [a]	0.83 [d]	5.67 [a]	12.06 [c]
M_2S_5	0.58 [a]	0.83 [d]	11.28 [a]	12.03 [c]
M_2S_6	0.74 [a]	1.22 [a]	16.62 [a]	20.86 [a]
S.Em. ±	0.03	0.03	0.92	0.35

Note : Means followed by the same letter are not significantly different at the 5% level by DMRT

mulched plots (M_1) recorded significantly greater leaf area and index, likely due to improved moisture retention, microclimate, and reduced weed competition enhancing canopy growth (Liu *et al.,* 2023 and Bhadauria *et al.,* 2015).

Among cropping systems, Maize+Greengram-Fieldbean (S_6) exhibited the highest combined leaf area and leaf area index at both 30 and 60 DAS. The interaction of mulch and cropping system was non-significant at 30 DAS, but at 60 DAS, Maize + Greengram-Fieldbean (M_1S_6) and Maize + Greengram-Fieldbean (M_2S_6) with and without crop residue mulching, respectively, showed significantly higher leaf area and index due to complementary intercrop effects and enhanced soil

Fig. 2 : The Leaf area (mm^2) of maize and green gram in leaf area meter

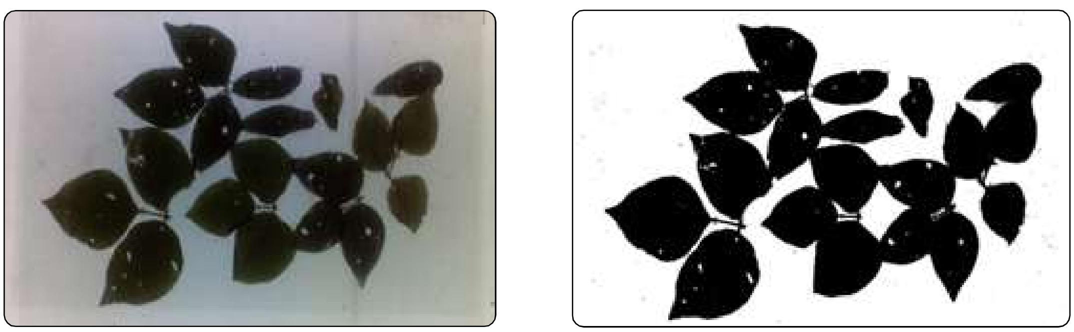

Fig. 3 : Difference between the real image and the gray-scale image generated in the leaf area meter

fertility from legumes and also utilization of organic mulches to retain moisture, control weeds and regulate soil temperature (Shettar *et al.,* 2024) through nitrogen fixation and continuous soil cover (Liu *et al.,* 2023 and Hussain *et al.,* 2022). The leaf area meter measures leaf area (mm^2) accurately and precisely. There was a need of manual noise reduction to get precise measurements (Fig. 3.).

The leaf area meter measures leaf area (mm^2) accurately and precisely. There is a need of manual noise reduction to get precise measurements.

Maize equivalent yield (MEY) (Table 4) was significantly higher under soil mulching with crop residue (M_1) at 7.79 t/ha, compared to 7.24 t/ha without mulching (M_2), a 7.6% increase demonstrating mulching's benefit to productivity.

Dhaincha - Maize + Greengram (S_2) had the highest MEY (8.04 t/ha), significantly outperforming Greengram-Maize (S_4) at 6.94 t/ha. The synergistic effects of green manure incorporation and legume intercropping likely enhanced nutrient availability and carbon sequestration, improving system productivity. Interaction effects showed the highest MEY in mulched Dhaincha-maize and Dhaincha - maize + Greengram systems (8.59 and 8.65 t/ha) (Malakannavar *et al.,* 2020 and Liu *et al.,* 2025).

TABLE 4

Maize equivalent yield, System carbon sequestration, soil organic carbon content and total soil carbon stock as influenced by mulching and cropping system

Treatment	Maize equivalent yield (t/ha)	System total plant carbon sequestration (Mg/ha)	Soil organic Carbon content (%)	Total soil carbon stock (t/ha)
Main plot				
M_1	7.79 a	5.44 a	0.55 a	8.6 a
M_2	7.24 b	4.15 b	0.48 b	7.4 b
S.Em. ±	0.12	0.07	0.003	0.051
SUB PLOT				
S_1	7.94 ab	5.11 ab	0.49 c	7.8 b
S_2	8.04 a	5.44 a	0.57 a	9.0 a
S_3	7.5 bc	4.65 b	0.51 bc	8.0 b
S_4	6.94 d	4.03 c	0.43 d	6.9 c
S_5	7.21 cd	4.59 bc	0.51 bc	8.0 b
S_6	7.44 bcd	4.94 ab	0.54 ab	0.84 b
S.Em. ±	0.12	0.12	0.01	0.14
INTERACTION				
M_1S_1	8.59 a	5.94 ab	0.54 bc	8.5 bc
M_1S_2	8.65 a	6.35 a	0.63 a	9.92 a
M_1S_3	7.7 bc	5.02 cd	0.54 bc	8.51 bc
M_1S_4	7.64 c	4.53 de	0.45 ef	7.09 ef
M_1S_5	7.73 bc	5.14 c	0.54 bc	8.51 bc
M_1S_6	8.18 ab	5.65 b	0.57 b	8.98 b
M_2S_1	7.3 c	4.28 e	0.45 ef	7.09 ef
M_2S_2	7.44 c	4.52 de	0.51 cd	8.03 cd
M_2S_3	7.31 c	4.29 e	0.48 de	7.56 de
M_2S_4	6.24 d	3.54 f	0.42 f	6.61 f
M_2S_5	6.69 d	4.04 ef	0.48 de	7.56 de
M_2S_6	6.7 d	4.24 e	0.52 cd	7.8 d
S.Em. ±	0.17	0.17	0.01	0.19
Initial			0.42	0.66

Note : Means followed by the same letter are not significantly different at the 5% level by DMRT

System total plant carbon sequestration was significantly higher with mulching (M_1), emphasizing improved organic matter inputs and soil structure. Dhiancha-Maize + Greengram (S_2) recorded the highest carbon sequestration (6.35 Mg/ha) mainly due to integration of green manure and leguminous intercrops. Mulching combined with these cropping systems maximized carbon storage, consistent with studies showing enhanced soil organic carbon through organic residue management (Lal, 2004 ; Yadav *et al.,* 2017).

Soil organic carbon content (%) was higher in with crop residue mulching (M_1) (0.55%) than without crop residue mulching (M_2) (0.48%), with Dhiancha-Maize + Greengram (S_2) (0.57%) and Maize+Greengram-Field bean (S_6) (0.54%) outperforming others, signifying improved residue retention and organic amendment effects in these systems. The lowest content appeared in S4 and the no-mulching S4 interaction (Malakannavar *et al*., 2020; Choudhary *et al*., 2018).

Total soil carbon stock ranged from 0.74 to 0.86 t/ha, with the highest in mulched Dhaincha-Maize+Greengram (M_1S_2, 0.90 t/ha), indicating legume-based green manure boosted carbon storage. Lower stocks in non-mulched Greengram-Maize systems confirmed the importance of integrated mulching and cropping practices. These findings align with long-term studies on soil carbon sequestration under organic residue management in various regions (Takakai *et al*., 2020 and Sugino *et al*., 2013).

The study clearly demonstrated that crop residue mulching combined with diversified legume-based cropping systems significantly improves maize equivalent yield, plant carbon sequestration, soil organic carbon content, and total soil carbon stock in *Alfisols* soils. Mulching enhanced soil moisture retention and moderated soil microclimate, while legumes contributed nitrogen through biological fixation, leading to increased biomass and organic carbon inputs. This integrated approach effectively restores soil fertility and water-holding capacity in *Alfisols* prone to degradation, promoting sustainable crop production under rainfed conditions. By improving soil structure, nutrient cycling and carbon sequestration, these practices offer a viable strategy for mitigating land degradation and enhancing climate resilience in resource-limited tropical watershed areas.

References

Adams, R. C., Maclean, F. S., Dixon, J. K., Bennett, F. M., Martin, G. I. and Lough, R. C., 1951, The utilization of organic wastes in New Zealand: Second interim report of the inter-departmental committee. *New Zealand Engineering*, (November 15), 396 - 424.

Aulakh, M. S. and Sidhu, G. S., 2015, Soil degradation in India: Causes, major threats, and management. Banda University of Agriculture & Technology and National Bureau of Soil Survey and Land Use Planning. In *MARCO Symposium* 1 - 6.

Bhadauria, N., Rai, G. K. and Pandey, R., 2018, Effect of mulching practices, varieties, and fertility levels on physiological parameters of clusterbean (Cyamopsis tetragonoloba L.). *Int. J. Curr. Microbiol. Appl. Sci.*, **7** (6) : 2781 - 2786.

Bhayal, D., Mahar, R., Basnyat, B., Pandey, D. and Sharma, R., 2018, Influence of green manure incorporation on dry matter accumulation in intercropped systems. *Int. J. Curr. Microbiol. Appl. Sci.*, **7** (12) : 1234 - 1240.

Choudhary, P., Singh, B. and Yadav, V., 2018, Influence of integrated nutrient management in intercropping systems on soil carbon storage. *Agric. Res.,* **7** (2) : 140-148.

Garg, K. K., Akuraju, V., Anantha, K. H., Singh, R., Dixit, S., Nune, R., Wable, P. and Budama, N., 2021, Impact of raised beds on surface runoff and soil loss in *Alfisols* and *Vertisols*. *Exp. Agric.,* **57** (3) : 418 - 433.

Hussain, M., Khan, R. and Ali, S., 2022, Impact of mulching on growth and yield of peanut (*Arachis hypogaea* L.). *Indian J. Agric. Res.,* **56** (1) : 15 - 21.

Kalyan Murthy, K. N., Naveen, D. V. and Lakshmipathi, R. N., 2025, Studies on Effect of Green Manuring and Different Organic Sources of Nutrients on Growth and Yield of Maize in Maize-Cowpea Cropping Sequence. *Mysore J. Agric. Sci.,* **59** (3).

Kumar, R., Sharma, P. and Singh, A., 2021, Effects of mulching on crop growth and nutrient use efficiency in maize. *J. Agron. Crop Sci.,* **207** (3) : 365 - 374.

Lal, R., 2004, Soil carbon sequestration impacts on global climate change and food security. *Science,* **304** (5677) : 1623 - 1627.

Liu, X., Wang, Y. and Chen, J., 2023, Effects of different mulch materials on photosynthetic rate and leaf area index in crop production. *Front. Plant Sci.,* **14** : 1280382.

Liu, X., Wang, Y. and Chen, J., 2025, Optimizing resources for sustainable maize production through intercropping. *Front. Sustain. Food Syst.,* **9** : 1584085.

Malakannavar, S. M., Shivakumar, M. and Muralikrishna, M. S., 2020, Effect of maize-pigeonpea intercropping system on yield, economics and soil properties. *Int. J. Curr. Microbiol. Appl. Sci.,* **9** (4) : 867 - 876.

Miller, J. T. and Lee, C. H., 2024, Dry matter yield improvement through integrated mulching and green manure cropping systems. *Soil Sci. Plant Nutr.,* **70** (2) : 200 - 210.

Richard, T. N. D., 2025, Estimating carbon content for organic matter calculations. Retrieved August 25, 2025, from https://compost.css.cornell.edu/calc/carbon.html

Sahu, D. K., Kumar, A., Padbhushan, R., Singh, Y. K., Kohli, A. And Ghosh, M., 2021, Soil organic carbon under various land uses in *Alfisols* of Eastern India. *Indian J. Agric. Sci.,* **91** (7) : 1623 - 1627.

Sharma, A., 2014, Numerical Agronomy. Kalyani Publishers, New Delhi. 194 pages. ISBN: 9789389667912

Shettar, Deepa, D. Vnaveen, Veeranagappa, P., Srinivasan, R., Venkatachalapathi, V. and Narasareddy. G., 2024, Positive and Negative Soil Relations in Intensive Tomato Cultivation in the Eastern Dry Zone of Karnataka, India. *Mysore J. Agric. Sci.,* **58** (4).

Singh, D. and Patel, V., 2023, Green manure and intercropping effects on soil fertility and crop productivity. *Soil Environ.,* **42** (1) : 45 - 55.

Sugino, S., Kato, K., Wakatsu, T., Imai, S. and Tanaka, A., 2013, Changes in soil organic carbon stock under long-term mulch application in maize cropping. *Soil Sci.,* **178** (8) : 379 - 387.

Takakai, F., Yamamoto, S. and Nakamura, T., 2020, Long-term effects of rice straw application on soil carbon storage. *Soil Sci. Plant Nutr.,* **66** (1) : 100-108.

Walkley, A. and Black, I. A., 1934, An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science,* **37** (1) : 29 - 38.

Wang, X., Li, Y. and Chen, Z., 2024, Mulching and intercropping impacts on biomass accumulation and water use efficiency. Agric. *Water Manag.,* **275** : 108256.

Yadav, V., Choudhary, P. and Singh, R., 2017, Green manure and legume intercropping effects on soil organic carbon and crop productivity. *Soil Tillage Res.,* **169** : 34 - 42.

Zeng, R., Wang, J. and Li, Y., 2021. Improved estimation of soil organic carbon stock in subtropical cropland of Southern China based on digital soil mapping and multi-source data. *J. Soil Sci. Plant Nutr.,* **21** (3) : 9148 - 9156.