

## Carbon dioxide equivalent carbon stock under wheat and eucalyptus based agroforestry system in central India

### Abstract

An experiment was organised to evaluation of carbon dioxide equivalent carbon stock or sequestration by wheat, weed and eucalyptus tree under an agroforestry system with different weed control treatments. The two year experiment was performed during 2016-17 and 2017-18 in a well managed farmer field of block shahpura village majitha, Jabalpur with supervision of department of forestry jnkvv Jabalpur. The result revealed that the wheat crop found total CO<sub>2</sub> equivalent C stock was significantly higher under hand weeding at 30 DAS 15.62 and 14.07 t/ha during 2016-17 and 2017-18, respectively over weedy check. The pooled data in wheat crop showed that weed management practices was found higher total CO<sub>2</sub> equivalent C stock range from (10.87 to 14.85 t/ha) over weedy check (9.68 t/ha) under wheat-*Eucalyptus tereticornis* based agroforestry system. The total CO<sub>2</sub> equivalent C stock in weed was significantly higher under weedy check (4.31 to 4.37 t/ha during 2016-17 and 2017-18, respectively) over hand weeding at 30 DAS (0.57 and 0.18 t/ha during both year). The pooled data showed that the average total CO<sub>2</sub> equivalent C stock in weed was significantly higher under weedy check (4.34 t/ha) over hand weeding 30 DAS (0.30 t/ha). The weed management practices was found lower CO<sub>2</sub> equivalent C stock range from (0.38 to 1.80 t/ha) under a wheat-*Eucalyptus tereticornis* based agroforestry system. The total CO<sub>2</sub> equivalent C stock of eucalyptus tree was found range between 195.11 to 204.61 t/ha and 248.39 to 258.78 t/ha was found during during 2016-17 and 2017-18, respectively under wheat-*Eucalyptus tereticornis* based agroforestry system. The statistical analysis of the pooled data showed that the CO<sub>2</sub> equivalent C stock in eucalyptus tree varied from 224.18 to 230.86 t/ha was found under wheat-*Eucalyptus tereticornis* based agroforestry system. CO<sub>2</sub> equivalent C stock of agroforestry system was found to range between 63.06 to 66.93 t/ha and 62.48 to 66.01 t/ha during 2016-17 and 2017-18 under wheat-*Eucalyptus tereticornis* based agroforestry system. The pooled data showed that total CO<sub>2</sub> equivalent C stock in agroforestry system was found varied from 62.77 to 66.47 t/ha under wheat-*Eucalyptus tereticornis* based agroforestry system.

**Key Words – Carbon stock, wheat, weeds, Eucalyptus, carbon dioxide**

### Introduction

The increasing atmospheric carbon dioxide is one of the important reasons to increase global warming. Every single element of the earth has capacity to store and release carbon in the earth. In the terrestrial ecosystem each component such as tree, crop and other vegetation have capacity to store atmospheric carbon through photosynthesis and other processes. The agroforestry system consist of three component such as tree crop

and animal. These component play important role to store atmospheric carbon and released it. The Eucalyptus tree is being exceedingly accepted by farmers due to its fast growth and short rotation or maturity period and various uses by industries. The crop are growing under a tree canopy is increase the overall productivity of land area and reduce the risk of failure of one crop. Wheat is growing in different region for food purpose and it is one of the income sources of the farmers under crop cultivation. For cumulative increasing the productivity of wheat crop, the management practices such as weed management, insect pest management is essential practices adopted by farmers. Here the experiment was conducted to know about the how much tree crop and weeds, the agroforestry vegetation are store carbon dioxide equivalent carbon stock under wheat and *Eucalyptus tereticornis* based agroforestry system with different weed management practices.

### **Material and Methods**

The experiment was conducted at farmer field of block shahpura village majitha, Jabalpur with supervision of department of forestry Jnkvv Jabalpur during 2016-17 and 2017-18 with 4 and 5 year old *Eucalyptus tereticornis* trees spacing of 3x1.5 m understory with wheat crop in agroforestry system and also applied with different weed control treatments. The randomized block design with three replications, consisted of ten weed control treatment [2, 4-D @ 0.5 lit /ha, Metribuzin @ 0.250 Kg /ha, Butachlor @1 lit /ha, Clodinafop-propargyl @0.140 kg /ha, 2, 4-D@ 0.5 lit /ha fb metribuzin @0.250 Kg /ha, 2, 4-D @0.5 lit /ha fb Butachlor @1 lit /ha, Metribuzin@ 0.250 Kg /ha fb butachlor @1 lit /ha, 2, 4-D@ 0.5 lit /ha + hand weeding 30 DAS, Hand weeding 30 DAS and Weedy check] was used in experiment. Variety LOK-1 Wheat was sown with 25 cm row spacing at a depth of 4 cm from the top of the soil. The herbicides were applied as post emergent at crop tillering stage i.e. about 30 DAS.

### **Data collection and analysis**

This study was undertaken to find out an agroforestry system total carbon stock, all material sample was collected from experimental field and convert into dry matter content and convert into dry biomass per hectare and dry biomass was converted into carbon by ash method. To determine carbon dioxide sequestration potential or equivalent carbon stock by trees, crops and weeds the biomass carbon stock was multiplied 3.67 factor for all

species by the formula suggested by Rajput (2010).Factor 3.67 were found by the carbon and oxygen molecule atomic weight ratio such as CO<sub>2</sub>have one molecule of carbon and 2 molecules of oxygen

The Carbonatomic weight is 12 and Oxygenatomic weight of is 15.9 so the total atomic weight of carbon dioxide is 43.9 [C(12) + 2 O (15.9+15.9) = 43.9) and the ratio of CO<sub>2</sub> to C is 43.9/12 = 3.67

Carbon dioxide equivalent Carbon stock = carbon Stock x 3.67

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## **Result and discussion**

The carbon pool of crops and trees were converted into carbon dioxide equivalent C stock, the significant variation was observed under agroforestry system for carbon dioxide sequestration potential.

### **Carbon dioxide equivalent C stock by wheat**

The significantly maximum aboveground CO<sub>2</sub> equivalent C stock of wheat crop (Table 1) was noticed under hand weeding at 30 DAS (12.56 and 11.32 t/ha) over weedy check during both the year. The different weed control treatments show higher CO<sub>2</sub> equivalent carbon stock varied from (9.31 to 11.21 t/ha) during first year and (8.19 to 9.98 t/ha) during second year. The statistical analysis of the pooled data also reported the same pattern of aboveground CO<sub>2</sub> equivalent C stock under wheat-*Eucalyptus tereticornis* based agroforestry system. The belowground CO<sub>2</sub> equivalent C stock was significantly higher under hand weeding at 30 DAS (3.06 and 2.75 t/ha) during both the year. The total CO<sub>2</sub> equivalent C stock was significantly higher under hand weeding at 30 DAS (15.62 and 14.07 t/ha) over weedy check during both the year. The statistical analysis of the pooled data reported that the average CO<sub>2</sub> equivalent C stock of wheat crop was significantly higher under hand weeding at 30 DAS (14.85 t/ha) over weedy check (9.68 t/ha). The weed management practices were found higher total CO<sub>2</sub> equivalent C stock range from (10.87 to 13.16 t/ha) over weedy check (9.68 t/ha) under wheat-*Eucalyptus tereticornis* based agroforestry system. The higher above and belowground CO<sub>2</sub> equivalent C stock was noticed under weedy check plot because the higher growth and biomass production was found under this treatment. Thevathasan and Gorden (2004) also concluded that, the annual CO<sub>2</sub> equivalent carbon stock in a hybrid poplar intercropping field was four times higher as compared to sole agriculture cropping fields. Higher CO<sub>2</sub> equivalent carbon stock in intercropping system compared to sole cropping system has supported in case of *Populus*+winter wheat (Zhou and Wang, 1997) and poplar based system (Peichlet *et al.*, 2006).

**Table 1 Carbon dioxide equivalent C stock of wheat crop under- *Eucalyptus tereticornis* based agroforestry systems**

Treatment	CO <sub>2</sub> equivalent C stock (t/ha)								
	Aboveground			Belowground			Total		
	2016-17	2017-18	pooled	2016-17	2017-18	pooled	2016-17	2017-18	pooled
T <sub>1</sub> - 2, 4-D @ 0.5 lit/ha	10.78	9.11	9.94	2.62	2.20	2.41	13.40	11.32	12.36
T <sub>2</sub> - Metribuzin @ 0.250 Kg /ha	10.84	9.30	10.07	2.63	2.25	2.44	13.47	11.55	12.51
T <sub>3</sub> - Butachlor @ 1 lit/ha	9.31	8.20	8.75	2.27	1.98	2.12	11.57	10.18	10.87
T <sub>4</sub> - Clodinafop-propargyl @ 0.140 kg /ha	11.21	9.98	10.60	2.73	2.41	2.57	13.94	12.39	13.16
T <sub>5</sub> - 2, 4-D @ 0.5 lit/ha <i>fb</i> metribuzin @ 0.250 Kg /ha	10.31	9.36	9.84	2.51	2.26	2.39	12.82	11.62	12.22
T <sub>6</sub> - 2, 4-D @ 0.5 lit/ha <i>fb</i> butachlor @ 1 lit/ha	10.00	9.01	9.51	2.45	2.19	2.32	12.44	11.21	11.82
T <sub>7</sub> - Metribuzin @ 0.250 Kg /ha <i>fb</i> butachlor @ 1 lit/ha	9.72	8.19	8.96	2.37	2.00	2.19	12.10	10.18	11.14
T <sub>8</sub> - 2, 4-D @ 0.5 lit/ha + hand weeding at 30 DAS	10.64	9.22	9.93	2.59	2.24	2.42	13.24	11.46	12.35
T <sub>9</sub> - Hand Weeding at 30 DAS	12.56	11.32	11.94	3.06	2.75	2.91	15.62	14.07	14.85
T <sub>10</sub> - Weedy check	8.66	6.90	7.78	2.13	1.66	1.90	10.79	8.56	9.68
<b>SEm±</b>	0.22	0.44	0.24	0.05	0.11	0.06	0.27	0.55	0.30
<b>CD (P=0.05)</b>	0.64	1.30	0.69	0.15	0.32	0.17	0.79	1.61	0.86

## **Carbon dioxide equivalent C stock weeds biomass**

### **Aboveground CO<sub>2</sub> equivalent C stock (t/ha)**

The significantly higher aboveground CO<sub>2</sub> equivalent C stock was noticed under weedy check (3.48 and 3.55 t/ha during 2016-17 and 2017-18, respectively) over hand weeding at 30 DAS (0.46 and 0.15 t/ha during 2016-17 and 2017-18, respectively). The pooled data showed that aboveground CO<sub>2</sub> equivalent C stock in weeds was significantly higher under weedy check (3.52 t/ha) over hand weeding at 30 DAS (0.31 t/ha) under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 2).

### **Belowground CO<sub>2</sub> equivalent C stock (t/ha)**

The belowground CO<sub>2</sub> equivalent C stock was significantly higher under weedy check (0.83 and 0.82 t/ha during 2016-17 and 2017-18, respectively) over hand weeding 30 DAS (0.11 and 0.04 t/ha during 2016-17 and 2017-18, respectively). The pooled analyzed data of belowground CO<sub>2</sub> equivalent C stock in weed was significantly lower under hand weeding at 30 DAS (0.07 t/ha) over weedy check (0.83 t/ha) (Table 2).

### **Total CO<sub>2</sub> equivalent C stock by weed (t/ha)**

The total CO<sub>2</sub> equivalent C stock in weed was significantly higher under weedy check (4.31 to 4.37 t/ha during 2016-17 and 2017-18, respectively) over hand weeding at 30 DAS (0.57 and 0.18 t/ha during 2016-17 and 2017-18, respectively). The pooled data showed that the average total CO<sub>2</sub> equivalent C stock in weed was significantly higher under weedy check (4.34 t/ha) over hand weeding 30 DAS (0.30 t/ha). The weed management practices was found lower CO<sub>2</sub> equivalent C stock range from (0.38 to 1.80 t/ha) over weedy check under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 2).

**Table 2. Carbon dioxide equivalent C stock potential of weeds under- *Eucalyptus tereticornis* based agroforestry systems**

Treatment	CO <sub>2</sub> equivalent C stock (t/ha)								
	Aboveground			Belowground			Total		
	2016-17	2017-18	pooled	2016-17	2017-18	pooled	2016-17	2017-18	pooled
T <sub>1</sub> - 2, 4-D @ 0.5 lit/ha	0.86	0.77	0.81	0.21	0.18	0.20	1.07	0.95	1.01
T <sub>2</sub> - Metribuzin @ 0.250 Kg /ha	1.17	0.89	1.03	0.28	0.21	0.25	1.46	1.10	1.28
T <sub>3</sub> - Butachlor @ 1 lit/ha	1.64	1.23	1.44	0.39	0.29	0.34	2.03	1.52	1.77
T <sub>4</sub> - Clodinafop-propargyl @ 0.140 kg /ha	1.65	1.26	1.46	0.40	0.30	0.35	2.05	1.56	1.80
T <sub>5</sub> - 2, 4-D @ 0.5 lit/ha <i>fb</i> metribuzin @ 0.250 Kg /ha	0.79	0.70	0.75	0.19	0.16	0.18	0.99	0.86	0.92
T <sub>6</sub> - 2, 4-D @ 0.5 lit/ha <i>fb</i> butachlor @ 1 lit/ha	1.37	1.04	1.20	0.33	0.25	0.29	1.70	1.28	1.49
T <sub>7</sub> - Metribuzin @ 0.250 Kg /ha <i>fb</i> butachlor @ 1 lit/ha	1.64	1.32	1.48	0.39	0.31	0.35	2.03	1.63	1.83
T <sub>8</sub> - 2, 4-D @ 0.5 lit/ha + hand weeding at 30 DAS	0.86	0.79	0.83	0.21	0.18	0.20	1.07	0.98	1.02
T <sub>9</sub> - Hand Weeding at 30 DAS	0.46	0.15	0.31	0.11	0.04	0.07	0.57	0.18	0.38
T <sub>10</sub> - Weedy check	3.48	3.55	3.52	0.83	0.82	0.83	4.31	4.37	4.34
<b>SEm±</b>	0.15	0.12	0.10	0.04	0.03	0.02	0.19	0.15	0.12
<b>CD (P=0.05)</b>	0.44	0.36	0.27	0.10	0.08	0.06	0.54	0.43	0.33

## **Carbon dioxide equivalent C stock from eucalyptus tree biomass (t/ha)**

### **Aboveground CO<sub>2</sub> equivalent C stock (t/ha)**

The aboveground CO<sub>2</sub> equivalent C stock in eucalyptus tree was increased with increasing age. During first year at the age of 4<sup>th</sup> year the aboveground CO<sub>2</sub> equivalent C stock in eucalyptus tree range between 161.95 to 154.68 t/ha was found and at the age of 5<sup>th</sup> year During second year of experiment aboveground CO<sub>2</sub> equivalent C stock of eucalyptus tree was ranged from 197.86 to 209.70 t/ha was found under wheat-*Eucalyptus tereticornis* based agroforestry system.

The pooled data showed that the average aboveground carbon sequestration potential of eucalyptus tree varied from 178.24 to 185.01 t/ha was found under agroforestry system (Table 3).

### **Belowground CO<sub>2</sub> equivalent C stock(t/ha)**

The belowground CO<sub>2</sub> equivalent C stock of eucalyptus tree range between 40.94 to 42.66 t/ha and from 49.23 to 52.74 t/ha was found during first and second year of experiment and the pooled mean of two year showed that belowground CO<sub>2</sub> equivalent C stock in eucalyptus tree varied from 45.20 to 46.66 t/ha was found under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 3).

### **Total CO<sub>2</sub> equivalent C stock by tree (t/ha)**

During first year (2016-17) the total CO<sub>2</sub> equivalent C stock of eucalyptus tree range between 195.11 to 204.61 t /ha and ranged from 248.39 to 258.78 t/ha was found during second year (2017-18) under wheat-*Eucalyptus tereticornis* based agroforestry system.

The statistical analysis of the pooled data showed that the CO<sub>2</sub> equivalent C stock in eucalyptus tree varied from 224.18 to 230.86 t/ha was found under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 3).

**Table 3. Carbon dioxide equivalent C stock in eucalyptus tree under- *Eucalyptus tereticornis* based agroforestry systems**

Treatment	CO <sub>2</sub> equivalent C stock (t/ha)								
	Aboveground			Belowground			Total		
	2016-17	2017-18	pooled	2016-17	2017-18	pooled	2016-17	2017-18	pooled
T <sub>1</sub> - 2, 4-D @ 0.5 lit/ha	154.68	206.31	180.49	40.44	50.74	45.59	195.11	257.05	226.08
T <sub>2</sub> - Metribuzin @ 0.250 Kg /ha	157.58	212.44	185.01	41.21	52.08	46.64	198.79	264.52	231.65
T <sub>3</sub> - Butachlor @ 1 lit/ha	156.68	202.46	179.57	41.16	51.47	46.31	197.84	253.93	225.88
T <sub>4</sub> - Clodinafop-propargyl @ 0.140 kg /ha	156.26	200.23	178.24	40.94	50.94	45.94	197.20	251.17	224.18
T <sub>5</sub> - 2, 4-D @ 0.5 lit/ha <i>fb</i> metribuzin @ 0.250 Kg /ha	158.49	202.79	180.64	41.56	52.74	47.15	200.05	255.53	227.79
T <sub>6</sub> - 2, 4-D @ 0.5 lit/ha <i>fb</i> butachlor @ 1 lit/ha	161.54	201.49	181.51	42.41	51.37	46.89	203.95	252.86	228.40
T <sub>7</sub> - Metribuzin @ 0.250 Kg /ha <i>fb</i> butachlor @ 1 lit/ha	157.13	209.70	183.42	40.99	52.02	46.51	198.12	261.73	229.92
T <sub>8</sub> - 2, 4-D @ 0.5 lit/ha + hand weeding at 30 DAS	157.31	202.72	180.02	41.17	49.23	45.20	198.48	251.95	225.22
T <sub>9</sub> - Hand Weeding at 30 DAS	160.71	207.69	184.20	42.22	51.10	46.66	202.94	258.78	230.86
T <sub>10</sub> - Weedy check	161.95	197.86	179.91	42.66	50.54	46.60	204.61	248.39	226.50
<b>SEm±</b>	3.89	4.15	2.81	1.09	1.25	0.82	4.98	5.02	3.49
<b>CD (P=0.05)</b>	11.37	12.12	7.98	3.19	3.65	2.32	14.54	14.64	9.91

### **Carbon dioxide equivalent C stock from agroforestry system (t/ha)**

#### **Aboveground CO<sub>2</sub> equivalent C stock in agroforestry system (t/ha)**

The aboveground CO<sub>2</sub> equivalent C stock in agroforestry vegetation was found range between 50.12 to 53.21 t/ha during first year (2016-17) and second year (2017-18) aboveground CO<sub>2</sub> equivalent C stock in agroforestry system ranged from 49.92 to 53.00 t/ha was found. The pooled data showed that the higher aboveground CO<sub>2</sub> equivalent C stock in agroforestry system was found under hand weeding at 30 DAS (53.10 t/ha) over all the weed control treatment due to higher biomass. The aboveground CO<sub>2</sub> equivalent C stock in agroforestry system varied from 50.02 to 53.10 t/ha under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 4).

#### **Belowground CO<sub>2</sub> equivalent C stock (t/ha)**

During first year the belowground CO<sub>2</sub> equivalent C stock in agroforestry system range between 12.95 to 13.72 t/ha was found and During second year belowground CO<sub>2</sub> equivalent C stock in agroforestry system ranged from 12.27 to 13.01 t/ha was found under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 4).

The pooled data showed that the average belowground CO<sub>2</sub> equivalent C stock varied from 12.68 to 13.37 t/ha was found under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 4).

#### **Total CO<sub>2</sub> equivalent C stock in agroforestry system (t/ha)**

The total CO<sub>2</sub> equivalent C stock in agroforestry system was found higher in hand weeding 30 DAS (66.93 t/ha and 66.01 t/ha during both of the year) over rest of the weed control treatment. CO<sub>2</sub> equivalent C stock was found range between 63.06 to 66.93 t/ha and 62.48 to 66.01 t/ha during 2016-17 and 2017-18 under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 4).

The pooled data showed that total CO<sub>2</sub> equivalent C stock in agroforestry system was found varied from 62.77 to 66.47 t/ha under wheat-*Eucalyptus tereticornis* based agroforestry system (Table 4). Thevathasan and Gorden (2004) also concluded that, the annual CO<sub>2</sub> equivalent carbon stock in a hybrid poplar intercropping field was four times higher as compared to sole agriculture cropping fields. Higher CO<sub>2</sub> equivalent carbon stock in intercropping system compared to sole cropping system has supported

in case of Pauownia+winter wheat (Zhou and Wang, 1997) and poplar based system (Peichlet *al.*, 2006). The results of present study was also confirm with the findings Mangalasseryet *al.* (2014), Prasad *et al.* (2012), Rijviet *al.* (2012), Swamy and Mishra (2014) and Chauhan *et al.* (2015).

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**Table 4. Carbon dioxide equivalent C stock in wheat, weeds and eucalyptus tree under agroforestry system**

Treatment	CO <sub>2</sub> equivalent C stock from agroforestry system (t/ha)								
	Aboveground			Belowground			Total		
	2016-17	2017-18	Pooled	2016-17	2017-18	pooled	2016-17	2017-18	Pooled
T <sub>1</sub> - 2, 4-D @ 0.5 lit/ha	50.30	51.14	50.72	12.94	12.53	12.74	63.24	63.67	63.46
T <sub>2</sub> - Metribuzin @ 0.250 Kg /ha	51.41	52.68	52.04	13.22	12.88	13.05	64.62	65.56	65.09
T <sub>3</sub> -Butachlor @ 1 lit/ha	50.12	49.92	50.02	12.95	12.56	12.75	63.06	62.48	62.77
T <sub>4</sub> - Clodinafop-propargyl @ 0.140 kg /ha	51.92	51.29	51.60	13.36	12.90	13.13	65.28	64.18	64.73
T <sub>5</sub> - 2, 4-D @ 0.5 lit/ha <i>fb</i> metribuzin @ 0.250 Kg /ha	50.73	50.61	50.67	13.09	12.97	13.03	63.82	63.59	63.70
T <sub>6</sub> - 2, 4-D @ 0.5 lit/ha <i>fb</i> butachlor @ 1 lit/ha	51.75	50.35	51.05	13.38	12.71	13.05	65.13	63.06	64.09
T <sub>7</sub> - Metribuzin @ 0.250 Kg /ha <i>fb</i> butachlor @ 1 lit/ha	50.65	51.44	51.05	13.01	12.71	12.86	63.66	64.16	63.91
T <sub>8</sub> - 2, 4-D @ 0.5 lit/ha + hand weeding at 30 DAS	50.83	50.56	50.69	13.10	12.27	12.68	63.92	62.83	63.38
T <sub>9</sub> - Hand Weeding at 30 DAS	53.21	53.00	53.10	13.72	13.01	13.37	66.93	66.01	66.47
T <sub>10</sub> - Weedy check	52.63	50.01	51.32	13.63	12.59	13.11	66.26	62.61	64.43
<b>SEm±</b>	0.97	0.80	0.62	0.27	0.26	0.18	1.24	0.98	0.78
<b>CD (P=0.05)</b>	2.84	2.33	1.77	0.79	0.75	0.52	3.62	2.86	2.22

### Conclusion

The agroforestry system play vital role to absorb atmospheric carbon dioxide and stored in different component. The agroforestry system was pooled higher carbon dioxide equivalent carbon stock due to higher biomass potential of more than one component such as crop, weed and trees than the solo cropping pattern. Under Agroforestry System we conclude that on average two year the wheat crop have capacity to store 9.68 to 14.85 t/ha, different weed have capacity to store 0.38 to 4.38t/ha with different weed management under the eucalyptus tree. The eucalyptus tree store 225.22 to 231.65 t/ha carbon dioxide equivalent carbon stock. The pooled

mean of two year experiment total CO<sub>2</sub> equivalent C stock in agroforestry system was found varied from 62.77 to 66.47 t/ha under wheat-*Eucalyptus tereticornis* based agroforestry system with different weed control treatment.

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