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ASSESSING THE STATUS OF CARBON POOL IN TWO RANGELAND GRASSES (*PANICUM ANTIDOTALE AND PANICUM MAXIMUM*) IN POTHWAR, REGION, PAKISTAN

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ABSTRACT:- Carbon sequestration study was conducted in two rangeland grasses *P. antidotale* and *P. maximum* in field area of Rangeland Research Institute (RRI), National Agricultural Research Centre, (NARC), Islamabad. Carbon is considered as the most important component of green house gases. Carbon sequestration during the photosynthesis process via plant biomass is the extent of this atmospheric gas. Data for above and below phytomass for two rangeland grasses was collected and carbon pool was estimated by Wet Combustion and Dry Combustion method. Four transect lines were drawn in each experimental plot. Twenty four samples of each experimental plot were collected with the help of ADC one m^2 quadrat method, weighed and then oven dried at 60 C° to find out the dry weight for above phytomass carbon Mg C ha^{-1}. Similarly, the one m^2 quadrats were dig out up to the root level for each grass and separated the root portion and weighed, oven dried at 60 C° for below ground phytomass carbon Mg C ha^{-1} estimation. Carbon pool in above ground phytomass was 1.16 Mg C ha^{-1} while below ground phytomass, 0.29 Mg C ha^{-1} was recorded. The carbon sequestration in below ground and the aerial phytomass depends upon the management practices, climate and response of different species.

Key Words: Carbon Pool; Rangeland; Grasses; Panicum antidotale; Panicum maximum; Pakistan.

INTRODUCTION

Pakistan has total land area of 88 m ha and about 59% of this is rangelands (GoP., 2009). Rangelands of Pakistan are fulfilling the feed requirement of more than 169 million livestock heads (GoP, 2013). Rangelands ecosystems have the high carbon storage beneath the soil and are great potential of carbon sink (Bronson et al., 2004; White et al., 2000). Rainfall variation also affected the plant productivity in arid and semi-arid regions, similarly the limiting economic alternatives to grazing activities (Noy-Meier, 1973). The traditional management of rangelands, often associated with stocking density over the carrying capacity, has resulted in floristic and physiognomic changes, loss of soil organic carbon, increase of bare soil and eventually desertification (Lal, 2002). Management practices that increase organic matter inputs to soils or that decrease losses from soil respiration and erosion can sequester additional carbon.

Globally there are more than 120 million pastoralists who are custodians of more than 5000 M ha of range-

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lands (White et al., 2000). Rangelandn based adaptation strategies such as seasonal grassland reserves (Angassa and Oba, 2007), revival of traditional grazing systems and development of forage reserves (Batima, 2006) are likely to benefit vegetation and soil carbon sequestration, and have the potential to play roles in both adapting to and mitigating further climate change. Carbon sequestration through grassland restoration has advantages as it is stored beneath the ground and it is not liable to loss from drought, disease and fire. Human activities such as fuel consumption and deforestation effect CO_2 concentration in the atmosphere (IPCC 2001a; Grace, 2004). This study was designed to assess the above and below ground phytomass carbon in two rangeland grasses in field area of Rangeland Research Institute (RRI), National Agricultural Research Centre (NARC) in Pothwar region, Islamabad, Pakistan.

MATERIALS AND METHOD

The present study was carried out in the field area of Rangeland Research Institute (RRI), National Agricultural Research Centre (NARC) to assess the status of carbon pool in two range grasses in Pothwar, region, Islamabad, Pakistan.

Phytomass Carbon Pool

The experimental material consisted of two perennial bunch grass species viz., *P. antidotale* and *P. maximum* evaluated for carbon sequestration pool in above and below ground phytomass for the said experiment by wet combustion and dry combustion method (Black, 1965). The study site is humid with subtropical climate. Hot and humid summers accompanied by a monsoon season are followed by cool winters. The study material was evaluated for soil organic carbon (SOC), soil inorganic carbon (SIC), and total carbon (C). In each plot for two grasses four parallel transects lines at 5 m interval at alternate site on transect line in 25 m length were established. In 25 m length six one m^2 quadrats, 5 m apart at alternate site on transect line were established. Above and below ground phytomass production at two sites was sampled by quadrat method, respectively. Vegetation rooted inside the quadrat harvested at ground level for above ground phytomass estimation. Fresh phytomass production data recorded immediately after harvesting and the same samples were oven dried at 60 °C till constant weight. Below ground root phytomass production were estimated by digging the below ground biomass at appropriate root depth within the $1m^2$ quadrat. Roots sieved to separate roots from soil and stone. Fresh and dry below ground phytomass production data were recorded. Coefficient of 0.50 was used for the conversion of phytomass for above and below ground phytomass to estimate carbon pool for two sites in two rangeland grasses (Brown and Luge, 1982).

Soil samples were collected with a 5 cm diameter soil core in 20 cm incremental depths (0-20, 20-40, 40-60, 60-80 cm) at each site. From one transect three soil samples for one depth were collected and total number of soil samples per transect were 12 and total samples for five transects were seventy two. The three soil samples of each transect were pooled to form one sample for each soil layer at each sites. All collected samples were immediately sealed in bags. The soil samples were air dried by spreading on a flat paper at room temperature for three days in the LRRI, NARC laboratory. Samples analyzed for soil organic carbon, soil inorganic carbon, and for total carbon. The soil organic carbon (SOC) was calculated by wet oxidation method (Walkely and Black, 1947). Soil inorganic carbon was determined by the Colorimetric method (Black, 1965). Total carbon was calculated by wet combustion and dry combustion method (Black, 1965).

Statistical Analysis

The experiments were laid out in Randomized Complete Block Design (RCBD). The collected data was analyzed statistically using two factorial designs. Difference among the mean were compared using LSD test at five percent probability level.

RESULTS AND DISCUSSION

Phytomass Carbon Pool

The above and below ground phytomass in two rangeland grasses (*P. antidotale, P. maximum*) was significantly different (P<0.05). The above and below ground phytomass in grass *P. antidotale* was recorded 1.28 Mg ha^{-1} and 0.63 Mg ha^{-1} respectively (Table 1). The total carbon pool Mg C ha^{-1} in above and below ground vegetation biomass in *P. antidotale* was 0.64 Mg C ha^{-1} and 0.15 Mg C ha^{-1}, respectively (Table 1). Similarly, in *P. maximum* the above ground phytomass was 1.04 Mg ha^{-1} and 0.28 Mg ha^{-1} in below ground biomass. The carbon pool in above ground phytomass was recorded as 0.52 Mg C ha^{-1} and 0.14 Mg C ha^{-1} in below ground biomass. Hence, the *P. antidotale*

Table 1. Above and below ground Phytomass (mg ha^{-1}) and Carbon Pool (mg C ha^{-1}) in *P. antidotale* and *P. maximum* at NARC

Depths (cm)	Phytomass		Mean	Carbon Pool		Mean
	Above	Below		Above	Below	
P. antidotale	1.28	0.63	0.95^a	0.64	0.15	0.39^a
P. maximum	1.04	0.28	0.66^b	0.52	0.14	0.33^b
Means	1.16^a	0.45^b		0.58^a	0.14^b	

LSD (0.05) for Phytomass (Grasses) = 0.1833
LSD (0.05) for Phytomass (Above and below ground)= 0.4863
LSD (0.05) for Carbon Pool (Grasses) = 0.0306
LSD (0.05) for Carbon Pool (Above and below ground) = 0.3524

gave the highest phytomass in above/ below ground bio-mass as compared to *P. maximum*. Similarly, in carbon pool the total carbon pool in above / below phytomass of *P. antidotale* was much higher as compared to the *P. maximum* in experimental areas of NARC. Regarding the soil depth, the carbon Mg C ha^{-1} decreased with soil depth due to the spreading and shallow root habit of grasses (Kumar and Goh, 2000) in *P. maximum*, while, in *P. antidotale* in the upper layers, the carbon Mg C ha^{-1} was less due to the vertical root penetration habit observed and higher carbon values were recorded with increasing depth rather than horizontal root spreading habit (Rajan, 2011). *P. antidotale* and *P. maximum* have different growth habits as observed that *P. antidotale* has greater root depths than the *P. maximum* and slightly more biomass production. These growth differences may have contributed differences in SOCP Mg ha^{-1}. In similar environmental conditions different stand structures and species composition have different growth and mortality rates and these differences eventually lead to differences in stand C stocks

(Vayreda et al, 2012).

Hence, the carbon sequestration in underground and the aerial phytomass depends upon the management practices, climate and response of different species (Schuman et al., 2002). Similarly, other factors, such as mean annual rainfall, temperature, soil disturbance, period of canopy cover, available water capacity, silt and clays also have prominent effects on carbon dynamics (Shrestha et al., 2004). The ability of rangelands to sequester carbon is also dependent upon environmental conditions. Climate and weather variation have also been shown to be influential on whether rangelands act as carbon sources or sinks over time (Svejcar., 2008).

Significant differences ($P<0.05$) for soil inorganic (SIC) % was recorded for all factors in *P. antidotale* and in *P. maximum*. The (SIC) % ranged from 0.02 to 2.08 % in *P. antidotale* and in *P. maximum* while the (SOC) % ranged from 0.54 to 1.35% in *P. antidotale* and in *P. maximum*. The SIC% was recorded higher in all depth in *P. antidotale*. Similarly the (SOC) % was also higher for both the grasses and the content of (SOC) % recorded higher in all depths in *P. antidotale*. Soil organic carbon pool (Mg ha^{-1}) at all depths was higher in *P. antidotale* than the *P. maximum* soil. The top soil layers (0-20 cm and 20-40 cm) contained highest (SOC) % Mg ha^{-1}. The (SOC) % Mg ha^{-1} decreases as the depth of soil increases. The SOCP (Mgch^{-1}) in *P. antidotale* soil at various depths ranged from 48.24 to 71.50, whereas in *P. maximum* soils, it ranged from 28.97 to 14.84 (Table 2). The ability of rangelands to sequester carbon is also dependent upon environmental conditions. Climate and weather variation have been shown to be influential on whether rangelands act as carbon sources or sinks over time (Svejcar , 2008). In particular, drought can cause rangelands to be carbon source while higher precipitation levels can contribute to carbon sequestration. Knapp et al. (2002) reported that the timing of precipitation may be more important than the total annual amount of precipitation in terms of annual carbon fluctuations. Jobbagy and Jackson (2000)

Table 2. SIC%, SOC% and SOC Mg C ha^{-1} in *P. antidotale* and *P. maximum* at NARC

Depths (cm)	SIC (%)		Mean	SOC (%)		Mean	SOCP (Mg C ha^{-1})		Mean
	P.anti	*P.max*		*P.anti*	*P.max*		*P.anti*	*P.max*	
0-20	0.53	0.15	0.34^{c}	1.35	1.02	1.18^{a}	48.24	28.97	38.60^{b}
20-40	1.43	0.02	0.73^{b}	0.96	0.62	0.79^{b}	63.51	17.14	40.32^{b}
40-60	2.09	0.10	1.09^{a}	0.79	0.62	0.70^{b}	79.50	17.14	48.32^{a}
60-80	1.81	0.29	1.05^{a}	0.74	0.55	0.64^{b}	71.50	14.84	43.17^{b}
Means	1.46^{a}	0.14^{b}		0.96^{a}	0.70^{b}		65.68^{a}	19.52^{b}	

LSD (0.05) for SIC (Grasses) = 0.1553
LSD (0.05) for SIC (Soil depths) = 0.2197
LSD (0.05) for SOC (Grasses) = 0.3010
LSD (0.05) for SOC (Soil depths) = 0.4256
LSD (0.05) for SOCP (Grasses) = 25.3654
LSD (0.05) for SOCP (Soil depths) = 4.1243

found that the distribution of soil carbon is related to vegetation type. Hence, rangelands have a low per acre potential to sequester carbon but the total rangeland area in Pothwar region has great potential for sequestering carbon. However, it has been recognized that general management practices that reduce soil erosion, prevent land degradation, or restore degraded land have the biggest impacts on soil carbon (Lal, 2002).

CONCLUSION

Data for above and below phytomass for two rangeland grasses was collected and carbon pool was estimated. Carbon pool in above ground phytomass was 1.16 Mg C ha^{-1} while below ground phytomass, 0.29 Mg C ha^{-1} was recorded. Hence, rangelands have a low per acre potential to sequester carbon but the total rangeland area in Pothwar region has great potential for sequestering carbon. However, it has been recognized that general mana-gement practices that reduce soil erosion, prevent land degradation, or restore degraded land have the biggest impacts on soil carbon.

Recommendations:

Based on the results several recommendations have been made:

- Community involvement by stakeholders to help in increase carbon storage by growing more grasses for their livestock's to be researched on extensively.
- Capacity building of stakeholders for engagement with carbon markets should be undertaken in interaction with sources of carbon finance.
- A strong long-term political commitment by the government to prevent un-control grazing to manage and protect the remaining rangeland is required as a high priority.
- Rangeland policy makers and managers in many countries, as well as key actors in the carbon finance sector, have relatively little aware-ness of the potential of rangeland carbon sequestration, monitoring and land rights issue.
- The problem of market for carbon and finding a buyer should be addressed extensively.
- Research on how to develop formulae for the cost of Carbon in Pakistan.
- The local community should be discouraged from destroying the natural indigenous rangeland.
- The importance of rangelands should receive better recognition in climate change mitigation and adaptation policy.
- Soil organic carbon is affected by vegetation, soil texture, landscape position, run off, wind erosion and deposition etc.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S.No	Author Name	Contribution to the paper
1.	Mr. Ummar Farooq	Concived the idea, Overall management of the article
2.	Dr. Sarfraz Ahmad	Conducted the research and collected data under his Supervision
3.	Dr. Mohammad Islam	Technical input at every step
4.	Dr. Imtiaz Ahmad Qamar	Technical input at every step

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