

Research on carbon sequestration capacity of artificial pasture in Hulunber

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Outline of the Content

1. Background
2. Research objective
3. Overview of the study site
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1. Background

- Hulunber has a vast territory, a total area of 253000 km², grassland 88000 km².
- The 2012 census results show that **degraded area** of grassland has arrived to **4.83×10⁶ ha**, which is account for nearly half of the available area of grassland, and there are nearly **3.00×10⁶ ha** of **potential desertification area**.

1. Background

➤ The **yield** of grassland is **decreasing** year by year;

➤ **Overgrazing** forces herders to reduce the number of animals;

➤ **Because of these, artificial pasture obtains the development opportunity.**

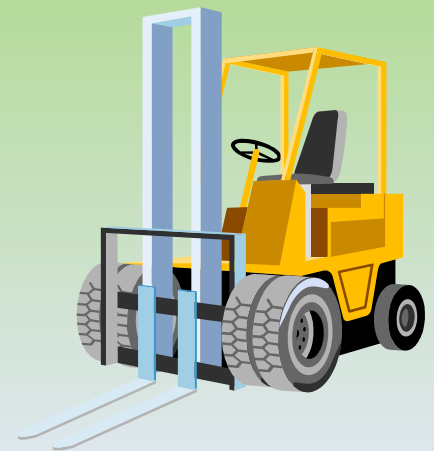
Storage becomes the bottleneck of the development of animal husbandry.



1. Background

The advantages of forage:

- High nutritional value
- High yield, improve the forage yield per unit land
- Man-made interference, affected by climate condition is small

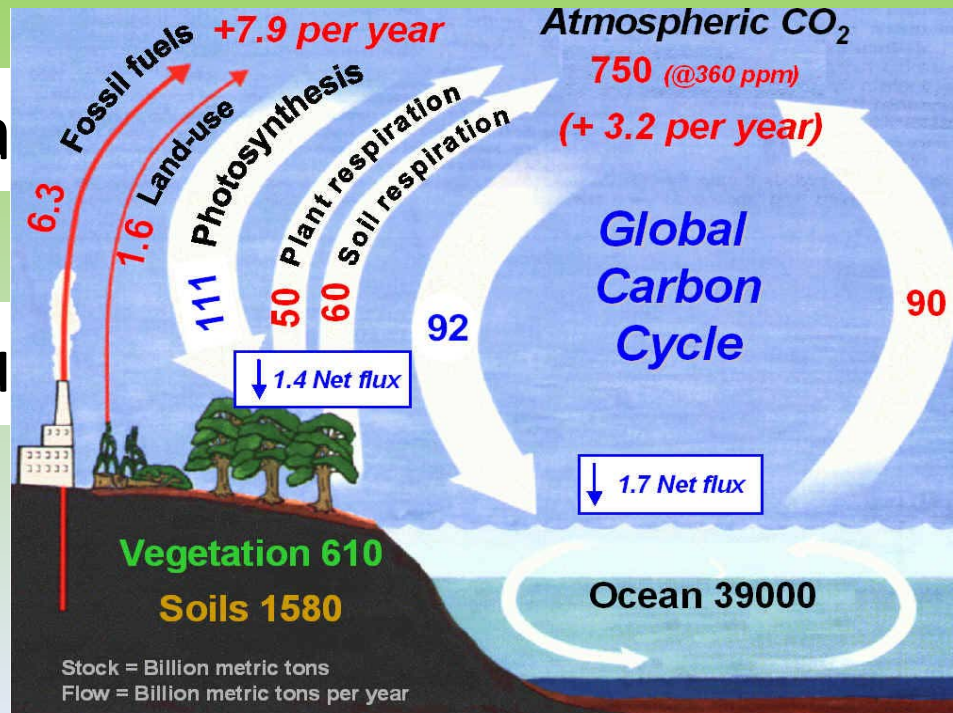


2. Research Objective

- Herbage caused national attention
- Farmers planting enthusiasm
- The planting area increasing

High for

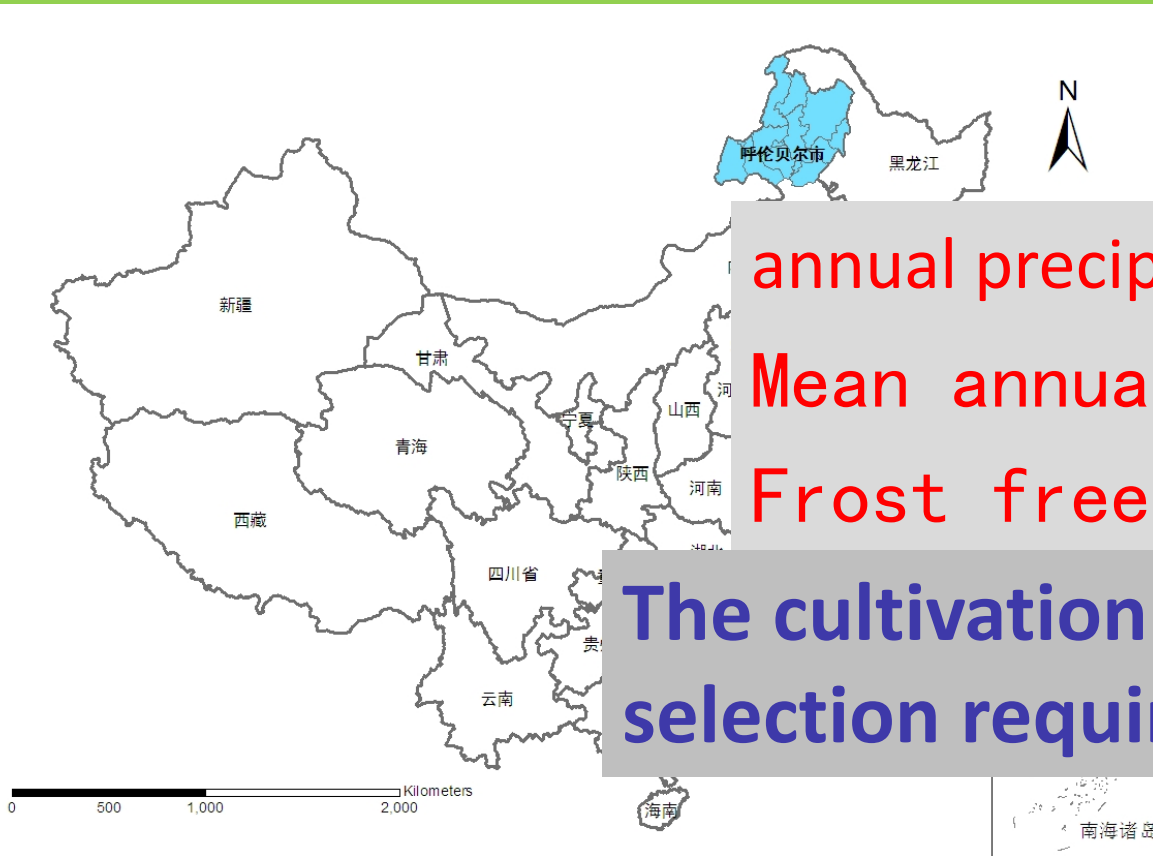
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3. Overview of the study site



annual precipitation: $\pm 350\text{mm}$

Mean annual temperature: -2°C

Frost free period: 110d

The cultivation of forage varieties
selection requirements

Site:

alfalfa, seedling(7.5kg/ha),
June2009, seeded,space(40cm)

Experiment design:

Samples: green house gases(GHG) collection,
soil and plant sample

Time: growing season,1 June to 30 September. 3 per day

Indexes: CO₂,nitrous oxide(N₂O),
biomass, soil texture, SOC, bulk density

DNDC model

Denitrification (decomposition) model is based on denitrification and decomposition process, which is the most successful N_2O absorption, one of the CO_2 release process mechanism model. The model includes climate, soil and plant function.

Soil parameter:
Texture, bulk density, pH, SOC

Crop parameter:
Variety, biomass fraction,
Water requirement coefficient
, root depth, C/N

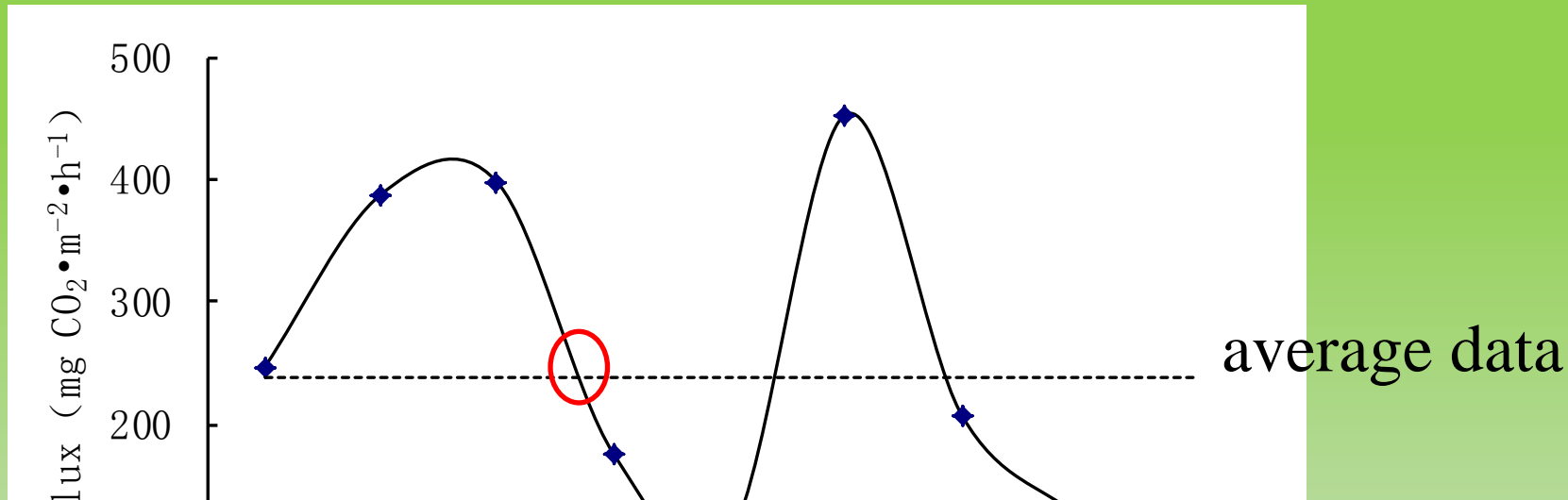
The screenshot displays the DNDC 9.5 software interface. The top menu bar includes 'Site', 'Region', 'Uncertainty', and 'Tools'. Below the menu is a 'Welcome to DNDC' banner with a background image of farmers in a field. The main window is divided into several sections for parameter input:

- Simulation Settings:** Includes 'Simulated years' (0), 'Record daily results' (checkbox), and 'Obtain meteorological data from your database' (checkbox).
- Climate File Selection:** A section for selecting a climate file, with options for 'Down' and 'Up' to navigate a year list.
- Input Parameters:** A list of parameters with input fields and checkboxes:
 - N concentration in rainfall (kg N/l or ppm) = 0
 - Atmospheric background NO_3 concentration (kg N/m³) (0-100) = 0.06
 - Atmospheric background CO_2 concentration (ppm) (0-500) = 350
 - Annual increase rate of atmospheric CO_2 concentration = 0
 - Or read annual CO_2 concentrations from a file (checkbox)
- Format Selection:** A section for selecting a format matching the climate file, with radio buttons for 'Jday, MaxT, Prec', 'Jday, MaxT, MinT, Prec', 'Jday, MaxT, MinT, Prec, Radiation', 'Jday, MaxT, MinT, Prec, WindSpeed', 'Jday, MaxT, MinT, Prec, WindSpeed, Radiation', 'Jday, MaxT, MinT, Prec, WindSpeed, Hum', and 'Global met data format'.
- Soil Parameters:** Includes 'Soil pH', 'Wilting point (kgps)', 'Porosity (0-1)', 'Soil structure', 'Bypass flow rate', 'Depth of water-retention layer (best be > 9.99)', and 'Drainage efficiency'.
- SOC Parameters:** Includes 'Initial soil organic C (SOC) content, partitioning and profile', 'SOC at surface soil (0-5cm) (kg C/kg soil) = 0', 'SOC profiles', 'Depth of top soil with uniform SOC content (m) = 0', and 'SOC decrease rate below top soil (0.5 - 5.0) = 5'.
- SOC Partitioning:** A table for defining SOC fractions:

Re-define	V.L. litter	Labile litter	Resistant litter	Humus	Manus	Char C
Fraction	0	0	0	0	0	0
C/N	5	25	100	10	10	500
- Decomposition Rates:** A section for modifying decomposition rates by multiplying a factor for 'Litter', 'Humus', and 'Manus'.
- Initial N Concentration:** Includes 'Initial N concentration at surface soil: nitrate = 0' and 'ammonium = 0'.
- Microbial Activity:** Includes 'Microbial activity index (0-1) = 1', 'Slope (0-90 degree) = 0', and 'Soil salinity index (0-100) = 0'.
- Other Parameters:** Includes 'Rain water collection = 1' and 'Use SOC and NH4LE functions' (checkbox).

4. Results

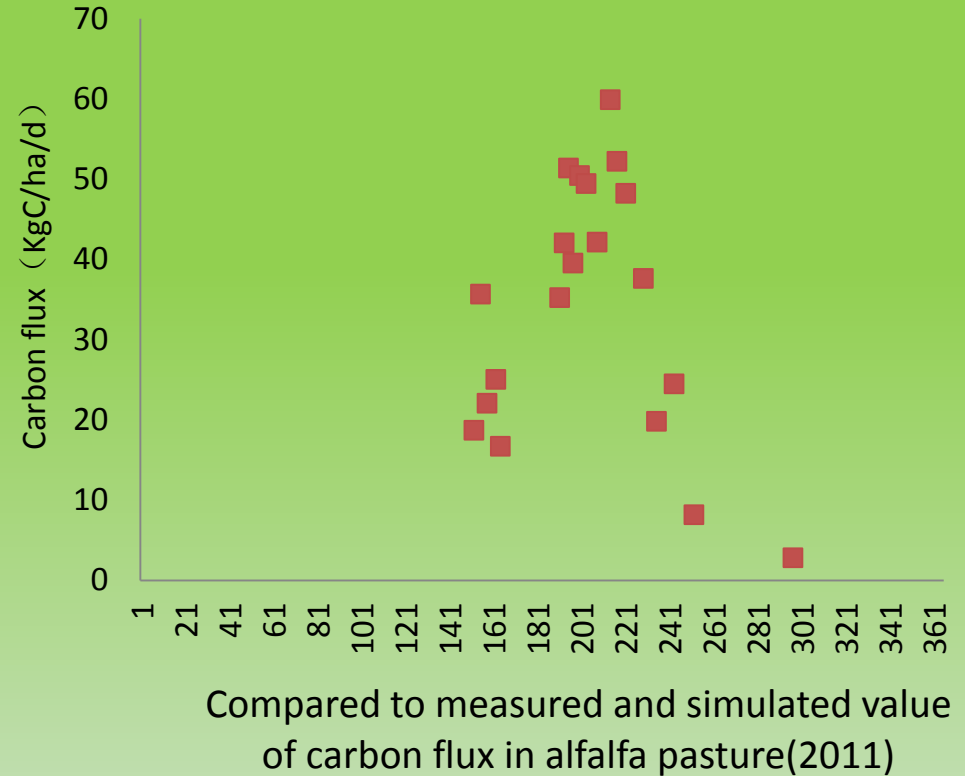
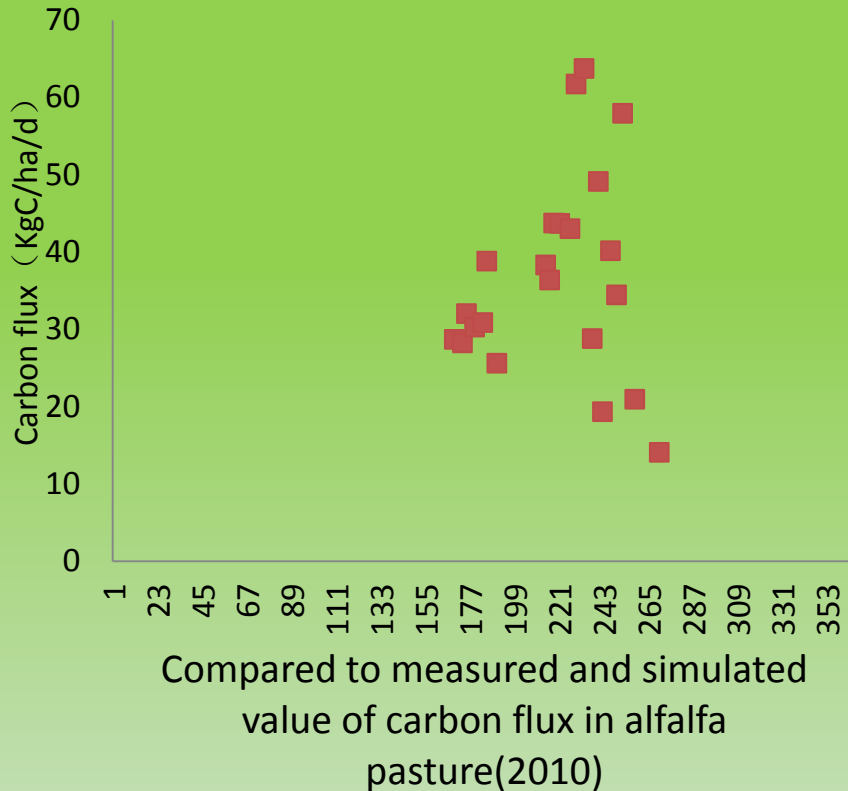
4.1 The dynamic flux of CO₂ emission



The average data of CO₂ flux happens to between 10:30 and 12:30, GHG collected is 9:00-11:00

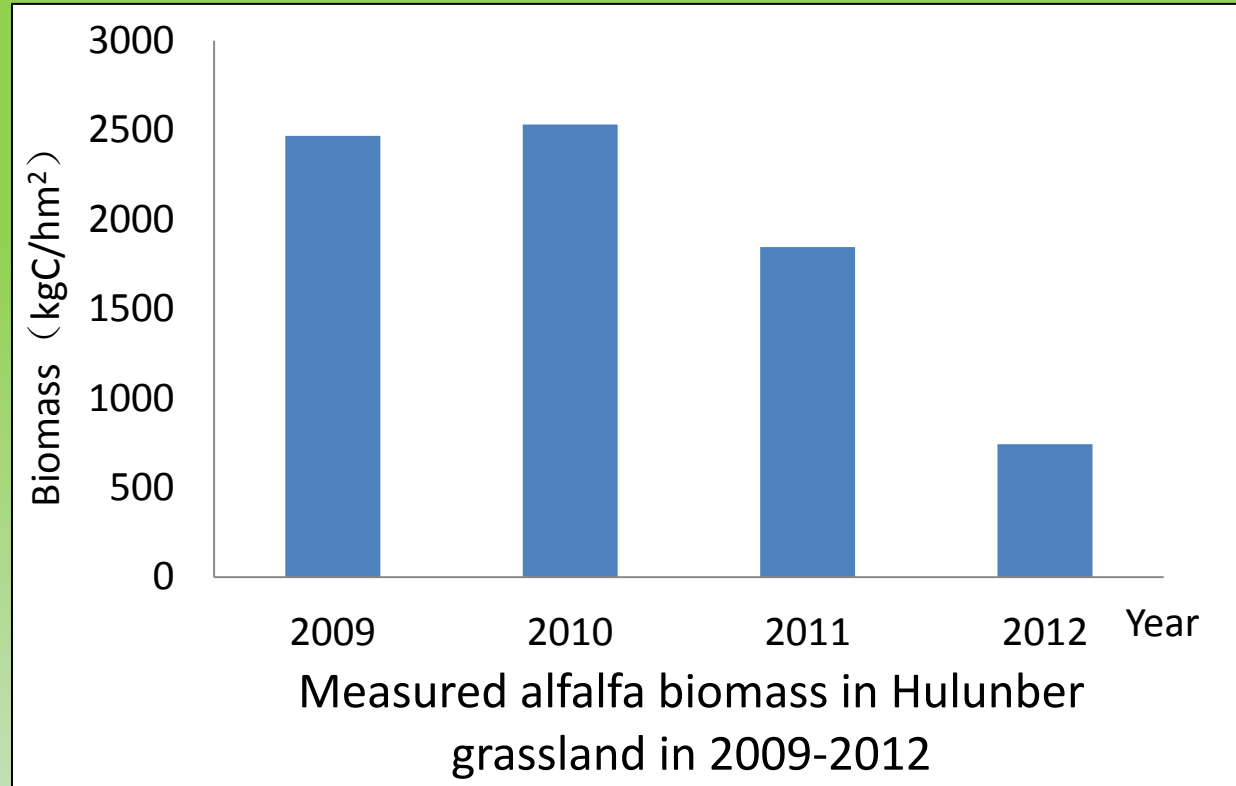
The dynamic flux of CO₂ emission in^{Time}
alfalfa cultivated pasture

4.2 The seasonal of CO₂ flux



CO₂ flux occurred mainly between July and August.

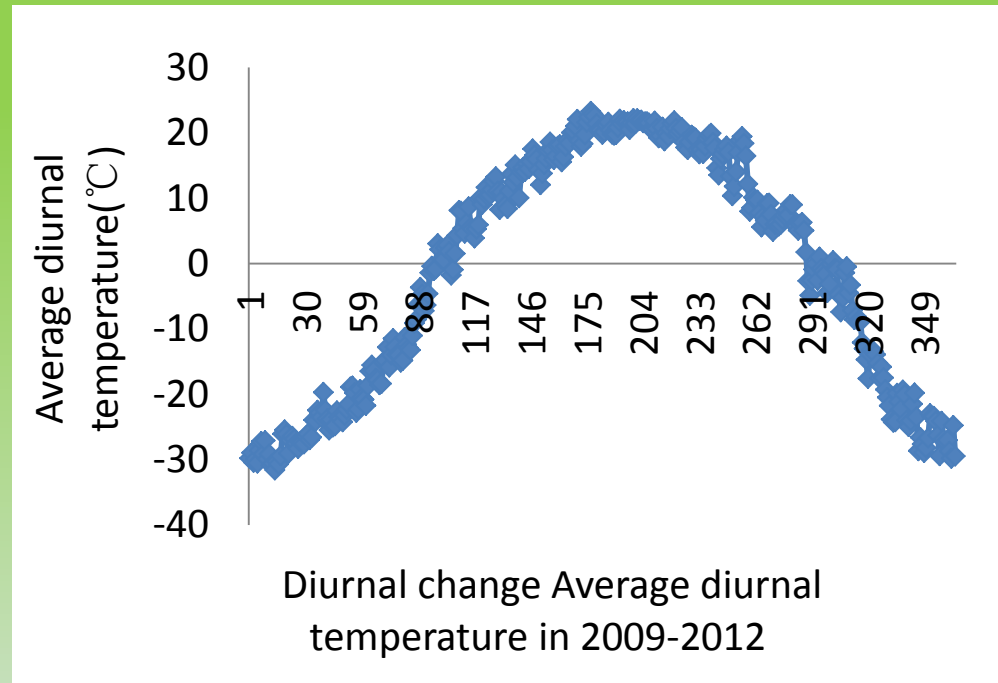
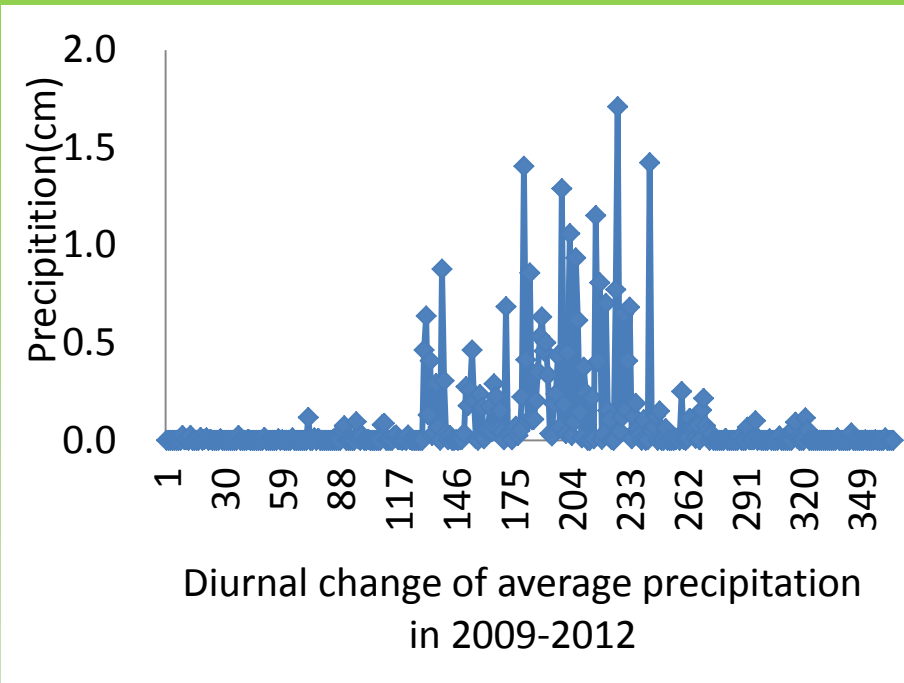
4.3 Change of alfalfa biomass in 2009-2012



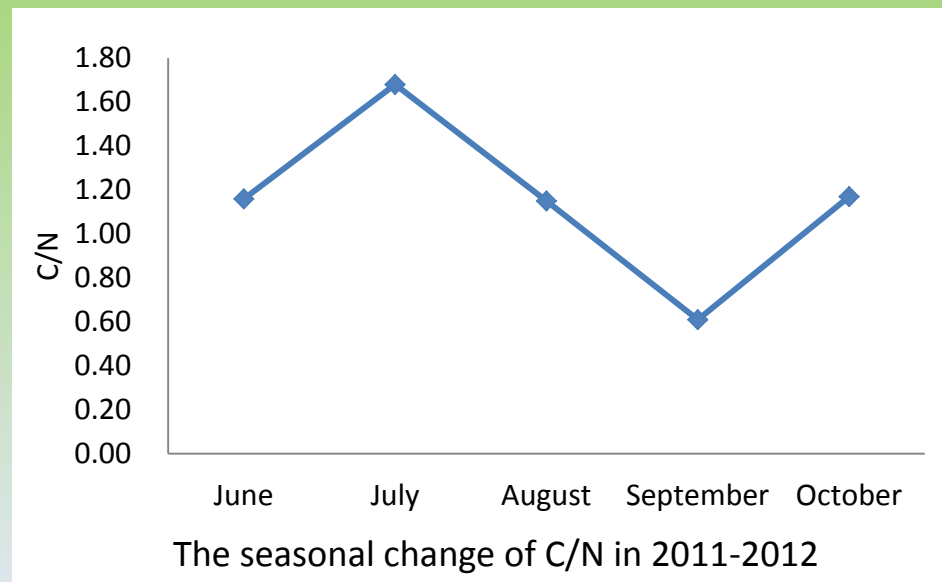
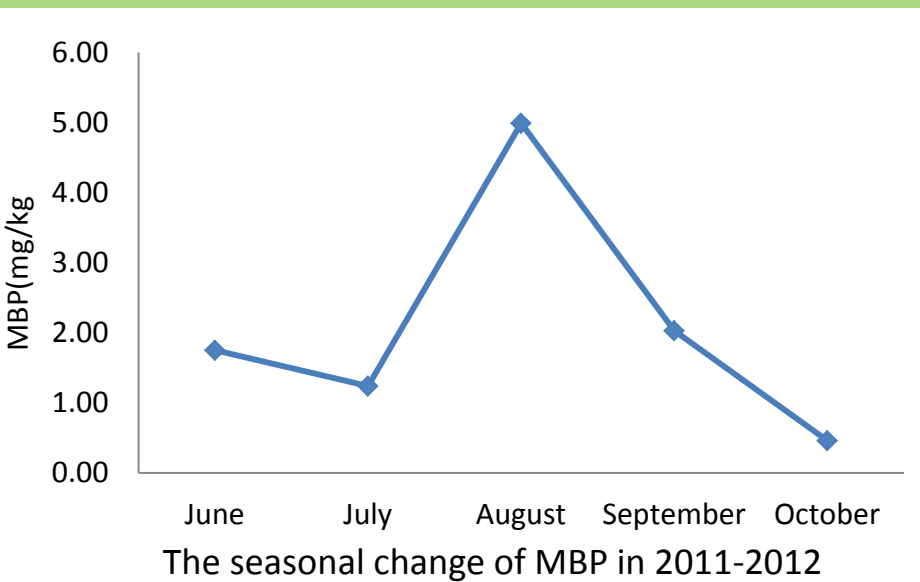
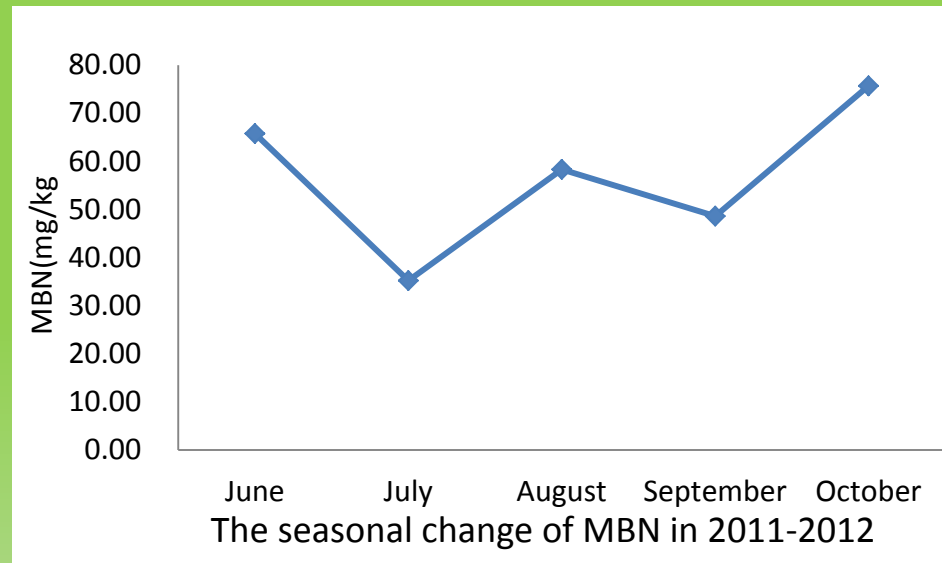
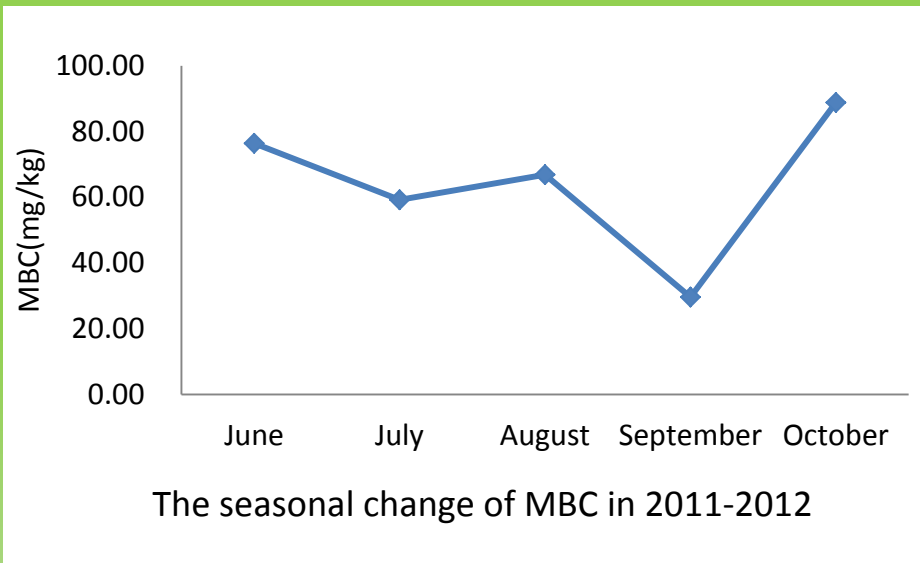
Biomass is influenced by precipitation, especially 2012.

4.4 Impact factors

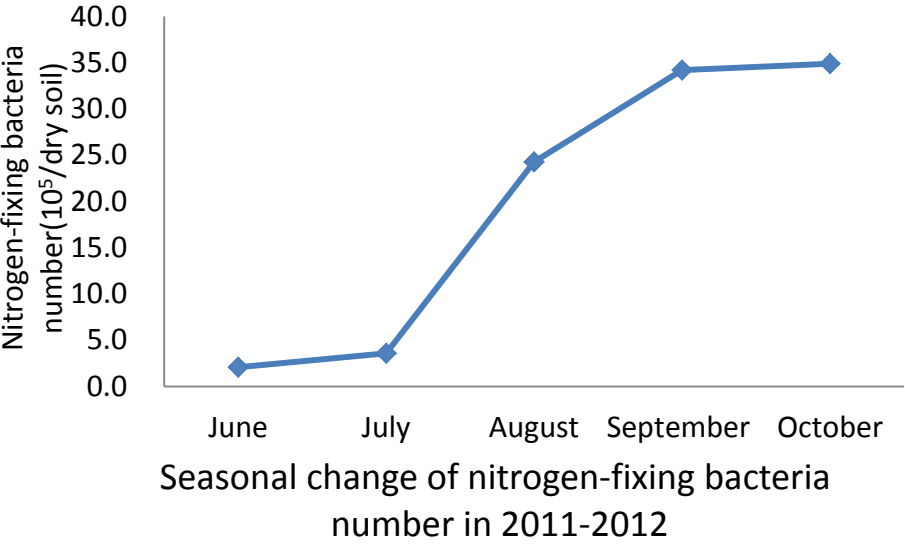
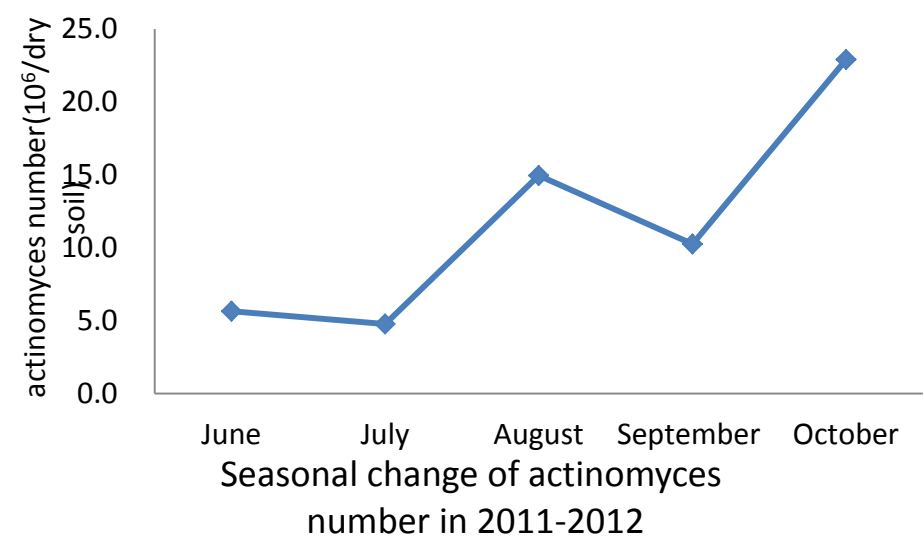
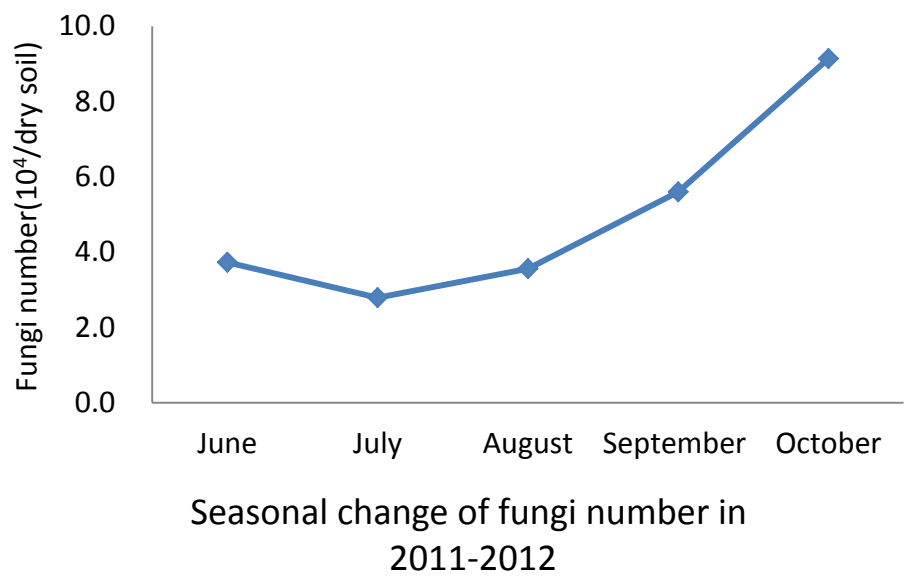
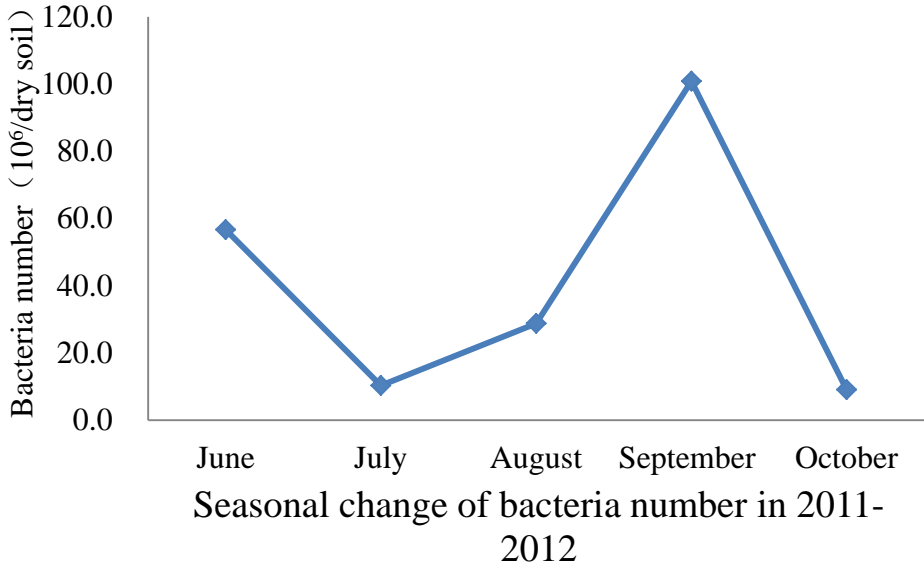
(1) Climate



(2) microbial character-microbial biomass



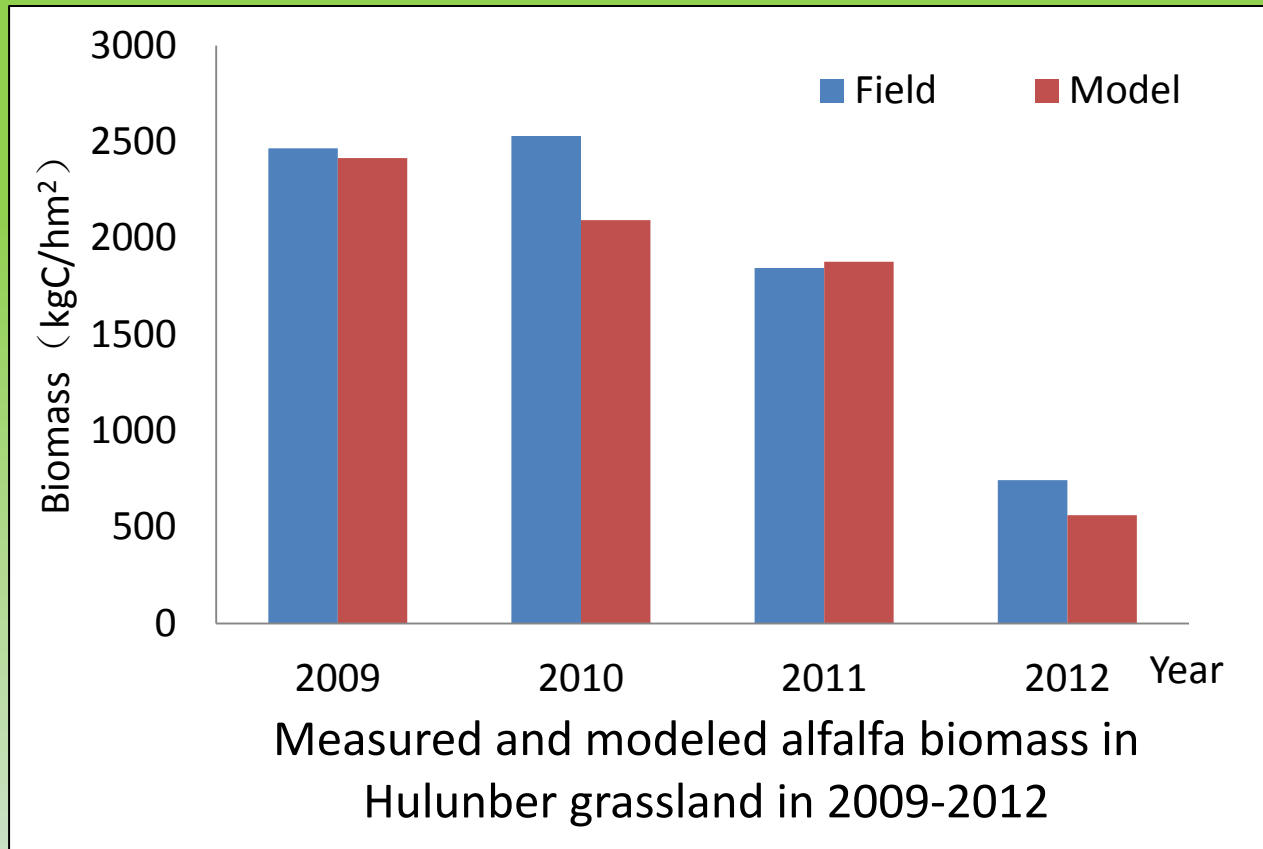
(2) microbial character-microbial amount



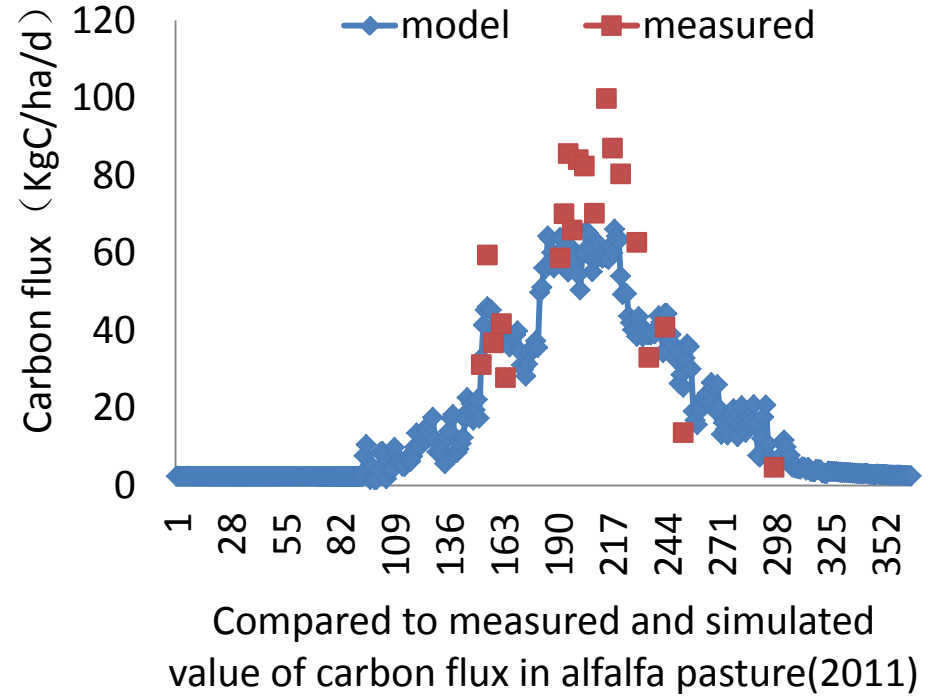
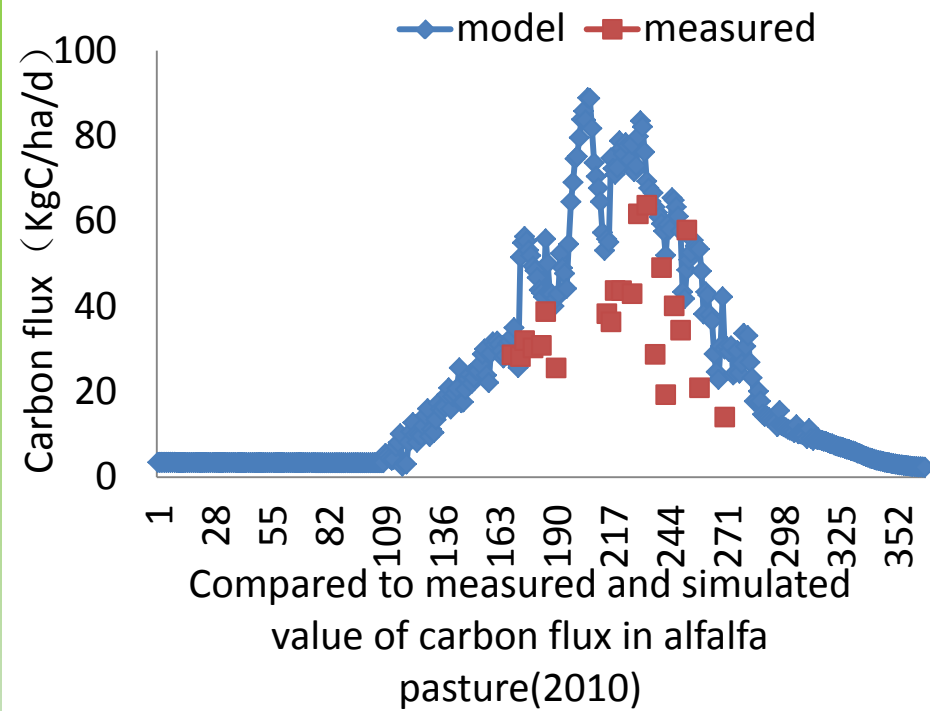
(3) Correlation analysis

	Index	Correlation	r	P
Carbon flux	MBC	$y = 3.443x + 53.244$	0.482	0.011
	MBN	$y = 5.974x + 51.367$	0.611	0.050
	MBP	$y = 4.945x + 37.191$	0.191	0.280
	MBC/MBN	$y = 18.462x + 31.621$	0.573	0.049
	Microbial amount	$y = 4.771x + 35.328$	0.785	0.003
	Soil temperature	$y = 23.638x + 236.86$	0.468	0.325
	Soil water content	$y = 24.918x + 101.64$	0.581	0.006
	Precipitation	$y = 27.672x + 14.994$	0.560	0.030
	Atmosphere temperature	$y = 37.297x - 31.463$	0.651	0.117

4.5 Biomass simulation



4.6 Carbon flux simulation



- Growing season of carbon sequestration capacity can present the whole year.
- Microbial biomass & amount, temperature, precipitation, soil moisture ,which have influenced CO₂ flux, is mainly affected by MBC, MBN, microbial amount, soil water content and precipitation.
- Through the model simulation ,the carbon sequestration capacity of alfalfa pasture is nearly 1300 kg C/ha.

4.7 Uncertainty analysis

Biomass frction	2009	2010	2011	2012	P<0.05 level
biomass frction+10%	2746	2356	2144	652	A
biomass frction-10%	2160	1870	1684	502	C
CK	2452	2108	1914	582	B

Water requirement coefficient	2009	2010	2011	2012	P<0.05 level
Water requirement coefficient+10%	2424	2068	1864	560	E
Water requirement coefficient+5%	2438	2088	1888	570	D
Water requirement coefficient -10%	2486	2166	1976	615	A
Water requirement coefficient-5%	2468	2128	1942	594	B
CK	2452	2108	1914	582	C

C/N	2009	2010	2011	2012	P<0.05 level
C/N+10%	2452	2110	1916	584	A
C/N-10%	2452	2120	1912	582	AB
C/N-15%	2452	2102	1908	578	B
C/N+15%	2452	2128	1916	584	AB
CK	2452	2108	1914	582	AB

SOC	2009	2010	2011	2012	P<0.05 level
SOC+20%	1440	2016	1798	538	B
SOC+10%	1440	2070	1814	556	B
SOC-20%	1476	2038	1876	562	B
SOC-10%	1508	1914	1868	491	B
CK	2452	2108	1914	582	A

Texture	2009	2010	2011	2012	P<0.05 level
sand	2610	2494	2174	568	A
loam	2272	2188	1956	675	A
loamy sand	2622	2136	1888	542	A
CK	2452	2108	1914	582	A

Irrigation	2009	2010	2011	2012	P<0.05 level
50mm	2582	2086	1886	570	A
75mm	2582	2102	1884	570	A
100mm	2586	2092	1884	572	A
200mm	2592	2084	1884	572	A
CK	2452	2108	1914	582	A

Fertilizer	2009	2010	2011	2012	P<0.05 level
Fer+10%	2418	2076	1886	572	A
Fer+5%	2418	2076	1886	572	A
Fer-10%	2418	2076	1886	572	A
Fer-5%	2418	2076	1886	572	A
CK	2418	2076	1886	572	A

Analyzed the different indexes, which affect the carbon
 Crop parameter mainly affect the carbon sequestration
 capacity of alfalfa artificial pasture in Hulunber.

difference between biomass fraction, C/N, demand
 water, SOC and carbon sequestration capacity
 (P<0.05), others not.

5. Further work

- ❖ The accuracy of DNDC model
- ❖ Effect on simulation of cutting to the productivity
- ❖ Simulation of the regrowth of perennial forage



*Welcome to China ,
welcom to Hulunber*

***Thank for your
attention***