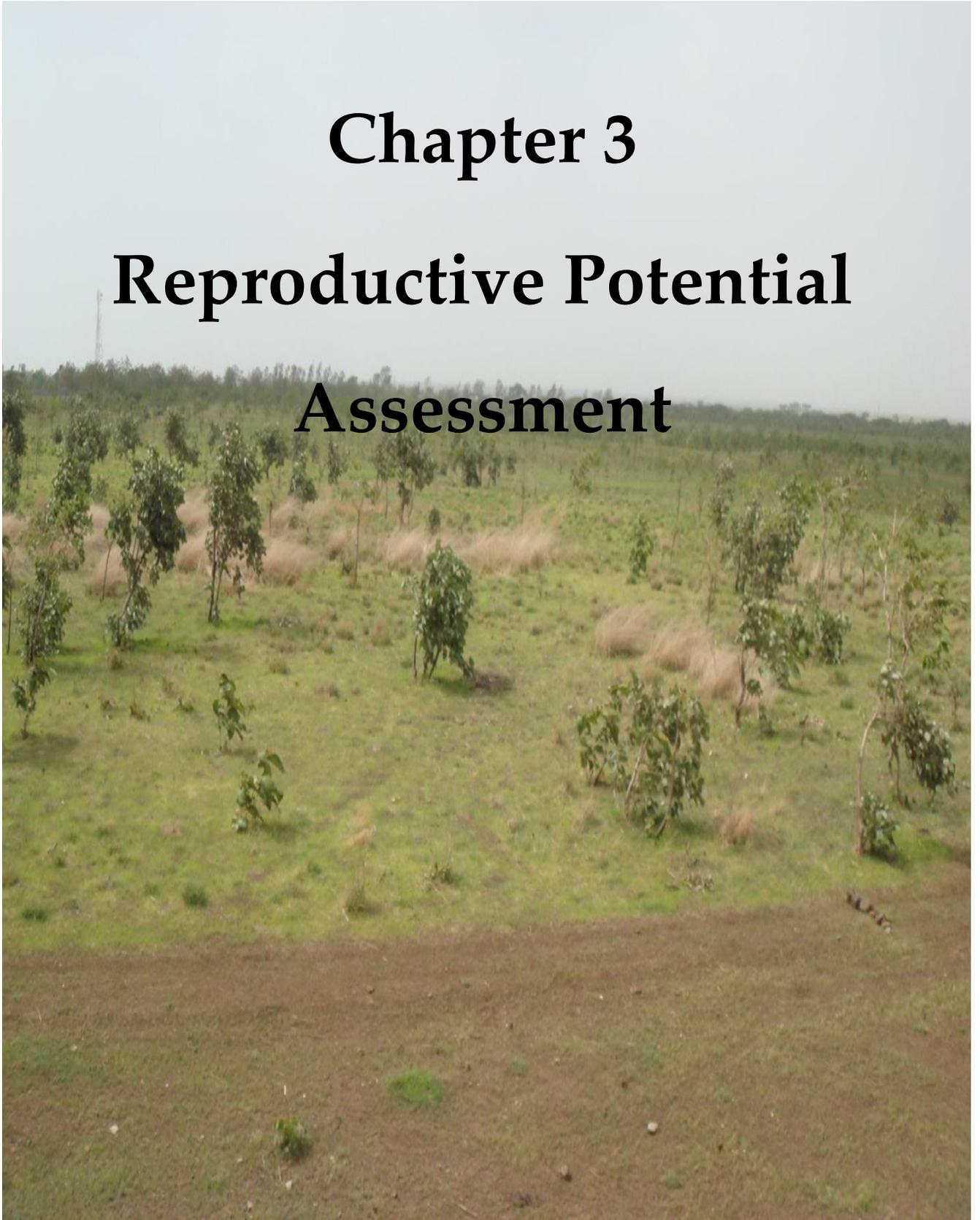


Chapter 3

Reproductive Potential Assessment



Chapter 3

Reproductive potential Assessment

Grasslands are important ecosystems and produce a wide variety of goods including livestock forage. Protection of these important ecosystems requires a good and correct management, and this needs to have an adequate and thorough knowledge and information about them. Recognition of forage species with high growth and reproductive potential is one of the important issues of proper range management and can lead to introduction of such species to enhance the utility of these systems (Akbarlou et al., 2013).

Reproductive potential is the relative capacity of a species to reproduce itself under optimum conditions. To know this potential, it is necessary to have a record of phenological events. Plant phenology is broadly defined as the study of the visible life cycle events. The knowledge about the timing and duration of certain life events provides valuable information about possible effects of climate fluctuations and changes in plants which helps in explaining the actual condition of the plants by themselves. According to Fanner (1997), the study of phenological aspects of plants involves the observation, recording and interpretation of the timing of their life history events. This review considers the phenology of leafing, flowering and fruit production in a range of species and communities. Plants are responding against even a minor change or fluctuations in the surrounding environment and these minor changes show great influence on vegetation all over. The value of such information is enhanced when gathered, phenological data can be evaluated in combination with the parameters like meteorological information, deposition or soil solution, crown condition, etc. According to Zhang et al. (2006) such kind of study provides basic knowledge about the plant growth,

development, effect of environment fluctuations on flowering and fruiting behavior which in turn also predict the community growth and development. Relative to vegetative phenology, variation in flowering induced by a variety of factors (significant rain in winter/summer, decreasing or increasing photoperiod, or drought induced leaf fall), results in a number of flowering patterns in tropical trees (Borchert et al. 2004). Thus, during the major fluctuating periods in environment each and every community showed major response towards it.

Phenology is influenced to a great extent by temperature, photoperiod and precipitation (Keatly and Fletcher, 2003). Because the flowering and fruiting phenology of plants is sensitive to environmental cues such as temperature and moisture, climate change is likely to alter community-level patterns of reproductive phenology (Sherry, et al. 2007). Climatic change factors, including increasing temperatures and rising CO₂ levels, have been shown to affect plant phenology (Caradonna, et al. 2014). Therefore it is also known as the study of relationship between different climatic factors and periodic phenomena in plant individual. Pattern of phenological events are variously used for characterization of vegetation type. The study of plant phenology provides knowledge about the pattern of plant growth and development as well as the effects of environment and selective pressures on flowering and fruiting behavior of particular plant species.

Material and Methods

On the basis of field observations and of similar schemes proposed by others (Castellani, Freccero and Lapietra, 1967; Dierschke, 1972; Ellenberg, 1974; Du Merle and Mazet, 1983; Puppi, Zanotti and Speranza, 1985), 9 phenological stages were recognized from Seedling stage to Grass dry up and for legume

Seedling stage to Seed dispersal stage (Table 3.1 and 3.2). The increase of any stage obviously coincides in time and is complementary to the decrease of the previous stage. Less frequently, the presence of three or more different phases can be observed in a single plant i.e. vegetative, pre flowering and post flowering. Data was collected for the following parameters:

1. Average Plant height (cm)
2. No. of Inflorescence / plant
3. No. of Flowers / Inflorescence
4. No. of Fruits / Inflorescence
5. Seed output / plant

Result and Discussion

In the present study, intensive phenological monitoring data was collected based on visual observations on individual plant. Since this monitoring is time consuming, these observations were recorded in depth in demarcated sample plots and thus, during three successive years of the study (i.e. from 2007 to 2010). The different phenological events observed and their response towards fluctuating environment is given in table 3.1 and 3.2 while the community output is given in table 3.3 and table 3.4. The phases monitored were Average Plant height (cm), No. of Inflorescence / plant, No. of Flowers / Inflorescence, No. of Fruits / Inflorescence, Seed output / plant for both grass and legume species.

Table 3.1 Phenological data of species at Bandheli grassland

Sr. No.	Species Name	Developmental Stage																	
		Aug			Sept			Oct			Nov			Dec			Jan		
		07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
Grasses																			
1	<i>Alloteropsis cimicina</i>	-	Sl	Sl	-	V	V	B, Of, If	V, Of	V, Of	Mf	If	If, Mf	Mf	D	Mf	Mf	D	-
2	<i>Apluda mutica</i>	-	Sl	Sl	-	V	V	V	V	B	Of, If	B, Of	B, Of	If, Mf	If	If, Mf	If, Mf	D	-
3	<i>Aristida adscensionis</i>	-	Sl	Sl, V	-	B	Sl, V	B, Of	Of	B	If, Mf	If	If, Mf	Mf	If	Mf	Mf-D	-	-
4	<i>Aristida funiculata</i>	-	-	Sl, V	-	Sl, V	Sl, V, B	V	B	B	If, Mf	Of	If, Mf	Mf	If	Mf	If, Mf, Mf-D	-	-
5	<i>Bothriochloa pertusa</i>	-	Sl	Sl	-	V, B	V, B	-	V	V	-	B, Of	B	-	Of	D	-	-	-
6	<i>Capillipedium huegelii</i>	-	-	Sl	-	-	V	-	-	V, Of	-	-	V, Of	-	-	-	-	-	-
7	<i>Cenchrus ciliaris</i>	-	Sl	Sl	-	V	V	B, Of	B, Of	B, Of	If, Mf	If, Mf	If, Mf	If, Mf	If, Mf	If, Mf	Mf, Mf-D	-	-
8	<i>Chloris barbata</i>	-	Sl, V	-	-	B, If	-	-	Mf	-	-	Mf, D	-	-	-	-	-	-	-
9	<i>Cymbopogon martinii</i>	-	Sl	Sl	-	Sl	Sl, V	V	B	B	Of, If	B	B	B, Of, If, Mf	If	If	If, Mf	Mf	D
10	<i>Cynodon dactylon</i>	-	Sl	Sl	-	V	V	V, B, Of, If	V	V	V, If, Mf	V	B	If, Mf	V	V	D, V	-	-
11	<i>Dactyloctenium aegyptium</i>	-	B		-	Of	V	V, B, Of, If	If	B	V, If, Mf	If	If	F, Mf	Mf	Mf	D, V	-	-
12	<i>Desmostachya bipinnata</i>	-	V, If, Mf	V, If, Mf	-	D	D	-	-	-	-	-	-	-	-	-	-	-	-
13	<i>Dichanthium annulatum</i>	-	Sl	Sl, V	-	B	B	V, B, Of	Of	B	V, B, Of, If	Of	Of	Of, If, Mf	Mf	Mf	If, Mf	D	D
14	<i>Digitaria adscendens</i>	-	B		-	If	If	B, Of, If	Mf	Mf	Mf	Mf	Mf	D	D	D	-	-	-
15	<i>Digitaria granularis</i>	-	-	-	-	-	-	-	-	If	-	-	B, Of	-	-	If, Mf	-	-	Mf, D
16	<i>Eragrostiella bifaria</i>	-	B	-	-	B, Of	-	-	If	-	-	Mf	-	-	D	-	-	-	-
17	<i>Eragrostis tenella</i>	-	Sl, V	Sl, V	-	B, Of, If	V, B	B, Of, If	Of, If	Of, If	If, Mf	If, Mf	Mf	Mf, D	Mf, D	D	-	-	-
18	<i>Eragrostis tremula</i>	-	-	B	-	-	V, Of	-	-	If	-	-	Mf	-	-	D	-	-	-
19	<i>Hackelochloa granularis</i>	-	-	V	-	Sl, V	Sl, V	B	V, B	V, B	V, B	V, B	V, B	-	-	-	-	-	-

Sr. No.	Species Name	Developmental Stage																	
		Aug			Sept			Oct			Nov			Dec			Jan		
		07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
20	<i>Heteropogon contortus</i>	-	Sl, V	Sl, V	-	V, B	V, B	B, Of, If	B, Of	B, Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf	D	D	D
21	<i>Imperata cylindrica</i>	-	Sl	Sl	-	V	V	V	V	V	B	B	B	Of	Of	Of	If, Mf	If, Mf	If, Mf
22	<i>Melanocenchris jacquemontii</i>	-	-	-	-	-	-	-	-	V	-	B, Of	V, B	-	Of, If	Of, If	-	Mf	Mf
23	<i>Panicum trypheron</i>	-	Sl	V, Sl	-	Of	B	If, Mf	If	If	If, Mf	If	If	Mf	Mf	Mf	-	-	-
24	<i>Paspalidium flavidum</i>	-	-	Sl	-	Sl	V	B	B, Of	B	B, Of	Of, If	Of, If	Mf	Mf	Mf	-	-	-
25	<i>Pterotis indica</i>	-	Sl	-	-	V	-	-	B	-	-	Of, If	-	-	If, Mf	-	-	D	-
26	<i>Schoenefeldia gracilis</i>	-	-	Sl	-	Sl	V	V, B	B, Of	Of	If	Of, If	Of, If	Mf	Mf	Mf	-	-	-
27	<i>Setaria glauca</i>	-	-	Sl	-	Sl	V	V, B	B, Of	Of	Of, If	If	If	Mf	Mf	Mf	-	-	-
28	<i>Sporobolus diander</i>	-	B	V	-	B, Of	B	B	If, Mf	Of	Of	-	Mf	Of	-	Mf	Mf	-	-
29	<i>Themeda cymbaria</i>	-	-	V	Sl	-	V, B	B, Of	-	B, Of	Of, If	-	If	Mf	-	Mf	-	-	-
30	<i>Themeda triandra</i>	-	Sl, V	Sl, V	-	V	V	B	B, Of	B, Of	If	If	If	Mf	Mf	Mf	-	-	-
Legumes																			
31	<i>Aeschynomene indica</i>	-	-	-	-	V	B	B	B	B	Of, If	Of, If	Of, If	If	If	If	Mf	Mf	Mf
32	<i>Alysicarpus monilifer</i>	-	Sl, V	Sl, V	-	V	B, Of	B, Of	B, Of	B	Of, If	Of, If	If	If, Mf	If, Mf	If, Mf	If, Mf	Mf	Mf
33	<i>Alysicarpus procumbens</i>	-	-	Sl, V	-	V	B, Of	B, Of	V	If	Of, If	Of, If	If	If, Mf	Mf	If, Mf	If, Mf	Mf	Mf
34	<i>Alysicarpus vaginalis</i>	-	-	V	-	V	B, Of	B, Of	V	B	Of, If	Of, If	Of	If, Mf	Mf	If, Mf	If, Mf	Mf	Mf
35	<i>Atylosia scarabaeoides</i>	-	V	V	-	V	V	-	B, Of	B, Of	-	If, Mf	If, Mf	-	Mf	Mf	-	Mf	Mf
36	<i>Cassia absus</i>	-	-	Sl, V	-	Sl	V	V	V	Of	Of, If	Of	Of	If, Mf	Mf	Mf	Mf	Mf	Mf
37	<i>Cassia mimosoides</i>	-	Sl	Sl	-	V	V	V	V	Of	B	B	Of	Mf	Mf	Mf	Mf	Mf	Mf
38	<i>Cassia occidentalis</i>	-	Sl, V	V	-	V	V	V	V	Of	Of	Of	If	Mf	Mf	Mf	Mf	Mf	Mf
39	<i>Cassia tora</i>	-	Sl, V	V	-	V	V	V	Of, If	Of, If	Of, If	Mf	If	Of, If	Mf	If, Mf	If, Mf	If, Mf	If, Mf

Sr. No.	Species Name	Developmental Stage																	
		Aug			Sept			Oct			Nov			Dec			Jan		
		07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
40	<i>Crotalaria notonii</i>	-	-	-	-	V	V	V	Of	Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf
41	<i>Crotalaria spectabilis</i>	-	-	-	-	-	-	V, Of	-	-	Of, If	-	-	If, Mf	-	-	If, Mf	-	-
42	<i>Indigofera cordifolia</i>	-	V	V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	If, Mf	Mf	Mf
43	<i>Indigofera echinata</i>	-	V	V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	If, Mf	Mf	Mf
44	<i>Indigofera hirsuta</i>	-	V	V	-	V, B	V, B	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf
45	<i>Indigofera linifolia</i>	-	V	V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf
46	<i>Indigofera tinctoria</i>	-	-	-	-	V	-	-	V	-	-	Of	-	-	If	-	-	Mf	-
47	<i>Tephrosia purpurea</i>	-	V	V	-	V	V	Of, If	Of, If	Of, If	If	If	If	Mf	Mf	Mf	Mf	Mf	Mf
48	<i>Tephrosia villosa</i>	-	-	V	-	V	B	Of, If	Of, If	Of, If	If	If	If	Mf	Mf	Mf	Mf	Mf	Mf
49	<i>Zornia gibbosa</i>	-	V	V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf

Sl = Seedling; V = Vegetative stage; B = Bud; Of = Opened Flower; If = Immature fruiting; Mf = Mature fruiting; D = Dried up; R = Regeneration; C = Cut off

Table 3.2 Phenological data of species at Rampura grassland

Sr. No.	Species Name	Developmental Stage																	
		Aug			Sept			Oct			Nov			Dec			Jan		
		07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
Grasses																			
1	<i>Andropogon pumilus</i>	-	-	-	-	Sl, V	Sl, V	V	B, Of	If, Mf	If, Mf	If, Mf	If, Mf	Mf	Mf, D	-	-	-	-
2	<i>Apluda mutica</i>	-	Sl, V	B, Of	-	B, Of	B, Of	B, Of	If	B	Of, If	Of, If	Of, If	If, Mf	If, Mf, D	Mf	Mf, D	Mf, D	Mf, D
3	<i>Aristida adscensionis</i>	-	Sl, V	V	-	V	V	V, B	V, B	V, B	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	If, Mf, D	If, Mf, D	If, Mf, D

Sr. No.	Species Name	Developmental Stage																	
		Aug			Sept			Oct			Nov			Dec			Jan		
		07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
4	<i>Aristida funiculata</i>	-	Sl	V	-	V	V, B	V, B	Of, If	Of, If	Of, If	If	If, Mf	Mf	Mf	Mf	Mf, D	Mf, D	Mf, D
5	<i>Arthraxon lanceolatus</i>	-	Sl, V	V	-	B	B	B	B, Of	Of	Of	B, Of, If	If	If	If, Mf	If	Mf	Mf, D	Mf, D
6	<i>Brachiaria eruciformis</i>	-	-	Sl, V	-	-	V	-	-	B, Of	-	-	Of, If	-	-	If	-	-	-
7	<i>Brachiaria reptans</i>	-	-	Sl, V	-	-	V, B	-	-	If	-	-	If, Mf	-	-	Mf	-	-	-
8	<i>Cenchrus setigerus</i>	-	V	B, Of	-	V	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	If, Mf	If, Mf	Mf, D	Mf, D	Mf, D
9	<i>Chionachne koenigii</i>	-	Sl	-	-	V	-	-	Of, If	-	-	Mf	-	-	D	-	-	-	-
10	<i>Chloris barbata</i>	-	Sl	Sl, V	-	B, Of	B, Of	If, Mf	If, Mf	If, Mf	Mf, D	Mf, D	Mf, D	-	-	-	-	-	-
11	<i>Chloris virgata</i>	-	Sl	Sl, V	-	B, Of	B, Of	If, Mf	If, Mf	If, Mf, D	Mf, D	Mf, D	Mf, D	-	-	-	-	-	-
12	<i>Chrysopogon fulvus</i>	-	Sl	V	-	V	V, B	B	B, Of	Of	Of	If	If	Of	Mf	D	If	D	-
13	<i>Coix lachryma-jobi</i>	-	-	Sl	-	-	V	-	-	B, Of	-	-	B, Of	-	-	Mf	-	-	D
14	<i>Cymbopogon martinii</i>	-	Sl	Sl	-	V	V	B	B, Of	B, Of	If	Of, If	If, Mf	Mf	D	D	Mf, D	-	-
15	<i>Cynodon dactylon</i>	-	Sl	V, B	-	V, B	B	Of	Of, If	Of	If, Mf	If, Mf	If, Mf	Mf, D	D	D	-	-	-
16	<i>Dactyloctenium aegyptium</i>	-	V	V, Sl	-	V, B	V, B	Of, If	Of, If	Of, If, Mf	Mf	Mf	Mf	D	D	D	-	-	-
17	<i>Dichanthium annulatum</i>	-	Sl, V	Sl, V	-	V, B	V, B	Of, If	Of, If	Of, If	Mf	If, Mf	Mf	D	D	D	-	-	-
18	<i>Dichanthium caricosum</i>	-	-	Sl, V	-	-	V, B	-	-	Of, If	-	-	If, Mf	-	-	Mf	-	-	-
19	<i>Digitaria adscendens</i>	-	Sl, V	Sl, V	-	V, B	V, B	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	D	D	D	-	-	-
20	<i>Dinebra retroflexa</i>	-	-	Sl	V	-	V	V	V	If	If	If	If	Mf	Mf	Mf	Mf	Mf	-
21	<i>Echinochloa colonum</i>	-	Sl	Sl	-	B, Of	Of	Of, If	If	If, Mf	Mf	Mf	If	If	Mf	Mf	Mf	Mf	-
22	<i>Echinochloa crusgalli</i>	-	-	Sl, V	-	-	B, Of	-	-	Of, If	-	-	If	-	-	Mf	-	-	-
23	<i>Eleusine indica</i>	-	Sl	V	V	B	B	Of, If	Of, If	Of, If	Mf	Mf	Mf	D	D	D	-	-	-
24	<i>Eragrostis tenella</i>	-	Sl, V	Sl, V	-	B, Of	B, Of	B, Of	B, Of	B, Of	If, Mf	If, Mf	If, Mf	Mf, D	Mf, D	Mf, D	-	-	-

Sr. No.	Species Name	Developmental Stage																	
		Aug			Sept			Oct			Nov			Dec			Jan		
		07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
25	<i>Eragrostis unioloides</i>	-	-	-	V	-	-	B	-	-	If	-	-	If	-	-	Mf, D	-	-
26	<i>Heteropogon contortus</i>	-	Sl	Sl, V	-	V	B	B	B, Of	If	If	If	Mf	If	If, Mf	Mf	Mf	Mf	Mf
27	<i>Ischaemum pilosum</i>	-	Sl	Sl, V	-	B	B	B	Of	B, Of	Of	D	B, Of	B, Of	-	B, Of	D	-	D
28	<i>Ischaemum rugosum</i>	-	Sl	V	-	V	V	V	If	Mf	If	If	Mf	Mf	Mf	Mf	Mf	Mf	D
29	<i>Melanocenchris jacquemontii</i>	-	-	V	-	-	V, B	-	B, Of	B, Of	-	Of, If	Of, If	-	Of, If	Of, If	-	If, Mf	If, Mf
30	<i>Ophiorus exaltatus</i>	-	V	Sl, V	-	V	V	V, B	V, B	V, B	If	If	If	D	D	D	-	-	-
31	<i>Panicum antidotale</i>	-	-	Sl, V	-	-	B, Of	-	-	B, Of	B, Of	B, Of	Of, If	B, Of	Of, If	Of, If	Mf	Mf	Mf
32	<i>Panicum trypheron</i>	-	Sl, V	Sl, V	V, B	V, B	V, B	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf	-	-	-
33	<i>Paspalidium flavidum</i>	-	Sl, V	Sl, V	-	B	B	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	-	-	-
34	<i>Sehima nervosum</i>	-	Sl, V	Sl, V	-	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf	D	D	D
35	<i>Sehima sulcatum</i>	-	Sl, V	Sl, V	-	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf	D	D	D
36	<i>Setaria glauca</i>	-	Sl, V	Sl, V	-	B	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf	-	-	-
37	<i>Sorghum halepense</i>	-	Sl	Sl, V	-	V, B	V, B	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf	-	-	-
38	<i>Thelepogon elegans</i>	-	-	Sl, V	-	-	V, B	-	-	Of, If	-	If, Mf	If, Mf	-	Mf	Mf	-	D	D
39	<i>Themeda laxa</i>	-	-	-	-	Sl	-	-	V	-	-	B, Of	-	-	If	-	-	If	-
40	<i>Themeda triandra</i>	-	Sl, V	Sl, V	-	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf	D	D	D
Legumes																			
43	<i>Aeschynomene indica</i>	-	-	-	-	V	B	B	B	B	Of, If	Of, If	Of, If	If	If	If	Mf	Mf	Mf
44	<i>Alysicarpus monilifer</i>	-	Sl, V	Sl, V	-	V	B, Of	B, Of	B, Of	B	Of, If	Of, If	If	If, Mf	Mf				
45	<i>Alysicarpus vaginalis</i>	-	Sl, V	V	-	V	B, Of	B, Of	V	B	Of, If	Of, If	Of	If, Mf	Mf	If, Mf	If, Mf	Mf	Mf
46	<i>Atylosia scarabaeoides</i>	-	V	V	V	V	V	V	B, Of	B, Of	B, Of	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf	Mf	Mf

Sr. No.	Species Name	Developmental Stage																	
		Aug			Sept			Oct			Nov			Dec			Jan		
		07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10	07-08	08-09	09-10
47	<i>Cassia mimosoides</i>	-	Sl	Sl	-	V	V	V	V	Of	B	B	Of	Mf	Mf	Mf	Mf	Mf	Mf
48	<i>Cassia occidentalis</i>	-	Sl, V	V	-	V	V	V	V	Of	Of	Of	If	Mf	Mf	Mf	Mf	Mf	Mf
49	<i>Cassia tora</i>	-	Sl, V	V	-	V	V	Of, If	Of, If	Of, If	If, Mf	If, Mf	If	Of, If	Mf	If, Mf	If, Mf	If, Mf	If, Mf
50	<i>Crotalaria calycina</i>	-	Sl, V	Sl, V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf
51	<i>Crotalaria juncea</i>	-	Sl, V	Sl, V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf
52	<i>Crotalaria mysorensis</i>	-	V	V	-	V, B	V, B	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	Mf				
53	<i>Crotalaria orixensis</i>	-	V	V	-	V, B	V, B	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	Mf				
54	<i>Indigofera cordifolia</i>	-	V	V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	Mf				
57	<i>Indigofera echinata</i>	-	V	V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	Mf				
58	<i>Indigofera enneaphylla</i>	-	V	V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	Mf				
59	<i>Indigofera glandulosa</i>	-	Sl, V	Sl, V	-	V	V	V	V	Of	B	B	Of	Mf	Mf	Mf	Mf	Mf	Mf
60	<i>Indigofera linifolia</i>	-	Sl, V	Sl, V	-	V	V	V	V	Of	B	B	Of	Mf	Mf	Mf	Mf	Mf	Mf
61	<i>Rhynchosia minima</i>	-	V	V	-	V	V	V, B	V, B	V, B	Of, If	Of, If	Of, If	Mf	Mf	Mf	Mf	Mf	Mf
62	<i>Sesbania aculeata</i>	-	Sl, V	Sl, V	-	V	V	V, B, Of	V, B, Of	V, B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf
63	<i>Sesbania sesban</i>	-	Sl, V	Sl, V	-	V	V	V, B, Of	V, B, Of	V, B, Of	Of, If	Of, If	Of, If, Mf	Mf	Mf	Mf	Mf	Mf	Mf
64	<i>Zornia gibbosa</i>	-	V	V	-	V	V	B, Of	B, Of	B, Of	Of, If	Of, If	Of, If	If, Mf	If, Mf	If, Mf	Mf	Mf	Mf

Sl = Seedling; V = Vegetative stage; B = Bud; Of = Opened Flower; If = Immature fruiting; Mf = Mature fruiting; D = Dried up ; R = Regeneration; C = Cut off

All the above mentioned species are long term species whose life span extended from June – July to December – January, due to fluctuating environment variation in phenology was observed.

Table 3.3. Community output of grasses

Sp. Index	Botanical name	Average Plant Height (cm)	No. of Inflo./ Plant	No. of Fruits/ Inflo.	Seed Output/ Plant
1	<i>Alloteropsis cimicina</i>	30 – 45	6	14	84
2	<i>Andropogon pumilus</i>	30 – 45	15	8	120
3	<i>Apluda mutica</i>	45 – 105	8	52	416
4	<i>Aristida adscensionis</i>	30 – 45	8	18	144
5	<i>Aristida funiculata</i>	30 – 45	4	9	36
6	<i>Arthraxon lanceolatus</i>	45 – 60	8	11	88
7	<i>Bothriochloa pertusa</i>	40 – 45	4	12	48
8	<i>Brachiaria eruciformis</i>	15 – 30	2	10	20
9	<i>Brachiaria reptans</i>	20 – 30	3	12	36
10	<i>Capillipedium huegellii</i>	45 – 60	4	16	64
11	<i>Cenchrus biflorus</i>	30 – 40	4	18	72
12	<i>Cenchrus ciliaris</i>	40 – 50	4	26	104
13	<i>Cenchrus setigerus</i>	30 – 45	2	19	38
14	<i>Chionachne koenigii</i>	100 – 160	6	5	30
15	<i>Chloris barbata</i>	30 – 50	2	22	44
16	<i>Chloris virgata</i>	30 – 50	3	24	72
17	<i>Chrysopogon fulvus</i>	50 – 60	5	15	75
18	<i>Coix lachryma-jobi</i>	120 – 180	6	1	6
19	<i>Cymbopogon martinii</i>	90 – 100	4	18	72
20	<i>Cynodon dactylon</i>	10 – 30	6	146	876
21	<i>Dactyloctenium aegyptium</i>	10 – 20	3	104	312
22	<i>Desmostachya bipinnata</i>	40 – 60	2	98	196
23	<i>Dichanthium annulatum</i>	30 – 45	3	96	288
24	<i>Dichanthium caricosum</i>	40 – 60	4	112	448
25	<i>Digitaria adscendens</i>	30 – 45	3	414	1242
26	<i>Digitaria granularis</i>	15 – 25	3	328	984
27	<i>Dinebra retroflexa</i>	30 – 40	1	192	192
28	<i>Echinochloa colonum</i>	30 – 60	5	32	160

Sp. Index	Botanical name	Average Plant Height (cm)	No. of Inflo./ Plant	No. of Fruits/ Inflo.	Seed Output/ Plant
29	<i>Echinochloa crus-galli</i>	20 – 60	3	36	108
30	<i>Eleusine indica</i>	30 – 50	2	45	90
31	<i>Eragrostiella bifaria</i>	15 – 25	2	56	112
32	<i>Heteropogon contortus</i>	60 – 80	4	46	184
33	<i>Imperata cylindrica</i>	75 – 90	2	4	8
34	<i>Ischaemum indicum</i>	45 – 60	3	34	102
35	<i>Ischaemum molle</i>	45 – 90	2	36	72
36	<i>Ischaemum pilosum</i>	50 – 120	3	12	36
37	<i>Ischaemum rugosum</i>	15 – 45	5	26	130
38	<i>Melanocenchris jacquemontii</i>	5 – 15	6	22	132
39	<i>Panicum trypheron</i>	30 – 60	1	38	38
40	<i>Paspalidium flavoidum</i>	60 – 100	1	42	42
42	<i>Pterotis indica</i>	30 – 45	4	18	72
43	<i>Schoenefeldia gracilis</i>	25 – 50	3	27	81
44	<i>Sehima ischaemoides</i>	30 – 40	2	15	30
45	<i>Sehima nervosum</i>	60 – 75	3	18	54
46	<i>Sehima sulcatum</i>	30 – 50	2	13	26
47	<i>Setaria glauca</i>	15 – 45	3	28	84
48	<i>Setaria tomentosa</i>	60 – 90	4	36	144
49	<i>Setaria verticillata</i>	25 – 65	3	35	105
50	<i>Sorghum halepense</i>	150 – 250	3	432	1296
51	<i>Thelepogon elegans</i>	30 – 90	4	98	392
52	<i>Themeda cymbaria</i>	90 – 100	3	35	105
53	<i>Themeda laxa</i>	60 – 90	3	42	126
54	<i>Themeda triandra</i>	30 – 60	3	45	135

Table 3.4. Community output of legumes

Sp. Index	Botanical name	Average	No. of	No. of	No. of	Seed
		Plant height (cm)	Inflo./ Plant	Pods/ Inflo.	Seeds/ Pod	Output/ Plant
1	<i>Aeschynomene indica</i>	50 – 80	48	4	8	1536
2	<i>Alysicarpus belgaumensis</i>	60 – 80	3	16	4	192
3	<i>Alysicarpus monilifer</i>	15 – 25	6	8	6	288
4	<i>Alysicarpus procumbens</i>	20 – 30	7	6	5	210
5	<i>Alysicarpus vaginalis</i>	15 – 30	7	18	6	756
6	<i>Atylosia platycarpa</i>	-	8	2	6	96
7	<i>Atylosia scarabaeoides</i>	-	8	1	4	32
8	<i>Cassia absus</i>	30 – 45	7	5	5	175
9	<i>Cassia mimosoides</i>	30 – 50	12	8	6	576
10	<i>Cassia occidentalis</i>	60 – 130	11	8	14	1232
11	<i>Cassia tora</i>	40 – 70	9	5	15	675
12	<i>Clitoria ternatea</i>	-	15	5	8	600
13	<i>Crotalaria albida</i>	20 – 55	5	8	18	720
14	<i>Crotalaria burhia</i>	30 – 50	3	16	6	288
15	<i>Crotalaria calycina</i>	40 – 60	5	4	12	240
16	<i>Crotalaria filipes</i>	30 – 50	5	6	8	240
17	<i>Crotalaria juncea</i>	120 – 180	7	5	14	490
18	<i>Crotalaria leptostachya</i>	60 – 110	12	14	18	3024
19	<i>Crotalaria linifolia</i>	35 – 55	6	3	6	108
20	<i>Crotalaria mysorensis</i>	45 – 65	8	5	8	320
21	<i>Crotalaria nana</i>	35 – 65	22	18	8	3168
22	<i>Crotalaria notonii</i>	45 – 55	8	12	8	768
23	<i>Crotalaria orixensis</i>	30 – 45	12	3	8	288
24	<i>Crotalaria spectabilis</i>	100 – 150	8	3	18	432
25	<i>Desmosium giganticum</i>	80 – 150	18	36	5	3240
26	<i>Goniogyna hirta</i>	10 – 30	25	1	2	50
27	<i>Indigofera cordifolia</i>	10 – 15	28	7	1	196
28	<i>Indigofera echinata</i>	10 – 15	31	6	2	372
29	<i>Indigofera enneaphylla</i>	10 – 15	29	18	2	1044
30	<i>Indigofera glandulosa</i>	20 – 40	37	10	1	370
31	<i>Indigofera hirsuta</i>	15 – 30	8	18	4	576
32	<i>Indigofera linifolia</i>	15 – 25	23	6	1	138

Sp. Index	Botanical name	Average	No. of	No. of	No. of	Seed
		Plant height (cm)	Inflo./ Plant	Pods/ Inflo.	Seeds/ Pod	Output/ Plant
33	<i>Indigofera spicata</i>	20 – 35	6	13	5	390
34	<i>Indigofera tinctoria</i>	40 – 50	15	12	8	1440
35	<i>Rhynchosia minima</i>	-	17	6	2	204
36	<i>Sesbania aculeate</i>	160 – 230	18	5	12	1080
37	<i>Sesbania sesban</i>	150 – 210	24	7	8	1344
38	<i>Tephrosia purpurea</i>	30 – 50	26	8	6	1248
39	<i>Tephrosia strigosa</i>	30 – 45	15	5	6	450
40	<i>Tephrosia villosa</i>	30 – 90	19	12	7	1596
41	<i>Zornia gibbosa</i>	10 – 30	45	2	5	450

Obtained results (Table 3.1 and 3.2) can help in collecting seeds for regenerating pure patches for desired species or fodder for cattle at appropriate stage with good quality. While table 3.3 and 3.4 gives details about individual plant species and can help in getting knowledge about seed quantity for collection.

Among grasses like *Andropogon pumilus*, *Apluda mutica*, *Cynodon dactylon*, *Dichanthium caricosum*, *Digitaria adscendens*, *Digitaria granularis*, etc, gives good amount of seed per plant. We can establish pure patches for such palatable species for good pasture development for future. While species like *Sorghum halepense* which also gives good amount of seed per plant should be removed before seed setting to restrict the regeneration as it is poisonous. Like wise, among legumes species like *Aeschynomene indica*, *Alsicarpus vaginalis*, *Crotalaria albida*, *Crotalaria leptostachya*, *Crotalaria nana*, *Desmosium giganticum*, *Indigofera ennaephylla*, *Indigofera tinctoria*, *Sesbania sesban*, *Tephrosia villosa*, etc., gives good amount of seeds and also be establish in pure patches. This will help in pure seed collection and being palatable species, vegetative parts of grasses and legumes can be used as cattle feed.

Seasonal timing of biological events, phenology, is one of the strongest bioindicators of climate change (CaraDonna et al. 2014). They also concluded that our general understanding of phenological responses to climate change is based almost solely on the first day on which an event is observed, limiting our understanding of how ecological communities may be responding as a whole. Using a unique long-term record of flowering phenology from Colorado, we find that the number of species changing their flowering times likely has been underestimated and the magnitude of phenological change overestimated. Phenology is a key process that may link climate change to population persistence and possibly to community composition (Miller-Rushing et al. 2010). Climate-driven shifts in phenology are altering ecological relationships and processes around the world (Forrest and Miller-Rushing 2010). These in turn time-sensitive relationships, such as migration, breeding and predation, may be disrupted or altered, which again alter the rates of reproduction and survival, leading some populations to decline and others to increase in abundance (Miller-Rushing et al., 2010). Thus, predictions about ecological consequences of climate changes must rely on additional information, in particular about the fundamental basis of the relationship between phenology and environmental conditions for which phenology estimating under different scenarios is essential. One simple example for this relationship is, rainfall does not predict the phenology of forest caterpillars, but rainfall does predict the phenology of ripe grass seeds.

Phenological effects on survival and reproductive success says that flowering too early may expose plants to cold weather conditions and damaging frosts while flowering too late may leave too little time for fruits to develop or for germination to occur before the end of the growing season.

Phenology, being a life style of a particular plant affects nearly all aspects of ecology and evolution. The term phenology is sometimes used interchangeably with life history because both incorporate the timing of growth, reproduction and senescence. Thus, in present study along with these phenological events, reproductive potential in terms of seed output was also incorporated as one of the base for community stability and its development against differing environmental fluctuations. And obtained data will use to provide an outlook to what kind of research is needed to estimate phenology influenced by climate change.

The term phenology is sometimes used interchangeably with life history because both incorporate the timing of growth, reproduction and senescence. Phenology is involved nearly all ecological relationships, and also exhibits clearly potential for important effects. According to Both et al. (2009) species will differ in the degree to which their phenologies shift, with potentially dire consequences for interacting species.

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