Changing Structures and Productivity of Different Types of Grassland under Anthropogenic Influence in Tajikistan

A. MADAMINOV

Tajikistan is a typical mountainous country with a most complex geological and geomorpho-logical structure and gipsometry elevation from 300 meters to 6,000 meters – 7,000 meters above sea-level.

More then 90 per cent of the territory of the Republic is occupied by the Pamiro-Alai moun-tains with the Western Tien-Shan mountain range entering the territory only in the north of the Republic.

The climatic regime of Tajikistan being characterized by a sharp continentality is mediter-ranean according to its type, that means it has an expressed heterorhythmic precipitation course with mild winters often allowing the plants to vegetate all through winter-time. The maximum precipitation occurs in the winter-spring period, the minimum during the long and almost rain-free hot summer period. Only in the Eastern Pamir we can registrate together with the strongly expressed temperature continentality the typical features of Central-asiatic type of climate with the homogeneous distribution of precipitation throughout the season, although the quantity of precipitation is very small. The mountain character of our Republic results in a complex mosaic of local bioclimatical conditions.

A complex relief combined with a significant meridional and longitudinal extension of the territory, the contrasting composition of arid, semiarid and humid microregions with precipitation varying from 50 to100 millimetres up to 1,300 to1,500 millimeters per year, as well as a complex florocenogenetic history of the Pamiro-Alai are responsible for the richness of its flora (4,500 to 5,000 plant species) and the complex phytocoenotic structure.

P.N. Orczinnikov (1957) distinguishes 20 florocoenotypes in the vegetation of Tajikistan.

Table 2: **Dynamics of aboveground productivity of short grasses of semisavannas (Carex pachystilis, Poa bulbosa)**

Year	Dry weight t/ha	Dry weight % to mean value	Year	Dry weight t/ha	Dry weight % to mean value
1950	0.18	23	1971	0.20	25
1951	0.22	29	1972	0.74	95
1952	0.28	36	1973	0.37	176
1953	0.30	38	1974	0.38	48
1954	1.05	135	1975	1.00	124
1955	0.33	43	1976	1.52	194
1956	1.14	146	1977	0.26	33
1957	0.85	109	1978	2.00	255
1958	0.59	76	1979	0.63	81
1959	0.37	47	1980	0.50	192
1960	0.96	123	1981	1.05	134
1961	0.75	97	1982	0.74	94
1962	0.84	108	1983	1.20	154
1963	0.60	77	1984	0.60	77
1964	0.60	77	1985	0.43	56
1965	0.50	64	1986	0.28	36
1966	0.30	38	1987	1.69	217
1967	0.30	38	1988	2.23	286
1968	0.32	42	1989	0.76	98
1969	0.96	123	1990	1.35	172
1970	0.37	48	Mean (x)	0.78	100

Table 1: **Aboveground phytomass of herbaceous florocoenotypes studied in Tajikistan (dry weight).**

Florocoenotypes	Total Area, x 10^3 ha	Phytomass tonnes / hectare	Phytomass Total, x 10^3 tonnes
Savannoids	70	42.5	2,975
Tall forbs semisavannas	600	4.5	2,700
Tall grass semisavannas	300	2.5	750
Tragacanth formations	400	1.5	600
Steppes	420	1.0	420
Meadows + saz	170	2.5	425
Short grass semisavannas	500	0.8	400

Group of herbaceous floro-coenotypes: semisavannas (short grass, tall grass, and tall forbs semisavannas); ephemeretum; savannoids; meadows; steppes of grasses and forbs; grass heath or cryophyton; saz – grass moor; *Tragacanth* formation; petrophyton.

Highest phytomass production (aboveground) among herbaceous vegetation is recorded in the savannoids of river valleys (*Table 1*).

The field stations of the Tajik Botanical Institute in Western Tajikistan are located along a profile of various zones and herbaceous florocoenotypes ranging from semisavannas, sub-alpine steppes to meadows. For several years now, they have been studying the above- and underground structure and species diversity of vegetation communities, their development from season to season, the changes in their biological productivity and water balance, and the biology of principal species and their biochemical

Author: Dr. Abdullo MADAMINOV, Institute of Botany, Tajik Academy of Sciences, 32, Karamova Str., DUSHANBE 734017, Republic of Tajikistan

composition connected with antropogenic influences (grazing, cutting, fertilizer application). This research has been accompanied by experiments with fodder crops, improvements of grassland and their rational use. The data on phytomass collected at the field stations of the Tajik Botanical Institute for different florocoenotipes are given below.

Kabadian Field Station in the southern foothills of the Ak-Tau Mountain Range, the zone of short grass semisavannas, 380 up to 400 m above sea level. The short grasses of semisavannas develop best in winter and spring (the most humid season from December to April). The grasses are low in productivity (0.2 – 2.2 t/ha of aboveground mass) which sharply fluctuates with seasonal changes in the weather (*Table 2*). The bulk of phytomass is produced by ephemeroids *Carex pachystylis* and *Poa bulbosa*. The aboveground to underground phytomass ratio equals 1: 36.

The application of mineral fertilizers results in a threefold increase in yields, the content of digestible protein increased to 200 per cent in the grass. The species diversity index (by Shannon, H) changes little: control – 0.951 and $N_{60}P_{30}$ – 0.977, equability index (J) respectively 0.453 and 0.439. *Poa bulbosa* is very responsive to N application.

Table 4: **Dynamics of aboveground productivity of alpine bunch-grass steppes (Festuca sulcata, Geranium regelii, Cousinia franchetii)**

Year	Dry weight t/ha	Dry weight % to mean value	Year	Dry weight t/ha	Dry weight % to mean value
1953	0.70	73	1973	1.45	151
1954	0.46	48	1974	1.19	124
1955	0.88	92	1975	0.90	94
1956	0.22	23	1976	0.89	93
1957	0.65	68	1977	1.02	106
1958	0.88	92	1978	0.88	92
1959	1.03	107	1979	0.89	93
1960	0.59	61	1980	1.01	105
1961	0.72	75	1981	1.13	118
1962	0.67	70	1982	1.28	133
1963	0.62	65	1983	1.22	127
1964	0.69	72	1984	1.38	144
1965	0.75	78	1985	1.09	114
1966	0.49	51	1986	1.18	123
1967	0.72	74	1987	1.42	148
1968	0.77	80	1988	1.47	153
1969	1.17	122	1989	1.38	144
1970	1.08	112	1990	1.48	154
1971	1.18	123	Mean (x)	0.96	100
1972	0.93	97			

Tash-Mechet Field Station (Rangon-Tau Mountain Range, 1,600 m above sea level). Dominated by tall grass semisavannas consisting of *Elytrigia trichophora*. Vegetation grows best in winter and early summer. Phytomass determinations of *Elytrigietum herboso-ephemeroso-hordeosum* community indicate that green assimilating parts make up 1.40-3.51 t/ha (*Table 3*), species diversity index (H) – 1.867, J – 0.542. The aboveground to underground phytomass ratio respectively equals 1 : 8. Fertilizer applications may raise total dry matter (DM) yield of this grassland 2.5 to 3 times (to 7.56 t/ha). Fertilizer application leads to lower species diversity index (H) to 1.037 and J – 0.318.

Table 3: **Dynamics of aboveground productivity of tall grass semisavannas (Elytrigia trychophora, Hordeum bulbosum)**

Year	Dry weight t/ha	Dry weight % to mean value	Year	Dry weight t/ha	Dry weight % to mean value
1953	3.26	129	1973	2.87	114
1954	2.96	118	1974	1.99	79
1955	2.46	98	1975	2.78	110
1956	2.11	84	1976	3.35	133
1957	2.69	107	1977	3.11	124
1958	2.76	110	1978	2.41	96
1959	2.54	101	1979	1.40	56
1960	2.18	81	1980	1.70	68
1961	2.21	88	1981	2.43	94
1962	2.46	98	1982	1.90	75
1963	2.72	108	1983	2.38	94
1964	3.00	119	1984	1.87	74
1965	3.33	132	1985	2.75	108
1966	2.75	109	1986	2.35	93
1967	3.30	131	1987	1.66	66
1968	3.51	139	1988	2.49	99
1969	2.73	108	1989	1.62	64
1970	2.58	102	1990	1.92	76
1971	2.55	101	Mean (x)	2.52	100
1972	2.68	106			

Elytrigia trichophora is more resistant to grazing, but *Hordeum bulbosum* is resistant to cutting. Cutting in all twelve years has increased yields of *Hordeum bulbosum* in the fertilized plots ($N_{90}P_{45}K_{30}$) from 0.4 t/ha in 1977 to 5.1 t/ha DM in 1988, compared to yields on control plots of 0,4 and 0.9 t/ha DM, respectively. The yield ratio *Elytrigia trichophora* to *Hordeum bulbosum* in control plots equals 1:0.2 in 1977 and 1:10.1 in 1988, in the fertilized plots 1:0.5 and 1:100.5 and in reservation plots 1:0.2 and 1:0.3, respectively.

Anzob Field Station (Gissar Mountain Range, the upper portion of the subalpine and the lower portion of the alpine zones, 3,150 – 3,420 m above sea level). The main florocoeno-types, in which phytomass was calculated, are as follows.

The yield of aboveground phytomass of the subalpine bunch grass steppe (*Festuca sulcata, Leucopoa olgae, Geranium regelii, Cousinia franchetii* community, at 2,500–3,500 m a.s.l.), depending on weather conditions, varies from 0.46 to 1.45 t/ha (*Table 4*). Alpine forb steppes

Table 5: **Influence of 3–year application of fertilizers on number of tillers (per 1 m²) in meadow at Rangon Mountain Range.**

Name of plant	Treatments			
	O	$P_{45}K_{30}$	$N_{45}P_{45}K_{30}$	$N_{90}P_{45}K_{30}$
Dactylis glomerata	960	718	681	1049
Elytrigia trihophora	102	94	31	12
Hordeum bulbosum	39	82	152	189
Carex turkestanica	660	613	566	151
Vicia tenuifolia	14	13	3	5
Other plants	63	54	73	51
Total number per 1 m²	1738	1604	1512	1457

(*Nepeta podostachys* + *Lindelophia olgae* + *Piptatherum alpestre* community, 3,200 – 4,000 m a.s.l.) yield 0.68–1.78 t/ha of phytomass. Alpine short grass meadows (*Puccinellia subspicata* + *Allium fedtschenkoanum* community) yield 0.30–1.40 t/ha. The application of fertilizer increased yields of alpine steppes and meadows on average to 2.94–3.50 t/ha DM. The bulk of organic matter (96-98 per cent) is made up by underground parts. The underground phytomass exceeds the aboveground phytomass by 26 to53 times in weight. Such a big ratio between underground and aboveground mass is a pointer to the high viability of plant in rigid habitats. The aboveground mass is mainly composed of annual green twigs, since the vegetation cover of the communities consist of perennial plants.

Application of fertilizer, mainly NP enhances the yields of swards in different types grasslands of Tajikistan 2.5 to 3 times. It is accompanied by a change of their floristical composition and structure (height, vertical distribution of the mass of aboveground organs, number of tillers, etc.).

Under the influence of fertilizers thequantity of tillers by *Poa bulbosa, P. bucharica, Hordeum bulbosum, Dactylis glomerata, Alopecurus zeravschanicus* increases. In the short grasses of semisavannas (*Carex pachystilis* and *Poa bulbosa* community) as the result of long–term application of $N_{60}P_{30}$, the number of tillers *Poa bulbosa* rose from 787 (control) to 7,922 (NP) per 1 m². In this case, the number of tillers *Carex pachystilis* decreased from 3,048 to 582 per 1 m².

On the tall grass meadow (*Dactylis glomerata* community), in the case of utilization for hay, under the influence of fertilizers the total number of tillers decreased from 1,738 (control) to 1,457 (NPK) per 1 m² (*Table 5*).

The ability of plants to reproduce by seeds is also significantly affected by fertilizers. The conditions of the seedling taking root on fertilized hay grasslands and the density of swards are also less favorable than on unfertilized grasslands owing to greater shading. As the result of the participation in swards of some species reproducing exclusively by seeds drops rather soon or they disappear entirely. Thus, in the fertilizer plots on the short grass semisavannas phytocoenoses reduces the number of *Cerato-cephala testiculata* – poisonous weed in the sward - but the alpine steppes and meadows phytocoenoses reduces the number of seedlings *Cousinia franchetii*.

Every plant species is peculiar in it response to fertilizers. As a result, fertilization of many component meadow phytocoenoses is always followed by changes in the quantitative relationships of their components and often change the dominants (Rabotnov 1973). This was demonstrated by the results of numerous field experiments in semisavannas, steppes and meadow phytocoenoses in Tajikistan under application of fertilizers (Madaminov 1992). In these experiments of responses by more than 200 plant species to application of fertilizers were studied, among them there are many species which are relatives of cultural plants. The results of the experiments with fertilization of grasslands show how the importance of the supply of nutrients, especially with nitrogen, for semisavannas, steppes and meadow plants for the determination of productivity, structure and composition of grasslands.

References

Orczinnikov, P.N.: Main Peculiarities of Vegetation and the Region's Flora of Tajikistan (Osnovnye chezty rastitel'-nosty I rayony florey Tadzhikistana*)*. Leningrad: *Nanka*, 1957, Vol. I, 7-20.

Rabotnov, T.A: Influence of Mineral Fertilizers on Meadow Plants and Meadow Phytocoenoses (Vlyanye minezal'nykh udobzenya ha lugovykh rastenya I lugovykh fytosenozov). Moscov: *Nanka*, 1973, 256.

Madaminov, A.A.: Productivity of Mountain Grassland of Tajikistan (Produktyv-nost' gornykh pastbysh Tadzikistana). Moscov: *VINITI*, 1993, 191.