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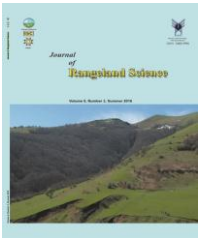

Research and Full Length Article:

Study the Effects of Range Management Plans on Vegetation of Summer Rangelands of Mazandaran Province, Iran

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Abstract. Rangeland rehabilitation and optimum exploitation are the first scientific and technical efforts with various programs in range management plans (RMPs) in Iranian range management sector. The range management plans have important roles in the natural resources conservation and improvement. In the present study, we evaluated the effects of accomplishment of range management plans on vegetation cover of Mazandaran's summer ranges over the past 22 years. First, twenty range management plans were randomly selected from 320 implemented ones in Manzandaran province, Iran. In order to collect the required data, field study was conducted to evaluate canopy cover percent, available forage, range conditions and trend before and after the implementation of range management plans. The data were analyzed and compared using parametric (t-paired) and non-parametric (Wilcoxon) tests. The results showed that the RMPs have increased the available forage production up to 14.7% ($P<0.01$). Also, range condition and trend had increased to 25% and 40% as compared to the control, respectively; but statistically, they had no significant effects. Although canopy cover percent of more range sites have increased, there was no significant effect. Thus, the execution of range management plans has relatively improved the range conditions but their positive effects were not clear for many range management plans.

Key words: Trend, Condition, Forage production, Summer rangelands

Introduction

Rangelands play an important role in forage supply, water and soil conservation, etc. In recent decade, many factors have the adverse effects on rangeland and vast areas of natural rangelands have been degraded. Rangelands are the sources of food for millions of farmers and pastoralists. The semi-arid rangelands occupy the majority of Iran. There is a variety of definitions for rangeland in Iran. Iran has 1,648,195 km^2 areas containing a variety of geographic and climatic conditions which may contribute to its ecological diversity (fauna and flora). Total area of Iran's rangelands is about 84.8 million hectares which cover 52.3 percent of the country (Eskandari *et al.,* 2008). Sheep and goat are the most common livestock; on the other hand, cattle, buffalo, camel, ass and mule are also kept in Iran. Total number of livestock in this country is 83 million animal units (AU: a sheep of 45 kg which requires 276.5 kg TDN[1] per year). Rangeland can meet the requirements of only 37 million animal units for a period of 7 months; so, there are some 46 million Animal Units excess to the grazing capacity of rangelands. Based on a study conducted by Natural Resources University of Tehran, an economic size of rangeland exploitation is 536 ha with 230 AUS. It suggests that the rangeland can meet the requirements of only 180,000 households whereas there are 916,000 households at present (Badripour *et al.*, 2006).

For the first time in 1967, a rangeland management plan was taken into account in the governmental sector and the structure of forest and rangeland organization was expanded to several offices including the rangeland office to deal with the previously mentioned issues (Badripour *et al.*, 2006). In order to improve the conditions of rangelands, government has ratified a national policy for regulating the use of range resources. The Rangeland Management Plan (RMP) has been designed on the basis of plant ecology and rangeland succession model. According to this model, a given rangeland has an ecological severe status in the absence of disturbances including overgrazing. The model indicated the ecological changes in stable conditions of rangelands due to the grazing pressure, but these ones were stabilized by 11 successional tendencies of vegetation (Westoby *et al.*, 1989; Azadinasrabad, 2005). Therefore, based on the model, the main approach to effectively manage the rangelands is to choose a stocking rate that creates a long-term balance between the grazing pressure and the succession tendency (Westoby *et al.*, 1989; Azadinasrabad, 2005). Boundaries of rangeland, legal consideration, trend and conditions, grazing capacity and grazing system made the main structure of the RMP; however, the instruction becomes a bit broader for management strategies. For instance, range management plan defines the grazing rotational system or paddock and rehabilitation programs that are supposed to be implemented for a specific area (Badripour *et al*., 2006).

There are numerous researches about this question: How range management plans have been conducted up to now? And have these plans been successful?

Ghaemi (2003) studied the effects of RMPs given to stakeholders in improving the rangeland of western Azarbaijan province. The results showed that there were significant differences between range condition and forage production of RMPs and public rangelands (rangelands without plan).

Such studies in other parts of Iran suggested illiteracy and pastoralism as important and effective issues (Sanaii *et al.,* 2010). Alizade and Mahdavi (2007) suggested that due to large area of rangelands and numerous pastoralists in

1-Total Digestible Nutrient

the country, NGO activities will be necessary. Rahimi & Sadeghi (2005) studied the effective factors in increasing RMP efficiency in three provinces of Kharasan, Yazd and western Azarbajan and reported that the forage production of these rangelands increased up to 55%. Karimian *et al*. (2008) studying RMPs in Semnan Province found that the designed technical projects of these plans are too weak and often non-practical. Dehdari (2012) and Sardari (2009) studied RMPs comparing many range sites and concluded that RMP execution in different provinces had no similar effects and even in some cases, on grazing management principals like early grazing.

Azarnivand *et al.* (2012) studied the effects of range management plans on soil properties and rangeland vegetation in winter rangelands of Eshtehard area with the arid climate; the study results showed that due to the reduction of plant species in the arid and semi-arid areas and the need for vegetation changes for a long time period, the differences of canopy percent between two sites were not significant but RMPs increased the yield and improved the range condition and trend of RMP which had increased the N and OM% of the soils and decreased P, K and bulk density.

Tanaka *et al.* (2005) stated that climatic factors such as rainfall, temperature, humidity, light and natural factors including soil depth, soil texture, soil salinity and slop and management factors such as the type of exploitation system of rangelands were the effective factors in the increase of production, maintenance and sustainability of rangelands. Nekooie *et al.* (2012) assessed the implementation impact of grassland management research on their production, condition and trends in Komijan city of Markazi Province, Iran. They measured production factors, status and trends in five grassland pastures with and without plans. They found that forage production and grazing capacity were increased in the rangelands with plans. Tavakoli *et al.* (2013) examined the performance of range management plans of Khorasan Razavi province, Iran using Fuzzy Delphi approach and multi criteria decision making models. Their results showed that Arehkamar, Baharkish, Kalkaghazi, Cheshmehnahoor, Farmad and Rahim Abad rangeland plans had the highest performance requirements. Borhani *et al*. (2014) studied the effects of range management plans on the vegetation in Semirom area. Their results showed that there was no significant difference for the mean total cover, production and number of seedlings between two managements while in the sites with plan, the vegetation cover, production and number of seedlings of class 1 plants, and cover and production of perennial grasses were significantly higher than those of the sites without plan. This result was also true in the case of litter. They stated that these variations in plant composition were due to the impact of controlling the intensity and schedule of grazing on the competition between palatable and perennial species with the invasive and annual ones.

Traditional exploitation systems of rangelands in the different ecological conditions included the ambiguity of the ability range management plans for solving the problems of rangelands, range management plans, the uncertainty of shortcomings in responding to the problem of reducing the production of rangelands, meadows and failure to assess the effects of the scheme Nomads. Whereas the management of pastures through range management plans and parameters was developed in this study, it included production plants, condition, trend and canopy implementation of pastoralists in Mazandaran province to determine the strengths and weaknesses of management practices regarding the rangeland management to achieve an appropriate model.

The intent of this paper is to provide information on techniques and procedures which may be employed by public and private range mangers to evaluate present and future range management plans. Accountability is becoming increasingly more important on all public rangelands.

Material & Methods

The study area

Mazandaran Province has 23841 Km^2 areas that is situated in north of Iran at the vicinity of Caspian Sea. According to the 2011 census, the population of province was 3.07 million people of which 53.18% live in cities and 46.82% in villages, and the remaining was non-residents. Sari is the capital of province. Mazandaran is divided into 20 counties (Fig. 1) (Statistical Centre of Iran, 2011).

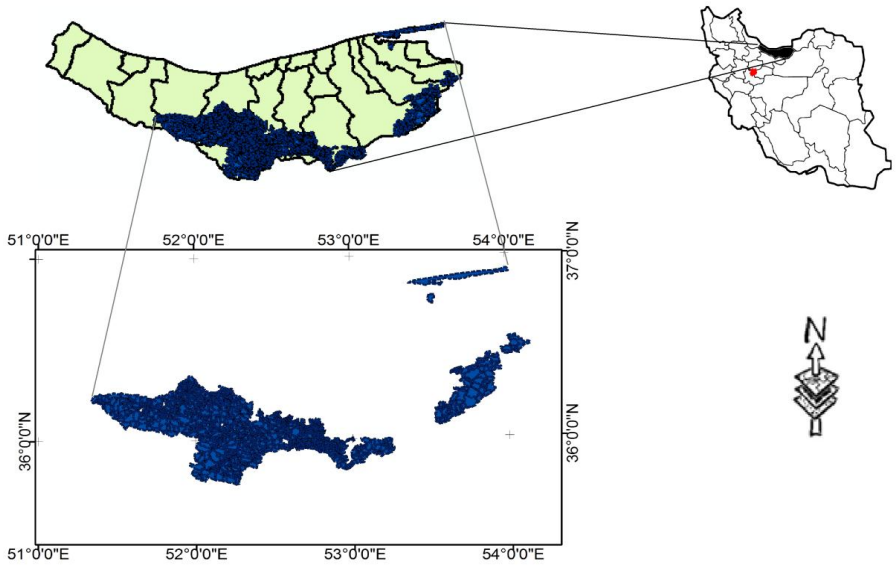

Fig. 1. The location of summer rangelands in Mazandaran Province

Rangelands of Mazandaran have been estimated to comprise about 387559 Ha which is about 0.11% of Iran and 16.3% of Mazandaran Province.

Rangelands distribute to geographical and climate conditions (Ministry of Jihad Agriculture, 2010). These factors also influence the plant growth. Natural Resource Organization has categorized the rangelands of the area into 4 ecological zones based on ecological factors such as plant species, soil type, grazing seasons and so on in 1993. More information on each category is presented in Tables 1, 2 and 3.

Table 1. Attributes of each ecological category of rangeland

Rangeland Condition	Area (ha)	Area (%)	Vegetation cover (%)	Dry matter (kg/ha)
Good rangeland	256281	256281	76-100	Up to 500
Fair rangeland	118624	118624	51-75	250-500
Poor rangeland	12655	12655	26-50	100-150

Table 2. The status of developed and abandoned plans

Pastoralism Unit	Area of Assigned Plans to Pastoralists (ha)	Developed plans Area (ha)	Summer rangelands (ha)
8301	319519 (82%)	367421 (95%)	(387870)

Table 3. Characteristic range management plans in study area

Unit Name	Area (ha)	Climate	Vegetation Type	Implementation Period	Altitude (m)	Exploitation Kind	Animal Units
Rinekooh	3050	Alpine	Br.to- Fe.ov-As.go*	2001-2006	2400-4200	Common	3579
Abkhory	312	Mediterranean-cool	Fe.ov-Br.to-On.co**	2001-2006	2900-3400	Cooperative	545
Nandal	1954	Mediterranean-cool	Fe.ov-Br.to-On.co	2001-2006	2330-3590	Common	2897
Chame ben	535	Mediterranean-cool	Fe.ov-Br.to-On.co	2001-2006	3000-3700	Cooperative	1120
Nazergardan	166	Alpine	Fe.ov-Br.to-On.co	2001-2006	3200-3800	Cooperative	394
Ashkarchal	343	Alpine	Fe.ov-Br.to-On.co	2001-2006	2950-3755	Cooperative	1295
Nessumlabi	655	Alpine	Fe.ov-Br.to-On.co	2001-2006	2600-3800	Cooperative	1244
Ernis	626	Mediterranean-cool	Fe.ov-Br.to-On.co	2001-2006	3100-3900	Common	1389
Bazkooli	409	Humid-moderate	Medow	2001-2006	65-75	Singleness	12
Dabbaghkheil	380	sub humid cool	Fe.ov-Br.to-Da.gl***	2000-2005	1400-2200	Common	374
Dedimdasht	845	Semi-humid cool	Fe.ov-Br.to	2000-2005	2100-2500	Cooperative	1829
Dizak&alikhani	1332	Semi-humid cool	Fe.ov-As.go-Ar.fr	2000-2005	2200-2450	Common	2090
Jenjoolak	182	Semi-humid cool	Fe.ov-Br.to-On.co	2000-2005	2500-3200	Common	237
Pain chalmish	580	Semi-humid cool	Fe.ov-Br.to-On.co	2000-2005	2300-2500	Common	909
Sootegandom	593	Semi-humid cool	Fe.ov-Br.to-Th.ko****	2000-2005	1500-2600	Common	1111
Siahchal	1237	Highland	Fe.ov-Br.to-On.co	1999-2004	2700-3700	Cooperative	2035
Lavar	675	Semi-arid cool	Fe.ov-Br.to	1999-2004	2600-3945	Nomadic	1434
Nazarolya	1711	Alpine	Fe.ov-Br.to-As.go	1999-2004	2700-3500	Common	1781
Zeryesharghi	503	Semi-arid moderate	Ar.fr-Fe.ov-As.go	1999-2004	1100-2200	Common	165
Khoshkavande	1855	Semi-arid cool	Br.to- Fe.ov	1999-2004	2100-3880	Common	3713

***- Bromus tomentellus- Festuca ovina –Astragalus gossypinus,*
****- Festuca ovina – Bromus tomentellus –Onobrychis cornuta,*
*****- Festuca ovina- Bromus tomentellus –Dactylis glomerata,*
******- Festuca ovina – Bromus tomentellus-Thymus kotchyanus*

Methods

In this research, 20 implemented plans (only 20 plans, the projects were fully implemented in accordance with the research reports) that were similar in terms of ecological characteristics were selected from 320 developed plans. Their vegetation characteristics including canopy cover, forage production, range condition and trend were determined in two time series before and after RMPs (After 10 years from RMPs). The canopy cover percent was determined by 'line intersect'' method and available forage production was estimated by 'clipping & weighting'' method in 10 systematically randomized and positioned plots. Also, range condition and trend were determined by vegetation and soil combination (four factors) method (with 5 degrees including Excellent, Good, Moderate, Poor and Very poor) (Stoddart and Smith, 1955) and balance method of rangeland trend (T-method with 3 states including Positive, Negative and Constant) (Mesdaghi, 1998). The data were analyzed using parametric (T-paired) and non-parametric (Wilcoxon Signed Rank Test) tests. Before comparing, the homogeneity of variances and data normality were tested by the Levene's test and the Anderson–Darling test.

Results

The measured vegetation attributes before and after RMPs including forage production, canopy cover and the pastoralist population in each range site are given in Table 4.

Table 4. Condition changes of rangelands, before and after RMPs

No.	Unit Name	After range management plan				Before RMPs			
		Trend	Canopy cover %	Production (kg/ha)	Condition	Trend	Canopy cover %	Production (kg/ha)	Condition
1	Rinekooh	Downward trend	70.7	386.1	Good	Constant	69.8	342	Fair
2	Abkhory	Constant	76	320	Fair	Constant	75.4	316	Fair
3	Nandal	Constant	82	305	Fair	Constant	81	303	Fair
4	Chame ben	Constant	74	377	Fair	Constant	71	358	Fair
5	Nazergardan	Constant	71	475	Good	Constant	53	210	Good
6	Ashkarchal	Upward trend	79.2	377.5	Good	Constant	69	309	Good
7	Nessumlabi	Upward trend	83	342	Good	Constant	71	312	Good
8	Ernis	Upward trend	77	480	Fair	Constant	84.3	290	Fair
9	Bazkooli	Upward trend	83	215	Good	Downward trend	90	167	Fair
10	Dabbaghkheil	Constant	70.9	347	Fair	Constant	84	350	Fair
11	Dedimdasht	Upward trend	73.6	498	Good	Constant	74	433	Good
12	Dizakalikhani	Downward trend	65.8	285.7	Fair	Constant	56	324	Fair
13	Jenjoolak	Constant	76	337	Fair	Downward trend	87	327	Fair
14	Pain chalmish	Upward trend	91	319	Good	Upward trend	86	282	Fair
15	Sootegandom	Upward trend	74	337	Fair	Constant	84	311	Fair
16	Siahchal	Upward trend	74	415	Good	Constant	60	350	Fair
17	Lavar	Upward trend	72	425	Good	Upward trend	79	346	Fair
18	Nazarolya	Constant	72	245	Fair	Constant	75	234	Fair
19	Zeryesharghi	Downward trend	60	116	Fair	Downward trend	50	376	Fair
20	Khoshkavande	Constant	63	915	Fair	Constant	63	614	Fair

The results showed that there is a significant difference ($P<0.01$) between after and before range management plan from the viewpoint of forage production (Table 5). The canopy cover does not have a significant difference and showed only 1.3% increase after RMPs. Also, the results showed that plan has the most positive effect on forage production in most RMPs as the mean production has the 12.5% increase after RMPs (from 312 kg to 351kg).

Fig. 2 shows forage production changes in each range management plan.

The Wilcoxon test results showed no significant differences between after and before RMPs from the viewpoint of range condition and trend (Table 6). Range condition was constant over 10 years in 25% of RMPs but the trend has been relatively improved in 40% of RMPs and was constant in 50% of RMPs (Figs. 3 and 4).

Table 5. Comparison of rangeland characteristics after and before RMPs by t-test

RMPs	Forage Production	Canopy Cover%
Before range management plan	312 b	73.12 a
After range management plan	351 a	74.40 a
T- value	-3.32**	-0.64 ^{ns}

^{ns} Represent non-significant

Table 6. Comparison of rangeland characteristics after and before RMPs by Wilcoxon test for all plans

RMPs	Condition	Trend
Before range management plan	Moderate (3)	Constant (2)
After range management plan	Moderate (3)	Positive (3)
Z-value	-1.65 ^{ns}	-1.79 ^{ns}

^{ns} Represent non-significant

Comparison of forage production changes before and after RMPs is given in Fig. 2. It can be seen that forage production was increased in most of rangelands after range management plan and the mean of production was 14.7%.

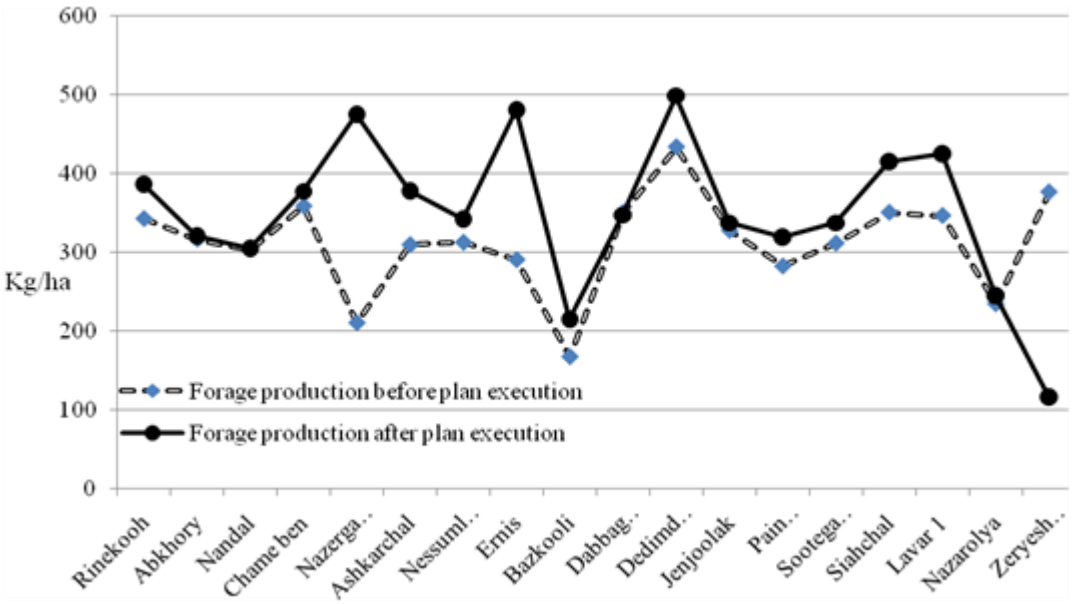

Fig. 2. Comparison of forage production changes after and before RMPs

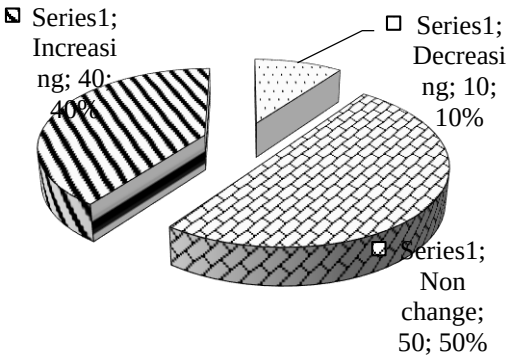

Fig. 3. The changes of condition of ranges sites

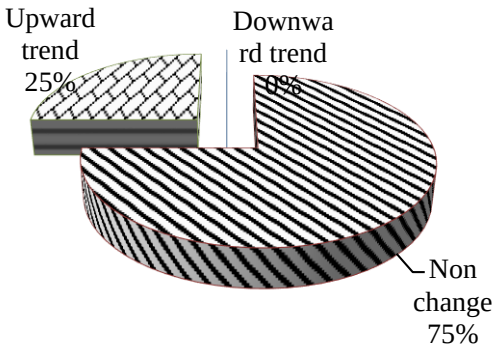

Fig. 4. The changes of ranges trend

Discussion

In this research, the results showed that range management plan had a positive effect on both forage production and canopy cover in most of the studied RMPs; therefore, the mean production increased from 312 to 351 Kg/ha (12.4% increasing) that is in agreement with other researches (Borhani *et al.*, 2014, Nekooie *et al.*, 2012 and Tanaka *et al.*, 2005). Also, Rahimi and Sadeghi (2005) stated that the forage production in the studied range sites in three provinces (Yazd, Azarbaijan and Khorasan) were improved up to 55% by the RMPs in recent decade. Tanaka *et al*. (2005) found that the stability of rangeland ecosystems depended on management factors such as the exploitation discipline. Also, the study of RMP efficiency in the eastern Iran has shown an increase in forage production up to 100% (Mazhari and Khaksar, 2009).

Three indices (trend, condition & canopy cover) had little increases in RMPs although there were no significant differences ($P<0.01$) between treatments. In this case, Moradian (1997) studied 53 range sites with different management scenarios in Fars province and expressed that many of them had poor condition and negative trend. He proposed that early grazing, fuel supply and shrub removal are the main factors of the range site degradation.

Results of many approaches suggested some important factors influencing the

RMP efficiency including pastoralism's population in a RMP, limited rangelands for a large group of livestock, fuel supply, illiteracy and other socio-economic issues. As the degradation of summer ranges in the northern mountainous regions of Iran is mainly due to overgrazing, the ways of forage supply in other seasons are the most important economical factor and determine the livelihood level. Although the executed projects in RMPs such as vegetation rehabilitation and water sources development are all necessary but light or moderate stocking rate and or short-term enclosure of destructed range sites are the most essential programs to prevent more degradation.

As many studied showed that socio-economic issues and isolated and divergent management were the main factor of natural resources degradation, governmental sector should pay more attention to current traditional husbandry system and its positive and negative impacts on natural resources.

The priority of programs such as water resources development, grazing management and grazing system implementation in the degraded rangelands were suggested with respect to common programs in RMPs and ecological issues of studied rangelands. Iranian northern rangelands are commonly summer ranges and the lack of winter ranges causes the early grazing of most of them. So, it is evident that grazing management and more control by governmental sector were the essential factors for management strategies. Although canopy cover percent of more range sites has increased, but there was no significant effect. Thus, the execution of range management plans has relatively improved the range condition but their positive effects were not clear for many RMPs. The bases of predictions after RMPs increase the forage production, canopy cover percent, range condition and trend while in the study area, the increased indices were much less than the predictions; one of the reasons for not being fulfilled the predictions is more ikely to be the climate changes, especially droughts.

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اثر طرح‌های مرتعداری بر پوشش گیاهی مراتع ییلاقی در استان مازندران

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چکیده. احیاء و بهره‌برداری صحیح از مراتع در قالب طرح‌های مرتعداری از نخستین اقدامات علمی و فنی در مرتعداری ایران است. طرح‌های مرتعداری بعنوان یک دستورالعمل حفاظتی و اصلاحی-احیایی از اهمیت ویژه‌ای در اصلاح مراتع دارند. در این تحقیق اثرات اجرای طرح‌های مرتعداری بر پوشش گیاهی مراتع ییلاقی استان مازنداران در طی ۲۲ سال گذشته مورد بررسی قرار گرفت. برای این منظور، ۲۰ طرح مرتعداری از میان ۳۲۰ طرح اجرا شده در استان مازندران به طور تصادفی انتخاب شدند. برای جمع‌آوری اطلاعات در پژوهش حاضر از روش مشاهده و عملیات صحرایی استفاده شد. بدین منظور فاکتورهای پوشش گیاهی شامل وضعیت، تولید، درصد پوشش تاجی و گرایش مراتع نمونه در قبل و بعد از اجرای طرح مورد بررسی قرار گرفت. به منظور مقایسه نتایج از آزمون‌های پارامتری (t جفتی) و غیر پارامتری (ویلکاکسون) استفاده شد. نتایج این مطالعه نشان داد که طرح‌های مرتعداری باعث افزایش حدود ۱۴/۷ درصدی تولید علوفه قابل دسترس شده است ($P<0.01$). همچنین وضعیت ۲۵ درصد مراتع روند افزایش داشته و گرایش ۴۰ درصد از مراتع نیز روند پیش رونده داشته است اما از لحاظ آماری معنی‌دار نبوده است. میزان تاج پوشش نیز در طرح‌ها مدیریت شده و معمولی تفاوتی نداشت و از نظر آماری نیز معنی‌دار نبوده است. بنابراین طرح‌های اجرایی به طور نسبی توانسته‌اند وضعیت مرتع را بهبود بخشیده، اما اثرات مثبت آنها برای هر طرح مرتعداری در مراتع استان مازندران به طور واضح مشخص نیست.

کلمات کلیدی: گرایش، وضعیت، تولید علوفه، مراتع ییلاقی