



Projection of Machine Usage in Agriculture of Ardahan Province

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Abstract

In this study, the usage projection of agricultural machinery used in agricultural operations in Ardahan province was examined. It is aimed to determine the projection of technology use in agriculture by using the data between 2011-2020. The change rates of 35 machines, including tillage, sowing, planting, fertilization, spraying, harvesting-threshing and other machines, between 2011-2020 were examined. Projection coefficients were calculated and by using these, coefficients were calculated and evaluated for the years 2021-2030. In the study, the data of the Turkish Statistical Institute and findings from the related studies on the subject were used. It has been concluded that the positive projection coefficients of 29 machines considered in the technology usage projection will increase until 2030, while the projection coefficient determined for 6 machines is negative and there will be a decrease in these machines.

Keywords: Ardahan, Projection, Agricultural machinery

Ardahan İli Tarımda Makine Kullanımı Projeksiyonu

Öz

Bu çalışmada Ardahan ilinde tarımsal işlemlerde kullanılan tarım makinelerinin kullanım projeksiyonu incelenmiştir. 2011-2020 yılları arasındaki veriler kullanılarak tarımda teknoloji kullanım projeksiyonunun belirlenmesi hedeflenmiştir. 2011-2020 yılları arasında toprak işleme, ekim, dikim, gübreleme, ilaçlama, hasat-harman ve diğer makineleri içeren 35 makinenin değişim oranları incelenmiştir. Projeksiyon katsayıları hesaplanmış ve bunlar kullanılarak 2021-2030 yılları için katsayılar hesaplanmış ve değerlendirilmiştir. Çalışmada, Türkiye İstatistik Kurumu'nun verileri ve konu ile ilgili yapılan çalışmalardan elde edilen bulgular kullanılmıştır. Teknoloji kullanım projeksiyonunda ele alınan 29 makinenin pozitif projeksiyon katsayılarının 2030 yılına kadar artacağı, 6 makine için belirlenen projeksiyon katsayısının ise negatif olduğu ve bu makinelerde azalma olacağı sonucuna varılmıştır.

Anahtar Kelimeler: Ardahan, Projeksiyon, Tarım makineleri.

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1. Introduction

Mechanization has great importance in increasing production, work efficiency and quality of work in agriculture, facilitating work, reducing costs, modernizing enterprises, opening new business areas, and improving the socio-economical population of agriculture. (Altay and Turhal, 2011). In addition to the necessity of using natural resources effectively and efficiently for the sustainability of agricultural production, it is obligatory to apply techniques that can help the people in production to develop socio-economically. In order to fulfil these conditions, it is necessary to eliminate the deficiencies of the implemented system and to develop new and effective technologies (Kaya et al., 2010).

Agricultural mechanization shows different levels of development and practice in all countries. This difference can be seen in the regions of a country as well as in agricultural enterprises within the same region. Depending on the technical and economic structure of the agricultural enterprise, the level of agricultural mechanization can be in different values (Koçtürk and Onurbaş Avcıoğlu, 2007). Conducting studies in the field of agricultural mechanization with up-to-date data in line with developments in agricultural production systems and technologies; It is of great importance for making the right decisions for the future by contributing to the agricultural development plans at regional, national and provincial level (Bayram and Altuntaş, 2016).

The use of machinery in agriculture, unlike other applications of agricultural technology, indirectly affects the increase in productivity and provides the application of new production methods in rural areas. In this respect, it increases the efficiency and economy of other technological applications and improves working conditions. Thus, by enabling the use of appropriate technologies, it helps to get more efficiency from production areas of a certain size (Saral et al., 2000; Demir and Kuş, 2016). In this study, it is aimed to determine the agricultural mechanization projection of the province of Ardahan for the next ten years, until 2030 and these values will guide the mechanization plans in the region.

2. Material and Method

Located in the northeast of Anatolia, Ardahan Province is surrounded by Georgia and Armenia in the northeast, Kars in the south and southeast, Erzurum in the southwest and Artvin in the west. Due to the high altitude of the region and the variability of the surface shapes, the continental climate prevails throughout the province, and the winters are long, harsh and snowy. In the province, which has an altitude of 1829 m above sea level, it is observed that the temperatures can reach the highest point at 33.6 °C in summer and decrease to -30.4 °C in winter (Anonymous, 2021a). The agricultural area of Ardahan province yields cereals and other herbal products on 427392 da, vegetables on 90 decares, and fruits, beverage and spice crops on 502 decares. The total agricultural area of Ardahan province is 427984 da, excluding meadow and pasture areas (Anonymous, 2021b). The material of the study consisted of the agricultural machinery data of the Turkish Statistical Institute for the years 2011-2020 for the province of Ardahan in general (Anonymous, 2021c). The projection coefficient was calculated based on the production and usage amounts of the technology used in agriculture in the past ten years. In this context, the usage projection of 35 machines commonly used in Ardahan (tillage, sowing, planting,

fertilization, spraying, harvesting-threshing and other machines) has been taken into consideration.

In line with the increase or decrease in the projection coefficient, ten-year projections of technology-use in agriculture in Ardahan province were determined. Depending on the number of machines in the previous year and the coefficient determined for that machine, the projections up to year 2030 of the agricultural machines widely used in Ardahan were determined by using the method of Demir and Kuş (2016), Baran et al. (2019), Solak et al. (2019). A positive projection coefficient indicates an increase in the number of existing machines, and a negative projection indicates a decrease (Demir, 2013; Demir and Kuş, 2016).

3. Results and Discussion

In the study, the number of soil tillage machines in the past ten years, the change rates compared to previous years, the projection coefficients calculated depending on the number of machines and the number of machines in the ten-year period are given in Table 1. According to the change rates calculated for the years 2011-2020, as seen in Table 1, the projection coefficients for the mouldboard plow, tooth harrow, disc harrow, cultivator, disc plow, mouldboard stubble plow, roller, arc opening plow, disc stubble plow and rotary tiller are -0.06, 0.67, -0.51, 38.40, 17.22, 4.27, -12.61, 3.30, 9.17 and 13.86 (%) respectively. According to the projection coefficient calculated for the years 2021 and 2030, it has been calculated that the largest increase will be observed in cultivator by 38.40% and corresponding to 10572 units, and the largest decrease will be observed in roller by -12.61 and corresponding to 18 units. The importance attached to tillage before sowing in grain production can explain the high number of mouldboard tractor plows.

The number of machines for sowing, planting and fertilizing machines in the past ten years, the rate of change compared to previous years, the projection coefficients calculated depending on the number of machines and the number of machines in the ten-year period are given in Table 2. According to the change rates calculated for the years 2011-2020, as seen in Table 2, the projection coefficients calculated for the chemical fertilizer spreader, tractor seed drill, combined seed drill, solid manure spreader and potato planting machine are 4.51, 2.83, 9.04, 37.16 and 25.93 (%) respectively. According to the projection coefficient calculated for the years 2021 and 2030, it has been calculated that the biggest increase will be in the solid manure spreader by 37.16% corresponding to 10572 units. It is possible to claim that the increase in the number of combined grain seeding machines over the years in Ardahan is because of the importance of grain production. Similarly, the number of potato planting machines increased from 1 unit in 2011 to 4 units in 2020. With the projection coefficient of 25.93% stated in Table 2, it can be assumed that the number of potato planting machines will increase to 40 in 2030. It can be thought that the low number of potato planting machines is due to the fact that potato cultivation is limited to an area of 292.48 da (Anonymous, 2021d) according to 2020 data and grain production has a greater importance in provincial agriculture.

The number of machines belonging to plant protection machinery in the past ten years, the rate of change compared to

previous years, the projection coefficients calculated depending on the number of machines and the number of machines in the ten-year period are given in Table 3. According to Table 3, indicating the change rates for the 2011-2020 period, the projection coefficients for back sprayer; stretcher, motorized sprayer duster combined atomizer; motorized sprayer and atomizer have been respectively calculated as 2.35, 6.79, -0.13 and 5.40 (%). According to the projection coefficient calculated for the 2021-2030 period, the greatest increase will be in in stretcher, motorized sprayer duster combined atomizer by 6.79%, corresponding to 23 units, and the greatest reduction will be observed in motorised sprayer by -0.13%, corresponding to 9 units. As indicated in Table 3, it can be said that there is not much tendency towards spraying machines in the province and therefore, plant protection activities with pesticide coverage are not carried out too much. According to Anonymous (2021a), this can be explained by the fact that almost all of the plant production and bee products in the province are ecological.

The number of harvesting-threshing machines in the past ten years, the change rates compared to previous years, the projection coefficients calculated depending on the number of machines and the number of machines in the ten-year period are given in Table 4. The projection coefficients calculated for the harvester and threshing machine, tractor pulled mower, hay rake, straw transfer-unloading machine, reaper, hay making machine, hay silage machine, corn silage machine and potato harvesting machine were

calculated as 0.24, 5.99, 2.89, 15.94, 6.51, -8.89, 6.15, 5.56, 5.56 and 20.37 respectively (Table 4). According to the projection coefficient calculated for the years 2021 and 2030, it has been calculated that the biggest increase will be in the potato harvester by 38.40% corresponding to 26 pieces and the biggest decrease will be observed in the number of reapers by -8.89 corresponding to 20 units. The fact that grain production has a greater importance in provincial agriculture can possibly have an effect on this. The high number of harvesting and thresher machines can indicate that grain production has a greater importance in provincial agriculture.

The number of other agricultural machinery for the past decade, the rate of change compared to previous years, projection coefficients and the number of machinery in the ten-year period are given in Table 5. The projection coefficients calculated for cream machine, churn, milking machine (mobile), milking facility, incubator, trailer, ladle, feed preparation machine, water tank and pump are -0.84, 0.08, 22.62, 37.62, 42.40, 2.18, 8.43, 1.19, 17.88 and 1.30 (%) respectively (Table 5). According to the projection coefficient calculated for 2021 and 2030, it has been calculated that the biggest increase will be observed in incubator by 42.40% corresponding to 823 units, and the biggest decrease will be observed in cream machines by -0.84 corresponding to 8611 units. This can be explained by the fact that the economy of the province is based on agriculture in general and livestock sector in particular (Anonymous, 2021a).

Table 1. Soil tillage machinery projection

Past Years	Mouldboard Plow	Tooth Harrow	Disc Harrow	Cultivator	Disc Plow	Mouldboard Stubble Plow	Roller	Arc Opening Plow	Disc Stubble Plow	Rotary Tiller
2011	5670	3092	1141	137	47	114	524	52	15	5
2012	5790	3152	1141	145	47	109	304	52	16	6
2013	5810	3177	1146	149	48	109	304	52	16	6
2014	5600	3181	1150	149	49	109	304	53	16	6
2015	5719	3207	1158	150	59	118	311	52	17	8
2016	5750	3234	1160	153	109	116	319	53	17	8
2017	5470	3384	1075	732	144	117	326	60	18	10
2018	5484	3384	1076	732	144	118	326	60	19	10
2019	5569	3221	1076	411	158	122	327	66	21	11
2020	5625	3275	1087	410	164	160	69	69	31	15
Exchange Rates	Mouldboard Plow	Tooth Harrow	Disc Harrow	Cultivator	Disc Plow	Mouldboard Stubble Plow	Roller	Arc Opening Plow	Disc Stubble Plow	Rotary Tiller
2011-2012	2.12	1.94	0.00	5.84	0.00	-4.39	-41.98	0.00	6.67	20.00
2012-2013	0.35	0.79	0.44	2.76	2.13	0.00	0.00	0.00	0.00	0.00
2013-2014	-3.61	0.13	0.35	0.00	2.08	0.00	0.00	1.92	0.00	0.00
2014-2015	2.13	0.82	0.70	0.67	20.41	8.26	2.30	-1.89	6.25	33.33
2015-2016	0.54	0.84	0.17	2.00	84.75	-1.69	2.57	1.92	0.00	0.00
2016-2017	-4.87	4.64	-7.33	378.43	32.11	0.86	2.19	13.21	5.88	25.00
2017-2018	0.26	0.00	0.09	0.00	0.00	0.85	0.00	0.00	5.56	0.00
2018-2019	1.55	-4.82	0.00	-43.85	9.72	3.39	0.31	10.00	10.53	10.00
2019-2020	1.01	1.68	1.02	-0.24	3.80	31.15	-78.90	4.55	47.62	36.36
%	-0.06	0.67	-0.51	38.40	17.22	4.27	-12.61	3.30	9.17	13.86

Projection	Mouldboard Plow	Tooth Harrow	Disc Harrow	Cultivator	Disc Plow	Mould board Stubble Plow	Roller	Arc Opening Plow	Disc Stubble Plow	Rotary Tiller
2021	5622	3297	1081	567	192	167	60	71	34	17
2022	5618	3319	1076	785	225	174	53	74	37	19
2023	5615	3341	1070	1087	264	181	46	76	40	22
2024	5612	3364	1065	1504	310	189	40	79	44	25
2025	5608	3386	1060	2082	363	197	35	81	48	29
2026	5605	3409	1054	2881	425	206	31	84	52	33
2027	5601	3432	1049	3988	499	214	27	87	57	37
2028	5598	3455	1043	5519	585	224	23	89	63	42
2029	5595	3478	1038	7639	685	233	21	92	68	48
2030	5591	3501	1033	10572	803	243	18	95	75	55

Table 2. Sowing, planting and fertilizing machinery projection

Past Years	Chemical Fertilizer Spreader	Tractor Seed Drill	Combined Seed Drill	Solid Manure Spreader	Potato Planting Machine
2011	327	43	25	2	1
2012	355	45	35	3	1
2013	393	48	40	3	1
2014	408	49	42	3	1
2015	407	48	43	10	3
2016	423	48	45	11	3
2017	450	49	45	14	4
2018	462	49	45	14	4
2019	482	50	48	15	4
2020	484	55	52	16	4
Exchange Rates	Chemical Fertilizer Spreader	Tractor Seed Drill	Combined Seed Drill	Solid Manure Spreader	Potato Planting Machine
2011-2012	8.56	4.65	40.00	50.00	0.00
2012-2013	10.70	6.67	14.29	0.00	0.00
2013-2014	3.82	2.08	5.00	0.00	0.00
2014-2015	-0.25	-2.04	2.38	233.33	200.00
2015-2016	3.93	0.00	4.65	10.00	0.00
2016-2017	6.38	2.08	0.00	27.27	33.33
2017-2018	2.67	0.00	0.00	0.00	0.00
2018-2019	4.33	2.04	6.67	7.14	0.00
2019-2020	0.41	10.00	8.33	6.67	0.00
%	4.51	2.83	9.04	37.16	25.93
Projection	Chemical Fertilizer Spreader	Tractor Seed Drill	Combined Seed Drill	Solid Manure Spreader	Potato Planting Machine
2021	506	57	57	22	5
2022	529	58	62	30	6
2023	552	60	67	41	8
2024	577	61	74	57	10
2025	603	63	80	78	13
2026	631	65	87	107	16
2027	659	67	95	146	20
2028	689	69	104	200	25
2029	720	71	113	275	32
2030	752	73	124	377	40

Table 3. Plant protection machinery projection

Past Years	Back Sprayer	Stretcher, Motorized Sprayer Duster Combined Atomizer	Motorized Sprayer	Atomizer
2011	51	8	11	6
2012	47	8	11	6
2013	52	13	13	5
2014	50	12	12	5
2015	55	12	10	6
2016	57	12	10	6
2017	58	9	8	6
2018	58	9	8	6
2019	61	11	10	7
2020	62	12	10	9
Exchange Rates	Back Sprayer	Stretcher, Motorized Sprayer Duster Combined Atomizer	Motorized Sprayer	Atomizer
2011-2012	-7.84	0.00	0.00	0.00
2012-2013	10.64	62.50	18.18	-16.67
2013-2014	-3.85	-7.69	-7.69	0.00
2014-2015	10.00	0.00	-16.67	20.00
2015-2016	3.64	0.00	0.00	0.00
2016-2017	1.75	-25.00	-20.00	0.00
2017-2018	0.00	0.00	0.00	0.00
2018-2019	5.17	22.22	25.00	16.67
2019-2020	1.64	9.09	0.00	28.57
%	2.35	6.79	-0.13	5.40
Projection	Back Sprayer	Stretcher, Motorized Sprayer Duster Combined Atomizer	Motorized Sprayer	Atomizer
2021	63	13	9	9
2022	65	14	9	10
2023	66	15	9	11
2024	68	16	9	11
2025	70	17	9	12
2026	71	18	9	12
2027	73	19	9	13
2028	75	20	9	14
2029	76	22	9	14
2030	78	23	9	15

Table 4. Harvest-threshing machinery projection

Past Years	Harvester and Threshing Machine (Thrasher)	Tractor Pulled Mower	Hay Rake	Baler Machine	Hay Transfer-Unloading Machine	Reaper	Straw Making Machine	Hay Silage Machine	Corn Silage Machine	Potato Harvesting Machine
2011	4194	2075	2469	150	128	250	26	2	2	1
2012	4185	2220	2559	232	173	250	27	2	2	2
2013	4199	2351	2623	270	174	250	29	2	2	2
2014	4303	2493	2638	318	176	250	30	2	2	2
2015	4343	2548	2810	343	195	50	31	2	2	3
2016	4381	2568	2864	349	194	50	37	2	2	3
2017	4406	2969	2976	386	200	50	40	2	2	4
2018	4411	2969	3146	392	200	50	40	2	2	4
2019	4094	3102	3192	487	210	50	43	2	3	4
2020	4268	3471	3184	529	217	50	44	3	3	4

Exchange Rates	Harvester and Threshing Machine (Thrasher)	Tractor Pulled Mower	Hay Rake	Baler Machine	Hay Transfer-Unloading Machine	Reaper	Straw Making Machine	Hay Silage Machine	Corn Silage Machine	Potato Harvesting Machine
2011-2012	-0.21	6.99	3.65	54.67	35.16	0.00	3.85	0.00	0.00	100.00
2012-2013	0.33	5.90	2.50	16.38	0.58	0.00	7.41	0.00	0.00	0.00
2013-2014	2.48	6.04	0.57	17.78	1.15	0.00	3.45	0.00	0.00	0.00
2014-2015	0.93	2.21	6.52	7.86	10.80	-80.00	3.33	0.00	0.00	50.00
2015-2016	0.87	0.78	1.92	1.75	-0.51	0.00	19.35	0.00	0.00	0.00
2016-2017	0.57	15.62	3.91	10.60	3.09	0.00	8.11	0.00	0.00	33.33
2017-2018	0.11	0.00	5.71	1.55	0.00	0.00	0.00	0.00	0.00	0.00
2018-2019	-7.19	4.48	1.46	24.23	5.00	0.00	7.50	0.00	50.00	0.00
2019-2020	4.25	11.90	-0.25	8.62	3.33	0.00	2.33	50.00	0.00	0.00
%	0.24	5.99	2.89	15.94	6.51	-8.89	6.15	5.56	5.56	20.37
Projection	Harvester and Threshing Machine (Thrasher)	Tractor Pulled Mower	Hay Rake	Baler Machine	Hay Transfer-Unloading Machine	Reaper	Straw Making Machine	Hay Silage Machine	Corn Silage Machine	Potato Harvesting Machine
2021	4278	5550	3276	613	231	46	47	3	3	5
2022	4289	5883	3371	711	246	42	50	3	3	6
2023	4299	6235	3468	824	262	38	53	4	4	7
2024	4309	6608	3568	956	279	34	56	4	4	8
2025	4319	7004	3671	1108	297	31	59	4	4	10
2026	4330	7424	3778	1285	317	29	63	4	4	12
2027	4340	7869	3887	1490	337	26	67	4	4	15
2028	4351	8340	3999	1727	359	24	71	5	5	18
2029	4361	8839	4115	2002	383	22	75	5	5	21
2030	4372	9369	4234	2322	408	20	80	5	5	26

Table 5. Projection of other machinery

Previous Years	Cream Machine	Churn	Milking Machine (Mobile)	Milking Facility	Incubator	Trailer	Ladle	Feed Preparation Machine	Water Tank	Pump
2011	10069	6729	281	30	3	4683	176	111	23	150
2012	10129	6889	458	30	3	4733	179	111	27	150
2013	10109	6795	588	40	3	4808	179	113	29	152
2014	10077	6345	713	53	3	4841	182	111	30	150
2015	10134	6454	732	53	12	5047	211	106	32	148
2016	10150	6492	739	48	17	5082	209	107	32	150
2017	10137	6498	1316	53	22	5346	223	113	81	150
2018	10222	6458	1327	53	22	5351	223	113	81	150
2019	10267	6483	1349	56	26	5501	333	118	59	162
2020	9291	6752	1440	205	24	5677	338	123	59	168

Change Rates	Cream Machine	Churn	Milking Machine (Mobile)	Milking Facility	Incubator	Trailer	Ladle	Feed Preparation Machine	Water Tank	Pump
2011-2012	0.60	2.38	62.99	0.00	0.00	1.07	1.70	0.00	17.39	0.00
2012-2013	-0.20	-1.36	28.38	33.33	0.00	1.58	0.00	1.80	7.41	1.33
2013-2014	-0.32	-6.62	21.26	32.50	0.00	0.69	1.68	-1.77	3.45	1.32
2014-2015	0.57	1.72	2.66	0.00	300.00	4.26	15.93	-4.50	6.67	1.33
2015-2016	0.16	0.59	0.96	-9.43	41.67	0.69	0.95	0.94	0.00	1.35
2016-2017	-0.13	0.09	78.08	10.42	29.41	5.19	6.70	5.61	153.13	0.00
2017-2018	0.84	-0.62	0.84	0.00	0.00	0.09	0.00	0.00	0.00	0.00
2018-2019	0.44	0.39	1.66	5.66	18.18	2.80	49.33	4.42	-27.16	8.00
2019-2020	-9.51	4.15	6.75	266.07	-7.69	3.20	1.50	4.24	0.00	3.70
%	-0.84	0.08	22.62	37.62	42.40	2.18	8.43	1.19	17.88	1.30
Projection	Cream Machine	Churn	Milking Machine (Mobile)	Milking Facility	Incubator	Trailer	Ladle	Feed Preparation Machine	Water Tank	Pump
2021	9290	6757	1766	282	34	5801	366	124	70	170
2022	9212	6811	2165	388	49	5927	397	126	82	172
2023	9135	6866	2655	534	69	6056	431	127	97	175
2024	9058	6921	3255	735	99	6188	467	129	114	177
2025	8982	6976	3992	1012	141	6323	507	130	134	179
2026	8906	7032	4895	1393	200	6461	549	132	158	182
2027	8831	7088	6002	1917	285	6602	596	134	187	184
2028	8757	7145	7360	2638	406	6746	646	135	220	186
2029	8684	7202	9024	3630	578	6893	700	137	259	189
2030	8611	7260	11066	4995	823	7043	759	138	306	191

4. Conclusions and Recommendations

Since mechanization is a high-cost production input, it needs to be chosen and applied correctly, otherwise it can negatively affect the profitability in enterprises. Since the most economical use of this input can only be possible by planning models that are suitable for local conditions, increasing the efficiency of mechanization in agriculture can be achieved by making agricultural mechanization planning correctly (Demir, 2013).

Based on the calculated projection coefficient, it is anticipated that the greatest increase in soil tillage machines for the 2021 to 2030 period will be observed in cultivators by 38.40%, corresponding to 10572 units, and the greatest reduction will be in rollers by -12.61, corresponding to 18 units; the greatest increase in sowing, planting and fertilization machines will be observed in solid manure spreaders by 37.16% corresponding to 377 units; the greatest increase in plant protection machines will be observed in stretcher, motorized sprayer duster combined atomizer by 6.79% corresponding to 23 units, and the greatest decrease will be observed in motorised sprayers by -0.13 corresponding to 9 units; the greatest increase in harvesters will be observed in potato harvesting machines by 20.37% corresponding to 26 units, and the greatest reduction will be observed in reaper machines by -8.89 corresponding to 20 units;

the greatest increase in other machinery will be observed in incubator machines by 42.40% corresponding to 823 units, and the greatest decrease will be observed in cream machines by -0.84 corresponding to 8611.

As a result of the positive projection coefficients determined for the 29 machines examined in the research, it was concluded that the technology usage projection in the agriculture of Ardahan province will increase until 2030, and there will be a decrease in these machines in line with the negative projection coefficient determined for 6 machines. Since grain production, animal husbandry and dairy products have an important place in Ardahan province, it has been concluded that machines in this class tend to increase and that supporting the producers within the scope of these machines can bring a positive trend to the provincial agriculture.

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