



Potential Field Work Days During Planting and Harvesting

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Profitable farming operations require strict control of production costs. One approach to production cost control is purchasing replacement machinery just large enough to complete the required work in the time available. Owning excess machinery capacity is an added expense, but planting and harvesting delays can also be costly. Cost conscious farmers will choose the size of their farm machinery based on the number of acres to be covered and the number of suitable days to do the required work. Unfortunately there are large fluctuations in the number of suitable field work days from year to year.

Estimates of the number of suitable field work days for planting and harvesting operations in North Dakota are presented in this circular. Various precipitation and temperature criteria were used to calculate the number of suitable planting and harvesting days using climatic data from 18 North Dakota National Weather Service stations. The years 1948 through 1988 were used in the analysis. The probability of occurrence of suitable planting and harvesting days was calculated from these estimates. These data, in conjunction with machinery cost and

capacity data, may be used to determine the optimum machinery capacity necessary for a North Dakota producer or they may be used to plan for possible future expansion.

Planting and Harvesting Periods

Planting before the end of May results in a yield advantage for the major crops grown in North Dakota. A 50-day spring planting period encompassing the most desirable planting times was chosen for each crop district based on typical climatic conditions. It consists of the period April 1-May 20 for all districts except the northeast (Table 1). Spring climatic conditions often delay planting in the northeast so April 11-May 30 was chosen for this region.

A 45-day harvest period was chosen (Table 1), but starting dates are more variable than those for planting. The periods vary according to the usual harvest dates in the various districts. Planting and harvesting periods were modified from those used in a 1969 circular (Olson et. al., 1969) to better represent actual conditions.

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Table 1. Planting and harvesting windows for various North Dakota climatic divisions.

State Climatic Division	Planting Period (50 days)	Harvest Period (45 days)
Northwest	Apr 01-May 20	Jul 25 - Sep 07
North-central	Apr 01-May 20	Jul 25 - Sep 07
Northeast	Apr 11-May 30	Jul 30 - Sep 12
West-central	Apr 01-May 20	Jul 25 - Sep 07
Central	Apr 01-May 20	Jul 25 - Sep 07
East-central	Apr 01-May 20	Jul 20 - Sep 02
Southwest	Apr 01-May 20	Jul 20 - Sep 02
South-central	Apr 01-May 20	Jul 20 - Sep 02
Southeast	Apr 01-May 20	Jul 20 - Sep 02

First Spring Work Day

The first spring work day was predicted to occur after 100 thawing degree days (TDD) had accumulated following the disappearance of snow cover. Thawing degree days are a measure of the energy available for warming the soil and evaporating surplus water. Daily TDD values are calculated by subtracting 32°F from the mean daily air temperature, but only positive daily values were used to calculate the total TDD accumulation. Thus, if the mean daily temperature was below 32°F no thawing degree days were subtracted from the accumulated total.

However, several other criteria were necessary to predict the first work day (Table 2). If snowfall resulted in depths of 1 inch or more during the period TDDs were accumulating or after 100 had already accumulated, the accumulation process started over at zero following snowmelt. Late snow is rare, but it has occurred at all locations, resulting in a loss of five to seven days during the last half of April and four to five days during the first half of May. If snow fell but melted immediately, TDD accumulation was not affected. "

Table 2. Criteria used to estimate the first spring work day each year.

Snow Depth	TDD accumulation	Resultant Action
> 0	and = 0	No TDD accumulated;
= 0	and < 100	Positive TDD accumulated;
> 0	and > 100	TDD total reset to 0 and start over
> 0	and < 100	TDD total reset to 0 and start over
= 0	and => 100	TDD accumulation stops; First or subsequent work day(s)

Unfortunately, snow depth information is missing in the climatic records at many stations. To compensate for the missing snow depth data, TDD accumulation was begun on several selected April dates. This model, ignoring snow depth, was run using Fargo and Williston climatic data. Results were compared to those obtained for the same stations based on snow depth and TDD criteria listed in Table 2. Results indicated that the use of snow depth data predicted the first work day more accurately in most years, so stations were chosen for analysis on the basis of available snow depth data.

Based on data analysis, the average starting date for spring field work is near mid-April everywhere but north-eastern North Dakota, where the average is April 25. These dates agree quite well with data from the North Dakota Agricultural Statistics Service, which show a statewide average starting date of April 17 for the years 1976-1990.

Rainfall Criteria

Once the first spring work day for each year was established, rainfall criteria listed in Table 3 were used to identify subsequent unsuitable work days during the planting season. Rainfall criteria were also established to identify unsuitable harvesting days (Table 3).

Table 3. Rainfall criteria used to determine unsuitable work days.

Planting		Harvest	
Daily Rainfall (Inch)	Number planting days lost	Daily Rainfall (Inch)	Number harvest days lost
0.00 - 0.10	0	0.00 - 0.05	0
0.10 - 0.49	1	0.06 - 0.19	1
0.50 - 0.99	2	0.20 - 0.49	2
> 1.00	3	0.50 - 0.99	3
		> 1.00	4

Climatic Data:

A model using rainfall and snowdepth criteria from Tables 2 and 3 was developed to determine the number of planting and harvesting days from daily climatic data. The model was run using data from 1948-1988 for National Weather Service stations listed in Table 4. This period was chosen because 1948 is the first year snow depth data are generally available on computerized data sets. To test the adequacy of this 41-year period the model was

run for Fargo and Williston beginning in 1900. Results from this 89-year period were nearly identical to those from the 41-year record. The years 1948-1988 were deemed adequate to represent the entire period of record for these stations.

Table 4. Climatic stations used in the analysis.

Ashley	Fargo	New England
Bismarck	Grand Forks	Oakes
Bottineau	Hettinger	Stanley
Crosby	Jamestown	Wahpeton
Devils Lake	Langdon	Watford City
Dickinson	Minot	Williston

Available Planting Days

The number of suitable planting days in North Dakota averages 25, but ranges from 19 to 29 across the state. However, it is extremely variable from district to district and from year to year, ranging from as few as five to seven to as many as 45 days at various locations. Probabilities are commonly used to make highly variable numbers more meaningful. For example, a 90 percent probability of occurrence means that, over a long period of time, a specified number of occurrences will be equalled or exceeded in 90 percent of the years. Similarly, a 50 percent probability means that a specified number of occurrences will be exceeded in 50 percent of the years, but in the other 50 percent of the years it will be less than the specified number.

Numbers of planting days with a 50 percent probability increase from 20 in the northeast to 27 and 28 in the south and northwest, respectively (Figure 1). There are

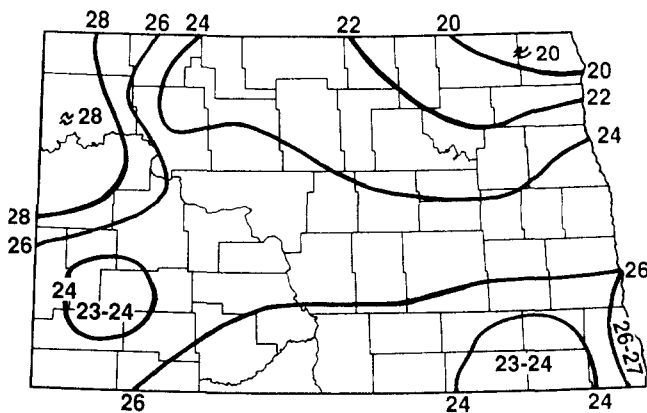


Figure 1. Number of planting days available in 50 percent of the years.

two isolated areas, located in southwestern and southeastern North Dakota, with 24 or fewer available planting days out of a possible 50.

For long range planning 90 percent probability levels are recommended. The cost of additional or larger machinery necessary for the worse case scenario is far greater than yield reductions associated with late planting. Since the worst case scenario may be as few as five planting days it is probably impractical to be completely prepared. Data in Figure 2 give the number of spring work days that are equalled or exceeded in 90 percent of the years across the state. Another interpretation of the 90 percent probability is that typically there will be at least the indicated number of field work days available in nine out of every 10 years.

At least eight to 10 work days are available in 90 percent of the years over an area encompassing most of the state except the extreme northwest and southeast (Figure 2). In the northwest the number of days increases very rapidly from Minot westward. Several stations from this area were used in the analysis to more accurately identify the rapid changes. Surprisingly, southwestern North Dakota is similar to the northeast district with fewer than 10 planting days occurring in one out of 10 years. This was due to several late April and May snowfalls in the region. This anomaly disappears rapidly as the probability level is reduced to 50 percent (Figure 1). The number of planting days increases rapidly from 12 to 18 in the southeast. This is due to consistently earlier spring snowmelt and ground thaw in the southeast. Spring generally comes earlier in this region and producers are able to get in the fields earlier.

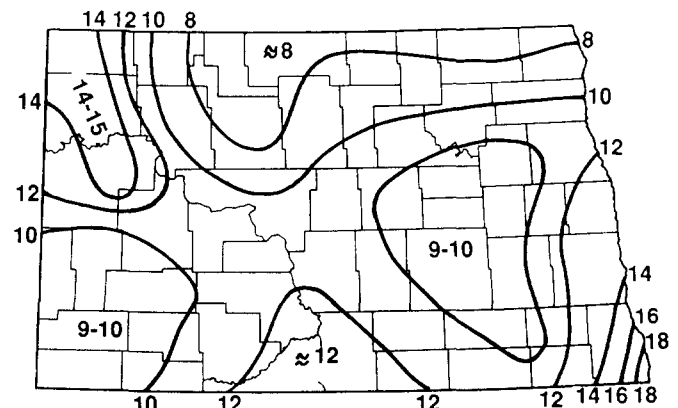


Figure 2. Number of planting days available in 90 percent of the years.

Harvesting Days

Numbers of suitable harvesting days depend on rainfall amounts and associated weather conditions. Rainfall criteria used in Table 3 were developed so that results represented conditions during the recent wet harvests of 1985, 86, and 87. Reported research (Bauer and Black, 1983) indicates that about 0.21 inch of rain will completely wet a typical small grain windrow. Thus, rainfall of 0.20 inches or more was assumed to cause a two-day delay. Rainfall less than or equal to 0.05 inches was assumed to cause little loss of harvesting time, but this depends entirely on the associated weather conditions occurring on those days.

The number of suitable harvesting days at the 50 percent probability level ranges from 28 to 32 over most of the state (Figure 3). There is an increase to 35 days in the northwest indicating the generally drier conditions in that region during July and August.

Ninety percent of the time there are at least 14 days available in the northeast, increasing to 24 in the southwest and 29 in the northwest (Figure 4). This trend reflects decreasing rainfall amounts from east to west across the state. Based on this analysis there are adequate harvesting days available in most years.

Summary

Estimates of the number of suitable field work days available for planting and harvesting operations during 50 and 90 percent of the years are provided in Figures 1-4. This information, combined with the number of acres to be covered, typical soil conditions, and machinery capacity data, allows estimation of the size and number of pieces of equipment necessary to complete the required work in most years. Decisions on purchasing replacement equipment, adding equipment, or selling excess equipment will be aided with these calculations.

In addition, farmers who are planning to expand their operations either by purchasing or renting additional land may use these data to estimate their equipment and labor requirements for the new operation. This will enable them to anticipate the true costs related to expansion. Helmer and Monji (1984) showed that at the 90 percent probability level total machinery cost per acre in Nebraska declines as farm size increases to 2000 acres. They also showed that reducing the completion probabilities to 80 percent tends to increase the optimum farm size to about 3000 acres, but data were inconsistent for farms larger than 3000 acres.

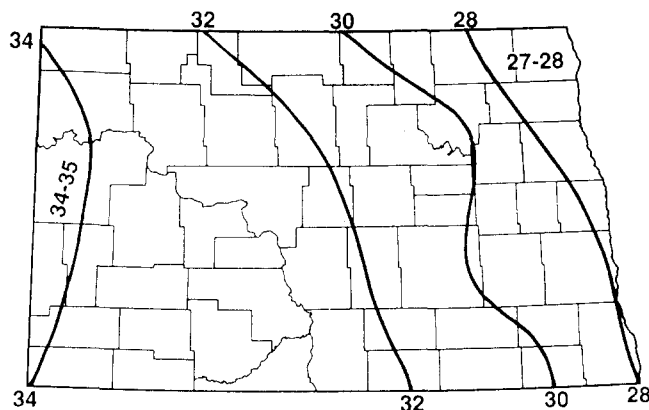


Figure 3. Number of harvesting days available in 50 percent of the years.

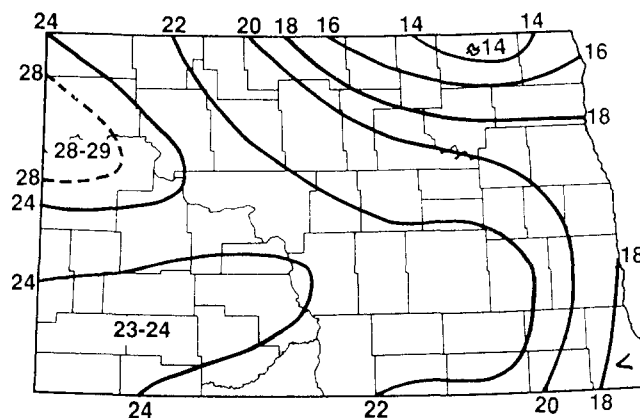


Figure 4. Number of harvesting days available in 90 percent of the years.

Information on machinery capacity, operational costs, and performance will be provided in subsequent circulars. Examples of calculations for typical planning scenarios will be included.

References

- Bauer, A. and A.L. Black. 1983. Rain-induced harvest losses in swathed and standing wheat. North Dakota Agricultural Experiment Station Research Report 97, September, 11 pp.
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