Chapter Three

Soil and Climatic Characteristics of the Flax-Cultivating Zone

The non-chernozem belt of the European USSR, where long-fiber flax occurs most abundantly, is best suited to the cultivation of this crop by virtue of its natural conditions.

The whole non-chernozem area, as well as the flax-growing zone, is characterized by abundant moisture, moderately warm climate, podzolic soils, large wooded areas, and numerous marshes. But these features serve only to distinguish this huge territory from the adjoining black-soil area. Within the limits of the non-black soil area itself and of the flax-growing zone we encounter a great variety of natural conditions affecting in various ways the growth and cultivation of flax.

Climate of the Flax-Cultivating Zone

According to data from the Flax Institute and a number of other scientific-research institutes, there is a close relationship between the growing of flax, its yield and quality, and climatic conditions. Therefore, it is of primary importance to delineate the agricultural-climatic zones and their varying value in regard to flax.

The sum of the temperatures during the growing season is taken as an agricultural-climatic index on the basis of which the thermal resources available to agriculture during the growing season can be approximately described. Using this index, G. T. Selyaninor laid out five thermal zones of the USSR, covering all types of agriculture, broken down by length of growing period and temperature requirements. In the second zone, with a temperature total during the growing season of 1,400-2,200 degrees centigrade, there occurs, among other crops, fiber flax. In fact, almost the entire flax crop lies within these isoline limits. But the extreme temperature total range — 1,400-2000 degrees — indicates that within the limits of this thermal zone

there are tremendous variations in supply of heat.

In keeping with the nature of the existing distribution of flax and taking into account the important role of the heat cycle in the development and growth of flax, A. A. Afanas'yev has deliniated in the territory of the flax-growing regions the following four thermal zones: cold, northern - with a total temperature of 1,400 degrees to 1,600 degrees; moderately cold - 1,600 to 1,800 degrees; moderately warm - 1,800 to 2,000 degrees; warm - 2,000 degrees and above.

Separation into thermal zones has made it possible to study other elements of the heat cycle in the same geographic section: thermal intensity during individual months, duration of the growing season, date of onset of the most important temperature changes, and others. Finally, the thermal zones according to total temperature are converted into zones distinguished by general characteristics of heat cycle.

Flax cultivation in the USSR is fundamentally distributed in a zone of so-called excessive moisture. But it would be erroneous to suppose that throughout the flax-cultivating zone we have, in reality, excessive moisture.

The zone of greatest rainfall during the growing season (195-250 millimeter) runs from southwest to northeast. The main part of the flax-growing is concentrated in this zone. But many of the flax-cultivating regions are in the zone having less rainfall (150-180 millimeters)

One of the characteristic peculiarities of the distribution of rainfall in the growing season in the flax-cultivating zone is the decreased and very irregular rainfall in May. The amount of these changes in the flax-growing regions constitutes, for the most part, from 40 to 55 millimeters. If it were not for the waters of the spring thaw, the moisture in the soil during that period would be completely insufficient for flax.

Therefore the conservation of thaw waters is one of the most important agro-technical measures.

The precipitation in June is decisive for flax, because that month in the majority of the flax-growing regions is the crucial period of its growth, requiring a large amount of moisture in the soil. The commonest amount of precipitation in June is from 60 to 70 millimeters.

Research and pertinent calculations show that the development of flax in that period, the most crucial for the formation of the fiber, (during May-June precipitation is about 110-120 millimeters), requires moisture in sufficient quantities. This would be correct if the total amount of precipitation were completely used by the flax. In reality this does not occur. Consequently, in studying the question of providing moisture for flax, it is insufficient to know the amount of rainfall. It is necessary to take into account the loss of moisture and, above all, evaporation, in order to know the amount of moisture remaining in the soil for use by the plant. This question has been very fully elaborated for us by G. T. Selyaninov. He determined the relationship between the amount of moisture entering the soil in the form of rainfall, and its consumption, including the evaporation factor, and suggested as an index of moisture equilibrium the hydrothermal coefficient, computed by dividing the total rain -fall for a month by the corresponding total temperature reduced by a factor of 10.

Taking into account the requirements of fiber flax for soil moisture, A. Afanasyev divides the territory of the flax-growing regions into four zones, characterized by the following hydrothermal coefficients: excessively wet (1.6 and higher), wet (1.3 to 1.6), insufficiently wet (1.1 to 1.3), and dry (1 to 1.1)

Soil Variations in the Flax-Cultivating Zones

According to the agro-soil regional map drawn up by the VIUAA the European USSR, flax-cultivating zones comprise the following four basic types of soil:

1. Podzolic and swampy, agrillaceous and sandy-loam in morainin lowlands. In 1940 about 22 percent of all flax crops were sown in these soils.

2. Podzolic, argillaceous, and sandy-loam, with topography characterized by ridges of hills; comprise about 11 percent of flax land.

3. Regions of podzolic, sandy and gravelly, and sandy-loam soils and marshlands along hollows and terraces with fluvio-glacial and early alluvial sediments; approximately 22 percent of the flax is grown on these lands.

4. Podzolic, dusty argillaceous soils of the high and and low plains on blanket-deposit rocks; approximately 39 percent of the flax is grown on these lands.

5. The ideal soils for flax are those with a predominance of light to medium dusty argillaceous earths over loess-like clay. These soils are rich in nutritive substances and are characterized by high moisture capacity, which is particularly important for growing flax. These soils are also highly permeable to water. The primary mass of this soil lies in Smolensk Oblast and extends west into Vitebsk and Mogilev Oblasts and east into Kalinin Oblast (southern and eastern rayons) and partially into Yaroslavl' and Vologda Oblasts.

The Agricultural-Climatic and Agricultural-Soil Zones of Fiber Flax Cultivation Regions

On the basis of an analysis of the geography, climate, and soil types suited to flax-growing, Afanas'yev of the Flax Institute has proposed a division of the entire fiber flax-growing region of the European USSR (as of 1938) into the following seven zones (Figure 16): I. Northern zone - cold, excessively moist, with swampy argillaceous and sandy-loamy soils (along the river beds).

Low and uniform temperatures during the growing period, adequate supply of moisture (coefficient of moisture equilibrium, 1.6 or more), great deal of cloudiness, favoring light dispersion, and marked increase in the length of the day, characteristic of norther latitudes, during the period of rapid growth of the flax create an exceptionally favorable climatic complex for obtaining high-quality flax. However, the short growing period (102 days) in certain years may endanger the maturing of the flax seeds and particularly in preparing the "tresta" during a flax crop year.

The soil mantle, consisting mainly of light soil types such as sandy-loamy (along the high fluvial terraces), argillaceous and sandy-loamy (in the morainic lowlands), soils rapidly warming and easily drained, are the most suitable for the cultivation of flax under the conditions of the northern latitudes. But these soils are poor in organic matter and require improvement in composition and elimination of excessive acidity. Like soils poor in nutritive matter, they require the addition of mineral fertilizers for a high flax yield.

On the whole the Northern zone may be considered, by virtue of its natural conditions, the most valuable for production of high-quality fiber.

II. Central zone - in greater part moderately warm, moist, predominantly dusty-argillaceous soils on loess-like loam and a covering of clay, with a significant percentage of argillaceous and sandy-loamy soil on morainic loam. A large part of this zone, by virtue of its natural conditions, is the best combination of climate and soil for a high and constant yield of flax.

Adequate thermal reserve (1,800 to 2,000 degrees centigrade), a long period without freezing temperatures (137 days), and an extended

growing period (129 days) permit considerable lee-way in the sowing dates for flax during the spring and still make it possible to prepare the "tresta" during the best days of August, before the autumn colds. Moderate and uniform temperatures during the growing period, precipitation (195 millimeters) and high humidity (coefficient of moisture equilibrium, 1.5) applied to loess-like loam, best for flax, create favorable conditions for a successful development of the flax plant.

Natural conditions are comparatively less favourable in the southern part of the Central zone, including Vladimir and Ryazan Oblasts; these oblasts are of little relative importance in the flax cultivation.

III. Northwestern zone - moderately cold and moderately warm, excessively moist, with very swampy and moderately swampy, with argillaceous and sandy-loamy soils upon morainic loams.

The heat cycle characterized by a considerable thermal reserve (1,600 to 2,000 degrees centigrade) and uniform and moderate temperatures during the period of growth, is favourable for flax cultivation. The moderate temperatures are accompanied by a large amount of precipitation (200 millimeters). The moisture equilibrium for the vegetative period is determined by the coefficient 1.6. For the month of June the coefficient is 1.5. The growth period is of adequate duration (126 days). The frostless period, by the mean wheather data, is of the same duration as that in the central zone. The northwestern zone, as compared to all other zones, except the southwestern, is characterized by autumns of long duration and considerable dampness. The time period elapsing between days with temperatures above 15oC and days with temperatures of over 5 degrees centigrade, comprises 54 days. This time interval is of great value in flax cultivation.

Thus, the northwestern zone, climatically, can be considered the most favourable for flax cultivation. Its top soil is less favourable, although the soils proper are thoroughly suitable for flax. They consist

predominantly of argillaceous and sandy loam varieties over morainic loams, situated largely on morainic plains. The first are characterized by swampiness, the second by perturbed configuration, which features to a degree restrict the successful growth of the flax plant. However, subsequent cultivation of these soils, particularly by the introduction of perennial grasses, as contemplated by the Soviet grass-and-crop rotation system of agriculture, incombination with favourable climatic conditions and use of mineral fertilizers, will assure a high yield and stability for the flax crop.

IV. The Northeastern zone - moderately cold, damp, with argillaceous and sand loam soils upon morainic plains, partially dusty-argillaceous upon top rocks, and light sandy and sand-loamy upon fluvial-glacial and ancient alluvial deposits.

The climate of this zone is fully favourable for flax cultivation, retaining, to a considerable degree, in its northern part, the flax-positive climatic features of the northern zone, such as the dispersion of sunlight and the rapid rate of increase in the number of daylight hours. It differs from the northern zone by its higher, but still even, temperatures, and a longer growth period (116 days). Due to the above, there is no delay in the seasonable ripening of the flaxseed and the preparation of the treated "tresta" the same year the crop is harvested. However, in the northern part of the zone, in the course of individual years with a large amount of precipitation, which tend to lengthen the period of growth, preparation of the "tresta" may not be accomplished in the year the crop is harvested, since the mean temperature for September, which is for this location from 8 to 9.5 degrees centigrade, is not favourable to the required field curing for the flax straw. The frostless period, according to average data, is 120 days. But the return of the cold here is sufficiently frequent, and in extreme cases the frostless period in the northern part of the zone is only 73 days (Totma), while in the more southern sections it is 102 days (Kostroma).

On the whole, the natural conditions of the Northeast zone are not only completely suitable for flax, but in these latitudes flax is the crop that can profit most by these conditions since it is a crop that adapts itself best to the rather variable thermal cycle during the spring in this region.

V. Southwest zone - warm, with heavy precipitation, humid, with argillaceous and sandy-loam soils on morainic loam, containing large quantities of sandy and sandy-loam soils and including some podzolized light and medium argillaceous soils of the wooded steppes.

The thermal cycle and precipitation are excessive for flax in this zone. The temperatures in May, June, and July are high, but thanks to the heavy precipitation, which here is heavier than anywhere else in the territory of the flax-cultivating zone, their negative influence on the flax is minimized. However, in years of irregular rainfall during the growing season (in particular in May and June) the higher temperatures can adversely affect flax.

Vitebsk, Polotsk, Minsk, and Mogilev Oblasts

The northern part of this zone offers better climatic conditions since it has somewhat lower temperatures and the same amount of precipitation.

The soil mantle of the Southwest zone, as already mentioned, is varied. Although the light sandy and sandy-loamy swamp soils of the Belorussian and Ukrainian Poles'ye are relatively the most important by area, they are not equal in value for flax. In the Ukrainian Poles'ye there is a considerably larger percentage of more binding soils. In the northern part of the southwestern zone still more biding argillaceous and sandy-loamy soils are found, primarily on morainic plains. Here the binding ability of the soils at high temperatures is of great importance for flax, since during the period of irregular rainfall these soils, retaining the moisture better and preserving it longer, permit the flax to endure dry periods more easily.

In general soils, in areas with large amounts of heat and moisture in the southwest zone, are, comparatively speaking, dominant natural factors in the successful growth of the flax plants. As a result it is possible to divide this zone into its separate parts:

(a) Northern -- comprising the above mentioned four oblasts: Vitebsk, Polotsk, Minsk, and Mogilev; in this section we have the very best combination of natural conditions for flax, which may be compared to the natural conditions of the Northwest zone.

(b) Belorussian Polesye -- including the Bobrusk, Gomel, and Polesa Oblasts, where sandy and sandy-loamy, undrained soils without fundamental improvement hampers production of high and resistant yields of flax.

(c) Ukrainian Polesye -- and adjoining regions of the podzolized soils of the wooded steppes, where, by virtue of somewhat larger bindingness of the soil types and heavy precipitation, flax can develop very successfully.

VI. Eastern zone - moderately warm, insufficiently moist, with heavy and medium argillaceous soils and frequent occurence of light sandy and sandy-loamy soils.

The above mentioned characteristics of the Eastern zone show that the climate and soil in this territory have properties contrary to those required by flax. Instead of a humid and mild climate, the features are those of a continental climate. The high temperatures of May, June and July are accompanied by decreasing rainfall. During the period May-July, the total rainfall amounts to 161 millimeters which is considerably below the norm of 200 millimeters set for average productivity. The moisture equilibrium is expressed by the coefficient 1.2, which likewise indicates insufficient moisture. The advent of spring is more rapid than in the more humid zones. The period during which the temperatures range from above 5 degrees centigrade to above 10 degrees centigrade lasts between 16 and 18 days. This necessitates special haste in the pre-sowing operations and the sowing of flax itself. The frostless period, on an average,

lasts 118 days; at the very least 93 days. The return of frosts in the extreme eastern section (Molotov Oblast) occurs in the beginning of June.

Medium and heavy clays upon clayey derivatives of parent rock, which in 1940, carried about 57 percent of all flax crops in the zone, are coarse soils, slightly cultivated, very responsive to climatic changes (it becomes a sea of mud and then dries up), and are hardly suitable for flax. Likewise unsuitable are the light sandy-loamy soils, on which, in 1940, about 24 percent of the flax was found, and in particular the southeastern part of the zone with an insufficient amount of rainfall and high temperatures.

All this taken together permits us to classify the Eastern zone as that part where the soil-climatic conditions are unfavorable for flax. The especially important significance of general soil cultivation for the production of constant harvests is stressed here more than anywhere else in the flax cultivating belt.

VII. Southeast zone - warm, dry, with arid periods, with podzolic soils of the wooded steppes including medium and heavy clays.

This zone in its natural state is clearly not suited for the cultivation of fiber flax. The high temperatures of May, June and July, insufficient rainfall (152 millimeters), low humidity, and dry periods, characterize the climate of this zone as continental, absolutely unsuitable for long-fiber flax.

In the present short review the soil-climatic characteristics of the Baltic area and Siberia are not given. For various reasons we have not been able to study, in those parts of the USSR, the soil-climatic features, even to the limited extent that we did in the flax cultivating belt of the European part of the USSR, (within the 1938 boundaries).

In order to fill this gap to some extent let us dwell for a moment upon the main characteristics of climate and soil in these territories.

The soils of the Baltic Republics are an extension of the turf podzolic zone and are characterized, by approximately the same differences as the Pskov, Velikiye Luki, and Novgorod oblasts of RSFSR, a part of the Northwest

soil-climatic zone described above.

Climatically, judging by the thermal reserve, the Estonian SSR and the northern part of the Latvian SSR, during the growing period, is related to the moderately warm zone, with total temperature from 1,800 to 2,000 degrees, a growing period of 124 to 131 days, with an average June temperature (according to data over many years) of 14.7 degrees centigrade and with maximim precipitation in August. The Lithuanian SSR with regard to thermal reserves may be considered as the warm zone with a total temperature of 2,000 degrees centigrade and more, with a longer growing period of 131 to 145 days, with somewhat higher June temperatures, on the average from 15.5 degrees to 16.2 degrees centigrade and the same maximum August precipitation.

The soil-climatic characteristics of Siberia are given for the flax cultivation area which is situated primarily to the north of the main Siberian railroad trunk line, in the wooded-steppes, the subtaiga and taiga zones of the great West Siberian lowlands.

Both the climate and soil aspects of this territory are highly varied, and they differ in many respects from the flax-growing zones of the European USSR.

The climate of the flax-growing part of Siberia is distinguished, in the first place, by its location in the body of the Asiatic continent. Its continental location and exposure to penetration by cold air masses from the polar regions is a basic factor, which determines the climate of Siberia as a whole and of the flax-growing sections in particular.

Summer in Siberia is short. The number of days with temperature above 15 degrees centigrade, which identifies the duration of the summer period, is in Tobolsk 66 days, in Tomsk 61 days, in Narym 57 days. The growing period, with temperature above 10 degrees centigrade at the same geographical points is 100 to 116 days. The duration of spring is short -- from 20 to 26 days. Autumn is still shorter -- from 13 to 19 days.

The Ural mountains retard the progress of the warm and moist currents of air from the Atlantic Ocean to the Asiatic continent, as a result of which the total amount of precipitation to the east of the Ural Mountains is reduced. Thus, the yearly rainfall in Molotov amounts to 600 millimeters, in Tobol'sk, to 441 millimeters, in Novosibirsk, to 379 millimeters. Further, toward the southeastern part of the flax- growing zone of Siberia, the yearly amount of rainfall is slightly higher. Thus, in Narym it amounts to 487 millimeters, in Tomsk, to 565 millimeters. The distribution of rainfall in the course of a year in the flax-growing regions is such that the largest amount falls in the summer months: in June, July, and August; in Tobol'sk 45 percent of the annual precipitation falls during these months, in Tyumen 42 percent; in Tar -- 48 percent; in Narym -- 50 percent, in Krasnoyarsk -- 53 percent.

The top soil of Siberia is highly varied.

In the flax-growing parts of Tyumen' and Omsk oblasts, we find leached out black-earth and podzolic soils of various mechanical composition, changing to marshy. Further in the east, in Novosibirsk Oblast (in its wooded steppes part) degradated forest soils, leached out and degradated black-earth, dark gray and gray podzolic forest soils and soils of a marshy type predominate. In the rayons of Tomsk Oblast, dark wooded steppe and highly degradated black-earth-like soils are widespread.

A general review of the flax-growing regions of Siberia shows that soil-climatic combinations, which might be very effectively utilized for the cultivation of fiber flax, exist in this huge territory. At the same time the great variety of soil-climatic conditions require, for the successful cultivation of flax, the utilization of correspondingly varied systems of agricultural techniques and fertilizers, in order to obtain here high and constant yields of flax.

TABLE 76

The Dynamics of mean Daily Temperatures, Length of Day and Precipitation during the Growing Period of Flax sowed on 13 May. (based on TSKhA data over many years).

Notation of data for	May II	May III	June I	June II	June III	July I	July II	July III	August I
Temperature (in degrees centigrade)	12.0	14.4	14.4	16.1	17.4	18.1	18.5	18.5	17.5
Length of Day (hours and minutes)	16:12	16:51	17:15	17:29	17:31	17:20	16:57	16:25	15:46
Precipitation (in millimeters)	13.6	16.3	21.9	22.0	23.1	26.3	24.2	27.6	26.8
Phases of Flax Developing	Coming up					Flowering			Ripening

TABLE 77

Notation of data for	JUNE II	JUNE III	JULY I	JULY II	JULY III	AUGUST I	AUGUST II	AUGUST III	SEPTEMBER I
Temperature (in degrees centigrade)	16.1	17.4	18.1	18.5	18.5	17.5	15.8	14.9	12.2
Length of Day (hours, mimutes)	17:29	17:31	17:20	16:57	16:25	15:46	15:03	14:19	13:5
Precipitation (in millimeters)	22.0	23.1	26.3	24.2	27.6	26.8	22.3	24.3	22.4
Phases of growth of Flax	Coming Up			Flowering				Ripening	

Dynamics of mean daily temperatures, length of day and precipitation during the growing period of flax sowed on 9 June. (based on TSKhA data over many years).