

NATURAL AGRICULTURE: WINTER WHEAT

IN NORTHERN EUROPE ACCORDING TO THE FUKUOKA-BONIFILS METHOD

This is a method that is modulated by the summer and winter solstices.

The wheat seed is sown into a carpet of spreading, perennial clover around the St. Jean (21/6). The wheat germinates and develops numerous and deep roots before resting during winter after the intense work of assimilation that is favoured by the bacterial activity of the soil (N, P, Mg, K, and trace elements) and a particularly intense photosynthesis of the leaves (C) during the summer and autumn.

It is ready, once the winter is over, to flower and to develop the grain without hindrance, so as to offer in mid-summer its heavy ears.

Plants 60 cm apart in either direction do not waste themselves in fratricidal struggle, developing thus such health that the wheat can come again on itself several years in succession. The new sowings are made at the St. Jean in the field attaining its maturity.

This balanced system can yield more than 10,000 kg each year. We are going to see how it employs to the best the potential residing in the chain of transformation that goes from the mineral uptake to its being put at the service of man and/or animal, passing by way of a mineral restitution and an increasing enrichment of the soil by microorganisms and earthworms.

We shall attempt to follow the complete cycle, bearing in mind three points that constitute its originality: early - open - surface sowing, without working the soil.

Respect the Living Work of the Soil

The soil, abundantly utilized by the roots and permanently covered with a soft blanket of straw mulch and clover, harbours an intense life. The bacterial mass can be evaluated at 6.5 tonnes/ha, and that of earthworms at 1 tonne/ha. If one cautiously considers the life of a bacterium to be one month, it follows that the annual production of bacterial corpses may be in the region of 80 tonnes/ha.

This constitutes, together with the work of mineralization, the basis of a high cereal yield. It is a question of a continuous production of minerals directly assimilable by the plant, as well as of organic matter structuring the soil in favourable manner by the formation of stable aggregates.

The roots benefit from an abundant and steady mineral uptake (osmotic doses in comparison to chemical fertilizers) as well as from a soil structure that can be readily exploited. They work at depth, and each dead root is a tube for the young roots that thus trace out a path along which they are guided, nourished by their decomposing parents. (The soil's buffer-reserve of moisture and minerals Improves from year to year. Amendments are no longer wasted. No more are humus and organic matter uselessly oxidized nor buried too deeply as when the soil is worked. Leaching-out is practically zero thanks to the joint action of the mulch, the humus-clay complexes, and the roots that retain water and minerals. The soil being covered, erosion is also practically eliminated. These few points are important, not only as regards the growth of wheat but also from consideration for the environment (nitrates) and the endangered heritage constituted by our soils.

Plants living in surroundings such as described resist better both drought and extreme temperatures, even though in damp periods the warming of the earth by radiation can be slowed down.

The water flux due to capillarity is better preserved than when the soil is worked. Germination occurs more readily, and the saying "a hoeing is worth more than two waterings" is turned back-to-front the mulch playing admirably the role of a thin layer of hoed earth.

The Breathing In

Wheat is one of the most vigorous plants that exist. Its index of competitiveness outdoing that of the grasses and crucifer above all if it is sown early. It has therefore no worse enemy than itself. Its association with spreading clover makes for an optimum occupation of the soil. It leaves no opportunity for other species to be a nuisance, which does not preclude a discrete, even useful or aesthetic, presence such as cornflowers.

The wheat is sown under the mulch In contact with the earth. Not too deeply. In order to have a short rhizome or none at all. The wheat will avoid bacterial attacks whose favoured site is the underground stem. On the other hand it will side-shoot rapidly, economizing on the time that would otherwise be taken for the rhizome to form and germinating better than at depth where the seed does not benefit from the same abundance of heat and light In combination with moisture.

In late July, early August is to be seen the beginning of an upsurge of exponential growth.

Wheat at the 7-leaf stage accelerates its development and stocks reserves in its roots. This interesting phase is best served by an early sowing, for it then takes place with a sufficiency of sunshine. The luminous energy is trapped in a particularly effective manner: the association of scarcely risen cereal sprinkling a covering of creeping clover acts as a veritable light-trap, recovering a portion that is normally reflected. The foliar index (ratio of leaf surface / occupied area of soil) of the two plants together is greater than their respective average when grown alone. This is another advantage of association over rotation.

Through photosynthesis that takes place in the leaves, wheat nourishes itself with carbon to synthesize sugars (starches), an energy reserve employed in respiration. Thanks to the good exposure of its leaves (open sowing) it finds the time (early sowing) to unfold as many as 25 leaves before the winter's rest. Side-shooting is therefore spectacular, and equally so the rooting.

This method avoids carbon starvation, which forces wheat, in order to compensate for a deficiency of sunshine, to expend too much energy on leaf development at the expense of rooting. The healthy and vigorous roots make ideal use of the mineralization of the organic matter and the seasonal production of nitrogen by the clover's root nodes, which is at a maximum during summer and autumn. It allows also a possible excess of autumn rainfall to be readily confronted.

Between the summer solstice and the winter solstice, the wheat plant, helped by the creeping clover, carries out essentially a task of assimilation and stocking-up of reserves of energy-rich matter (starch) and potential structural matter (albumin).

As the days shorten and the weather gets cooler, the wheat slows down its metabolism, and then spends the winter replenished and asleep.

The breathing out

At the winter's end, the wheat which has undergone hardening is going to be able to initiate its flowering. It then lives on the reserves accumulated the previous year. This is necessary in the spring, for the bacterial activity of the still cold soil is limited and does not assure sufficient nourishment.

The yield of the cultivation will be a function of several factors:

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- the number of plants per unit area
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- the number of ears per plant
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- the number of ear lets per ear
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- the number of grains per earlet
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- the unit weight of the grain

It can be seen from the following table how in natural agriculture one influences those elements in comparison to conventional methods:

Conventional INRA Trial Bonfils Method

no. of plants/m ²	350	80-100	3-4	1.5-2
qty. of seed/ha	160-180kg	40-50kg	1.5-2kg	0.7-1.5kg
ears/plant	0-3	5-7	100-150	200-300

earlets/ear	12-15	18-20	35	
grains/earlet	1-3	2-5	7	
quality of grain	low unit weight of grain	relatively high unit weight	high unit weight of grain	

The number of ears per plant depends above all on the side-shooting that is encouraged by open, early sowing. The number of earlets depends upon the floral initiation and the subsequent stages as well as upon other factors. At stage A, the apex of the master shoot measures nearly half a millimetre. This stage takes place in February-March, when the length of day reaches 11-12 hours. When stage B occurs 15 to 40 days later (the ear is then 1 cm long), the precursory rings of the earlets begin to form on the apex. The straightening-out stage follows, when the apex, 1.5 mm long, contains as many rings as earlets. The mounting occurs next, the stamens lengthening and the ovaries developing, up until fertilization. At that moment the weight of the ovary determines the maximum weight that the mature grain will be able to attain. After fertilization, the seed forms its enveloping layers, or in other words there is a high rate of cellular growth. When these enveloping sheaths have been formed, the seed accumulates starch and other reserve materials, brought as related substances by the sap from other parts of the plant. This phase of assimilation is known as the "water landing" for the weight of water remains constant during 10-15 days while the dry-matter accumulates. The dry-matter ends up by replacing the water, the seed having then reached maturity.

From stage A up until fertilization (mounting) regular and sufficient nourishment is essential. This allows the greatest possible number of earlets to form and the ovaries to develop without aborting. Each earlet contains 9 potential flowers of which 5 at the most will reach maturity, rarely more.

Every stress factor, such as lack of light, a too dense sowing, a sudden addition of fertilizer (osmotic shock), an excess of heat, risks speeding up the mounting, and so denying the possibility of all ears, earlets, and ovaries from forming. The larger the ovary at fertilization, the larger will be the grain at harvest.

Open-sown wheat economizes on energy expended on straw, and does not wither for lack of light. This makes it more resistant to disease, to lodging, and to drying out. The demons of disease and lodging withdraw terrified at the sight of happy fields of wheat bursting with health. They can almost be forgotten. The demon of drying-out, although more in evidence, should not make one too frightened. It takes hold of wheat when, strong sunlight striking at excessive temperatures, it causes the evaporation of so much water through the heads that the rest of the plant is by-passed. The columns of water present in the stem vessels are vaporised, the pump un-primed.

This is less likely if the rooting is deep and the stems short. If it occurs during the formation of the sheaths, the size of the grain is fixed by it. Its appearance will be normal but small. During the "water landing", drying-out interrupts the assimilation of dry-matter. The grain will become crinkled by losing its water and breathing in the absence of sap. The risks of being taken before maturity are equally diminished by early sowing. The wheat can commence the floral initiation once the winter is over. This is not always the case with late sowing, when the wheat awakens and sometimes has yet to side-shoot, despite several little leaves.

Trees Also Have a Place

Once you have lived through a cycle such as that described, you will doubtless wish to see trees growing in your field. They will be delighted to complete the association, above all if they are well chosen.

They will set to work in assisting the clover's task of nitrogen assimilation (leguminous or otherwise). With their deep roots they can dissolve the mother-rock and bring up quantities of trace elements and precious minerals that they spread around with their leaves. They drain the soil. If it is occasionally drowned, at the same time inhibiting leaching out.

They must keep their distance from one another (15-20 metres) and their foliage must be thin in order not to pinch too much light.

Wheat will grow readily at their feet, encouraging you, when you have the time after a meal, to come there discretely to digest in calmness and thankfulness.

Varieties

The ideal spreading leguminous plant is a local white clover. The commercial type may be suitable. For a dry climate 'lupuline' (*Medicago lupulina*) may be suitable. Sowing should be carried out at 5kg/ha.

The wheat (or other cereal) should have a strict winter character. It must not mount before the winter. Seek vigorous varieties (long straw, deep roots, vigorous side-shooting) and late maturity. Wheat and barley adapt to clayey limestone soils. Wheat and rye grow in acid soils. Oats needs a light soil and a mild, maritime climate. It does not tolerate temperatures below -10°C. Sow at 2 kg/ha, or up to 80 x 80 cm spacing for very vigorous varieties (Poulards), or for Capitole 50 x 50 cm.

Trees: - robinia (*Robinia pseudoacacia*); clay-limestone soils; beware of spiny suckers - alder, various varieties for damp soils.

To Bring a Meadow Back into Cultivation: No Ploughing or Digging

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- sow the clover in April
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- wheat in June (15th-30th)
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- scythe the meadow when it goes to seed
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- re-sow clover in summer and in autumn if it has taken badly at all events the wheat will grow

