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MAIZE FOR FODDER AND SILAGE

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In the Netherlands maize for fodder has been grown for a long time, but on a rather limited scale. Most of it is used for feeding horses in the autumn. With the growing motorization the number of working horses in Dutch farms is gradually decreasing and so is the small acreage of foddermaize.

The utilization of fodder maize as a green fodder crop in the last part of the summer, to compensate for shortage of pasture, is not known in the Netherlands. In countries with a more severe summer drought this practice is widely spread. For instance: probably most of the 46.000 hectares of green maize grown in 1955 in Western Germany was fed directly from the field to cattle (1). Undoubtedly this holds true for the 220.000 hectares of this crop grown in 1954 in France (2). It struck me, however, that DESROCHES (2) apparently is strongly convinced that the growing and feeding of green maize in France deserves little appreciation. According to his opinion green maize is rather poor as a feed and not much more drought resistant than a pasture of clover and Italian ryegrass or of lucerne and orchard grass.

The old practice of growing fodder maize is to take a very late variety and to sow at least 100 kg, even up to 150 or 200 kg of seed per hectare. Often heavy, very leafy crops, not yet or hardly tasseling, are the result. But the percentage of dry matter and protein is low. Therefore this crop is not attractive for making silage, also because the great amount of water in it increases the transportation costs.

Far more interesting in my opinion than maize for fodder is maize for silage. In the Netherlands and in other countries in Western Europe a rising interest for this crop is developing in the latter years. Most of this interest is due to the shortness of labour of present day agriculture, which very often makes growing of fodder beet impossible.

In the Netherlands the climatic conditions for fodder beet production are very favourable. More than 50.000 hectares are grown every year. It is a special crop for rather small family farms on sandy soils with part of the land under permanent grass and the other part arable. In many cases, however, these sandy soils are too light and susceptible to drought for profitable growing of fodder beet. Therefore in 1953 we started experiments on a practical scale with maize for silage on this type of soil. A number of 35 small farmers grew together 16 hectares of this crop. The average yield was 64 tons of green matter with 20, in many cases up to 22 % and more, of dry matter. This was a far better yield than would have been possible with fodder beet on the same soil. On many of these fields in fact the growing of fodder beet was considered to be impossible.

Since 1953 the farmers' interest in maize for silage is increasing. Official statistics mention 180 hectares in 1954 and about double that figure in 1955. But the principal reason for growing this crop certainly is the saving of labour and only a minority grows it with regard to soil characteristics. The amount of hand labour for growing maize for silage, including the harvesting and ensiling is less than half the amount required by fodder beet growing, harvesting and storing.

There are several problems in the growing of maize for silage, some of which will be dealt with in this paper. Some of the results of our experiments will be valuable also for other countries although we must admit that climatic conditions in the Netherlands are rather extreme as far as the coolness in summer is concerned.

The selection of varieties is still influenced by the old practice of fodder maize growing. Farmers like to see a heavy crop, but the value of a high percentage of dry matter and of a great number of well developed ears with well filled kernels is gradually recognized. Most of our modern hybrids produce vigorous plants of which the stems and leaves remain green till the kernels are in the hard dough stage. They are so well suited for the production of a good crop for silage, that one can hardly foresee any success for a breeding programme with the aim of breeding a special silage variety. This does not exclude the importance of variety trials.

In the Netherlands nowadays we are comparing two groups of varieties: flint-dent and pure dent hybrids. Both have their advantages and disadvantages. The flint-dents have as a rule more cold tolerance in spring and they mature earlier than the pure dents. Some of the early flint-dents, however, cannot compete in total yield, although they are quite satisfactory in grain production. Lodging, especially root lodging, is more frequent with flint-dents than with pure dents. In our windy climate this is an important point with regard to mechanical harvesting. The best dents regarding lodging resistance are often too late for producing really well filled kernels. Nevertheless their yield in total dry matter is satisfactory. We need more knowledge, based on experiments with animals, concerning the value of the kernels. But good farmers will tell that the cows do better on maize silage with many than with few kernels.

Table 1 shows the results of two variety trials, carried out in 1954 en 1955 respectively. The varieties are arranged according to maturity type, the earliest at the top. The Pioneers are pure dents, the others flint-dents. In both years the earliest varieties including Pioneer 395 were at harvest time in different grades of the dough stage of maturity, the later Pioneers in the milky stage; Pioneer 352 was not yet that far advanced.

Looking at this table we have to consider that the summer of 1954 was exceptionally cold and rainy, which is responsable for the low dry matter content. In 1955 the spring was cold till the middle of June. After that summer temperatures were about normal but it rained less than normal.

This light soil on which crops sometimes suffer from drought is well fertilized. We suppose that the C.I.V.-hybrids are better adapted to this type of soil than the Pioneer hybrids.

The capacity of the rather late Pioneer 377A to produce a heavy yield of green matter is clearly demonstrated, relatively more even in 1955 than in 1954. The cause of the very low protein percentage of C.I.V.7 and the very high protein percentage of Pioneer 395 is not clear. In 1954 this figure was low for Pioneer 395. Late varieties in general have a relatively high percentage of crude fibre. This is probably caused by less filling of the kernels. It is amazing that the computation of starch equivalent does not show greater differences. The maturity type hardly finds its expression in this figure for 1954. In 1955 the starch equivalent of the three latest maturing varieties at least was clearly lower.

Sowing time is very important for the yield of maize for grain in the Netherlands. The limit for early sowing is the critical temperature of 8-10°C, below which no maize will germinate. The average 24 hours temperature in April is 8.0°C, in May 11.9°C. In several years we observed the temperature in the upper 3 cm of top soil and in the lowest 5 cm of air. During sunny periods the soil was often 7-8°C warmer than the air. The type and texture of the soil is very important. A light loamy sand warmed up more than a heavy moist river deposit clay.

The fact that the layer of the soil in which the seed is sown is often warmer than the air explains the experimental result that the last ten days of April are the best time for sowing maize for grain in the Netherlands, both for yield and maturity.

Some people suppose that later sowing will be possible for maize for silage, because maturity is less important. Although this is true to a certain extent, there are some arguments against it. Later sowing as a rule involves a drier seedbed, which may result in retarded and unequal germination. Such crops may yield a quite satisfactory mass of green matter, but the maturity will be retarded and therefore the percentage and yield of dry matter will be disappointing.

On an experimental field on which maize for silage was sown this year, beginning on April 20 with intervals of two weeks till the end of June the first sown crop looks convincingly better than all the others including the second.

Early development of maize is slow according to the opinion of many people in our country, because earlier sown crops like small grains are already shooting when maize has only a few leaves. But those crops need just as much or even more time to reach that stage. The difference is rather that many weeds are growing fast during this period of early development of the maize. This often involves much work for weed control unless herbicides are used. In our experiments DNC has been most effective so far, followed by 2,4-D. Of DNC we use 4 kg in 800 litres water per hectare, of 2,4-D 1 kg active matter in 800 litres water per hectare. MCPA turned out to be more harmful for maize than 2,4-D.

A stimulating effect in the early stages of development by placing superphosphate near the seed is often observed, even with a fair supply of phosphate in the soil. Sometimes no other effect is stated, but on many sandy soils an improvement in yield and maturity may be the result. Experiments of PRUMMEL and others (4) with this method of fertilization in our country were convincing. Following this track we tried placing of phosphate on moist sandy soils where maize always strongly shows the purple leaves indicating lack of phosphate together with poor growth (table 2). The results were strikingly in favour of placing, although less at Goirle where the soil contains more humus and is in a better condition.

This year we sowed maize on a 2.5 hectare field of sandy soil, where every attempt to grow maize in previous years had failed, probably because phosphate was fixed by iron. 600 kg per hectare of superphosphate in a band near the row at sowing time produced a crop of about two meters high and estimated at a weight of more than 60 tons of green matter per hectare.

The most efficient number of plants per hectare for maize for silage is much discussed in most countries. Again there are the problems of the relation of green yield, dry matter content and yield of dry matter and the influence of ear and kernel growth on the quality of the fodder.

So far the highest yield of dry matter has been our aim. In experiments in 1944 and 1946 we tried populations of 12 up to 24 plants per m^2 and stated an increase of 17 % in 1944 and of 23 % in 1946.

Having no experience in this respect with our modern hybrids, we started again in 1954 with an experiment comparing four populations, three distances between rows and using the rather early variety Goudster and the somewhat later maturing variety Foliant (table 3). This experimental field was situated on the same light sandy soil as the variety trials mentioned before.

The green yield was clearly favoured by increasing population and so was the dry matter yield, because of the small and meaningless differences between the dry matter percentages. The average yield of all entries with 10 plants per m^2 was 113 quintals per hectare of dry matter, with 12 plants/m^2 118 q/ha, with 14 plants/m^2 120 q/ha and with 18 plants/m^2 131 q/ha. Only these differences are significant.

Distance between rows had no influence, the average yield of dry matter at 50 cm row distance being 122 q/ha, at 60 cm 118 q/ha and at 75 cm 122 q/ha.

The two varieties yielded equally well, Goudster averaging 120 q/ha and Foliant 121 q/ha of dry matter.

The very small differences between the percentages of digestable crude protein, are, just like those of crude fibre and of starch equivalents, probably due to small inaccuracies in sampling and analyzing. There are no relations of these figures to differences in plant population.

On the basis of these results the scheme for the experiment in 1955 was somewhat modified. A third, definitely later maturing variety, Pioneer 377A, was added. As row distances only two "practical" measures were chosen: 50 and 67 cm, being the distances between the pipes of a two meter drilling machine with 3 and 2 pipes respectively. Plant populations were, being the most effective, more strongly varied (table 4). The field was situated on the same farm as in 1954.

The average yield of dry matter reached the very high level of 151 quintals per hectare. This is certainly due to the much better summer in 1955.

There are no significant differences between the resulting yields of this experiment. The only data with some meaning are the relatively high percentages of crude fibre in Pioneer 377A with corresponding low figures for starch equivalent. It is remarkable that 9 plants per m^2 were a sufficient number to reach the highest yield of starch equivalents. For Goudster and Foliant the optimum for grain yield will be about 7 plants per m^2 and a population of 9 plants will probable give a reduction of not more than 10 % in grain yield, according to our experiments of earlier years.

The conclusions based on these experiments are contradictory regarding the influence of plant population. This is the more amazing because in general at a higher level of productivity a higher plant population will be optimum than at a lower level. SHUBECK and CALDWELL in Minnesota (3) found that fertilizing with nitrogen was more effective on grain yield with a greater plant population. Increasing plant population had a better result in proportion as the supply of moisture and fertility was better.

In earlier experiments with different gifts of nitrogen fertilizer to maize for grain we noticed, that the length and leafiness of the plants were still increased by increasing nitrogen, when the optimum for grain yield had already been surpassed.Therefore for silage it will be useful to experiment with combinations of different plant populations and gifts of fertilizers. We started this year combining plant populations and different gifts of nitrogen.

The time of harvesting maize for silage is sometimes chosen too early by our farmers. When the plants have grown to full length and the ears are swelling, they think that there is nothing to be gained by waiting longer. Furthermore they fear that the lower parts of the stalks will become more fibrous. Another argument for an early harvest is that some farmers want to grow a crop of turnips or green rye after the harvest of the maize. The turnips then are harvested in the following winter, the rye in the following spring. The sowing of the turnips has to start before the 10th of August, the rye must be sown in the beginning of September.

The question arises if these crops will yield more feed than can be produced by the maize if this crop gets time to finish its growth. Therefore in 1955 an experiment with 6 different times of harvest was started. The dates of harvest were the following.

August 2 and 10, with regard to the sowing time of turnips; the maize was fully flowering on both dates;
September 2, with regard to the sowing of green rye. The maize was already far in the milky stage of maturity, nearly in the dough stage;
September 8, because one harvest was planned in the soft-dough stage, which occurred earlier than expected;
October 1, with kernels in the hard dough stage;
October 22, with fully mature kernels and partly withered leaves and tops but still green stalk bases.

The experiment was situated on a well fertilized sandy soil near Wageningen.

In table 5 the most important results are summarized.

Although the plants reached full length on August 2 and the highest yield of green matter on August 10, only half of the maximum yield of dry matter was produced on the first and nearly two thirds on the second of these dates. During the month of August the yield of dry matter was nearly doubled. In other words: waiting till the beginning of the dough stage of maturity seems to be necessary to be sure that the full production capacity will be realized, both in total dry matter and in yield of protein.

During the ripening period loss of water seems to be the only loss. No decrease in quality of the dry matter is stated. The opposite is true: the average crude fibre content of the whole plant continues decreasing till the hard dough stage.

To get an impression of the quality of the different parts of the plant, separate samples of leaves, upper stalks, stalk bases and unhusked ears were analysed. Table 6 shows the percentages of crude fibre in these parts. In the hard dough stage no striking rise in crude fibre content was found in any part of the plant. The strongly growing ears with a low and decreasing crude fibre content are causing the continuously decreasing percentage in the whole plant. During the last phase of the ripening the withering of the leaves and upper stalks apparently causes a sharp rise in crude fibre. The still green stalk bases change very little in this respect.

The harvesting methods are very different according to size of farm and other conditions. In the United States most of the maize for silage is harvested with a field chopper, which cuts and chops the plants and blows the chopped fodder on a wagon trailing behind the chopper.

In the small family farms of 10-20 hectares, where maize for silage is principally grown in the Netherlands, a field chopper is too large and expensive. The fields are as a rule too small and the available equipment for power and transport is insufficient. Even co-operative exploitation of a field chopper has no chance of efficient and economic employment in these farms.

Most farmers harvest with a grain binder of which several makes turned out to be strong enough for this work. Some of the newest German types seem to be especially well fitted for it.

The tall plants of late varieties, as may be grown under more favourable climatic conditions, probably are too large to be handled by a grain binder.

After cutting, the sheaves are brought to the silo and put through a stationary cutter-blower or shredder-blower with a capacity of 6-8 tons of green matter per hour.

It may be that the newest type of American forage harvester is cheaper and better adapted to small fields than the conventional type. As far as I am informed this is a field shredder, which shreds the plants without cutting them before and throws the shredded parts on a trailing wagon.

For ensiling maize no high silos of the American type are used in the Netherlands. The construction of those is much too expensive. On the small farms sometimes simple pit silos are used with good results. Most of these pit silos are made of concrete, cilindrical with a depth of 1½-2 metres and 3 or 5 metres in diameter. During the filling the mass must be mixed to prevent the heavy parts of ears and stalks from being heaped up on one spot and the lighter leafy parts from being blown to another spot. Furthermore treading and after filling heavy pressing by a weight of 80-100 cm of soil is necessary to prevent heating and decay.

Trench silos probably are easier to fill and to press. Another advantage of this type of silo is, that not more than can be fed in a short time needs to be cleared from the soil. Thus the remainder is kept under pressure preventing heating.

So far our results with the feeding of maize for silage have been very good. It is a healthy palatable roughage with a good influence on the condition of cattle.

During the winter of 1953-1954 we analyzed 46 maize silages of farmers and found the following average percentages:

soil free dry matter	20-22 %
in the dry matter:	
crude protein	8.2 %
digestible crude protein	5.9 %
crude fibre	27.7 %
anorganic matter	5.6 %

The pH of the silages was 3.78 on the average; 1.45 % of lactic acid, 0.64 % of acetic acid and 0.02 % of butyric acid was found. Not more than 6.7 % of the total nitrogen was found in the form of ammonia.

Although many of these farmers were only beginners, the silages and the feeding results were very satisfactory.

The problems of conservation and feeding certainly are not the most difficult ones in connection with maize for silage.

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Table 1

Results of two variety trials on light sandy soil with about 5.8 % humus in 1954 and 1955

Variety and year of harvest	Green matter q/ha	Dry matter %	Dry matter q/ha 1)	Digestable crude protein % 2)	Digestable crude protein q/ha	Crude-fibre %	Carbohydr. + fat %	Starch equivalent % 3)	Starch equivalent q/ha
1954									
Goudster	761	15.9	121	7.7	9.32	22.0	61.7	62	75.0
Wisc. 240	677	15.6	105	7.1	7.46	25.4	57.3	59	62.0
C.I.V.6	777	15.6	121	7.7	9.32	25.5	58.4	60	72.6
C.B.33	682	14.3	97	8.2	7.96	25.3	57.3	60	58.2
Pioneer 396	681	16.4	111	7.1	7.88	25.2	59.6	61	67.7
" 395	805	14.4	116	6.5	7.54	25.7	59.3	60	69.6
" 382	767	14.3	110	6.9	7.59	28.6	55.0	58	63.8
" 388	797	14.7	117	7.3	8.54	27.2	56.9	59	69.0
" 377A	870	14.7	127	7.8	9.91	25.9	57.4	60	76.2
" 352	868	13.1	113	7.7	8.70	30.2	51.9	57	64.4
1955									
Goudster	619	20.7	128	7.0	8.96	21.4	62.5	62	79.4
C.I.V.6	639	19.9	127	6.1	7.75	22.6	61.8	61	77.5
C.B.419	613	22.6	138	6.0	8.28	23.7	61.6	60	82.8
C.B.418	647	19.8	128	6.6	8.45	22.1	62.4	61	78.1
C.B. 33	616	19.6	121	7.3	8.83	23.9	59.8	60	72.6
C.I.V.7	692	21.8	151	5.7	8.61	21.5	63.6	61	92.1
Pioneer 395	658	18.7	123	8.4	10.33	24.0	60.1	62	76.3
" 382	663	19.2	127	5.3	6.73	26.9	58.1	57	72.4
" 388	678	18.0	122	6.9	8.42	27.8	56.3	58	70.8
" 377A	725	17.1	124	6.4	7.94	27.1	57.6	58	71.9

1) 1954 D 0.05 = 13; 1955 D 0.05 = 7.9

2) Determination with pepsin and hydrochloric acid

3) Computation according to the Futterwert-Tabellen der DLG, 1952

Table 2

Yields of maize on moist sandy soil in 1955

Fertilization kg/ha	Green matter at Goirle quintals per ha	Grain yield at Diessen quintals per ha
75 P_2O_5 broadcast	427	26.7
75 P_2O_5 in rows	505	40.7
125 P_2O_5 broadcast	471	23.3
125 P_2O_5 in rows	550	48.7

Table 3

Yields and percentages of the spacing experiment
CI 1769 in 1954 on light sandy soil at Beckum

Variety	Row distance	Plants per m²	Green matter q/ha	Dry matter %	Dry matter q/ha 1)	Digestable crude protein % 2)	Digestable crude protein q/ha	Crude fibre %	Starch equivalent 3)	Starch equivalent q/ha
Goudster	50 cm	10	718	15.4	111	8.1	9.0	23.1	61	67.5
	"	12	745	16.3	122	7.3	8.9	23.4	62	75.3
	"	14	796	15.5	123	7.7	9.5	24.4	60	74.1
	"	16	830	16.2	134	7.2	9.7	21.8	62	83.3
	60 cm	10	706	15.8	112	7.6	8.5	20.6	62	69.2
	"	12	731	14.9	109	7.8	8.5	22.8	61	66.5
	"	14	776	14.9	116	7.7	8.9	25.3	60	69.4
	"	16	836	15.5	130	7.7	10.0	22.9	61	79.0
	75 cm	10	678	16.6	113	7.3	8.2	22.1	62	69.8
	"	12	716	16.1	115	7.8	9.0	23.3	61	70.3
	"	14	765	15.8	121	7.8	9.4	21.8	62	74.9
	"	16	814	16.2	132	7.8	10.3	22.9	61	80.5
Foliant	50 cm	10	785	15.2	119	7.5	8.9	24.6	60	71.6
	"	12	769	14.6	112	7.7	8.7	24.0	60	67.3
	"	14	802	14.4	116	7.9	9.1	24.4	60	69.3
	"	16	825	16.5	136	7.0	9.5	21.8	63	85.8
	60 cm	10	725	15.3	111	7.6	8.4	23.4	61	67.7
	"	12	768	16.3	125	7.2	9.0	23.1	61	76.4
	"	14	796	14.4	115	7.5	8.6	25.7	60	68.8
	"	16	857	15.2	130	7.4	9.6	24.9	60	78.1
	75 cm	10	746	15.3	114	7.7	8.8	24.3	60	68.4
	"	12	806	15.2	123	7.7	9.4	23.0	61	74.7
	"	14	885	14.9	132	7.7	10.2	25.7	60	79.1
	"	16	837	14.7	123	7.6	9.3	25.6	60	73.8

1) D 0.01 = 10, D 0.05 = 8

2) Determination with pepsin and hydrochloric acid

3) Computation according to the Futterwert-Tabellen der DLG, 1952

Table 4

Yields and percentages of the spacing experiment

CI 1945 in 1955 on light sandy soil in Beckum

Variety	Row distance	Plants per m²	Green matter q/ha	Dry matter %	Dry matter q/ha 1)	Digestable crude protein % 2)	Digestable crude protein q/ha	Crude fibre %	Starch equivalent 3)	Starch equivalent q/ha
Goudster	50 cm	9	600	25.5	153	8.1	12.4	22.2	61	93.4
	"	12	624	25.1	157	8.1	12.7	22.8	61	95.6
	"	15	650	24.1	157	7.4	11.6	23.0	60	94.0
	"	18	684	23.1	158	7.7	12.2	25.8	59	93.1
	67 cm	9	610	24.5	149	8.2	12.2	19.9	63	94.0
	"	12	625	23.7	148	8.3	12.3	21.6	62	91.7
	"	15	643	23.3	150	8.0	12.0	23.2	60	89.9
	"	18	643	22.4	144	8.2	11.8	24.6	60	86.4
Foliant	50 cm	9	624	23.4	146	7.9	11.5	21.9	62	90.5
	"	12	669	22.7	152	8.2	12.4	22.5	61	92.6
	"	15	683	22.7	155	7.5	11.6	23.4	61	94.5
	"	18	697	22.4	156	7.7	12.0	24.3	59	92.1
	67 cm	9	629	24.1	152	7.9	12.0	22.8	61	92.4
	"	12	670	23.4	157	8.0	12.5	22.8	61	95.7
	"	15	676	22.3	151	8.1	12.2	22.0	61	91.9
	"	18	697	22.6	158	8.3	13.1	22.8	61	96.1
Pioneer 377A	50 cm	9	720	20.5	148	8.1	12.0	25.7	59	87.1
	"	12	750	19.4	146	8.0	11.6	27.0	58	84.4
	"	15	757	20.0	151	7.5	11.4	28.6	57	86.3
	"	18	771	19.3	149	7.7	11.5	27.6	58	86.3
	67 cm	9	735	19.8	146	7.9	11.5	26.3	59	85.8
	"	12	767	19.9	153	7.8	11.9	27.0	58	88.6
	"	15	743	19.6	146	7.7	11.2	28.0	58	84.5
	"	18	745	19.2	143	7.8	11.2	27.3	58	82.9

1) No significant differences

2) Determination with pepsin and hydrochloric acid

3) Computation according to the Futterwert-Tabellen der DLG, 1952

Table 5

Yields and percentages of maize for silage at different times of harvest

Date of harvest ⟶	2 Aug.	10 Aug.	2 Sept.	8 Sept.	1 Oct.	22 Oct.
Green matter, q/ha, D 0.01 = 80, D 0.05 = 59	611	734	694	675	540	408
Dry matter, %	11.6	12.7	19.5	20.3	26.4	35.7
Dry matter, q/ha D 0.01 = 18.4, D 0.05 = 13.5	70.7	93.2	135.2	137.0	142.6	145.7
Digestable crude protein, % 1)	11.2	9.3	7.3	7.0	6.6	5.8
Digestable crude protein, q/ha	7.9	8.7	9.6	9.6	9.5	8.5
Crude fibre, %	30.3	30.0	26.1	25.9	23.8	25.9
Starch equivalents 2)	57	59	62	60	61	58
Starch equivalents, q/ha	40.3	55.0	83.8	82.2	87.0	84.5

1) Determination with pepsin and hydrochloric acid

2) Computation according to the Futterwert-Tabellen der DLG, 1952

Table 6

Crude fibre percentages of leaves, upper stalk parts (above 50 cm), stalk bases (lower 50 cm) and unhusked ears at different times of harvest

Crude fibre content (%)	2 Aug.	10 Aug.	2 Sept.	8 Sept.	1 Oct.	22 Oct.
of the whole plant	30.3	30.0	26.1	25.9	23.8	25.9
of leaves	28.4	28.2	30.1	29.8	31.2	39.4
of upper stalks (above 50 cm)	30.1	29.9	28.8	32.5	33.2	40.2
of stalk bases (lower 50 cm)	34.1	32.9	31.8	30.4	32.8	33.1
of ears and husks	-	-	17.5	16.9	14.1	12.6