Crop Rotation and Monoculture in Corn Production

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The theory and practice of crop rotations are debated today just as hotly as at the beginning of the century or during the last century. The following citations illustrate the contradictory views:

KÖNNECKE /1962/: "The basic principles of crop rotations continue to be the preconditions of maintaining and increasing soil fertility."

In his monography COOK /1961/ replies with wit to the opinions questioning crop rotations: "Surely the blind following of a rotation is not wise but the production of soil building crops is always wise."

ALDRICH /1978/ writes in his well-known work "Modern Corn Production": "The concept that corn, small grains and hay must be rotated to keep soils productive is no longer valid. With modern fertilizer practices, reduced tillage, and special conservation methods when necessary, many farmers can crop their fields intensively, even to continuous row crops if that is most profitable."

There is an even more extreme formulation by D. GARST /1964/ in his study "Rotations are Obsolete": "In the future crop rotations and legumes will have to be eliminated in the same way horses have been eliminated and for the same reason. Modern production methods are not compatible either with horses or crop rotations."

At present the debate in Western Europe concerns the proportion of cereals in the crop rotation, while in Hungary it is about the proportion of corn.

In the first point of his summary on the principles of crop rotation ROEMER /1952/ writes the following: "The more seldom one and the same crop is grown in the same field the higher will be its yield per hectare." ROEMER lists corn among the self-tolerant crops.

Table 1 presents data on corn from long-term experiments conducted at Martonvásár, over the average of 22 years.

The data clearly reveal that the grain yield of corn increases both in fertilized and non-fertilized treatments as its proportion decreases in the crop rotation.

It is interesting to observe that the inclusion of alfalfa in the crop rotation hardly affects corn yields if sufficient fertilizer is applied. Together with the soil tests, this indicates that in the case of corn the yield is closely correlated with the water management of the soil.

Table 2 shows the yield data of wheat as affected by the proportion of winter wheat.

Table 1

Corn yields in various crop rotations /Martonvásár, 1961-1982/

Crop rotation	Ratio of corn in the crop rotation, %	Grain yield, %		Relative yield /average of fertilizer treatments/
		Non-fertilized	Fertilized	
Corn monoculture	100.0	100.0	100.0	100
3 years alfalfa - 5 years corn	62.5	112.7	102.1	103
2 years winter wheat - 2 years corn	50.0	120.4	104.9	107
3 years alfalfa - 3 years corn - 2 years winter wheat	37.5	120.8	108.8	109
Norfolk rotation: corn, spring barley, peas, winter wheat	25.0	122.9	114.3	112

Table 2

Winter wheat yields in various crop rotations /Martonvásár, 1961-1982/

Crop rotation	Ratio of winter wheat in the crop rotation, %	Grain yield, %		Relative yield /average of fertilizer treatments
		Non-fertilized	Fertilized	
Winter wheat monoculture	100.0	100.0	100.0	100
3 years alfalfa - 5 years w. wheat	62.5	110.3	109.7	114
2 years winter wheat - 2 years corn	50.0	116.4	118.5	114
3 years alfalfa - 3 years corn - 2 year winter wheat	25.0	111.7	121.2	119
Norfolk rotation: corn, spring barley, peas, winter wheat	25.0	147.9	132.2	135

Wheat yields increase both in fertilized and non-fertilized treatments with a decrease in the wheat ratio. In a monoculture the yield decrease is related to weather-induced pathogenic factors, mainly root diseases. In the case of winter wheat significant differences can be observed in the monocul-

ture tolerance of various varieties. The yield depression due to continuous cropping is related to the tolerance and resistance of the various varieties.

The different responses of corn and wheat to crop rotation are also summarized in Tables 1 and 2, respectively. The two series of data clearly reveal that winter wheat responds more strongly to crop rotation than corn.

The data presented unequivocally support the classical statement of ROEMER quoted above.

If this is so, why is it that from time to time corn monocultures appear in countries which produce corn on a large scale?

1. Monoculture experiments have revealed that, as a function of variety changes, corn yields can be increased even in continuous cropping.

2. With regard to total yields, a corn monoculture is more effective than crop rotation, as shown by the summarized data of crop rotation experiments expressed in grain units /Table 3/.

Table 3

Total yields of various crop rotations in grain units /Martonvásár, 1961-1972/

Crop rotation	Total yield in grain units*	
	t/ha	%
Corn monoculture	147.4	100
Winter wheat monoculture	72.1	49
3 years alfalfa - 5 years corn	132.0	89
3 years alfalfa - 5 years winter wheat	89.9	61
2 years corn - 2 year winter wheat	125.5	85
3 years alfalfa - 3 years corn 2 years winter wheat	122.6	83
Corn, spring barley, peas, winter wheat	101.3	69

* Simple calculation of grain units:
Grain unit of corn = 1, of winter wheat = 1, of peas = 2; hay yield of alfalfa = 0.5

It is evident from the data that with regard to total yields the corn monoculture resulted in the highest grain yields over the average of 22 years. In this case an opposite tendency can be observed: the higher the ratio of corn in the crop rotation, the higher the total yield of the crop rotation.

Considerations regarding total yields led several large farms in Hungary to change to continuous corn production. Some farms produced corn on the whole area of the farm, on more than ten thousand hectares.

Why did corn monocultures fail?

The majority of Hungarian farms abandoned continuous corn production and returned to crop rotation farming.

It was not so much the spread of plant diseases or the large-scale appearance of pests that caused most farms to give up continuous cropping, but principally the extreme weed infestation of the corn fields. Weed control became more and more difficult in continuous cropping. On some fields Sorghum halepense became widespread. Atrazine-resistant forms of Amaranthus appeared. At first only a few tolerant weeds developed, but recently more and more resistant weeds can be observed from year to year.

Summarizing the theories supporting crop rotations, it can be said that it is difficult to find a general theory, since under different ecological and production conditions different factors /soil fertility, diseases, soil structure, pests, etc./ come to the fore.