INDUSTRIAL TECHNOLOGY OF GROWING AND HARVESTING MAIZE FOR GRAIN

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FOREWORD

This paper is one of a series reviewing various forms of traditional agricultural production and related aspects. Preliminary work on this review was carried out within the scope of activities of the Food and Agriculture Program's Task 2 ("Technological Transformations in Agriculture: Resource Limitations and Environmental Consequences"). One of the goals of this task's activities is the review of various alternative technologies available in the world for the production of major crops and animal products. This paper can be seen as a first step towards this final objective providing information backed by concrete data.

Research work on the topics presented has been carried out partly at IIASA and partly at the All-Union Research Institute of Information and Technical-Economic Research in Agriculture.

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INTRODUCTION

Traditional and modern industrial technology are the two technologies of maize production presently employed in the USSR. The industrial technology provides for a minimum number of soil tillage, combined use of high-yielding and different maturing maize hybrids, increased rates of mineral fertilizer application, effective herbicides which quickly decompose and high-efficiency machinery making it possible to perform all operations in exact compliance with process requirements for optimal time and high quality. A distinguishing feature of industrial technology is that nearly all work aimed at uniform stand free of weed is performed before sowing, thus excluding the necessity of weeding and inter-row cultivation. It is mainly achieved by using highly effective herbicides.

Under traditional cultural methods the technological cycle of soil preparation and fertilizer application consisted of 9 operations, the number of which increased to 11 with the introduction of new industrial technology (See Appendix 1 and 2) due to herbicide liquid preparation and its spraying. However, the use of high- efficiency machinery equipment resulted in a labour input decrease of from 3.55-6.58 to 1.59-4.66 man-hours per ha.

According to flow sheets the total number of operations where industrial technology is employed accounts for between 16-20 in comparison with 23 if maize is grown by traditional cultural methods. For the same yield (60 metric centners/ha) labour expenditure is 3.67-8.03 and 18.31-28.96 m/hrs, respectively; i.e. the industrial technology provides a means for 4-5 times lower labour expenditure. This is mainly achieved through reduced or fully eliminated sowing maintenance operations and the use of high-efficiency machinery.

Under the industrial technology maintenance operations are carried out if soil weediness is high which happens when the amount of pre-sowing herbicide application is not adequate. In this case herbicides are introduced during the vegetation period. Labour input for these operations accounts for 0.72-0.75 man-hours/ha (see Appendix 1). The traditional technology includes 7 sowing maintenance operations and labour input is 2.36-2.62 man-hours/ha.

In Chadyr-Lungsky district (The Moldavian Soviet Socialist Republic) the industrial technology of maize cultivation has been tested since 1977. In 1979 the area to be sown by maiye employing the industrial technology reached 160 thousand ha; the yield being 51.5 centners/ha which exceeds yield of maize grown by the traditional method by 23.8 centners/ha. In 1980 the area under maize grown according to the new technology extended to 1160 thousand ha (over 40% of total aarea under this crop).

During the 11th Five-year period the industrial technology will be introduced to all Soviet Republics engaged in maize growing, to all sown areas where it is possible to use high-efficiency machinery and herbicides.

CROP DISTRIBUTION

While employing the industrial technology much attention is being given to the proper choosing of foregoing crops which are harvested early. The best foregoing crops are: winter and spring cereals, pulses, potatoes, sugarbeets and maize.

SOIL CULTIVATION

Industrial technology allows to reduce number of cultivations from 15-17 to 10-12. After harvesting of foregoing crop stubble paring is performed (7-8 cm. depth) with stubble parers LDG-10, LDG-15, LDG-20 or harrows BD-10 or BDT-7. If the field is contaminated with root sucker weeds, it is necessary to perform second stubble paring (to the depth of 12-14 cm) before plowing. Second stubble paring is performed with share stubble parer PPL-10-25, heavy-duty harrow BDT-7 or other implements. 2.4 D herbicides are used to control growing weeds.

Plowing is performed to the depth of 27-30 cm with a plow with a jointer. Plow PYA-3-35 provides the best quality of plowing if there is much stubble in the field. After plowing blind furrows and back ridges are levelled.

APPLICATION OF FERTILIZER

Dosing and fertilizer ratio are determined with regard for actual fertility of the field (data from agrochemical laboratories are considered) and planned yield in the range of 330-440 kg/ha. Fertilizer distributors 1-RMG-4, RUM-8 and truck spreaders KSA-3 are used for mineral fertilizer application. Spreader-trailers PRT-10, PRT-16, KSO-9 and low-clearance spreader RPN-4 are used for application of organic fertilizer. Normally fertilizer is applied in land plowed in autumn. If mineral fertilizer was not applied in autumn it is applied in spring before or at sowing.

WEED CONTROL

The industrial technology of maize production envisages use of highly effective herbicides (eradican, linuron, agelon, nitazin, atrazin, simazin, zeapos, oleo-gezaprim, dialen, 2.4D amino salt, etc.).

Herbicide solutions for spraying are prepared with the use of special equipment - APLH-12, APR "Temp", water distributors VR-3M equipped with jet agitator, OVT sprayers.

Herbicide solution is applied through continuous blanket spraying. Spraying is performed by horizontal boom sprayers POU, OP-1600-2 or OVT. Sprayers are equipped with track finders to assure uniform spraying.

If eradican is employed, spraying is performed simultaneously with embedding by complex units consisting of disk harrows and K-701 tractor with mounted tank for 2-3 tons of working solution. A boom of POU sprayer is placed in front of the applying implement.

Observance of all agronomic and cultural requirements when applying herbicides assures stand completely free of weeds thus eliminating the necessity of repeated seedlings treatment.

MAIZE PROTECTION FROM PESTS AND DISEASES

Pre-sowing seed treatment with 80% solution of TMDT or combined chemical (phentiuram, tigam) results in good control of diseases and pests affecting germinating seeds. High populations of certain pests make it expedient to apply chemicals controlling those pests at sowing in addition to pre-sowing seed treatment.

During vegetation season chemical treatment may be performed several times which depends on species and population of pests.

PRESOWING CULTIVATION

The industrial technology of maize growing makes soil levelling obligatory. Levelling is performed by drags or VPS levelers at tilth at 45 degrees angle to the direction of plowing. To ensure good quality levelling on heavy silty soil harrowing of fall-plowed land with heavy-duty harrows is carried out before levelling. Highly lumpy fall-plowed land requires repeated harrowing in the direction perpendicular to the direction of first harrowing.

Presowing cultivation involves creation of loose upper layer and compact seedbed at seeding level, which is performed after application of herbicides. The following machinery may be employed--BP-8 spring-tined harrows (equipped with levelling devices), cultivators USMK-5, 4, KPS-4, KPG-4 or inter-row duckfoot cultivators KRN-5.6.

Cultivators for general cultivation also may be used with high degree of efficiency. These cultivators must be equipped with levelling boards of sheet steel and batteries of double spiral-coil land rollers taken from USMK-5.4A beet cultivator.

SOWING

Seed is sown when average daily soil temperature at a depth of 10 cm reaches 10-12 degrees C. It is recommended to sow not less than 3 hybrids which differ in duration of vegetative season and feature high crop capacity, resistance to lodging and reliable good crop in the given location. Seed is incorporated into moist soil layer. Seed-level must not be deeper than 5-7 cm. Deeper seed-bed level is not recommended since the new technology does not envisage harrowing of sown field and inter-row cultivation.

Pneumatic drills SUPN-8, SPCH-6M are employed for sowing. Star-wheeled rollers or toothed disk rollers are used for after-sow rolling.

HARVESTING

It is necessary to begin harvesting maize cobs when grain moisture content does not exceed 40% and harvesting with threshing when moisture content does not exceed 30%. If moisture content is less than 30% harvesting maize in cobs without hushers helps to reduce losses and increase productivity of combine harvesters. Hushing may be performed in production flow lines under stationary conditions.

Harvesting with threshing in the field allows to double labour productivity after harvest and makes for considerable reduction of fuel consumption compared to that if cobs are dried.

Cobs are dried at sites of active ventilation on the basis of heat generators of various types. Grain is dried at KZS driers, also column driers and drum driers may be used.

Taking into account advantages of grain drying over drying of cobs it is advisable as the experience gained by farms in Dnepropetrovskaya and other regions has demonstrated to give preference to the combined technology of harvesting. This method involves harvesting cobs, threshing

them at a threshing-floor and grain drying at cleaning-drying complexes. For this purpose special lines with KZS complexes are established. These lines include a seed pit with a vibration feeder, a corn conveyor, a husher, a thresher and a grain carrier.

ORGANIZATION OF LABOUR

The main producing units are special-purpose permanent groups or teams of operators operating a fixed set of machinery and equipment. A group or a team is responsible for 300-400 ha of maize fields (a seasonal load for SUPN-8 drill or SPCH-6M). A set of machinery required to grow maize in such an area includes: 5 tractors (K-701 or K-700, T-150K, T-74 or DT-75, two MTZ tractors); 1 disk harrow BDT-7; 1 spring-tined harrow BP-8; 1 water- distributor VR-3M (to prepare herbicide solution); 1 sprayer POU or OVT-1A; a set of drags-rollers; 2 combine harvesters KSKU-6 (4 "Khersonets-7") or 4 combine harvesters "Niva" with PPK-4 attachments. A team is provided with transportation means for bringing water and herbicides and for harvesting. Teams have mobile repare shops with necessary kit of spare parts, equipment and tools.

INNOVATIONS IN PRODUCTION

The team of machine-operators led by Hero of Socialist Labour S.M. Parmakly, who is the advocator of the new technology introduction (Chadyr-Lungsky dist., the Moldavian Soviet Socialist Republic), enjoys stable high yield of grain. In 1977-1979 yield of grain (maize) averaged 66.7 centners/ha. Consider, also, that in 1979 the team harvested 72 centners of maize from each of 716 ha.

Team of machine-operators N2 (belonging to Production association for mechanization and electrification of Slobodzeysky district council of collective farms) has achieved a record highest yield of industrially-grown maize. The team harvested 81.5 centners of grain from each of 300 ha, including 102.3 centners from each of 142 ha of irrigated land. Expenditure of labour for production of 1 centner of grain amounted to 0.35 man-hours, cost price being as low as 2.96 roubles.

Overall in Moldavia, 48 specialized teams employing the industrial technology of growing maize for grain achieved yield over 60 centners/ha.

In the RSFSR in 1979 20 thousand ha of maize were cultivated by the industrial method in 30 farms (in Krasnodarsky krai, Rostovskaya reg., the Kabardino-Balkarian Autonomous Soviet Socialist Republic and the North Ossetian Autonomous Soviet Socialist Republic).

In "Khumalag" collective farm (Pravoberezhny dist., the North Ossetian Autonomous Soviet Socialist Republic) 1290 ha of maize grown by the industrial technology yielded 60.5 centners/ha (compared to 34.3 centners/ha by traditional technology). Cost price of 1 centner of grain was cut from 5.38 roubles to 3.28 roubles.

In "Po zavetam Ilyicha" collective farm (Prigorodny dist., the North Ossetian Autonomous Soviet Socialist Republic) the industrial technology resulted in yield increase by 17.9 centners (67.7 centners vs. 48.6 centners) and reduced cost price of 1 centner of grain (4.5 roubles vs 5.7 roubles).

In the Ukraine inn 1979 the industrial technology of growing maize for grain was employed at 39 farms with total area of 20 thousand ha. 2.7 thousand mechanized teams and inter-farm groups of operators were established. In Dnepropetrovskaya region introduction of new technology allowed for reduction of cost price of 1 centner of grain by 1.16 roubles.

In Belgradsky dist. (Odesskaya reg.) labour expenditure per 1 centner of grain of maize grown by the industrial technology amounted to 0.46 man- hours which is 3.7 times less compared to traditional technology. Cost price of 1 centner of grain even with regard to cost of herbicides and special-purpose machinery was in the range of 3.68 roubles to 4.13 roubles, compared to 6.24 roubles.

Introduction of the new technology at 39 Ukranian farms resulted in estimated savings of about 10 thousand of tractor shifts and 500 tons of fuel owing to exclusion of mechanized operations on sowing maintenance, manual weeding and stand density regulation. It also allowed to release a considerable number of workers to be involved in other operations.

APPROXIMATE FLOW SHEET OF GROWING AND HARVESTING MAIZE FOR GRAIN ACCORDING TO THE INDUSTRIAL TECHNOLOGY (YIELD: 60 CENTNERS/HA)*

Nos.	Name of work	Unit composition		Unit output per hour ha	Labour input per ha man-hours
		Tractor vehicle model	Car, truck model, number		
1	2	3	4	5	6
I.	Soil preparation, fertilizers and herbicides application				
1.	Shallow cultivation of field stubble (stubble paring)	T-150K	LDG-10	5.34	0.19
	"	K-701	LDG-20	13.1	0.08
	"	T-150K	PPL-10-25	2.1	0.48
	"	K-701	BDT-7	3.0	0.33
2.	Grinding, mixing and loading of mineral fertilizers onto vehicles	MTZ-80	PF-0.75	15.0t	0.07
		MTZ-80	ISU-4	4.0t	1.0
3.	Mineral fertilizers transportation	ZIL-MMZ--554	-	48 t-km	0.15
4.	Mineral fertilizers application	ZIL-MMZ--554	KSA-3	4.6	0.22
		MTZ-80	I-RMG-4	4.0	0.25
5.	Fall-plowing	K-701	PN-8-35	2.31	0.43
		K-701	PTK-9-35	2.39	0.42
		PT-75	PYA-3-35	0.5	2.00
		T-150K	PLP-6-35	0.9	1.10
6.	Levelling of fall-plowed land	K-701	S-18U+ drag(9)	11.0	0.09
		T-74	S-11U+ +SHB-2.5	10.0	0.1
7.	Water transportation (supply) for herbicide solution preparation (herbicide: eradican)	GAZ-53A	AC-4.2-53A	26.6 t-km	0.08
8.	Herbicide solution preparation	MTZ-80	VR-ZM	5	0.2
9.	Solution haulage	T-40	VR-ZM	5	0.2

* Centner is a unit used in the USSR and is equivalent to 220.46 pounds.

1	2	3	4	5	6
10.	Application and incorporation of herbicides	K-701	BDT-7+POU	4.5	0.20
11.	Presowing cultivation	T-150K	BP-8	5.0	0.2
		2MTZ-80	2USMK-5.4	5.0	0.2
		T-150K	2KPS-4	5.0	0.2
II.	Sowing preparation and sowing				
12.	Loading of seeds from sacks to seed tanks	Electric engine	LT-10	2.5t	0.01
13.	Seeds transportation and drills filling	GAZ-53A	UZSA-40	23.3t-km	0.01
14.	Sowing	MTZ-80	SUPN-8	3.8	0.26
		T-74	2SPCH-6M	5.0	0.4
15.	Rolling	MTZ-80	SP-11+3KKSH--6(2)	12	0.08
III.	Sowing maintenance (if necessary)				
16.	Water transportation (supply) for herbicide solution preparation (oleo-gezaprim, zeapos-10 or 2.4-D)	GAZ-53A	AC-4.2-53A	26.6 t-km	0.13
17.	Herbicide solution preparation	MTZ-80	VR-ZM	10 t	0.21
17a.	Solution haulage	MTZ-80	VR-ZM	10 t	0.21
18.	Application of herbicide solution of zeapos-10 or oleo-gezaprim at the stage of 1-2 leaves of monocotyledonus weed	MTZ-80	POU	5.0	0.20
	or 2.4D at the stage of maize having 3-5 leaves	MTZ-80	POU	6	0.17
IV.	Maize harvesting for grain				
19.	Maize cobs harvesting	T-150K	KOP-1.4V Self-propelled	0.5	2.0
			KSKU-6	1.5	0.7
20.	Cobs harvesting with threshing		Self-propelled "Niva" + +PPK-4	1.0	1.0

LABOUR INPUT FOR GROWING AND HARVESTING MAIZE FOR GRAIN ACCORDING TO THE TRADITIONAL TECHNOLOGY (YIELD: 60 CENTNERS/HA)

Nos.	Name of work	Labour input per ha, man-hours
1	2	3
	Fertilizer application and soil cultivation	
1.	Shallow cultivation of field stubble (stubble paring)	0.26
2.	Manure mixing with mineral fertilizers	0.20
3.	Manure transportation and distribution	0.77
4.	Fall-plowing	1-1.43
5.	Double snow retention	0-45
6.	Early spring harrowing	0.11
7.	First cultivation	0.26-1.50
8.	Second cultivation (presowing)	0.26
9.	Soil rolling	0.12
	Sowing and plant maintenance by 6-row machine (12-row machines)	
1.	Loading and transportation of seeds, fertilizers and pesticides	0.10(0.10)
2.	Checkrow drilling with fertilizers and pesticides application	0.77-0.83 (0.48-0.56)
3.	Pre-emergence harrowing	0.11(0.11)
4.	Post-emergence harrowing	0.13(0.13)
5.	Water haulage (supply) for herbicide solution preparation	0.13(0.13)
6.	First inter-row cultivation:	
	length-wise with herbicide application	0.77(9.45)
	length-wise without herbicide application	0.70(0.42)
	cross-wise	0.70(0.42)

1	2	3
7.	Mineral fertilizers loading	0.01(0.01)
8.	Mineral fertilizers transportation up to 7 km	0.03(0.03)
9.	Second inter-row cultivation:	
	length-wise with mineral fertilizers dressing	0.87(0.53)
	length-wise with aqua ammonia dressing	1.00(0.62)
	cross-wise	0.70(0.39)
	Cobs harvesting with hushing at the threshing floor	
1.	Combine harvesting	2.00-5.00
2.	Cobs delivery to the threshing-floor	2.00
3.	Silage mass transportation	8.40
	Harvesting with cobs threshing for grain and stem shopping	
1.	Combine harvesting	2.50
2.	Grain driving	3.30
3.	Grain preservation	3.30
4.	Silage mass transportation	8.40
	Cobs harvesting with combine cleaning	
1.	Combine harvesting	2.50
2.	Cobs driving to the threshing floor	2.50
3.	Silage mass transportation	8.50