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TECHNOLOGICAL FACTORS OF CEREAL, POTATO AND COTTON PRODUCTION

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PREFACE

The focus of this paper is on the revision of the technologies presently used for the production of grain, potatoes, and cotton. Its main purpose is to provide an overview of the diversity of the technologies used. Preliminary work on this review was carried out within the scope of the activities of Task 2 ("Technological Trasformations in Agriculture: Resource Limitations and Environmental Consequences") of the Food and Agriculture Program. The ultimate goal of this task's activities is the establishment of a data base on the 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 high quality information backed by concrete data. However, it was not feasible to structure the information in such a way as to allow full integration with the planned data base during the first phase of research activities.

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

This review provides a general analysis of the principal technological factors of production of the main agricultural crops, such as grain crops, potato and cotton. The above factors imply selection work, seed breeding, fertilizers, irrigation, pest and disease control, and the mechanization of production processes. The above data are basic to the quantitative determination of the agricultural technology status and further selection of relevant information materials to carry out a systematic analysis of factors affecting the productivity of agricultural crops. Correlations revealed will result in the determination of each factor's share in the total volume of the yield increase with further multifactorial modeling of agricultural technological processes. The development of such models would provide the possibility of obtaining comparable results in various countries, thus optimizing the use of the technological production factors with consideration being given to economic and climatic conditions of agricultural production in any particular country.

GRAIN CROPS

Selection and Seed Breeding

Under conditions of the further intensification of grain crop production, crop variety is becoming an important factor of yield increase; the characteristics of a crop variety determine the possibilities of modern agricultural technology use. In the USSR the increase of the yield of grain crops, and first and foremost of winter wheat, is closely related to the substitution of dwarfish, lodging resistant, high yielding (up to 90 m.c. per ha) varieties with a good response to fertilizers and suitable for mechanized harvesting, and for traditional high stemmed low yielding varieties. Thus, in the Ukraine the introduction of such "intensive-type" varieties as Mironovskaya 808, Bezostaya I, etc., resulted in the increase of the average yield from 17.5 m.c. per hectare in 1960 to 35.2 m.c. in 1978. In Byelorussia the introduction of the Mironovskaya 808 variety resulted in the increase of winter wheat yield up to 29.4 m.c. per hectare (before the introduction of this variety the average winter wheat yield was 13.7 m.c. per hectare).

A number of "intensive-type" rye and barley varieties have been developed. In Byelorussia, due to widespread use of the tetraploid winter rye variety Belta in 1978, 29.4 m.c. of grain per hectare were obtained.

In the United States a number of valuable "intensive-type" winter wheat varieties, such as Blueboy, Yorkstar, Dalcrop, Arthur 71, Homestir, as well as spring wheat, such as Red River, World Seeds series, etc., have been developed. The introduction of the Reines and Newgeines varieties resulted in a 30 per cent increase in net winter wheat productivity in the United States. The increase in grain production in the United States depends to a considerable extent on the use of heterosis hybrids of corn and sorghum. Due to an almost complete substitution of these hybrids for "wind-and-insect" pollinating varieties, the average yield of corn and sorghum increased up to 63.5 and 34.6 m.c. per hectare correspondingly in 1978.

A similar pattern is observed in Western Europe. Intensive technology of grain crop cultivation is effective only when corresponding varieties are used. Further improvement of the technology depends on the introduction of new, better varieties.

In Great Britain for instance, the complete replacement of wheat varieties used in production served as a background for the further increase of the wheat yield. A list of varieties recommended for 1979 includes 16 winter wheat and 5 spring wheat varieties, with the oldest one-- Maris Huntsman--having been introduced in 1972.

In Western European countries a number of wheat varieties used for animal feeding have been developed and introduced (such as Maris Huntsman, Clement, Benio, etc.); they are characterized by a high yielding capacity (70-80 m.c. per hectare) but poor flour-grinding and baking qualities. At present, selection and breeding work with grain crops in European countries is aimed at the improvement of grain quality and the increase of yield stability rather than at yield increase.

Thus, the replacement of old varieties is the most important link in the technological process of grain production in various parts of the world.

Recently, variety replacement's contribution to the grain crop yield has been: 27-37% in the United States; 19-51% in West Germany (depending on the crop); and about 30% in Great Britain, the G.D.R., and Hungary.

The efficiency of variety crop replacement is closely related to the seed breeding system. Poor seed quality results in 10 to 20 per cent yield loss. Besides, a good seed breeding system provides possibilities for the rapid, large-scale introduction of high yielding varieties and hybrids.

Since the level of seed breeding is still hindering the intensification of grain crop farming in many countries, all the leading grain producers pay much attention to the improvement of the seed breeding system.

At present, large-scale commercial seed breeding is well developed in the United States. Seed breeding is to a considerable extent separated from commercial grain production. Some 500 private seed breeding companies are engaged in the seed breeding of grain and leguminous crops. Big companies have considerable areas planted with the above crops. But a considerable share of the seeds is produced by farmers under contracts.

Seed separation, drying, size grading, treatment, and sometimes the innoculation and pelleting of seeds is done at specialized plants belonging to seed breeding companies. All the seeds produced in the system of commercial seed breeding and supplied to the market are labelled with complete and reliable quality information. The labels required are legally binding, and judicial sanctions are applied against infringers. However, despite the fact that there is a network of highly specialized seed breeding units in the United States providing high quality seed material, non-certified seeds are still used on a considerable part of the area under grain crop cultivation, except for corn and sorghum.

The European system of commercial seed breeding is rich in tradition, this is especially true for Sweden. In this country seed breeding activities are headed by the Swedish Seed Breeding Association, established in 1894. The Association supervises the activity of various joint-stock companies, the Union of Swedish Agriculturists, private firms, etc. Sweden produces seed material not only for its own needs but for export as well.

In Great Britain the seed breeding industry meets 92% of its requirements in wheat, 68% in barley, and 75% in other agricultural crops.

The quality of the seed material is guaranteed, and its cost is lower than farmers' expenditures for independent production, storage, and pre-sowing treatment of seeds. Renewed seed material produces yields some 15-20% higher than that obtained from seeds of multiple reproductions.

In France the seed breeding industry is less concentrated and seed material is produced mainly on small specialized farms (42,000 farms). These farms are a part of large seed-breeding associations, companies, and cooperations, the total number of which exceeds 400. In France the specialized seed-breeding industry can meet nearly all the requirements of the country, but considerable areas are still sown with seeds produced on private farms. However, the use of certified seeds increases constantly; on the average the share of certified seeds in the seed material used in 1978 made up 50% as compared to 33% in 1972. Corn seeds used for sowing are now 100% certified.

The use of certified seeds made it possible to decrease the average sowing rate of grain crops in France by 11.2%. (from 151 kg per hectare in 1971 to 135 kg per hectare in 1977-78).

In the USSR the system of commercial seed breeding is undergoing a significant change. Considerable experience in the practice of seed breeding industrialization has already been gained in Byelorussia, the Ukraine, Moldavia, the Urals, and in Kirgizia. The point is that seed production is to be concentrated on specialized seed breeding farms equipped with the machinery necessary for handling and treating the seeds. The introduction of the new system resulted in 83% of seed material meeting first and second classes of sowing standards (average for the USSR). The share of first and second class seed material in the Ukraine, Byelorussia, Lithuania, Moldavia, and Kirgizia was 95 to 100 per cent. Further industrialization of seed breeding will result in an increase of the grain crop gross yield in the USSR.

Fertilizers

In the USSR fertilizer application to small grains increased by 89% during the period 1970-78 and made up 51 kg a.i. per hectare; the average level of fertilizer application to wheat in 1978 amounted to 42 kg a.i. per hectare. The reason for relatively low fertilizer application rates lies in the limited supply of fertilizer materials as well as in the fact that large areas planted to grain crops are located in the low rainfall zones where fertilizer application is not actually worthwhile. In all the republics except the Russian Federation (with large areas planted to grain crops in the arid Volga basin zone), Kazakhstan and the Ukraine, the average application rates exceed 100 kg a.i. per hectare. In the non-chernozem zone, the fertilizer application rate for small grains is on the average 124 kg a.i. per hectare, in Byelorussia 235, in the Baltic Sea region 170 to 251 kg a.i. per hectare. The increase in fertilizer use resulted in the growth of grain yields. Byelorussia serves as an example of efficient fertilizer use; here an increase of average grain yield from 10 to 25 m.c. per hectare was achieved during the period 1968-76. The efficiency of fertilizer application in Byelorussia was 4.8-8.1 kg grain per 1 kg NPK.

In the USSR the fertilizer application rate for corn is on the average 180 kg a.i. per hectare, with 175 kg in the Ukraine, 200 kg in Byelorussia, and 324 kg in Kazakhstan.

In the United States considerable growth of fertilizer application rates took place in the sixties. Starting from 1972 the application rates for wheat stabilized, with insignificant fluctuations by years. In 1964 the application rates for wheat were 81 kg a.i. per hectare, in 1970, 118 kg; in 1972, 134 kg; in 1978, 135 kg. The highest application rates for wheat are in the Corn Belt (186 kg a.i. per hectare); but the areas under this crop are not large. In the main zones of spring wheat cultivation (Montana, North Dakota, and to some extent South Dakota) the application rates are not high, 60 to 80 kg a.i. per hectare, mainly because of insufficient rainfall.

In Oklahoma and Texas where winter wheat is grown, the rates are higher, 112 to 189 kg a.i. per hectare because of the higher moisture supply, or irrigation. In the mountains and in the Pacific Ocean coastal area, the application rates are rather high (90 to 159 kg a.i. per hectare), since wheat is cultivated there under irrigation. Since a considerable part of wheat areas are located in the zones with irregular and insufficient rainfall, the average wheat yield in the United States is not high; during the last decade it amounted to 18-22 m.c. per hectare.

About half of the fertilizers produced in the United States are applied to corn. In 95% of the area planted to corn, 1 to 3 fertilizer formulations are used. In 1978 the average application rates were 307 kg a.i. per hectare for the whole country, with 332 kg per hectare applied in the Corn Belt. Nitrogen rates are especially high—150 to 180 kg. Favorable climatic conditions (the annual precipitation rate is 825 to 1150 mm.), and the use of high yielding hybrids in the Corn Belt provide for a good response of corn to high fertilizer application rates; the average corn yield for the United States amounts to 50 m.c. per hectare, in some years as much as 60 m.c.

In West Europe fertilizers are most efficiently used. Application rates and grain yield are higher there than in any other part of the world.

In Great Britain the increase of nitrogen application rates from 40 to 120 kg per hectare during the 30-year period provided for a 30% yield increment over the same period. In 1978 the fertilizer application to spring wheat plantations amounted to 138 kg a.i., to winter wheat 206 kg, with nitrogen rates being 87 and 125 kg per hectare correspondingly. Sufficient amount of rainfall and mild climate provide for a highly efficient fertilizer use. Adequate soil treatment and the use of the "intensive-type" varieties contribute to the efficient use of fertilizers, especially of nitrogen. Wheat yields during the last decade averaged 40 m.c. per hectare, in some years amounting to 49 m.c. But yearly fluctuations are still rather high, the differing up to 7 m.c.

During the last 10-15 years, grain regions have become the biggest fertilizer consumers. Fertilizer application rates on 26% of agricultural lands in France exceed 200 kg a.i. per hectare (as compared to the average 143 kg for the country). These areas are main grain producers.

A high level of fertilizer consumption is observed in West Germany. The reason for this is not only the high efficiency of fertilizer application, but a very intensive grain crop as well. The area Schleswig- Holstein serves as an example of an intensive grain crop cultivation; during the last decade, the winter wheat yield averaged 50-58 m.c. per hectare. This high yield was obtained with annual applications of 200 kg per hectare of nitrogen, 70 to 100 kg of phosphorus, and up to 180 kg of potassium.

Analysis of the relevant factors shows that the efficiency of high application rates depends on the amount of rainfall. But even in West Germany, with its annual precipitation rate of 600-700 mm, yearly yield fluctuations depending on weather conditions remain one of the main problems to be solved.

Irrigation

In the USSR land reclamation serves the main purpose of agriculture--i.e. grain production. Grain crops under irrigation in 1978 covered an area of 3211 hectares, which makes up 24.8% of the total irrigated area, or 2.49% of the total area planted to grain crops. The main share of irrigated grain crops is in the Russian Federation (928,200 hectares), in the Ukraine 473,000, in Kazakhstan 490,000, Uzbekistan 394,700, and Azerbaidjan 327,300 hectares. On the irrigated lands the main crop is winter wheat. In 1978 it was planted on an area of 1,166,800 hectares, which is 5% of the total area planted to winter wheat and 9% of the total area under irrigation.

Considerable irrigated areas are planted to corn grown for grain; 490,900 hectares, or 19.6% of the total area planted to corn, or 3.79% of the total irrigated area. The gross yield of grain crops was as much as 10,532,800 tons in 1978, including 3,887,100 tons of winter wheat and 2,485,300 tons of corn. In 1978 the grain crop yield on irrigated lands averaged 32.8 m.c. per hectare; winter wheat, 33.3; corn, 50.5 m.c. per hectare. On non-irrigated lands the figures were 18.5, 29.8, 35.2 m.c. per hectare respectively.

The establishment of irrigated regions of guaranteed grain production in the arid zones of the USSR made it possible to increase grain yields considerably. Yields of 40-45 m.c. per hectare are common on irrigated lands. Even in the dry year of 1975, 45.3 m.c. per hectare were harvested in the Nizhegorodsk district, and the Crimean region; sovkhoz "Volzhsky, the Saratov region, yielded 47.9 m.c. per hectare.

In the main arid zones of the USSR (Ukraine, North Caucasus, Volga basin), areas planted to grain crops under irrigation increased 2.5 times; grain production increased 3.6 times. In the North Caucasus more than 500,000 hectares of a total of 1,460,000 hectares of irrigated land were planted to grain crops; in the Ukraine, grain crops under irrigation occupied an area of 480,000 hectares in 1978, with the total area under irrigation being 1,800,000 hectares.

All the rice produced in the Russian Federation comes from reclaimed lands; 25% corn, 70% vegetables, 15% hay are produced on reclaimed lands as well.

In 1978 in the Ukraine, the yield of grain crops under irrigation was 43.2 m.c. per hectare with 44 m.c. per hectare of winter wheat; in Moldavia, 46 m.c. per hectare of winter wheat were obtained on an area of 19,500 hectares of irrigated lands. In Crimea, 55 to 58% of agricultural produce, including 34 to 35% of grain, are obtained from irrigated lands constituting 24% of the total arable land.

In the North Crimea canal region, the grain crop yield averaged 49.7 m.c./ha, the grain crop area being 87,300 hectares. The best farms produce 65-70 m.c./ha of winter wheat, 71 and even up to 100 to 136 m.c./ha of corn.

In 1979 high yields of agricultural crops were obtained on irrigated lands in a number of regions. State and collective farms of the Izobilnensky region, Stavropol territory, produced 45.2 m.c./ha of winter wheat on an area of 5,900 hectares; Izobilnensky osvhoz of the same region produced 48.9 m.c./ha. In the

Kirov collective farm of the Byelozersk region, Kherson, the grain crop yield averaged 67.7 m.c. per hectare (excluding corn for grain).

In Bulgaria some 24% of irrigated land is planted to wheat, 6% to barley, some 20% to corn, 1.9% to rice. Of the total arable land, 15 to 16% of wheat, 18-19% of corn, and 100% of rice are cultivated under irrigation.

In 1980 grain crops under irrigation will occupy 22% of the total arable land.

Wheat yield was found to increase by 25% under irrigation. The gain is 6.6 m.c./ha of grain per each additional 1000 cu.m/ha of irrigation water. Such yield increments can be obtained at 1 to 3 waterings at a rate of 1600 cu.m/ ha.

High yields of agricultural crops are produced under irrigation. Thus, "Trakiiskoye pole" cooperative in Pezardzhik produced 31.7 m.c. in the period 1961-65, and 43.9 m.c. in 1966-70; wheat area under irrigation is 1200 hectares. In Bulgaria special attention is given to corn under irrigation. It ranks second after vegetable crops.

Irrigation results in an average yield increment of 35.3 m.c. (87%), with minimum and maximum increments being 17.5 and 56.9 m.c. respectively. Each 1000 cu.m of irrigation water produces an additional 17.4 m.c. of grain per hectare. Corn yield under irrigation is generally 24.6 to 52.4 m.c./ha higher than on non-irrigated lands. This is achieved at optimum fertilizer application, and 2 to 5 waterings at a rate of 1200 to 4840 cu.m/ha.

In view of the increased grain production in the G.D.R. (gross yield increased to 10.5 million tons in the period 1976-80, with the average yield increasing by 30%) and the cultivation of high yielding varieties with high requirements of water, much attention is given to the possibilities of irrigating grain crops. Even in the period 1975 and 1976, the best farms produced 45 to 55 m.c./ha of wheat on sandy soils and 60 to 70 m.c. on chernozems under irrigation. In Munchenberg in 1972-1976, 80-89 m.c./ha of Kavkaz and Altsedo winter wheat varieties and 55-73 m.c./ha of Elgin and Triumph spring barley varieties were produced. Grain crops occupy 20-30% of the total irrigated area, and the percentage is going to increase in the future.

A constant increase of grain crop yield under irrigation has recently been observed. Irrigation almost doubled winter wheat yield during the periods 1967-1970 and 1971-1975 (the yield increased from 2.9 to 5.6 m.c. per hectare).

It is planned to increase the yield of winter wheat up to 50 m.c. on sandy soils and up to 60 m.c. on loams and loesses by combinations of irrigation and other relevant factors.

The irrigation of grain crops in Czechoslovakia started after 1967. Of the total irrigated area, 38-40% is occupied by grain crops, including 14-18% under corn for grain. The greatest share is in South Moravia - 50%.

In 1973-75 irrigated lands produced 73.7 m.c. per hectare of winter wheat at an irrigation rate of about 1000 cu.m per hectare. The effective use of irrigated lands makes it possible to get 90-100 m.c. of corn grain and 70-80 m.c. of wheat.

In France wheat, corn and sorghum are irrigated. Of the total area planted to wheat, 12 to 32% are irrigated; the figures for corn and sorghum are 5 to 67%.

In France in 1976, 2.7 million hectares were planted to corn, with 2/3 grown for grain and 1/3 for silage. Corn ranks second together with barley after wheat. The area planted to corn increased from 300,000 hectares to 1,000,000 during the period 1948-68, and up to 2,000,000 during the period 1968-73. The average corn yield increased from 15 to 55 m.c. per hectare during the period 1950-73.

The main corn area is in the South-West (in 1975, 774,000 hectares were planted to corn, or 37.5%), as well as in the central and eastern regions of the country. With the introduction of early corn varieties, it has moved to the Paris region (28% of the total arable land in 1975) and to Picardie. These regions have 80% of their area planted to corn.

Some 300,000 hectares of the corn-growing area is irrigated. In 1970 in France, 11% of farms had irrigation equipment, and 28% of 138,000 farms grow corn. In 18 departments, 794,000 hectares were under corn in 1972-73 (42% of the total), with the irrigated land being 102,600 hectares (13% of the corn area).

In France irrigation of corn normally yields 20 to 25 m.c. per ha. extra grain, the figure being considerably higher in dry years.

Great attention is given to the production of sowing grain; in 1975, 40% of corn sowing grain went for export. France ranks second after the United States in the export of sowing corn grain. The irrigation of corn seed breeding areas is considered obligatory. In 1980, 12,000 hectares of the seed breeding area will be irrigated.

In Italy the irrigated area makes up 3.4 million hectares; the main crop under irrigation there is corn. It occupies more than 410,000 hectares. On the irrigated lands, mainly hybrids are cultivated. Corn yield under irrigation averages 67-68 m.c. per hectare, i.e. 21-25 m.c. higher than under dry farming conditions. Corn yield under irrigation grows constantly; during the period 1961-73 an increase from 61.5 to 68.3 m.c. was observed. Nothing similar was observed under dry farming conditions.

In the United States, the main grain producing regions have a favourable amount of rainfall; they can manage there without irrigation. The greatest percentage of irrigated lands under grain crops is in the west (arid and semi-arid zones), with the annual rainfall 300-500 mm. In the United States the main trend in the use of irrigated lands in arid and semi-arid zones is the expansion of lands planted to grain crops. Thus, during the 20-year period 1939-59 the area under grain crops increased 2.5 times.

In 1974 grain crops in the United States occupied about 40% of the total irrigated area, including corn for grain; 13.7%, sorghum for grain, 6.2%; wheat, 8%; barley, 3.3%; rice, 6.3%. On irrigated lands 9.1% of corn for grain is cultivated; sorghum, 19.7%; wheat, 5.2%; barley, 18.3%; rice, 100%. In 1974 irrigated lands provided 10% of the gross yield of wheat, and about 25% of the gross yield of barley and sorghum. The share of irrigated grain crops in some states is considerable. Thus in Utah, the 25% of wheat-planted area which is irrigated provides half of the gross wheat yield. In Texas, New Mexico, California, and Idaho, the irrigated 19-34% of wheat area provides 21-61% of gross grain yield.

Reclamation Bureau irrigation systems covered 29% of grain crops (3.7 million hectares). The yields were: corn, 69 m.c.; wheat, 55 m.c.; rice, 65 m.c.; sorghum, 49 m.c. per hectare.

In the United States corn for grain has a considerable share on irrigated lands. In 1969, 1,316,000 hectares of corn were under irrigation, i.e. 6.4% of the total area planted to corn; in 1974 it increased to 223,800 hectares, or 9.1%. The corn share increased from 8.3 to 13.7%.

On average, irrigation results in 20 m.c. increment, and in some states (Nebraska, Colorado) it goes up to 45 m.c. Corn yield under dry farming averaged 43.4 m.c. in 1974, while corn yield under irrigation averaged 64.0 m.c. per hectare.

Corn areas are expanding mainly in the Great Plains, and especially in Nebraska. In Nebraska there are 1,183,000 hectares planted to corn under irrigation, i.e. half of the total area of irrigated corn in the United States.

The irrigated corn areas are increased due to the use of ground waters and sprinklers of circular action, with large operating width. During the period 1972-75 irrigated corn area enjoyed the greatest increase: 84.6%. On 88.9% of irrigated lands, the sprinklers of circular action with large operating width were used.

Many Nebraska farms harvest a yield of 90 m.c. per hectare and more.

Pre-sow ammonia application at the rate of 168 kg N per hectare, NPK application at the time of sowing at the rate of 224 kg per ha, and regular irrigation contribute to the high yields obtained.

THE MECHANIZATION OF MAJOR GRAIN PRODUCTION PROCESSES

The development of the mechanization of grain production in the U.S.S.R. is carried out using the machinery involved in the complex mechanization system of 1976-1980 as a basis. The machines meet the requirements of scientific and technical progress and benefit from the advance experience gained so far. The system envisages the use of various integrated machine units intended for different zones of the country.

In the USSR tillage of the soil for cereals is conducted by general-purpose tillage machines. But in semi-arid areas, particularly in the Eastern part of the country, chisel ploughs are used. Most of the area sown to grain crops is cultivated by the PN-4-40 four gear tractor carried plough for deep ploughing, the KPG-2 weeder for deep fertilizer application, stubble breakers and disc harrows.

The PTK-9-35 nine gear semi-mounted plough with an operating width of 3.15 m, a speed of 8-12 kilometers per hour and an all over capacity of 2.89 ha/h.

When cultivating corn fields slightly affected by weeds, pre-ploughing stubble breaking takes place. The operation is carried out by the LDG-10, LDG-15 stubble breakers and the BD-10 and BDT-7 harrows at a depth of 7-8 cms. Stubble breaking in fields affected by offset weeds is performed twice; firstly by disc implements at a depth of 6-8 cms, and then by the PPL 10 25 gear stubble breaker at a depth of 12-14 cms.

The ploughing of land in the fall down to corn is carried out by ploughs with coulters, PN-8-35, PJA-3-35 at a depth of the Ap. In the spring, operations start with soil leveling using buck rakes. The output capacity of the K-700, T-150 tractor units and 5 or 8 buck rakes amounts to 9 and 14 ha/h net work respectively.

The BP-8 spring-tooth harrow or combined soil tillage implements are used for pre-sowing loosening of the earth, soil leveling and lump breaking.

In the USA and Western Europe soil tillage is carried out mainly by share ploughs without coulters. Mounted, semi-mounted and trailer reversible ploughs are used to cultivate land at a depth of 25-30 cms. The major soil tilling machine in the USA is a six-gear plough.

Disc ploughs with a cutting width of 6 meters and over are also used. In some states of the USA mounted and trailer chisel vibration ploughs are widely used and these provide deep and uniform soil loosening without destroying the structure.

Minimum and zero soil tillage methods have been developed recently in the USA, Canada and other countries mainly in Europe for zones with low humidification and subject to water and wind erosion. In the USA the transition to nonmoldboard soil cultivation has resulted in a drastic decrease of mold board ploughs. (In 1958 they numbered 2990 thous. units and by 1978 only 2686 thous. units). There has been a corresponding increase of nonmoldboard ploughs (disc and chisel). In 1978 the number of nonmoldboard tractors amounted to 300 thous. In Canada nonmoldboard ploughing is practiced everywhere.

In the USSR the minimization of soil tillage is achieved by the reduction in number of and depth of tilling, and the combination of different production operations. The PVK-3 unit is designed for example, for presowing soil tillage with a simultaneous loosening and cultivation, micro relief leveling and field surface rolling. The unit capacity is 1.5-2 ha/h net work. The maximum operating speed is 10 km./h.

In the steppe and forest steppe areas of Kazakhstan, Western Siberia, the Volga area and the Ukraine, nonmoldboard soil tillage is applied as a method which has been put forward by the soil protection program.

The application of mineral fertilizers to grain crops in the USSR is performed simultaneously with the sowing. The combines used for harvesting are intended to distribute fertilizers and sow grain. 3CA-40 truck loaders deliver fertilizers to the fields and load fertilizers and grain fertilizer sowers.

The spring topdressing of winter crops in the steppe and forest steppe areas is done by aircraft.

Fertilizer application to corn together with herbicides is accomplished mainly in the autumn during ploughing and (seldom) in the spring. The IRMG-4 distributors are designed for the main application of fertilizers.

The application of herbicides in the USSR is especially common in corn fields where industrial production methods are practiced. The APN-12 units, with a power capacity of 14 cwts, a load capacity in the main tank of 3200 l. and in the auxiliary tank of 550 l., are used for the preparation of herbicidal sprays. The P 04 unit or OVT-IV sprayer are equipped with the PO4 bar and integrated units, including the tractor-mounted sprayer as well as an implement for the incorporation of herbicides in the soil. When using the PO4 unit or OVT-IV sprayer, the incorporation of herbicides is accomplished by the VDT-7 disc harrows.

In our country sowing is carried out by the general purpose sower S3-3.6 which is intended for fertilizer drilling, the S3V-3.6 for the sowing of seeds with a narrow row space. Both sowers have an operating width of 3.6 m and a maximum speed of 12 km/h. Several sowers are connected to form seeding units with a maximum operating width (20 m). The application of anti-erosion sowers is on the increase. They are S3S-2.1. with an operating capacity of 1 ha/h.

A new family of sower modifications have been turned out on the basis of the S3-3.6. One of these is the S3P-3.6 sower equipped with the V-type metal press rollers and a bar to form a line of sowers connected as a unit with a wide operating width.

New sowers with a wide operating width are being developed. Some of them are intended for grain sowing and fertilizer distribution, and have an operating width of 15m and speed of 9-10 km/h.

The S4PN-8 general purpose mounted sower has a pneumatic sowing attachment and is produced by our industry. It's purpose is to carry out the precise sowing of corn seeds and other crops and has a working span of 5.6 m, and a maximum operating speed of 12 km/h and a working capacity of 6.7 ha/h net work. In the steppe areas seeds are sown at a depth of 5 to 7 cm. After sowing the soil is packed and rolled by rubber ring rollers.

In many countries mounted grain drills with spacious seeder hoppers and fertilizer hoppers are widely used.

In the USA the MF-30 drills are applied for row grain seeding. They develop a speed of 10-12 km/h and have a working span of 2.3 m; 2.6 m and 3.5 m.

In the USA the "International Harvester" company turns out different modifications of drills with a working span of 2.3 m and 3.7 m and equipped with a spaceous bin of 270-300 1/m.

In Canada drills intended for corn, and precise sowing and which are provided with pneumatic seeder attachments and bins for the application of mineral fertilizers and herbicide micropellets are widely used (Cycle 500).

Great Britain widely utilizes "Ronsomes" drills. They have general-purpose modifications with a working span varying from 2.5-3.0 m to 6 m. (grain modification)

Ireland manufactures "Uni Drills" drills with a higher speed and a working span of 2.5 m. They are designed for direct seed sowing on old pastures and in stubble.

The FRG firm "Trester" turns out the "Chassia" grain drill (15 modifications) with a working span of 2-3.3 m (15-25 rows). Modifications with the working span of 6 m, and a bin capacity of 160 1/m are manufactured and equipped with coil type seeder attachments. The "Amazonen" firm turns out mounted grain drills with coil-pivot attachments having a working span of 2-4 m and a bin capacity of 50-110 1/m.

Grain harvesting in the USSR is conducted by grain combine harvesters equipped with a set of various attachments, mechanisms, equipment and machines intended for the harvesting and handling of grain, chaff and straw.

Harvesting machine sets differ with the zone of their application. Direct or separate harvesting is carried out with an eye to this fact. The Soviet industry manufactures high capacity self-propelled grain combine harvesters such as "Niva" "Sibiryak", and "Kolos" with engines developing 100-150 h.p. The thrasher output capacity in the first two harvesters is 5-6 kg/sec and that of the latter 6-8 kg/sec. The thrasher width in the three harvesters is 1200 mm. Reapers mounted on self-propelled harvesters have a working span of 4.1-7 m.

Nowadays harvesters with an engine of 220 h.p. and over and a nominal output capacity of 12 kg/sec. (wheat harvesting) are used.

The SCHVC-6 trailer windrower with a working span of 3.6 m, a maximum operating speed of 9 km/h, and an output capacity of 3.2 ha/h of net work are intended for the separate harvesting of grain and groat crops.

The SCHN-6 mounted windrower has a working span of 6 m, an operating speed of 9 km/h, an output capacity of 4.3 ha/h. The reversible windrower SCHVR-10 has a working span of 10 m.

Corn harvesting is performed by the 6-row self-propelled corn combine "Khersonets" or grain combine "Niva" equipped with a PPK-4 attachment.

Continuous grain harvesting is conducted by grain combines used together with machines and attachments for straw harvesting. In the USSR the PUN-5 and PUN-6 general purpose choppers which operate in a set together with the SK-5 "Niva" and the SK "Kolos" combines, are designed for straw harvesting and the PUV-0.6 attachment, mounted on the combine instead of a stacker, is intended for straw windrowing.

The windrow is picked up by the FN-1.2 feeder with the PVF-1.4 pnematic pick up. The PV-6.0 packer-pick-up with a working span of 1.8 m is intended for straw windrow picking, packing and loading in tractor trailers.

The GDR industry turns out the high capacity F-516 grain combine with an engine of 220 h.p. Its maximum operating speed is 8 km/h (12 km/h when thrashing windrows). The combine nominal throughput capacity is 12 kg/sec of wheat, with thrashing losses of grain of not more than 1.5%, and the rate of injured grain less than 0.5%. The combine shows a high productivity and quality of grain crop harvesting, the yield being equal to 80-100 cwt/ha.

Sweden and Finland are testing a new harvesting program aimed at harvesting the entire biological yield of grain and other crops. The program envisages crop harvesting and chopping in unfavorable weather conditions and the whole process in stationary conditions.

In the USA the New Holland firm manufactures the 8080 combine with a Diesel engine of 170 h.p. on a wide scale and has started turning out the TR-7 Rotor combine with two parallel thrashing drums equipped with an engine of 145 or 167 h.p. The latter can be used with 6 reapers having a working span of 3.3-6.7 m, windrow pick-ups with a working span of 3.3-5.2 m.

In Canada separate harvesting is very common. Trailer and self-propelled reapers are widely employed in separate mowing. The combine harvesters are equipped with detachable reapers, having a different operating span.

Post harvesting grain processing in the USSR includes such operations as cleaning, grading and drying. The 3AB 20A grain cleaning units consisting of the GUAR-15N truck unloader, the PN3-20 loader, the grain cleaning machine, tedder and others. The secondary grain cleaning operation is carried out by the SV4-5A with a capacity of 6 t/h.

To prolong the grain storage period before drying and cool the grain after drying, the CHMVI-30 machine is used. It is designed to cool humid grain immediately after harvesting and has a capacity of 100 t/day (the wheat grain being cooled down from 25 degrees C to a temperature of 10 degrees C).

To process harvested grain on open-air thrashing floors mobile units are involved in cleaning, grading and drying. "Mine" and "Drum" driers with different capacities, the 6V-25 being with active ventilation and other mechanisms, are intended for grain drying.

On large-scale grain farms in the FRG, self-propelled grain combines operate in a complex with mobile heater ventilation units, stationary cleaning centre, special purpose tractor trailers and handling mechanisms of tower storages. The 24 hour exploitation of a complex of this type results in harvesting, drying, cleaning and the putting in storage of 60-100 tons of grain.

Counter-flow grain driers are widely used in England. This method is based on the following principle: hot air moves upwards and the grain downwards.

In France both natural ventilation (in the open air) and artificial drying in "mine" dryers are used for drying corn grain with a humidity rate varying from 30 to 40%. The country has 2500 centralized drying centres, processing 90% of grain.

The FRG uses grain two chamber "mine" dryers, the altitude of a mine being 3.5 m. When dried the grain is continuously stirred. The drive of the air blower consumes 90% of the dryer energy and the drive of transport devices 10%. Electric power consumption rate makes up 0.5 cwt/h per 1 cwt of dried grain. Grain is also dried in ventilated storages.

New methods involving solar energy for grain drying have recently been developed in the USA and France.

In Italy "portion" high-temperature dryers with a capacity of 30 t/h are used to dry big grain lots. The dryers are equipped with a dump mechanism.

The FRG industry turns out round ventilated grain storages, equipped with handling mechanisms. ("Tornado", "Beckum" and others).

The Dutch firm "Erufarm" builds tower type storages equipped with handling mechanism complexes. Storage panels have plastic and enameled coatings. In the USA pre-fabricated metal storages are set up.

On the whole, in grain production of the USSR and other countries, there is a tendency of transition to the integrated complexes of machines and equipment intended to fully mechanize and automize operations dealing with grain growing, harvesting, post-harvest handling and storage.

Recently, the USSR has employed industrial production methods on a wider scale in corn cultivation. These methods imply continuous operations minutely performed, the strict observation of agro-technical norms and minimum soil tillage operations. This technology is based on a combination of farm operations dealing with crop cultivation, the application of new effective herbicides (pre- and post harvesting application); the use of highly productive complexes of machines and implements, and the reduction to a minimum of crop cultivation operations.

These production methods which are employed in the Moldavian and Ukrainian SSRs make it possible to harvest on the average 60-71.1 cwt/ha 100 cwt/ha on the best farms and to reduce cost price to 3.03 roubles as compared with 4.65 roubles/cwt (traditional technology). In 1979 the area sown to corn was 160 thou.ha (new technology) and in 1980 it will increase to 1 mln.ha. The growth of the area sown to corn and cultivated on the basis of new technology will continue in future.

POTATO

Breeding and Seed Production

In countries where potato production is highly developed, emphasis is placed on the cultivation of highly productive varieties resistant to viruses and other diseases, and therefore suitable for processing and mechanised harvesting, and typical in their good quality of taste and preservation.

Extensive research work is being carried out at breeding centres in the USSR, the USA and Europe on the development of highly productive potato varieties for various uses.

A large number of potato varieties has been recently developed in the USA suitable for processing and fresh consumption. The practical yields of many of these varieties reach 500-600 centners per hectare. Over 100 potato varieties are grown in the USA, but the most popular varieties (covering 80% of the total area under cultivation for this crop) include Russet Burbank (to the greater extent spread in the western states), Kennebec, Katadia (the main variety in the eastern states), Superior, Norchip, Nordland and others. According to American experts, however, local varieties are easily attacked by cancer, as well as late blight, viruses and other diseases. During the past few years those varieties resistant to nematode, scab, viruses and other diseases have been bred. A new variety of great value is Atlantin which is highly productive and resistant to nematode, scab and late blight.

In Europe, about half of the seed potato varieties grown are of Dutch origin (Bintje, Jarla, Erstling and others). An early yield along with a rather high quality tuber explain the wide use of this variety. A great diversity of potato varieties is also typical for European countries.

About 60 scientific establishments dealing with potato breeding exist in the USSR. Since 1978 over 100 potato varieties have been produced, 90 varieties of which were bred under local conditions. In districts where potato production is intensive and to a great extent mechanized, varieties which mature during the early/mid and mid-season are of great importance because of their stable yield, and preferred in zones with comparatively short frost-free periods. Amongst the best mid-season maturing potato varieties belong Gatchinsky (grown in 36 regions), and Ogonjok (grown in 50 regions), Stolovy (grown in 19 regions), and Ostansky. The mid/late and late maturing varieties such as Lozkh, Loshitsky Ramensky, Sotka, Yantarny, and Temp cover large areas of potato cultivation.

The main principles of seed production are based on:

(1) the production of seed stock by district in zones highly suitable for the growth of a potato variety with high seed yield;

(2) the establishment of sanitation centers in these zones;

(3) the production of disease-free initial stock (initial seed production);

(4) the strict observance of seed and phytosanitary requirements.

In the USA potato seed production is supervised by the Department of Agriculture and is practically realized by a large number of establishments: by regional research laboratories, experimental stations, farmers' associations, private companies.

Experimental stations are dealing with the development of healthy initial stock under conditions of strict isolation. This initial stock is used for clone nursery planting by exploiting the method of apical meristem culture and by using setologic and indicator evaluation for viruses.

These elite seeds are cultivated on private farms which are duly isolated from each other and all the requirements necessary for virus free seed production are observed. Potato seed production is practised in 19 states, but the main areas of plantation (80%) are concentrated in the states of Minnesota, Idaho, North Dakota and Wisconsin. Scientific research on seed production and the implementation of the results in practice are carried out at universities and experimental stations in the United States.

The virus-free stock developed at research establishments and specialized scientific centers in many countries is dispatched to elite seed production farms as seed stock for the production of super-super elite seeds. Here, the stock is reproduced in elite form and dispatched to reproduction farms, where it goes through a second reproduction and is subsequently marketed to commercial farms for the whole plantation area. Such forms of production and propragation of seed stock are as a rule based on a system of cooperation and fixed contracts. In a number of countries zones of closed seed production have been created, ie. potato sanitation centers in regions most suited to the production of a healthy seed stock with a high yield.

Production - scientific associations have been established in the USSR to deal with the potato seed production carried out at zonal research institutes, experimental stations attached, and the testing and production farms. To these associations belong leading specialized state farms which handle the initial potato seed production, farms specializing in the cultivation of the elite seeds, as well as many other seed production and commercial farms involved with the reproduction of elite stock as far as the third and fourth reproduction.

At the specialized farms equipped with scientific laboratories, the super-super elite stock is grown on virus free bases which are dispatched to the farms for the cultivation of elite stock by means of double reproduction. The production of elite stock is also carried out at scientific and educational establishments and those farms under obligation to produce and market it. Stock cultivated at special elite production farms is transferred to commercial farms (collective and state farms) where it is reproduced in special nurseries and on seed growing plots as far as the third reproduction.

At present research is being carried out in a number of countries on cutting the cost of virus free seed production and the development of more efficient technology to include the active methods of sanitation, speedy reproduction, seed production by cutting, and summer planting.

Fertilization

In the period 1970-1978 the application of fertilizers in potato production in the USSR increased by 65% and reached 287 kg. (active ingredient) per hectare. Such a great increase in fertilizer use is not necessarily accompanied by an equivalent increase in potato yield in the country on average which totaled 115 centners per hectare during the period 1966-1970, 113 centners per hectare during the period 1971-1975, and 122 centners per hectare in 1978. The R.S.F.S.R. is the largest potato producer and the application of fertilizer to this crop increased from 155 to 287 kg. (active ingredient) per hectare between 1970-1978, whereas the yield between 1971-1975 was the equivalent of 106 centners per hectare, and 103 centners per hectare in 1978.

The highest rates of fertilizer used for potato production occur in Byelorussia: 303 kg. (active ingredient) per hectare, Latvia - 419 kg. per hectare, Lithuania - 351 kg. per hectare, and Estonia - 356 kg. per hectare. Yields in these republics are higher on a small acreage than in the R.S.F.S.R. In Byelorussia the potato yield increased from 142 centners per hectare on average between 1971-1975 to 179 centners per hectare in 1978, although there was almost no increase in fertilizer application. In the main potato producing areas significant fluctuation brought about by unfavorable weather conditions has been observed, especially during harvesting time, a fact which considerably decreases the fertilizers' efficiency. Therefore, the average yield of 148 centners per hectare was reached in Latvia between 1966-1970; in 1976, the yield attained was 145 centners per hectare, and in 1978, due to complicated harvesting conditions and a high precipitation rate in autumn, the yield fell to 113 centners per hectare.

Further increases in potato yield in the USSR do not influence the level of fertilizers applied, which is comparatively high in the main potato producing areas, but does effect other factors such as the organization of the seed production of this crop and the improvement of harvesting mechanization. The main cause of the potato yield increase can be traced back to the specialization of potato production, where light soils are preferable, not only because of the biological peculiarities of the potato crop which necessitates such soils for a better development but also because the mechanical harvesting problems encountered on light, fast-drying soils have to some extent been reduced.

The level of fertilizer application in potato production in European countries is very high - as much as 600-700 kg. (active ingredient) per hectare. In Great Britain 99% of the acreage under potato cultivation is fertilized using between 1-3 types of mineral fertilizer, and 44% of the acreage is also manured. In 1978, 631 kg. (active ingredient) per hectare were applied on average in the country including 180 kg. of nitrogen, 193 kg. of phosphorus and 252 kg. of potassium per hectare. The high level of potassium applied is favorable to not only the potato yield but also improves its quality and resistance to various diseases.

High rates of fertilizer application are also typical in Western Germany, the Netherlands and other Western European lands. The favorable climatic conditions and the high level of farming practices in this part of the world are the reason for high returns in potato production after the use of fertilizers. The intensive application of of fertilizers and their higher efficiency assisted the increase in potato yield to such an extent that it was possible to reduce the acreage under this crop considerably during the past few years.

Irrigated Potato Growing

In the USSR the potato crop is irrigated in Central Asia, Kazakhstan, Transcaucasus, in the southern part of the Volga river, areas in Moldavia, and in parts of Western and Eastern Siberia. In 1978 irrigated potato plantations in the USSR covered 202.7 thousand hectares, i.e. 2.89% of the total area under this crop and 1.56% of the total area under irrigation. Zones of irrigated potato growth are found in places where soil and climatic conditions are extremely unfavorable for the cultivation of this crop, i.e. where lack of soil moisture is accompanied by severe droughts. The cultivation of the potato in these regions would be practically unfeasible without irrigation and the yield is extremely low. In 1978, the average yield for potato tubers grown under irrigation in the country comprised 98 centners per hectare in addition to the yield not under irrigation, whereas under more favorable soil and climatic conditions the potato yield rose to 120 centners per hectare. The overall yield of irrigated potatoes in 1978 was 1973.9 thousand tons, i.e. 2.7% of the total potato production in the country.

At present, the potato crop is irrigated in European countries, in Canada and the USA. Potatoes for consumption are also irrigated in Poland, the GDR, Bulgaria and Hungary. In the GDR the use of sprinkler irrigation is considered as highly effective for early potato varieties because it speeds the ripening of the tubers and subsequently allows early marketing. On vast areas of irrigated potato acreage, extra yields of potato with various ripening times vary from 40 to 80 centners per hectare. On large farms where irrigation is used, yield supplement gains make up about 70 centners per hectare, and leading farms have yields of potato tubers of up to 281 centners per hectare. Each millimetre of water applied returns 22 kg. of dry matter. As from 1972, about 22 thousand hectares under potato cultivation were irrigated in Great Britain, including 8.4 thousand hectares under early varieties and 13.6 thousand hectares under midseason and late ripening varieties.

In the USA, the bulk of potato acreage is irrigated (58% of the total), or 311 thousand hectares of a total of 540 thousand hectares under potato cultivation.

Irrigated potatoes cover 1.9% of the total irrigated area. The zone where potatoes are not irrigated is found in the humid eastern states. Irrigated potatoes are cultivated in western states where the four of them (namely; Idaho, Washington, Oregon and California) claim 67.2% of the total irrigated area under the potato crop. In the state of Idaho potato production is carried out exlusively under irrigation (126.35 thousand hectares), and Idaho therefore ranks first before all other states in potato production. Idaho provides 25% of the total potato production alone in the USA. Potatoes are planted on areas fed by large irrigation systems covering 1000-1400 hectares. Plantations are located in mountain valleys and depressions where brown, chestnut and black soils prevail, formed on loess deposits. Precipitation rates are insufficient (250-500 mms) in these regions, therefore irrigation is a must in arable farming. Potatoes grown in Idaho cover 10-15% of the irrigated area.

In the USA, potato cultivation on irrigated land is considered a profitable venture. Research carried out in the state of Washington has shown that the potato crop, due to profits gained, ranks second after sugar beet among the arable crops. As an illustration of this: production costs involved in the cultivation of potatoes amount to 1665.68 dollars per hectare; tuber yield amounts to 627.5 centners per hectare; and the net profit amounts to 1447.74 dollars per hectare. And for the production of sugar beet we have the corresponding figures: 951.40 dollars per ha.; 672.3 centners per hectare for yield; and 2013.76 dollars per hectare profit. For apples the following figures apply: 3223.47 dollars per ha.; 268.9 centners per ha.; and 927.75 dollars profit per ha. For wheat: 461.97 dollars per ha. production costs; 67.2 centners per ha. for yield; and 333.68 dollars profit per ha.

In regions with a history of potato irrigation, water is fed by furrows, whereas in areas where irrigation is a fairly recent innovation, the sprinkling method is used. Self-propelled wide-cut sprinkling installations with a circular action prevail in the latter regions, and these help to cut down labor losses, make it possible to develop the low fertility sandy soils unsuitable for surface irrigation, as well as secure higher potato yields. With sprinkling irrigation, potato yields on sandy soils reach 670 centners per hectare or even higher. It should be mentioned that the expenses involved in irrigation installations of the sprinkler type are considerable. In Idaho, for instance, irrigation sprinklers consume 122-150 dollars per hectare annually, i.e. 10-12% of total potato production costs, whereas in the case of surface irrigation, costs amount to as little as 29 dollars per hectare, i.e. 6% of the total. Rough areas, with light mechanical soil composition in mountain valleys and depressions, favor the progress of irrigation induced erosion which in turn brings about contamination of water reservoirs with suspended sediments. Therefore, when potato cultivation takes place on irrigated land as a row crop, a special set of soil protection measures should be taken.

Irrigated potato production is one of the most highly specialized branches of agriculture in the USA. Specialized potato growing farms cover 81.1% of the total irrigated acreage under potato cultivation. A total of 85.7% potato plantings in the USA (both irrigated and non-irrigated) is concentrated on specialized potato production farms.

THE MECHANIZATION OF TECHNOLOGICAL PROCESSES IN POTATO PRODUCTION

Soil cultivation

Soil cultivation for potato growing in the USSR is practiced with the utilization of general purpose soil cultivators. Since grain crops are followed by potatoes, soil cultivation should be as follows: fall stubble harrowing with stubble plough disc harrow LD-20, LDG-15 etc. (single or double-run depending on weed population); deep late fall ploughing, more seldom spring ploughing, using ploughs with skim coulters PH-4-35 or PBN-3-35 to the full depth of the ploughing (at slightly saline light and medium soils, late fall ploughing is sometimes replaced with deep hoeing or harrowing and discing), early spring cultivation; spring ploughing with the application of organic and mineral fertilizers and hoeing of furrow bottom with subsoiler to a depth of 10-12 cms.

Deep ploughing of potatoes is practiced in the USA mainly in the autumn; on light sandy soils ploughing is done in the spring to control erosion, and in the autumn winter cereals are sown both to control erosion and to serve as green fertilizers. Seedbeds are formed before sowing, and the interrow distance is 80-1000 cms. The whole set of machines for soil treatment involves the 125 h.p. tractor, the 4-furrow plough, the stubble plough disc harrow, the 8-raw bedder.

This system of soil cultivation for potatoes is used in the majority of Western European countries. In England and West Germany soils are considerably stony and one of the operations of soil preparation for potato planting is the disposal of stones by means of mechanical stone collectors or modified potato diggers.

Potato Planting

Mounted potato planters are used in the Soviet Union: the SN-4-B for an interrrow space of 70 cms and the KSN-90 for an interrow space of 90 cms; the semi-mounted 6-row planters SKM-6 and SKS-6 and the 4-row planters SAJA-4 for planting or vernalized potatoes. The maximum operating speed of the SKM-6 is 7.1 km/h, of the SKS-6 is 8 kms/h, and of the SAJA-4 is 6.3 km/h, and the capacity of the first machine is 3 hectares/ hour, of the second machine is 2.5 and of the third is 1.3 ha/h.

All planters are provided with devices for the application of fertilizers and hydraulic markers. The loader 3 KS-0,2 is used for the mechanized loading of SN-4B and KSN-90. The SKM-6 can be loaded directly out of tippers by special devices.

In the USA planting is carried out mostly with 4-row planters. The planters have distributors of the cup and fork types and are widespread throughout the country.

In most Western European countries 2-row potato planters are used. The operational organs of the planters are usually actuated by the wheels of the machine. The planting units are mostly of the elevator type, and they are supplied with compensating devices. Most planters in Western Germany are supplied with vertical elevators (Unior, DCD, Triplex) or with a vertical belt with cups fixed to it (Nassia)

In England the 2-row potato planter with belt planting units is used, e.g.: Chiftane, Smallford, Howard Roterplanter. The capacity of the first machine is 0.7 and that of the two others is 0.4 hectares per hour in one shift when vernalized tubers are planted.

Soil treatment on the plantation consists of pre- and after germination harrowing (spiketooth harrow 3 B3S-1,) and 3BP- 0,6 as well as net ones BSO-4,0), BS-2 and BSN-4,0); interrow cultivations aimed at soil turning up and weed control (cultivator ridgers KON-2, 8P, KON-2, 8PM), and applications of pesticides with mounted tractor sprayers ON-400-I or POU.

In the majority of Western European countries the care of plants is restricted to two or three pre-germination harrowings with network harrow or aggregates, consisting of a ridger and harrows, as well as postgermination treatment with ridgers and net harrows.

In England and the USA weeders with spring teeth (of the KRN-38 type, which is used in the USSR) are used for weed control.

In Holland and other countries, the V-type harrow ("hedgehog") is used beside the network harrows. This harrow allows for the combination of harrowing and ridging.

In Canada the first cultivation - which takes place 3-5 days after planting - is performed with cultivators with fixed hoeing operational organs in front of the machine and ridgers at the back.

In Western Germany all-purpose implements are used. They combine removable side-wings with spring rakes for interraw cultivation at a speed of up to 10 km/h.

In England rototilling implements are widely used for intensive soil hoeing (the 3-row rotary cultivator, the combined implement of the Stenden firm, including bar blades, cutting sections and banking bodies).

In all potato growing countries great attention is paid to disease and pest control. The first spraying against phytophtors takes place at the beginning of vegetation, and the process is repeated each 10-12 days (4-6 treatments altogether). Tractor-mounted sprayers and dusters are used in this case.

Preharvesting Top Separation

Preharvesting top separation in the majority of potato growing countries is considered to be an important operation, especially during early harvesting. In this case mowing, pulling and chemical defoliation are used. In the USSR the tops are mowed before harvesting with the UBD-3A machine, the mower-chopper KIR-1,5, or they are removed by the method of chemical spraying with defoliants. In England, the USA and West Germany and other countries, a combined method is used: mechanical mowing with subsequent spraying. In the Netherlands, besides other methods, the method of top removal is used and burning cultivators employed. Chain breakers of a simple construction and safe to use are used for mechanical top separation in some countries apart from beaters and silage harvesters.

Potato Harvesting

Potato Harvesting in the USSR is done with the potato diggers KTN-2B and KST-1,4, the universal potato harvester (swathing device) the UKV-2 and the combines: the two-row KK-2 and its modifications as well as the 4-row combine KKM-4. On the basis of the last machine, the 4-row self-propelled combine, the KSK-4 has been developed. In the USSR mechanized engineering is used for harvesting 93% of the land under potatoes, including 43% of the land which is harvested by combines. The capacity of Soviet combines is 0.2 to 0.5 ha (KK U-2) and up to 0.6 to 1.6 ha/h. by the KSK-4. Manual labor (between 5 to 8 men) is used for sorting and grading.

Various types of harvesting are used: continuous harvesting, intermittent, and single or two-stage harvesting., depending on local conditions. The development of the harvesting and mechanized transport brigades, and the group utilization of engineering is taken as a basis for industrial technology in harvesting.

In the case of flow-line technology harvesting operations, the transportation and postharvesting treatment of tubers are well coordinated, and, as a matter of fact, they are united as a single continuous mechanized process.

Under difficult soil conditions, intermittent harvesting is more efficient, since it provides postharvesting treatment of tubers after they are kept in heated grading permanent stations for a period of 2 to 3 weeks. Using this technology, mechanical damage to tubers is reduced by between 10% and 20% (this is mainly due to the drying and hardening of the skin).

In some areas of the Ukraine, straight-line harvesting is practiced. This type of harvesting provides for the separation of foreign bodies and potato grading directly in the combine, as well as the preparation for storage from the combine.

In most Western European countries, 1 and 2-row potato combines are widely used. Their daily capacity is 1 to 2 and in some cases 2.5 hectares under favorable conditions. The capactiy of the tipping tanks is 0.9 to 1.6 tons.

The potato harvester in the USA is a 2-row combine. 4-row combines are not widely used because of high yields with which the separating organs cannot operate. The separation of tubers in combines is done pneumatically.

The two-stage method of harvesting is widely used in the USA and also in England and the following machines are used: the "Johnson" digger-swath maker and the Harvy-Harvesting harvester (England), the digger-swath makers and "Lockwood" harvesters (USA).

Postharvesting potato treatment in the USSR is implemented with the KSP-15 potato grading station for the separation of foreign bodies with simultaneous grading by 3 fractions and the transportation of graded potatoes in packages or transport facilities. The capacity of the station is 15 tons/hour. The machine is operated by 7 to 9 people.

There is a trend in most foreign countries to practice initial treatment of potatoes not in the field or in the combine, but under conditions of special stations during postharvesting treatment, specifically under conditions of harvesting in medium or heavy soils.

The basic method of potato production on an industrial basis in the G.D.R. is the utilization of digger-loaders of the E-684 type in the complex with the station line of postharvesting treatment. The most important part of the operation is the utilization of the device for the separation of small tubers, soil and vegetative mass, the K-720 and the automatic installation (using X rays) for the separation of tubers and solid matter, the E-691. The utilization of this machinery allows for the increase of production by 290% and the reduction of the cost price of potatoes by 15% as compared with the former technology when manual labor was used in the combine E-665.

In Western Germany postharvest treatment is done at special stations at commerical and processing units. At the processing units the lines of postharvesting treatment (permanent or mobile) are established in the reception division of the storage. The lines include reception bunker devices, roller and bolter graders.

The specific technology used for harvesting in the USSR and other countries, is, when the potatoes received at supply units or storages, have not undergone any process of initial postharvesting treatment. This technology is used in the case of harvesting under good weather conditions in light stoneless soils.

For potato grading in the USA special grading steel wire devices are used (the Lockwood grading system or grading by continuously moving belts of transporters with holes as well as the John Bin roller grading system).

In most countries the preparation of potatoes for market takes place at specialised enterprises where commercial potatoes are processed, or at equipped units of commercial and procuring factories, the lines involving equipment for grading, sorting, washing, drying and packing.

Storage

Different systems of transport for storage and handling operations are used in the USSR: the STX-30 transporters, the transporter-loader T3K-30. The transporter-pickup TP K-30 is used for unloading potatoes when they are stored in bulk.

Belt transporters, installed in passages are used abroad in those areas where central passage is available. If those storages are not available, permanent equipment is installed, e.g.: receiving bunkers, loading, central and mobile or turning distribution transporters. In the storages where potatoes are kept in bulk, transporter-loaders of the T3K-30 type are used.

Potato loading is done with a Lockwood in the USA, VLV-20 transporter-loaders are used, each of them consisting of two chain-web conveyors, one of which receives with a lifting part and the other of which distributes with hydraulic regulation of the loading height.

The set of equipment for loading potatoes in storages of the Yabelman firm is widely used in West Germany. It includes a dumper, receiving bunkers, inclined cleat transporters, and screens for soil separation. The set of implements provides for the reception of potatoes out of tippers, their initial treatment, loading in layers of up to 5 m. unloading and the secondary treatment of tubers.

The storage of potatoes in the USSR is practiced in temporary clamps, trenches or permanent storages with storage bulk, in barns, in racks or with package-type storage. The main bulk of the potatoes is stored in underground or semi-underground types of storage with active ventilation and a temperature of between 2 and 4 degrees C and a relative air humidity of 85% to 90%. Local industry is manufacturing automatic systems such as the SCHAU-AV and SCHACH-1, operating with semiconductors for regulation of the temperature and humidity regime in potato storages.

Storages with active ventilation, used in the country, have a capacity of between 500 and 3000 tons; they are equipped with sets of machinery for automatic regulation of the storage regime and for the loading and unloading of the produce. Storages for seed potatoes of the 1000 to 3000 t capacity (typical projects 813-123, 813-15/72, 813-14/70 and others as well as some storages for food potatoes are additionally equipped with a section for artificial cooling.

A set of equipment with artificial cooling for the storage of 500 tons is being developed on the basis of the autonomous cooling and heating installation, i.e the CHMO-32.

Open-type potato storages are primarily used in the USA. They are of light construction with a capacity of between 5 and 10 tkbs. The type of storage buildng with a wooden carcass, covered with corrugated iron is widely spread. The space between the planking is filled with special insulation material.

Potatoes are stored in bulk, in layers often reaching 6 m in height. The temperature is plus 5 degrees and the relative air humidity is 95%. This temperature is reached by a system of ventilation and air conditioning.

Open storages of the barn type are used in England. They have concrete floors and walls, slate roofs and no overlapping ceiling. Walls are covered with aerated plastic. Sections are divided by mobile metal welded supports, connected by joints. Metal or wooden drying tubes are placed under the potato layer, where air comes out of wooden air suppliers of the P shape.

Large barn type storage buildings have been built in Western Germany in recent years and have a capacity of 1500 tons. They are equipped with handling mechanisms and special buildings for the treatment of potatoes.

COTTON

Cotton Breeding and Seed Production

Cotton breeding which in some cotton producing countries is conducted with the use of up-to-date methods, is aimed at the development of high yielding, early maturing, disease resistant cotton varieties distinguished for a top quality of cotton fibre. Due attention is paid to a genetic improvement of morphological character such as leaf shape, type of stalk and leaf pubescence, presence of gossypol glands or their absence, etc.

As a result of the enhancement of the industrial development in some countries, commercial varieties of an intensive type characteristic for being early, having a high performance and a good quality cotton lint, have become widely used.

Acala 1517, Delphos-4, Acala SY-1, Acala 4-442, Delta Pine 16, Stoneville 213, Stoneville 7A, Coker 310, are the most common varieties in the USA.

All the cultivated varieties meet the requirements of the textile industry for fibre type. Range of quality characters depending on fiber type of the seed cotton variety are as follows. Yield capacity about 8000-9000 kg/ha, staple length from 30 to 40 mm, metric count from 5,000 to 7,500, breaking length from 35.0 to 25.0 mm, micronaire value from 3.5 to 4.5 and other parametres of technological fiber quality corresponding to the best standards in the world. Recently, a sortment of released and approved varities was unified in the USA. The study conducted by IIASA scientists on the technological parameters of cotton varieties which are grown under different soil and climatic conditions, revealed that the Coker 310 (lint yield is 1,109 kg per ha), Stoneville 213 (1270 kg per ha), Deltapine 16-(1290 kg per ha), Deltapine 45A (1260 kg per ha) varieties and others have the best performance.

New varieties should be wilt resistant, early maturing and similar, or even superior in cotton fibre quality to hereto grown varieties.

Upland cottons are mostly grown in the USA. Some restricted areas of Arizona, New Mexico and Texas are sown to long staple varieties.

The cotton breeding system and seed production inherent to the USSR is permitted to develop and release over 130 cotton varieties. Varieties were renewed four times and now the fifth renewal is under way. At present 25 varieties are grown in the Soviet Union of which ten are of Soviet selection and long staple. The 108F, 138-F, 149-F, C-4727, Kzyl-Ravat, Tashkent-1 and other varieties are distinguished by their good quality and medium and long staple length. Of a good quality are the fine fibre cottons such as: 8763-I, 9078-I, 9155-I, 9647-I, 5595-B, 6465-B.

In the USA specialised firms are engaged in seed production and the improvement of new varieties. Foundation seed stock is multiplied on the firm plots or on the farmers plots under contract. Those firms or companies engaged in seed production usually do not conduct research but are in close contact with research organizations. Primary lines and strains are obtained by the firms from research institutions. There is an extensive exchange of breeding material in the USA in order to accelerate breeding procedures.

For instance, in California, the Corporation "Cotton Seed Distributor for California", run by a Board of Directors of 15 people, is in charge of the primary multiplication and distribution of cotton seeds.

The corporation embraces about 3 thousand farmers and multiplies and distributes cotton seeds among the members of the Corporation for planting. The directorate of the corporation furnishes the farmers with top quality seed.

Foundation stock is maintained by the Universities for Crop Research Service, USDA from which it is passed over to the California Corporation. The corporation in question concludes contracts with seed producing farms and multiplies a small stock to get seeds of the third reproduction in the amount needed for the area covered by the Corporation. According to a special methodology, seed material is tried in the field and there is close supervision of seed purification and storage, and seed germination, which should be no less than 80%, is determined; seeds are subjected to X-ray exposure in order to detect damaged and unripe seeds.

In the USSR cotton production is oriented towards the specialization and concentration of the industry on the basis of interfarm cooperation and agro-industrial integration, as well as the steady improvement of labor organization, production management, i.e. the establishment of specialized agrocomplexes for seedcotton production, procurement and primary commercial processing.

Twenty four research institutions are engaged in the development of new varieties in the USSR. The two experiment farms of the G.S. Zaitsev All-Union Research Institute of Cotton Breeding and Seed Production and eight seed producing state farms maintain seeds and improve new varieties and supply collective and state farms with new variety seeds for varietal trials and field verification.

During the State varietal trials on test plots of conventional farms, new varieties are thoroughly examined and finally approved for commercial production. The Central Research Institute for Cotton Industry and textile enterprises evaluate the technological parmeters of fibre of the new varieties and define their suitability for the textile industry.

As for the variety seed distributed, multiplication is done in the foundation stock and seed producing farms, which are specialised only in the production of seeds of these particular varieties.

98 elite seed producing farms produce elite seeds and those of the 1 reproduction. On each of such farms 20-40 ha. are under elite or foundation seeds and 200-350 ha. under the seeds of the 1 reproduction. The seeds of the II and III reproduction are grown by some 1300 collective and state farms in almost all regions or in 60% of the total number of cotton sowing farms. Each farm has on the average 600 ha. under cotton grown for seed purposes.

The Central Control Seed Station of the USSR Ministry of Agriculture, six Republican Cotton Seed stations and 110 cotton seed laboratories, under the Ginneries of the Ministry of Light Industry, conduct a supervision of seed production and preparation of seeds for planting.

Cotton Fertilizers

Fertilizers were first applied to the cotton growing areas of the USSR. In 1970 the average fertilizer rate for all crops was 39 kg of active substance per hectare while that for cotton 350 kg/ha a.i. for Uzbekistan it is 356, Turkmenskaya SSR 338, Kirgizskaya SSR 406, Tadjikskaya SSR 428 kg/ha a.i. For the period 1970-1978 the use of fertilizers for cotton in the USSR increased on an average of 24 per cent and for the above Republics it was 452, 400, 576, 452 kg a.i./ha, respectively. Irrigation systems and a high level of mechanization alongside intensive applications of fertilizers contributed to the fact that the USSR has a lead in cotton yield in the world.

Apart from fertilizer rates, the forms of cotton are also very significant. Since all cotton plantings are concentrated in irrigated areas, nitrate soluble fertilizers are not applied: they are replaced by ammonia and amide fertilizers.

In the USA high rates of fertilizers are usually used, though average rates for cotton (20 kg/ha, a.i. in 1978) are lower than in the USSR, and this is due to the fact that two-thirds of the cotton fields are within an area with a relatively high rainfall and where cotton is grown in rained fields. No increase in the use of fertilizers for cotton has been reported in the USA for the last 15 years. The country average rate of fertilizers for this crop was 227 in 1965, 210 in 1970, 210 in 1976, 204 in 1977, and 205 kg/ha a.i. 1978. The average rate of 205 kg/ha for 1978 contained 85 kg/ha of nitrogen, 60 of phosphorus, 60 kg/ha of potassium. About 69% of the total acreage under cotton receives fertilizers.

In the cotton producing areas of the USA much attention is attached to the prevention of nutrient losses. In order to reduce these losses slow acting nitrogenous fertilizers are applied of which the most effective ingredients are urea, capsulated sulphur; nitrofocation inhibitors are also applied, for instance, nitropyrin. (Trade name N serve).

Irrigation

In the USSR cotton is grown only on irrigated land. The sowing acreage for 1978 was 2,920 thousand hectares, or 27,18% of the total acreage under irrigation. The water dose for cotton varies considerably with climatic conditions. For instance, the irrigation rate for the Karakalpakia Autonomous Republic is 3,000-4,000 c.m./ha, while for Vakhsh Valley 13,000-15,000 cubic meters per ha. In designing irrigation systems, water consumption and watering regimen for crops are defined for each district of Central Asia. Surface irrigation is the major method used for cotton.

During the last years surface irrigation was successfully mechanized; studies for automizing the irrigation system are under way.

In the USA about one third of cotton planting is done on irrigated land (out of a total of 4.91 mln ha of sown acreage, 1.49 mln. ha are under irrigation). Of the total irrigated land (16.39 mln. ha), the share given to cotton is 9.1%. During the last decade there was a decrease in cotton acreage in the old areas of the "Cotton Belt", where it was grown on dry land, and now there is an expansion of cotton production on irrigated land in the Southern part of the Great Plains and south west states. 94.5% of the irrigated cotton areas are concentrated in four states (California, Arizona, New Mexico, Texas). The yield of cotton lint averages 520 kg/ha for the country (without irrigation 375 and with irrigation 750 kgs/ha) and for California and Arizona, there are 1,190 and 1,320 kgs/ha, respectively.

THE MECHANIZATION OF COTTON CULTIVATION AND HARVESTING. PRINCIPAL PREPARATION OF THE SOIL

In the USSR stalk removing follows cotton harvesting (in Central Asian Republics at the end of October and the beginning of November). Stalks are uprooted with the help of a stalk puller-roller KV 4A and KV-3,6 A. The pick-up baler PS-1,6X picks stalks with simultaneous pressing and wagon loading. Stalk cutting is done by a cutter KI-2,4 or KI-3,6.

Prior to fall ploughing, organic matter and mineral fertilizers are applied by a sprayer PTO-4 and I RMG-4.

Ploughing is done in November-December 30-40 cm deep. At present two-tier ploughing is increasingly used with the trailed ploughs Pya-3-35 and mounted plough PD-4-35, which are aggregated with tractors of Class 3-4 ts, T-4A, DT-75.

About 56% of the total irrigated land consists of salt soils. Slightly salted soils are washed in September-October prior to fall ploughing with cotton in the field (just like vegetation watering). With a medium and high level of salts the soils are washed in autumn or winter following fall ploughing when ground water is very deep.

Then ploughing ridges and furrows are levelled with a grader-leveler GN-4, autograder D-598B and universal type of aggregate KZU-0,3 with subsequent levelling with long-base levellers P-4, P-2.8 and the automatic leveller PA-3.

A leveled field is divided into checks 0.1-0.35 ha of size by a KZU-0.3 The same machine digs a temporary irrigation canal every 70-100 meters. The soil is washed 1-5 times depending on the degree of salinity.

In the USA, stalks are cut in the field after harvestng with the help of special machines of a different design. Depending on soil conditions and agricultural practice principle ploughing is done either in December or in February, largely without a moldboard but with 2-6 body plough-loosers. Ploughing is done differentially 18-55 cm deep and more. Prior to ploughing the field is spread with phosphorous fertilizers with the help of special machines.

Work is done in the irrigated zone to enlarge field leveling activities and make them more durable. Field maps are 10-15 ha in size and more, with a slight slope. Current levelling is carried out every year with the use of graders, scrapers, and long base levellers.

Large wheeled tractors of different performance are used in the field. In Australia, for example, the main soil cultivation is done by caterpillar tractors.

Pre-sowing Preparation of the Soil

In the USSR non-saline soils are harrowed early with two tracks done by toothed "criss-cross" harrows. Washed fields free of woody weeds are treated with disc harrows BDNT-2.2 with a simultaneous loosening and rolling. Soils that are not free from debris are treated with chisel cultivators e.g. the ChKU-4, and the steam and flame cultivators KPN-4A and Ko-2,4A.

In the USA during the pre-sowing time great attention is paid to weed control by mechanical and chemical means. On light soils wide-row cultivators and toothed harrows; on clay soils chisels, and heavy disc harrows. Herbicides are widely used.

After the current levelling, furrows are cut 25-30 cm deep and 400-600 m long for pre-sowing irrigations which terminate two weeks before sowing. Water is put into irrigation furrows from cement canals through syphon plastic or aluminium pipes 1.5 m long and 50 mm in diameter.

Sowing

In the USSR cotton is sown in rows with a spacing of 60 cm, and in rows with frequent drilling, with a spacing of 50 cm, and wide-row sowing/plant density per 1 ha is rather good, plants receive more light, heat and air. Seeding done together with the application of herbicides results in clean fields and therefore this method is promising.

The sowing of non-pubescent cotton seeds is carried out by the sowing machines STKh-4A (row spacing 60 cm) and the C4Kh-4A-M (row spacing 90 cm). The sowing of pubescent seeds by the sowing machines STKh-4-B (row space of 60cm) and C 4Kh-4A-1 (row spacing 90 cm). For a wide row sowing a 6-row frequent drilling sowing machine CKh4-5,4 of two modifications (for pubescent and non-pubescent seeds). Precise sowing of non-pubescent seeds is done by the sowing machines (SPCh-6 m) imported from Rumania. Here seeds are placed together with mineral fertilizers and herbicides.

In the USA sowing is carried out with wide (1 m) spacings. They alsc use two band sowing - two bands per row, and also alternative sowing according to which sown sections in one field alternate with the clean sections.

Sowing is done with 4 or 6 row-sowing machines. They are furnished with devices for fertilizers, herbicides and fungicides.

Cultivation

Post-emergence cultivation is carried out at a depth of 6-8 cms. Cultivation occurs together with a fertilizer dressing (two-three times per growing period) with the machines KRKh-4, KRKh-3,6, KRT-4 and KRKh-5,4.

Cotton cutting (the cutting of the apical part of the main stalk) is done in July-August with the help of the implements (ChEKh-4), mounted on a tractor together with a cultivator.

In the USSR cotton is grown on artificially irrigated land. Irrigation through furrows dug by the cultivator prior to each treatment, is popular. Temporary canals and outlet furrows are dug by the aggregate KZU-0.3 with T-4 tractor (DT-75).

Cotton irrigation is done at the budding, flowering and ripening stage up to seven times and over.

After soil treatment and drying, temporary canals and outlet furrows are dug and levelled with the machine KZU-0.3.

Recently plastic or rubber pipe-syphones for the rationing of water came into use.

Sometimes flexible pipelines with openings are used. The disadvantage of such a system is that the auxiliary elements available require technological services which are highly expensive.

The irrigation system practised in the USSR is as follows: the irrigation water from the main reinforced canal which is 200 m long and has a capacity of 200-300 l/sec. passes through side gates into the furrows. Such a system allows for the irrigation of 3-4 ha per day.

Now sprinkling is preferred. This method results in an increase of yield by 150-300 kg per hectare, and as consumption is 5000-5500 cubic meters per ha., 30% water is saved.

In order to control cotton pests and diseases, sprayer-dusters of the type OVKh-14 are used. A large portion of the plants are treated with the help of aviation.

In the USA the following methods of vegetation watering are used: in each furrow, in every alternate furrow, subsoil irrigation, and irrigation by sprinkling is being studied.

The furrow method is predominantly used and as a rule watering is done by means of a concentrated water current.

A subsoil plastic irrigation pipeline is placed at a depth of 45 cms at intervals of 0.5 to 1.5 m. This technique allows for the simultaneous application of time soluble minerals and water is saved at a rate of 30% when compared with furrow irrigation. But this method is costly.

Cotton Harvesting

Seed cotton harvesting is 55% mechanized in the USSR. On some farms harvesting is mechanized to an extent of 94 to 97%.

Sprayers (OVKh-14) and aviation are used for defoliation and dessication.

Prior to harvesting, margins with a width of 7 to 8 m are prepared at the end of field sections.

The two-time harvesting of seedcotton is the most effective way of harvesting with the available set of machines. Harvesting starts following the defoliation of 75 to 80% and when no less than 55 to 60% of the bolls are open. When 60% of the bolls are open, machines are used for tier harvesting (i.e. separate picking of seedcotton from the lower and upper tiers of cotton plants) with the machines KhVA-1.2 and KhVA-1.8 with a cutting width of 1.2 and 1.8 m respectively.

With a spacing of 60 cm, harvesting is done with a four-row horizontal-spindle mounted machine 14XV-2, 4A with a cutting width of 2.4 m and a capacity of 0.9 to 1.2 ha per hour (the machine is used in conjunction with the T-28X4 tractor).

In order to pick fine fibre cotton, the XVN-1.2A machine is used with a cutting width of 1.2 m, and a capacity of 0.45 to 0.6 ha/hour (together with the T-28X4 and T-28X4M tractors).

Cotton grown with a spacing of 90 cms is harvested by a mounted two-row 17XB-1.8B machine with a cutting width of 1.8 m and a capacity of between 0.67 and 0.9 ha/hour (together with the T-28X4 tractor) and a four-row mounted KhN-3.6 m machine (whose cutting width is 3.6 m and capacity is 2 to 3.6 ha /hour) used together with the MT3-80Xkh tractor. A line type of cotton harvesting is used in the USSR according to the scheme: field-bin-transport-heap. Cotton pickers operate in groups of between 3 to 5 machines in one or more adjacent fields. Each group of cotton harvesting machines is affixed to 6 or 10 tractor trailers or 1 to 2 tractors.

Afterwards the second mechanical harvesting strippers (SKO-2,4 and SKO-3,6) machines are used. Cotton is picked up from the ground by mechanical strippers of the PKhN-1.2, PKhN-1,8, and PKhN-2.4 type. In each group of machines there are 2 to 3 machines of this type.

These machines are used at a time when the cotton plants have dried or when the greater part of the bolls have been dried.

The sticks are removed according to a shuttle scheme of aggregate movement, beginning from the edge of the field and then following the route of the sowing machine.

There are 2 to 3 tractors per stripper and pickers, and one UPKh-1.5B cotton cleaning machine per cotton harvesting machine and two pickers.

After harvesting the fields are readied for fall ploughing. 2PTS-4-887B tractor trailers are used for cotton transportation.

When cotton is mechanically harvested in the USA, about 70% of the cotton is harvested by pickers (cotton harvesting machines) 28% by strippers (stick picking machine) and 1% by mechanical pickers.

Spindle harvesting is done twice. Tier type seed cotton harvesting came into use recently.

After being unloaded from the lorries, the seedcotton is baled into special bins, then delivered on to the platform with an automatic handling system and finally transported to the ginneries.