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Agriculture and Mechanization: the Italian Case

1.1. *Development Over the Past 20 Years*

1.1.1. From 1970 until today, Italy has experienced general socio-economic development whose principal parameters are summarized in Table 1.1, in which all monetary values are expressed at 1970 prices.

During the time period under consideration, and despite population growth of approximately 6%, the number of farm workers was practically cut in half. Meanwhile, the service sector developed at a significant rate, with a consequent in-crease in employees in this area of over 36%.

GNP, at 1970 prices, increased by approximately 53%, while gross agricultural output (GAO) increased by 37%.

Hence, there was a significant increase in the standard of living and the cost of labour, which had repercussions on agri-culture as well.

1.1.2. The area used for agriculture (AUA), which in 1970 was just over 17,800,000 ha (3100 m^2/inhabitant), now represents 15,500,000 ha, corresponding to 2690 m^2/inhabitant). In management terms, this area can be broken down into just under 1,400,000 farms with a unit surface area over 1 ha, covering 98% of the AUA and having an average surface area of approximately 11 ha. In numerical terms, there are 15% fewer farms now than in 1970. The above-mentioned in-crease in GAO (I.6-fold during the two decades 1950-1970) was mainly due to innovations introduced in the fields of genetics and chemistry, in addition to the contribution made by machinery, which became increasingly more in tune with requirements. Increases in yields ranged from a minimum of 18% for the production of cow milk to maximums of 28% for grapes, 42% for tomatoes and 54% for maize. Nonetheless, Italian agriculture continues to satisfy just over 75% of domestic requirements for agricultural raw materials for food and non-food purposes.

Furthermore, during the period under examination, the following aspects became widespread; crop specialization with the gradual abandonment of various forms of combined crops, a tendency to-wards single crops with a reduction in the areas subjected to rotation, and employment of the unifeed technique for animal feeding. In addition, there was a gradual reduction in the area devoted to winter grains and a significant expansion in proteaginous crops, especially in the case of soybeans. Over the course of five years, the amount of land devoted to soybeans has increased tenfold.

Finally, in economic terms, in the face of slight variations (at constant money values) (Fig. 1.1) in prices paid to farmers for their products, the price of machinery increased by approximately 20%, that of energy used for agriculture by 47% (the highest increase occurred during the period 1974-1980, naturally) and the cost of farm labour went up by over 250%.

The increased use of various factors of production (especially chemicals and machinery) created a situation in which the rise in net product (15%) was sharply inferior to that of GAO (37%).

1.1.3 This gap between costs and income, in addition to young people's growing desire to escape from the countryside, has led to the gradual development of mechanisation, which was already fairly entrenched at the end of the 1960's. The fleet of tractors and other comparable self-propelled machines increased approximately 2.2.-fold (Fig. 1.2.), while implements and agricultural machines (expressed in tons) increased by over 1.5-fold, reaching a total average of 270 kg/ha of AUA.

Total installed power with regard to tractors (Fig. 1.3.) increased 3.5.-fold, reaching an average of 3.5. kW/ha Aua, while energy consumption rose only twofold. The reason is that hourly utilization of the power itself, which in 1970 was approximately 300 h/year per installed kW, dropped in 1988 to 129 h/year.kW. Mechanisation has, then, progressively reduced its efficiency.

However, the increase in unit tractor power (which sometimes exceeds requirements) and the work capacity of the agri-cultural machines have made it possible to make up for the enormous decline in the availability of labour, with each full-time working unit responsible for an ave-rage of 9 ha. The possibility of carrying out several field operations simultaneously, as well as stable automation, have al-so helped in this regard. Furthermore, it should be remembered that there are two harvests a year on approximately 20^{0}7o of AUA, and the total number of animals exceeds 27,000,000 heads, equally divided among cows, sheep/goats and pigs.

At present, the mechanisation of Italian agriculture taken as a whole covers 23^{0}7o of GAO and 47^{0}7o of Total Agricultural Inputs.

1.1.4. This evolution in the field of me-chanisation took place at the same time as developments in the manufacturing of tractor, implements and agricultural machinery. This industry presently boasts approximately 2400 companies (of which only 500 have over 20 employees) with a total production of approximately: 200,000 t/year of tractors; 345,000 t/year of implements and stationary plants, and 100,000 t/year of separate and spare parts. These values represent approximately 6% of total production in the field of Italian mechanical engineering, employing just over 3.4% of all the personnel engaged in this industry. This activity has become increasingly internationalized over time and in market terms. Indeed, over 50^{0}7o of the tractors and self-propelled derivatives and 40% of the implements and machines produced are currently exported. This broad international market, over half of which is represented by E.C. countries, produces a sharply positive trade balance.

The industry is characterized by a relative concentration in the segment including tractors and derivatives, engines, self-propelled machines and stationary plants; a considerable fragmentation in the implements and agricultural machine segment. Overall, 80^{0}7o of production is concentrated in fewer than 250 companies. In-deed, approximately 1900 companies have a production level between 300 and 1,000 t/year, and of the remaining 200, fewer than 15 have a production level over 30,000 t/year. A large number of companies operating in this industry is turning into assemblers of non-in-house components, rather than operating as genuine manufacturers; this is especially true of small and medium-sized companies.

In the specific case of tractors, the top ten companies cover 94^{0}7o of the market (the top three cover 64%). In the case of engines, on the other hand, out of 18 companies, the top three are responsible for 75% of total production.

The top ten companies that manufacture self-propelled machines and derivatives (walking tractors, combine harvesters, power mowers, etc.) hold over 60% of the market.

In reality, however, many companies operate in several technologically similar segments (e.g., tractors, power tillers etc.), so that there are just under 200 companies working in the area of self-propelled machinery and tractors.

In terms of implements, agricultural machines and stationary plants, on the other hand, the first 800 companies (36^{0}7o of the total) are responsible for over 80^{0}7o of production.

The present selling value of tractors and agricultural machinery ranges between 7,000 and 12,000 US$/t. It increased, at constant money value, by approx. 20% from 1970.

1.1.5. The innovations that have been introduced in agriculture have attempted to respond to changed requirements in: agronomy and animal production (machinery satisfying requirements originating from various types of production), economics (machines meeting the need to in-crease work productivity and the timeliness with which various operations are carried out), ergonomics and worker safety.

All of this has mainly concerned agri-cultural production on flatland, herbaceous crops (grains, forage, industrial crops), cultivation operations for fruit tree crops and cattle, swine and chicken stock farms. On the other hand, mechanization for the harvesting of fruit tree and vegetable crops, for sloped surfaces and for sheep and goat stock farms is still inadequate.

Development in this area has mainly been based on mechanical reproduction of work originally done by hand, with significant improvements in some cases. At-tempts have only recently been made to increase operator comfort and safety and to come up with more radical innovations for systems or based on automation.

Although this path had to be followed inevitably and is full of valid results that have brought Italian industry to the top of the world of manufacturing, its limitations have become clearer in the past few years.

Indeed, research into advanced innovation has been neglected to some degree in the following cases: machines designed on the basis of highly innovative concepts, definition of mechanization systems in which the relationships between various machine components are optimized, and the use of physics and advanced engineering in this field.

Moreover, it should be noted that industry has almost never been spurred on by agriculture. The agricultural world has mainly aimed at solving incidental problems rather than developing a comprehensive vision of the future and its requirements.

1.2. *Prospects for Future Requirements*

1.2.1 With respect to the current situation, the prospects for development in Italian agriculture over the next 20 years appear to be connected with the following problems:

– on the *socio-economic level:* stability or a slight decrease in the total population; a significant reduction in the population working in agriculture (probably on the order of 50% with respect to cur-rent values); average annual GNP growth between 2.5 and 3.5%, and further growth in the service sector;

— on the *agricultural level:* a reduction in cultivated areas and an increase in extensive cultivation with a decrease in areas used for grain, forage and vineyards gradual elimination of price supports for agricultural products on the part of the E.E.C; the need to maintain (or better still, increase) the current average level of the income-cost differential by ensuring the economic competitiveness of crops and animal pro-ducts; the development of crops for the production of raw materials for non-food purposes and for industrial transformation; decreased chemical inputs; application of the results of biotechnological re-search; improvement in the quality and sanitary level of products, and development of mechanisation services;

— on the *general level:* protection of the environment and rural areas, and development of energy sources (at present, 90% of Italy's energy requirements are met by foreign sources), especially in light of the gradual exhaustion of oil sources;

— on the *industrial level:* increasing competition among companies because of the gradual internationalization of market: the need to produce at lower costs, partially based on a strong stimulus to-wards specialization and the concentration of groups of companies; improvement in product quality.

1.2.2. In this context, it is clear that we must consider what, where and how to

cultivate (everything from biomass for energy to that from fibers and for industrial use), and how to reduce production costs in order to ensure the required level of profitability for agriculture.

In mechanical and agricultural terms, at the very least all of this suggests that there is a need for significant innovation, on both the construction and applicative level, aimed at:

— reducing the production costs of machinery (15-20%);

— decreasing the costs of carrying out various operations in the field and at the farm (40-50%);

— completing mechanisation for sloped areas and of production cycles which are currently under-mechanised;

— designing mechanisation for new crops which have food, industrial and energy uses;

— developing technologies designed to maximize product quality and animal health while protecting the environment.

1.2.3. *A reduction in the production costs of machinery* as such is linked to the following requirements:

— definitive standardization of various machine models as well as their components in order to get the most out of the economies of scale resulting from the in-crease in standardized production to be reached also through a progressive concentration of manufacturing units;

— rationalization of machine design (especially in the case of implements and agricultural machines), including optimization of dimensioning and a thorough analysis of the possibility of using new materials with improved mechanical and physico-chemical properties;

— Analysis of the real possibility of producing machines with less gradual and more uniform technological obsolescence so as to guarantee increased productive flexibility in agriculture.

1.2.4. *A reduction in the costs of carrying out various operations* will require:

– improvement in the qualitative and quantitative performance of various machines and chains of machines;

— identification of new solutions with an improved input/output ratio;

— extended use of electronics and artificial intelligence;

— modification of cultivation systems;

— identification of solutions to improve product quality;

— definition of differentiated and optimized mechanisation for agro-mechanical enterprises and large farms, on the one hand, and routine operations on small and medium-sized farms on the other;

— the possibility of increasing added value at the farm level.

1.2.5. *New mechanization requirements* will be based on assisting:

— new crops, with special reference, to fiber products, those that are part of the chain of production of silkworm cocoons and those for energy and industrial uses (oils, essences, etc.);

— sloped areas, especially those used for animal and grain production as well as specific fruit trees (hazel and chestnut trees, etc.);

— automation of some farm operations, especially milking, and gradual computerized management of all operations typical of stock farms, as well as operations at seedbed nurseries and for transplants;

— automated, integral mechanization of the harvesting of some fruit tree and vegetable products for use as food, with gradual ripening.

Finally, the possibility of application of advanced physics to both mechanization and, more generally, qualitative and quantitative improvement of vegetable and animal products, with a consequent reduction in costs, should also be considered. This, in particular, means the development of: sensors; vision systems; robotic systems; artificial intelligence, modelling etc..

Table 1.1. - Italy: economic and social indicators

Indicators		Years 1970	1980	1988
Total population	(millions)	54,140	56,500	57,500
Active population	(%)	55.2	54.9	54.6
Working population	(millions)	19,900	20,487	20,742
	(%)	36.7	36.2	36.0
Engaged in				
— agriculture*	(%)	18.2	14.2	10.0
— industry	(%)	38.9	37.6	33.5
— other activities	(%)	42.9	48.2	56.5
Gross Natl. Product (at 1970 prices)	(M US$)	104,800	142,590	158,470
Agricultural area used	(M ha)	17.8	16.5	15.5

* Including farm owners, farmers and wives

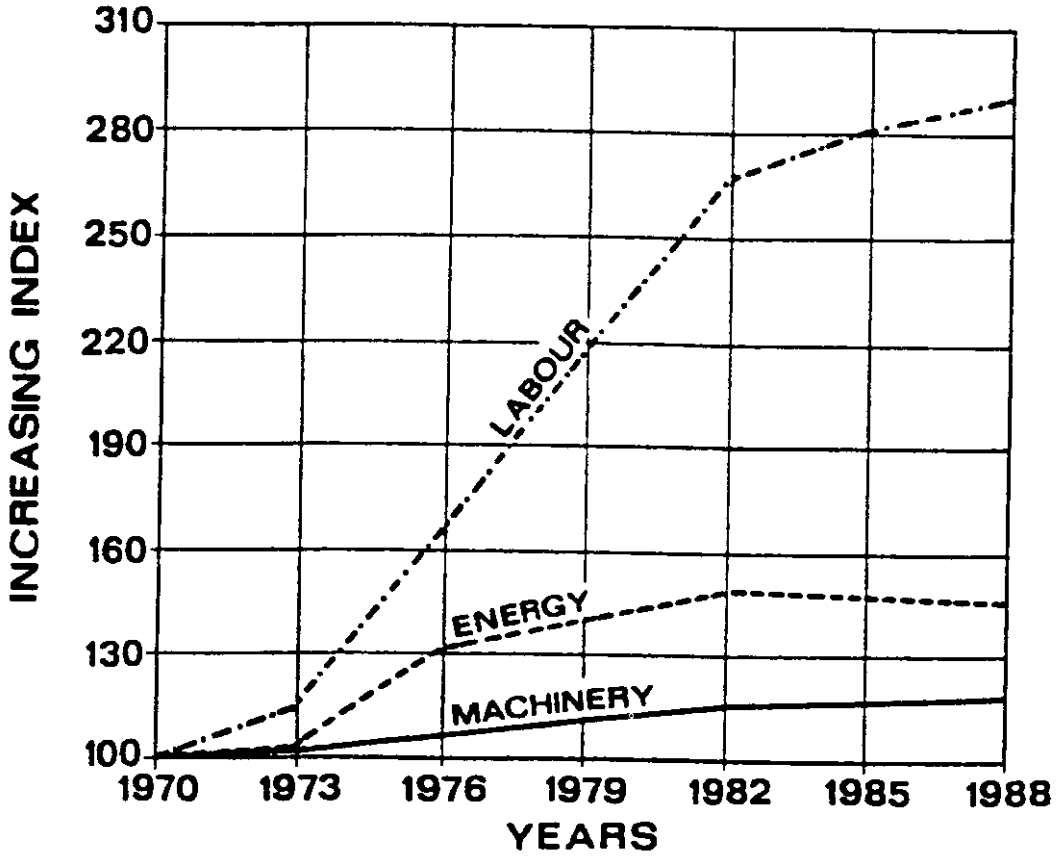

Fig. 1.1. - Increasing of labour, energy and machinery prices payed by farmers in relation to the prices of agricultural products payed to farmers

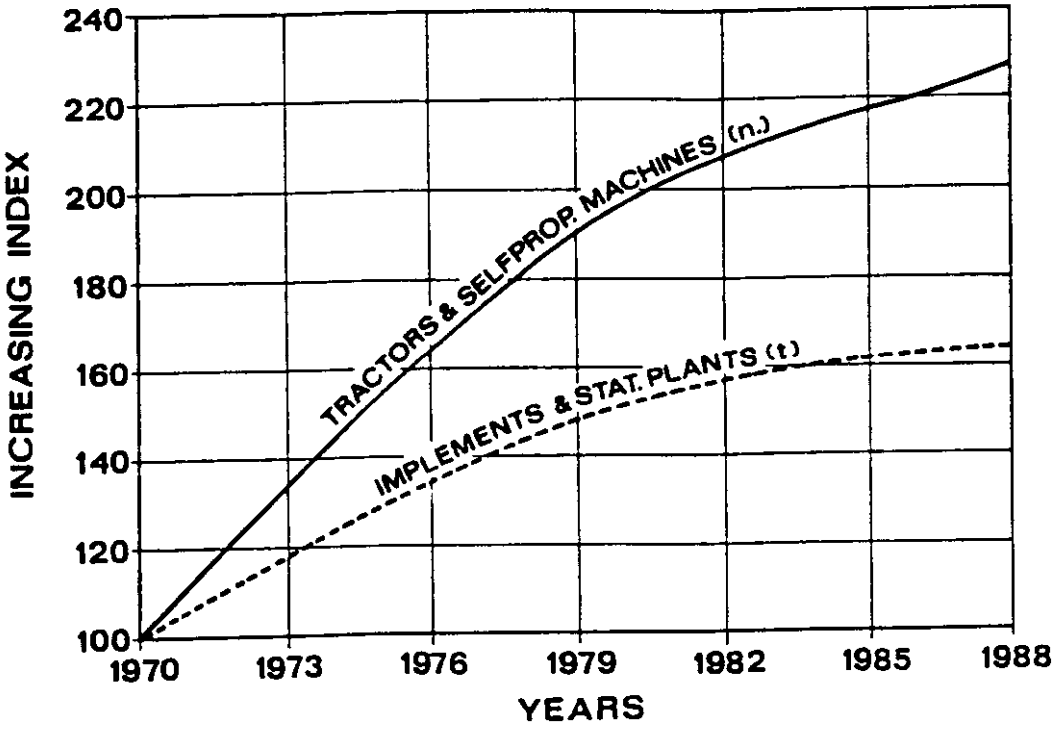

Fig. 1.2. - Development of tractor and agricultural machinery fleet in Italian Agriculture

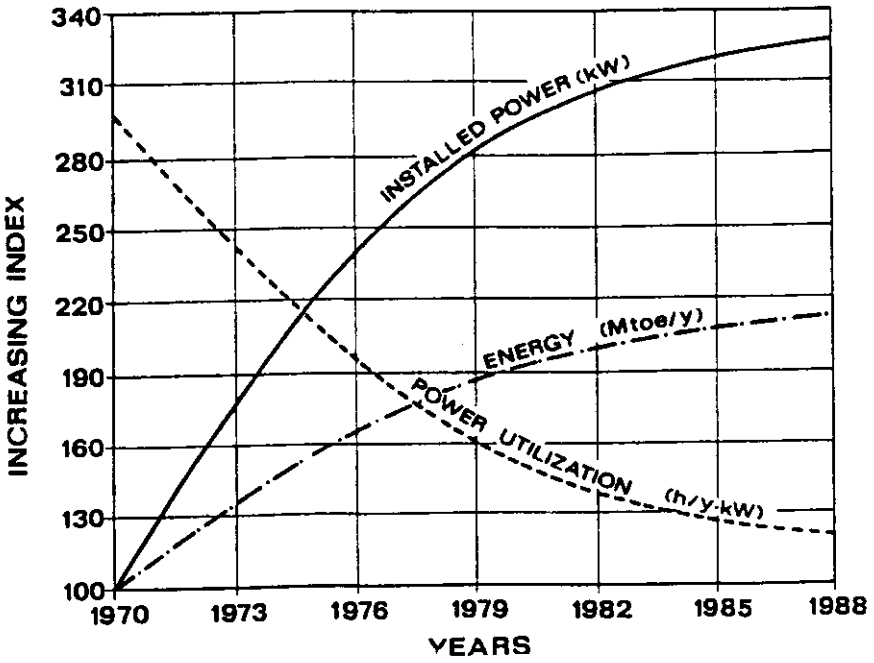

Fig. 1.3. - Development of installed power, energy consumption and power utilisation in Italian Agriculture

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In addition to the four analyses presented I am pleased to inform you that Dr. O.S. Marchenko (USSR) would like to briefly report on the present situation and the future requirements of the development of agriculture and mechanisation in USSR. Due to the interest of the subject I think it useful to invite Dr. Marchenko to take the floor. Moreover I am pleased to inform you that Prof. Hua Guozhu, of the Chinese Academy of Agricultural mechanisation Sciences (Beijing), sent us a short re-port on his country. This report will be included in the proceedings of this meeting.

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Agriculture and Mechanization in the USSR

1. Development of Agriculture and Mechanization Over the Past 20 Years

1.1. Since 1970 the population of the country has increased approximately by 17%, while the rural populations has de-creased from 44% down to 34%. The number of working people and members of their families in agriculture has decreased approximately from 30^{0}7o down to 22% of the total population (Table 1).

Gross National Product (GNP) in actually functioned prices, as well as Gross Agricultural Output (GAO), has almost doubled. National Income has doubled, and Agricultural Income has increased by 1,9%.

1.2. Table 2 represents the data concerning the area used for agriculture (AUA) and its distribution between collective farms, state farms and other land users, including by-work farms of enterprises, organizations and institutions, as well as individual by-work farms.

The data concerning the number of collective farms, state farms, interfarm enterprises and by-work farms and their ave-rage sizes are reported in Table 3 in order to characterize the main producers more completely.

The largest areas of agricultural land are appointed to state farms, the average size of which have decreased from 20.8 thousand ha down to 15.6 thousand ha, in connection with the growth in the number of state farms from 15.0 up to 23.3 thousand, 1970-1987 (Table 4).

The average size of collective farms has changed negligibly (6.1...6.3 thousand ha) but the number of collective farms reduced from 33.0 thousand down to 26.6 thousand.

Small size by-work farms which number 21.9 thousand have, on an average, 200-260 ha of the area to be used for agriculture and about 80-90 ha of the area under crops.

The data concerning individual by-work farms will be reported further on.

In connection with positive changes in the country, the possibilities of extending forms of land use, organization of small-size farms and rent and family collectives are being considered. This will demand specifying the technical policy in relation to providing them with corresponding means of mechanization. New forms of farming not financed by the State are being introduced into agriculture.

From the beginning of 1988, 53 agro-industrial combined manufacturing units, 21 agro-industrial formations and 25 agro-firms were formed.

Over the above period, the production of main farm products increased by 13% (grain), by 40% (vegetables), 53% (meat) and 200^{0}-lo (eggs). The production of potatoes decreased by 22% (Table 5).

Some increase in crop (Table 6), increase of livestock and poultry population (Table 7), increase of average annual milk production per cow by 19%, at the level of 2508 kg in 1987 (while, in advanced

farms, index amounts to 6000 kg) have been achieved.

Direct human labour expenditures to produce 100 kg. of farm products in collective and state farms over the period from 1970 up to 1987 were reduced: doubly on sugar beets; 1.5, on beef and grain: six times on eggs; 1.3, on milk (Table 8).

The main data concerning the development of individual by-work farms are re-ported in Table 9. The areas under crops of individual by-work farms amount to about 4 million ha., cows, pigs, sheep/ goats and rabbits — plus 81.5 million poultry — plus 383 million.

Individual farms provide approximately 22-25% of meat, milk, eggs and vegetables and more than half the production of potatoes.

Over the above period, the rates of growth of labour productivity in agriculture, in comparison with 1970, amount to 16% in 1980 and 43% in 1987.

As a whole, our agriculture does not completely satisfy internal demand as far as agricultural products for food and industrial purposes are concerned.

1.3. Unsolved problems of complex mechanization for producing agricultural products in the country are connected with the incomplete state of technological complexes with machines of high output, in-sufficient scales of introducing intensive resource-saving technologies and technique supply and the necessity for increasing reliability and technical level of agri-cultural machines produced by our industry.

The data characterizing the rates of satisfying a machine and tractor fleet with agricultural techniques and its annual sup-ply over 1987, are reported in Table 10.

The normative demand for tractors as a whole is satisfied by 75^{0}7o: wheeled tractors "Belarus", by 53%: 12-30 kW tractors, by 80%; trucks, by 58%: tractor ploughs, by 63%: drills, forage harvesters and balers, by 56%.

Machines for producing cotton, sugar beets, vegetables, potatoes, grapes, fodder root crops and technical crops concern only 10% of the arable area while 35^{0}7o of all human labour expenditure in crop production spent to produce them increase slowly.

The level of mechanization in crop and livestock production is given in Table 11.

The main field operations (plowing, planting of grain, cotton, sugar beets and the harvest of grain and forage crops) are completely mechanized.

At present (1989) mechanical potato harvesting makes up 55%, cotton harvesting by combines, 45%.

On the first of January 1988, the main agricultural production funds reached 32 billion roubles in comparable prices, the cost of main funds per agricultural worker was 14.4 thousand roubles and the cost of main funds per 100 ha. of the area used for agriculture, 603. thousand roubles.

In 1988, the installed power per agricultural worker reached 25.4 kW, while in Great Britain it is 55 kW, in the FRG 48 kW; about 276 kW for 100 ha of arable areas in collective and state farms. For our conditions, the rated installed power must be equal to no less than 44 kW per worker or 3.9 kW per ha of arable land.

1.4. The multi-branch structure of collective and state farms, the low level of specialization, the lack of high productive species of main crops and breeds of animals, the lack of conveyor (production li-ne) technologies and the combined multi-operational techniques, all create additional difficulties in completing complex mechanization. They require an increase in demand for machines and operators and do not permit reduction in labour expenditures significantly for producing main kinds of agricultural products.

So direct human labour expenditures to produce 100 kg of grain in the USSR re-quire 1,1 man hours and in the USA 0,15 man hours (in advanced farms of our country, 0,52 man hours; to produce 100

kg of raw cotton, 32 and 2.0 man hours, respectively; sugar beets, 0.8 and 0.1; potatoes, 2,3 and 0,25; beef, 36 and 2,2; pork, 22 and 0,66 and so on). The difference in labour productivity in the USSR and the USA is 6-10 fold and more.

Against the background of the existing deficiency in agricultural technique and its insufficient reliability for answering the needs of collective and state farms regarding techniques at existing levels of labour and material resources and present machine building production capacities, the problem cannot be solved without carrying out radical changes in the whole agro-industrial complex on the modern technological and technical base.

2. Some information on the tendencies of forage harvester development and the use of existing and new tractors.

The analysis of the structure of the farm tractor fleet (Table 10) shows that USSR tractors are usable only to some degree in combination with prospective forage harvesters.

31% of the tractor fleet is track-type tractors of 2, 3, 4 and 6 tons of drawbar pull with 38...118 kW engines (Fig. la).

The power of the most part of the wheeled tractors is in the range of 44 up to 59 kW (Fig. lb). The tractors are combined with trailed mower-choppers (Fig. lc) which amount to approximately 54% of the total amount of forage harvesting ma-chines.

Trailed forage harvesters (24%) are mostly combined with tractors of 30 kW of drawbar pull with 110 and 114 kW engines.

Wheeled tractors of 5 tons of drawbar pull with 198 kW engines are not used for combination with the existing forage harvesting machines.

Approximately 21% of the forage harvesting machines are self-propelled forage harvesters KCK-100A with 147 kW engines and E-281 (DDR) with 125 kW engines as well as less than $1^{0}{}_{10}$ — self-propelled track-type forage harvesters KC — 3,2 with 74 kW engines and hoppers.

In close perspective, self-propelled forage harvesters will be changed for a new forage harvesting complex "Polesje" ma-de on the base of the disengaged integral all purpose power unit of increased power - 184,206 and 220 kW (Fig. lc).

If we take into account the necessity of harvesting the forage crops at high nutrition stages and at high yields in the shortest time, we need a powerful energy unit and a harvester which will allow us to pre-pare high quality forage, especially if we need to cut the corn stem and grain into small pieces with full crushing of the grain.

Fig le shows the trend of the development of self-propelled forage harvesters in DDR, the U.S.A., Italy and FRG which also underlines the steady increase of their engine power.

"Fiatagri" (Italy) produces self-propelled harvesters of high output "Hesston" 7715-7720-7725-7730, the engine power of which is 176,220,254 and 257 kW respectively; "Ford - new Holland" (USA) - models "New Holland" - 1800, 1900, 2200 (162, 206, 250 kW); "John Deere (USA) - models 5730 and 5830 (165 and 207 kW); "Mengele" (FRG) - models SF-5200, SF-6000, SF-65000 and SF-7000 (206, 243, 265 and 320 kW); "Class" (FRG) - models "Jaguar" 685 SL, 690 SL, 695 SL (184, 232 and 260 kW).

The main distinctive features of new harvesters are as follows: a powerful engine, a quickly and easily dismantable drum type cutting head and the possibility of fitting a mounted system in its place to aggregate any kind of machines and equipment in order to use them the who-le year round.

Self-propelled forage harvester constructions are being designed with the aim of increasing operating speed and operating width that also ensures a high capacity of the cutting units and a high quality of forage chopping when the engines

are so powerful. Constructions include quickly removable feeding-cutting modu- les, automatons for blade sharpening, me- tal detectors, units for additional corn grain crushing (grain of complete and wax ripeness). Practically all the self-propelled combines with 147 kW and more power- ful engines, have front and driving axles, and a hydrostatics transmission.

Reversible tractors such as "Intrack". "MB-Track", "Unitrack", "Robotrack" and so on, find expanding applications for front aggregating of rotor mower-swath makers, mower-conditioners, rotary rakes and mounted forage harvesters.

The use of integral scheme reversible tractors (front and rear mounted system and power take off shafts) for forage harvesting provides the possibility for one operator to carry out for one run, different technological processes based on combining; for example, such operations as mowing, picking up, chopping, loading, transportation and distribution of additional green food on outdoor plots; raking of slightly dried grass in a swath, picking up, baling and putting bales on a piler-baler-accumulator-transport means with subsequent pile placing at an edge of a field; mowing and crushing of wax ripeness corn with complete crushing of grain, loading of cut mass into transport capacities trailed behind a forage harvester, transportation of it to a place of re-hitching or re-loading and so on.

The application of mounted forage har-vesters on the base of reversible tractors with 132...147 kW engines does not apparently solve the problem of forage harvesting in the shortest time. Insufficient power of these tractors and absence of a variable speed transmission are the causes of their relatively low output for forage harvesting. They are characterized by such disadvantages as low longitudinal stability with a mounted harvester, high specific pressure on soil, insufficient vi-sibility of working tools and difficult steering of a silo-tube because of a central tractor cab arrangement.

In our opinion, the most progressive conception is a completely disengaged four wheel driven integral power unit with a hydrostatic or hydro-mechanical transmission with quickly mounted forage harvesters, transport capacities for chopped forage and other agricultural machines. The integral scheme of this power unit provides the possibility of using it for obtaining in-line reloading, without re-loading technologies, for carrying out harvest-transport operations, the combination of different technological operations as tilling and drilling, as loading manure, as taking out fodder and other operations, including road-communal works that pro-vide the possibility for using this all-purpose power unit the whole year round.

The use of powerful, light-weight energy means (the drawbar pull capacity of its driving wheels is limited) provides the possibility of reducing significantly any ad-verse effects of the wheels on the soil and the decrease of soil compaction. The integral scheme of such energy means provides the possibility of reducing the mass of mounted farm machines, of improving their mounting ability, of combining ma-chines with active working tools which do not create draft resistance and therefore do not damage the soil structure by the driving wheels.

This provides the possibility of significantly increasing labour productivity, together with limited expenditures for material and fuel resources.

For creating reversible tractors and energy means, especially of increased unitary power, it is necessary to take into consideration the possibility of combining technological and transport operations in-to a single process, a quick changing of an arrangement scheme which meets technological and technical requirements placed upon the forage harvesting technique.

This will widen possibilities for powerful tractors and energy means used with forage harvesters and other machines, and make their usage more effective by carrying out the modern technologies of agri-

cultural crop production. This provides the possibility of making a radical turn in the development of driven and draft-driven concepts and forcing out a draft concept from agricultural mobile energetics.

References

[1] "The USSR Agriculture", USSR Goscomstat, "Finance and Statistics", M., 1988.

2] "USSR National Economy Over 70 years", USSR Goscomstat, "Finance and Statistics", 1987.

3] "Foreign Forage Harvesting Techniques", — "Mechanization and Electrification", N12, M. 1989 (V/O "Agropromizdat")

Table 1. - Population and average annual quantity of workers engaged in agriculture, Gross National Product and National Income

	1970	1980	1987
Total population (millions)	241.7	264.5	281.7
including agricultural population	105.7	98.3	95.7*
Engaged in all the branches of agriculture (millions),	27.0	26.0	25.4
including			
in collective farms	17.0	13.5	12.4
in state farms	10.0	12.0	12.6
in interfarm enterprises	0,0	0,5	0,4
Enrolled workers from other enterprises and organizations	0.6	1.3	1.4
GNP (billion roubles)**	643.5	1078.5	1425.8
including agriculture	103.8	152.6	232.6
National Income (billion roubles),	289.9	462.2	587.4
including agriculture	63.1	68.9	121.2

* - In 1987 agricultural working people and their dependents made up 22% of the total population of the USSR
** - According to the official course, 1 US$ = 0.65 rouble

Table 2. - Total land area of the USSR and distribution of the area used agriculture (AUA) by the end of 1987

	Total land area	Total AUA	Including		
			arable land	hayland	pastures
Total area (million ha)	2227.6	605.0	228.2	39.4	333.2
Area used for agriculture,	1049.6	556.7	227.5	33.4	290.7
including					
collective farm land	244.3	173.3	102.0	10.8	58.9
state farm land	797.8	377.6	122.1	22.2	230.0
State land reserve and forest organizations	1107.0	30.2	0.4	5.1	24.7
Other land users,	71.0	18.1	0.3	0.9	16.8
including by-work farm of enterprises, organizations and institutions	5.2	5.2	1761*		

* area under crops, thousand ha

Table 3. - The number of agricultural enterprises and farms, by-work farms of enterprises, organizations and institutions

	1970	1980	1987
Collective farms, including those whithout fishing	33.6 33.0	26.3 25.9	27.0 26.6
State farms	15.0	21.1	23.3
Interfarm enterprises and organizations	4.6	9.6	7.2
By-work farms of enterprises, organizations and institutions	—	no data	21.9

Table 4. - Average sizes of collective and state farms

	1970		1980		1987	
	Collect farms	State farms	Collect farms	State farms	Collect farms	State farms
One collective farm has AUA (thousand ha)	6.1	20.8	6.6	17.2	6.3	15.6
including						
area under crops	3.0	6,2	3.7	5.3	3.5	4.7
beef cattle	1258	1944	1844	1906	1904	1863
including cows	409	669	621	645	581	568
pigs	891	1116	1085	1120	1066	1168
sheep/goats	1633	3607	1755	3281	1650	2923
Tractors	29	54	41	57	45	55

Table 5. - Production of main agricultural products

	1970	1980	1987
Gross yield of crops, (million t)			
Grain	186.8	189.1	211.4
Raw cotton	6.9	9.1	8.1
Sugar beets	78.9	81.0	90.4
Potatoes	96.8	67.0	75.9
Vegetables	21.2	27.3	29.3
Products of livestock			
Meat (carcass weight), million t	12.3	15.1	18.9
Milk, million t	83.0	90.9	103.8
Eggs, billions	40.7	67.9	82.7
Wool (in physical weight), thousand t	402	443	461
Milk, average litres/yr	2110	2159	2508
Average annual wool clip of one sheep, kg	3.1	3.1	3.2

Table 6. - Average yields of main agricultural crops

	1970	1980	1987
Grain crops (t/ha), including	1.56	1.49	1.83
Winter wheat	2.28	2.21	3.02
Corn (grain)	2.80	3.17	3.23
Winter barley	1.80	2.13	2.66
Oat	1.53	1.32	1.57
Rice	3.65	4.19	4.08
Raw cotton	2.51	2.89	2.29
Sugar beets	23.9	21.8	26.6
Sunflowers	1.28	1.06	1.46
Potatoes	12.0	9.6	12.1
Vegetables	13.8	15.0	15.9

cultural crop production. This provides the possibility of making a radical turn in the development of driven and draft-driven concepts and forcing out a draft concept from agricultural mobile energetics.

References

[1] "The USSR Agriculture", USSR Goscomstat, "Finance and Statistics", M., 1988.

2] "USSR National Economy Over 70 years", USSR Goscomstat, "Finance and Statistics", 1987.

3] "Foreign Forage Harvesting Techniques", — "Mechanization and Electrification", N12, M. 1989 (V/O "Agropromizdat")

Table 1. - Population and average annual quantity of workers engaged in agriculture, Gross National Product and National Income

	1970	1980	1987
Total population (millions)	241.7	264.5	281.7
including agricultural population	105.7	98.3	95.7*
Engaged in all the branches of agriculture (millions),	27.0	26.0	25.4
including			
in collective farms	17.0	13.5	12.4
in state farms	10.0	12.0	12.6
in interfarm enterprises	0,0	0,5	0,4
Enrolled workers from other enterprises and organizations	0.6	1.3	1.4
GNP (billion roubles)**	643.5	1078.5	1425.8
including agriculture	103.8	152.6	232.6
National Income (billion roubles),	289.9	462.2	587.4
including agriculture	63.1	68.9	121.2

* - In 1987 agricultural working people and their dependents made up 22% of the total population of the USSR
** - According to the official course, 1 US$ = 0.65 rouble

Table 2. - Total land area of the USSR and distribution of the area used agriculture (AUA) by the end of 1987

	Total land area	Total AUA	Including		
			arable land	hayland	pastures
Total area (million ha)	2227.6	605.0	228.2	39.4	333.2
Area used for agriculture,	1049.6	556.7	227.5	33.4	290.7
including					
collective farm land	244.3	173.3	102.0	10.8	58.9
state farm land	797.8	377.6	122.1	22.2	230.0
State land reserve and forest organizations	1107.0	30.2	0.4	5.1	24.7
Other land users,	71.0	18.1	0.3	0.9	16.8
including by-work farm of enterprises, organizations and institutions	5.2	5.2	1761*		

* area under crops, thousand ha

Table 3. - The number of agricultural enterprises and farms, by-work farms of enterprises, organizations and institutions

	1970	1980	1987
Collective farms, including those whithout fishing	33.6 33.0	26.3 25.9	27.0 26.6
State farms	15.0	21.1	23.3
Interfarm enterprises and organizations	4.6	9.6	7.2
By-work farms of enterprises, organizations and institutions	—	no data	21.9

Table 4. - Average sizes of collective and state farms

	1970		1980		1987	
	Collect farms	State farms	Collect farms	State farms	Collect farms	State farms
One collective farm has AUA (thousand ha)	6.1	20.8	6.6	17.2	6.3	15.6
including						
area under crops	3.0	6,2	3.7	5.3	3.5	4.7
beef cattle	1258	1944	1844	1906	1904	1863
including cows	409	669	621	645	581	568
pigs	891	1116	1085	1120	1066	1168
sheep/goats	1633	3607	1755	3281	1650	2923
Tractors	29	54	41	57	45	55

Table 5. - Production of main agricultural products

	1970	1980	1987
Gross yield of crops, (million t)			
Grain	186.8	189.1	211.4
Raw cotton	6.9	9.1	8.1
Sugar beets	78.9	81.0	90.4
Potatoes	96.8	67.0	75.9
Vegetables	21.2	27.3	29.3
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