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inputs.⁸ In the example presented above the general expression for computing isocline is,

$$(-) \frac{a - 2b X_1 + e X_2}{c - 2d X_2 + e X_1} = - \frac{P_{x1}}{P_{x2}}$$

Use of Studying Production Function

The two main purposes of deriving or studying production functions of an enterprise are : (1) to compute physical input-output ratios to be used for guiding farmers in the use of agricultural practices, for use in budgeting, linear programming, and other types of analyses to indicate optimum farm organization or resource use ; and (2) to provide "benchmarks" or "yardsticks" of how efficiently resources are being used on farms under particular conditions.

The computation of the physical input-output ratios, usually involving physical production functions, can be used for specific farm policy recommendations. The second purpose regarding the provision for a benchmark, usually involving a most common production function of the type such as Cobb-Douglas, provides "diagnostic benchmark."

BRIJ B. KHARE*

DEVELOPMENT OF AGRICULTURE IN CZECHOSLOVAKIA

The development of Czechoslovak agriculture during the years 1949-1960 has received a fillip by the change-over to the socialist system of farming. The socialist sector in Czechoslovak agriculture increased relatively quickly especially in two stages ; the first between 1950-52 and the second between 1957-59. The number of unified agricultural co-operatives increased to an all-time high of 12,560 by the end of 1959. In 1960, 40 per cent of these co-operative farms were joined into larger economic units, so that their number decreased by the end of the year to 10,816. The extent of agricultural land farmed by co-operatives however increased to 12.28 million acres (the areas of arable land to 8.5 million), that is 67.3 per cent of the total agricultural land. About 15 per cent of the cultivated area was under state farms while other enterprises of the socialist sector accounted for only 5 per cent of the land. At the end of 1960 the state farms farmed 2.76 million acres of land.

8. The general form of isocline equation expressed explicitly in terms of one factor-input is,

$$X_2 = f(X_1, P_{x1}, P_{x2}).$$

$$\text{Also, } \frac{dX_2}{dX_1} = \frac{\partial Y / \partial X_1}{\partial Y / \partial X_2} = - \frac{P_{x1}}{P_{x2}} = - \frac{MPP_{x1}}{MPP_{x2}} = MRS_{x1} \text{ for } X_2.$$

The above marginal product ratio denotes how much of X_2 has to be given up to increase X_1 by one unit and maintain the production at the same level. The relationship, $\frac{MPP_{x1}}{P_{x2}} = \frac{MPP_{x2}}{P_{x1}}$, holds true at all points on an isocline, but at the optimum point,

$$MVP_{xi} = P_y. \quad MPP_{x1}/P_{x1} = P_y. \quad MPP_{x2}/P_{x2} = 1.$$

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Agricultural Production

Even though during the First and Second Five-Year Plans there was considerable increase in agricultural production, this growth was not satisfactory. Over the past ten years an average of more than 2 per cent annual increase in agricultural production was achieved. In the Third Five-Year Plan (1961-65) higher targets are laid down for agriculture. They are however realistic and can be fulfilled, because the co-operative farms are becoming economically stronger and are introducing the techniques of mass production. Besides, the state plays an important role in the development of agriculture. For instance, the total investment during 1961-65 is expected to be considerably larger than the amount invested in agriculture in the first two Five-Year Plans.

Crop Production

The crop pattern in the Czechoslovak Socialist Republic is gradually changing. The area devoted to root and technical crops which are profitable is being extended. The composition of the main crops in cropping pattern is shown in Table I.

TABLE I—PERCENTAGE OF LAND SOWN TO CROPS

	1955	1960	1965 (Plan)
Grain	52.7	50.8	51.7
Technical Crops	7.3	7.8	7.8
Potatoes	12.2	11.0	10.0
Vegetables	0.9	0.9	0.9
Fodder Root Crops	26.9	29.5	29.6

The average yield of crops per acre increased during the Second Five-Year Plan in the case of the majority of crops. For the Third Five-Year Plan, the anticipated increase is still greater as shown in Table II.

TABLE II—YIELD PER HECTARE (IN QUINTALS) OF PRINCIPAL CROPS

Crop	1955	1960	1965 (Plan)	Yield Index		
				1960	1965	1965
				1955	1960	1955
Wheat	20.4	23.1	27.0	114	117	132
Rye	18.9	20.5	25.0	108	122	132
Barley	20.1	24.7	26.5	122	107	132
Sugar Beet	285.1	347.0	327.4	121	94	114
Potatoes	127.3	92.3	180.0	73	198	141
Permanent Meadows ..	49.3	47.5	66.0	96	138	134

A considerable increase in gross production and marketable surplus is connected with the acreage yield. The total crop production and production for the market in Czechoslovakia are given in Table III.

TABLE III—TOTAL CROP PRODUCTION AND MARKETABLE SURPLUS (IN THOUSAND TONS)

	1955	1960	1965 (Plan)	Production Index		
				1960	1965	1965
				1955	1960	1955
Total Grain Production ..	5,261	5,906	7,081	112	119	134
Wheat	1,473	1,504	1,998	102	132	136
Barley	1,291	1,744	1,842	135	106	143
Maize for Grain	391	593	720	152	121	184
Potatoes	7,905	5,254	9,002	68	172	114
Sugar Beet	6,152	7,890	7,972	128	101	130
Fodder Crops calculated to Hay	11,175	11,196	14,867	100	133	133
Maize for Silage	326	1,424	2,688	425	189	824
Marketable Surplus* ..	1,599	1,640	1,805	102	110	112
Wheat	554	365	466	66	84	128
Rye	438	506	614	115	122	140
Malt Barley	477	660	630	138	132	96
Maize	31	30	35	96	116	112
Edible Pulse Crops	44	78	100	176	128	226
Potatoes	1,421	1,293	1,360	91	105	95
Sugar Beet	5,109	7,853	7,972	152	157	101
Hops (in 50 kg.)	101	146	194	144	133	192
Vegetables and Strawberries	412	572	742	139	130	180
Fruits	91	200	265	220	132	292
Grapes	18	13	55	68	300	439

* Under 1955 is the average for the years 1955-1957.

The measures taken in crop production are mainly aimed at increasing the production of crops valuable as fodder. For this reason the surplus of production of some crops for the market (e.g., wheat, potatoes and maize) may not increase in the Third Five-Year Plan.

Livestock Production

Livestock production in Czechoslovakia has had an upward trend over recent years, though it has grown unevenly. In the Third Five-Year Plan, larger increases in the number of farm animals and in the yield obtained from them are expected. The improved fodder bases and a further increase in the technology of mass production should help towards a substantial increase of livestock production for the market. The progress achieved in the number of farm animals during the first two Plan periods and that anticipated in the Third Plan is shown in Table IV.

TABLE IV—LIVESTOCK POPULATION (in thousands)

	1955	1960	1965 (Plan)	Index		
				1960	1965	1965
				1955	1960	1955
Total Livestock	4,107	4,394	4,800	106	109	116
Cows	2,084	2,065	2,300	99	111	110
Pigs	5,285	5,860	5,680	110	97	108
of which Sows	470	510	580	106	114	123
Sheep	1,000	680	600	68	88	60
Poultry	23,367	28,900	27,500	124	96	116

The population of cows has declined from 50.5 per cent of the total number of cattle in 1953-57 to 48.1 per cent in 1960 and is expected to decline further to 47.9 per cent in 1965. On the other hand, sows have increased from 8.4 per cent of the total number of pigs to 8.7 per cent and is expected to increase to 10.2 per cent during the same period. The density of livestock per 100 hectares of arable land during the three periods is given in Table V.

TABLE V—LIVESTOCK DENSITY PER 100 HECTARES OF ARABLE LAND

	1955-57	Number per 100 hectares	
		1960	1965 (Plan)
Cattle	55.8	59.7	66.7
Cows	28.2	28.2	31.9
Pigs	104.7	113.5	109.2
Sows	8.8	9.9	11.2
Poultry	327.7	392.9	381.9

Table VI gives the livestock production that is achieved in the *Czechoslovak Socialist Republic* during the first two plans and planned to be achieved in 1965.

TABLE VI—TOTAL LIVESTOCK PRODUCTION

	1955-57	1960	1965 (Plan)	Index		
				1960	1965	1965
				1955-57	1960	1955-57
Milk yield of one Cow per year (in litres)	1,707	1,800	2,350	105	130	138
<i>Average Live Weight :</i>						
Cattle for slaughtering (in kilograms)	383	397	417	103	105	109
Pigs for slaughtering (in kilograms)	104	101	88	97	87	85
<i>Number of Weaned Young :</i>						
Calves per 100 Cows	72.9	76.5	82.5	105	108	113
Piglets per Sow	10.5	10.2	12.1	97	118	115
Average Egg yield per Hen ..	100.7	102.3	134.0	102	130	132

Marketable Surplus

Table VII gives data regarding marketable surplus of main kinds of livestock products.

TABLE VII—MARKETABLE SURPLUS OF LIVESTOCK PRODUCTS

	1955-57	1960	1965 (Plan)	1960	1965	1965
				1955-57	1960	1955-57
				Meat Production (in thousand tons)	672.3	788.9
of which						
Beef	292.3	346.5	445.0	119	128	152
Pork	321.5	369.5	505.0	115	136	157
Poultry (meat)	10.9	25.7	32.0	236	124	294
Milk (in million litres) ..	1,834.3	2,312.3	3,455.0	126	149	189
Eggs (per head)	959.8	1,280.0	1,807.0	134	141	194

It may be noted that outturn of livestock products for the market has increased more rapidly than gross agricultural production especially as a result of socialisation. While the gross agricultural production increased by 11 per cent in 1960

as against 1955 (crop production by 7 per cent and livestock production by 17 per cent), the turnover of marketable surplus has increased in the same period by 28 per cent (crop production by 18 per cent and livestock production by 33 per cent).

A decrease in the share of marketable surplus in total production occurred during the Second Five-Year Plan only in those cases where their increased use as fodder had been planned. For instance, the percentage of purchase of the total production decreased in the case of wheat (from 36.6 per cent to 21.2 per cent), maize (from 7.6 per cent to 5.2 per cent) and potatoes (from 16.2 per cent to 14.6 per cent), whereas in the case of other crops intended mainly for human consumption, the share of purchase in the total production was increased (for instance, in the case of rye from 44.3 per cent during 1955-57 to 51.1 per cent in 1965, in the case of malt barley from 35.9 per cent to 37.3 per cent, in the case of pulses from 69.7 per cent to 82.1 per cent and vegetables from 45 per cent to 52.7 per cent).

The same is the case with animal production, where especially in the Third Five-Year Plan, a growth of the share of marketable surplus in the total production is anticipated.

TABLE VIII

Percentage of purchases to Production	1955-57	1960	1965 (Plan)
Total Meat Production	74.0	74.6	80.4
of which			
Beef and Veal	100.0	100.0	100.0
Pork	63.4	65.4	72.2
Poultry (meat)	18.9	28.3	39.0
Milk (plus farm butter)	51.7	61.4	64.3
Consumer Eggs	50.6	50.5	60.2

Measures to Augment Agricultural Production

Various measures are taken to ensure a steady increase in agricultural production. Large funds are granted to agriculture for investments, amelioration, purchase of means of mechanization, ensuring of technical development, research and the use of the newest discoveries of agricultural science in production, and for increased production of artificial fertilizers, etc. Attention is devoted to uncovering reserves, decreasing harvest losses, maximum use of mechanization, the introduction of progressive technology of agricultural mass production into all branches, the training of key personnel and their correct deployment.

Investment Outlay: The total investment in agriculture during 1951-55 amounted to 12.48 thousand million crowns; in the Second Five-Year Plan, 30.1 thousand million crowns were invested and in the Third Five-Year Plan, it is expected that the total investment would amount to almost 42.6 thousand

million crowns, which equals the whole amount invested over the past ten years. This would mean that in 1951-55, 1,733 crowns were invested into every hectare of farm land, 4,179 crowns in 1956-1960 and it is expected that in the Third Five-Year Plan this figure would increase to 5,915 crowns. About 65 per cent of the investment is intended for the unified agricultural co-operatives, and the remainder for the state sector, including the amount allotted for amelioration, which will be carried out for the co-operative farms by enterprises of the state socialist sector.

During the Third Five-Year Plan, it is proposed to construct cowsheds for 7,12,000 milking cows and for 1.5 million other cattle, pigsties for 285,900 sows and for about 1.8 million other pigs, provision of irrigation facilities for 81,367 hectares of land, draining of 199,761 hectares of land and intensive manuring of 93,150 hectares. Rivers and streams will be put in order over a length of 860 miles.

Mechanization of Agriculture : Although supplies of the means of mechanization of agriculture were large during the Second Plan, the number of machines and equipment delivered in 1961-65 will be much larger. A total of 1,11,760 tractors would be delivered of which 11,200 would be caterpillar tractors, besides, 10,000 lorries, 10,900 grain combines, 10,000 sugar beet combines, 5,000 potato combines, 27,500 silage combines, 20,000 reapers and binders, 11,000 threshers, 10,000 high-pressure presses, 152,780 trailer carts for tractors, etc. Table IX gives data on the progress of mechanization in agriculture during 1957, 1960 and 1965.

TABLE IX—MECHANIZATION IN AGRICULTURE

	1957	1960	1965 (Plan)
	Area Commanded Arable Land in Hectares		
1 Wheel Tractor (calculated at 15 HP) ..	116	72	34
1 Caterpillar Tractor	947	620	325
Trailer Carts per 1 Tractor	0.98	1.05	1.46
<i>Land Sown to Grain :</i>			
1 Grain Combine (hectares)	604	385	164
1 reaper and binder (hectares)	141	99	71
1 Thresher (hectares)	516	177	87
<i>Land Sown to Potatoes :</i>			
1 Combine	5,210	717	94
<i>Land Sown to Beet :</i>			
1 Combine	—	300	23
<i>Land Sown to Maize for Food :</i>			
1 Combine	563	318	40
<i>Land Sown to Maize for Silage :</i>			
1 Combine	42	23	13

These figures are valid for the socialist sector; the decline in the arable land or sown area is influenced by an increase in the areas of land in the socialist sector, especially in 1957-60. In regard to the deliveries of machines to agriculture, annual deliveries of tractors would be higher by 7.5 fold on an average during the Third Plan than in 1955, of beet combines higher by three fold, of threshers and harvesters by more than twice and of grain combines by 50 per cent. The progress of mechanization of the main agricultural operations is indicated in Table X.

TABLE X

	Extent of Mechanization (in per cent)		
	1957	1960	1965 (Plan)
Ploughing	58	80	95
Inter-row Cultivation	30	65	80
Sowing of Grain	43	76	88
Reaping of Grain by Combine	10	24	60
Reaping of Maize for Food by Combine	11	16	90
Reaping of Silage Crops by Combine	70	80	95
Sugar Beet Lifting by Combine	—	8	80
Potato Lifting by Combine	—	4	45
Loading of Stable Manure	—	24	85
Spreading of Stable Manure	—	10	85
Haycutting	52	80	90

Artificial Fertilizers: Annual consumption and production of artificial fertilizers have also tended to increase. While the consumption of fertilizers was only 160 thousand tons in the farm year 1949-50, it increased to 326 thousand tons in 1954-55 and to 500 thousand tons in 1960. By 1965, about 900 thousand tons of fertilizers would be used. During the Third Plan, production of artificial fertilizers is expected to increase to 33.76 million tons of which nitrogenous fertilizer (including ammonia) would amount to 10.15 million tons, phosphatic fertilizer 10.45 million tons and potassic fertilizer 13.15 million tons. The quantity of fertilizer used per hectare of farm land during 1954-55, 1960 and 1965 is shown in Table XI.

TABLE XI—UTILIZATION OF FERTILIZERS PER HECTARE OF FARM LAND

Quantity of fertilizer applied per hectare of farm land (in kilogram)	1954-55	1960	1965	Index		
				1960	1965	1965
				1954-55	1960	1954-55
Nitrogenous (incl. ammonia)	10.7	20.2	39.7	189	197	371
Phosphatic	12.2	20.4	37.6	167	184	308
Potassic	21.7	28.7	54.2	132	189	250
Total	44.6	69.3	131.5	154	190	295

In addition to fertilizers, large quantities of farm manure or compost have also been used in farm production. A national campaign for the production of compost in 1960 resulted in over 14 million cubic meters of compost.

New Technology of Production : The objective of increasing agricultural production is to be achieved mainly by the introduction of new technology on the farms. In livestock production the spread of new methods of stabling, specialisation and the use of mechanization are propagated. Much importance is attached to the training of farm people who tend cattle and poultry. In crop production, a systematic maintenance of the areas sown according to farm budgeting, agronomic—technical time limits in the preparation of the soil, in cultivating the crops and in harvesting which will guarantee high yields and full use of all means of mechanization are advocated. For instance, in recent years, in Czechoslovakia there has been more cultivation of soft wheats, which increase the fodder basis and the yield which amounts to on an average about 40-60 quintals per hectare. The new technology of harvesting is a great problem. To a large extent, two or even three-phase harvesting is being introduced. It is expected that in 1961 this will be carried out on 20 per cent of the total grain area, in 1963 on 35 per cent and in 1965 on 60 per cent of the total grain area. Closely connected with the mechanization of field work is the problem of reducing harvest losses, which at present amount to 6-8 per cent of the total harvest. For this reason a systematic fight is being waged in Czechoslovakia against harvest and storage losses and against pests, both in the case of grain and also other crops. Great stress is laid on the production of seedlings and high-yielding varieties of crops.

Conclusion

The tasks that Czechoslovak agriculture has set itself for the Third Five-Year Plan are very big. By 1965, it is proposed to produce on every hectare of arable land 1,230 kilograms of grain and 579 eggs and on every hectare of farm land 178 kilograms of meat and 746 litres of milk.¹ As compared with 1960, an additional 230 thousand tons of meat, 11 thousand million litres of milk and 528 million eggs would be purchased by the state.

The wide introduction of new technique and mass production technology in the socialist farms will play a decisive part in achieving these aims. It is especially important in view of the fact that the number of permanent workers in Czechoslovak agriculture has dropped in recent years. Whereas in 1950, 2.1 million permanent workers worked in agriculture, in 1955 the number had declined to about 1.8 million. By 1960 it further declined to 1.49 million and by 1965 it is expected to fall to 1.2 million. On the other hand, gross production per farm worker has tended to increase during the last decade. In 1960, it increased by 70 per cent as compared with 1950 and by 1965 it is expected to increase by 50 per cent as compared with 1960. All the measures taken in agricultural production will help not only to increase gross production and marketable surplus, but also to level out the differences between industry and agriculture.

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1. A litre is about one quart.

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