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COMPARATIVE OUTPUT AND PRODUCTIVITY  
OF U.S. AND SOVIET AGRICULTURE

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Kennan Institute

Comparative Output and Productivity  
of US and Soviet Agriculture\*

To satisfactorily cope with the advertised title of my talk would require much more than the allotted time today. Therefore, I propose to center most of my remarks on the comparative output and productivity performance of US and Soviet agriculture since 1950. Less time will be given over to a consideration of the future. Hopefully, during the discussion period, we can focus on some of the recent research findings for the US and USSR concerning growth potential for farm output. The hand-out material will be useful background for both presentation and discussion purposes.

The Agricultural Setting

Before turning to comparative productivity, it may be helpful for those who are not familiar with Soviet agriculture, to provide a few facts concerning the institutional and geographical settings.

Agriculture in the USSR faces severe environmental limitations. Because most of the sown area is climatically comparable to the Northern Great Plains area in the United States and Canada, the farmland of the USSR is less productive on the average than that of the United States. Moreover, although like these North American regions the USSR has had a

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\* I am greatly indebted to W. Lee Davis and Constance B. Krueger for research assistance in preparing this paper.

long history of wide cyclical swings in weather conditions, the fluctuation in Soviet grain yields is considerably greater. Improved farming practices, which have dampened such fluctuations in North America, have not been widely adopted in the USSR.

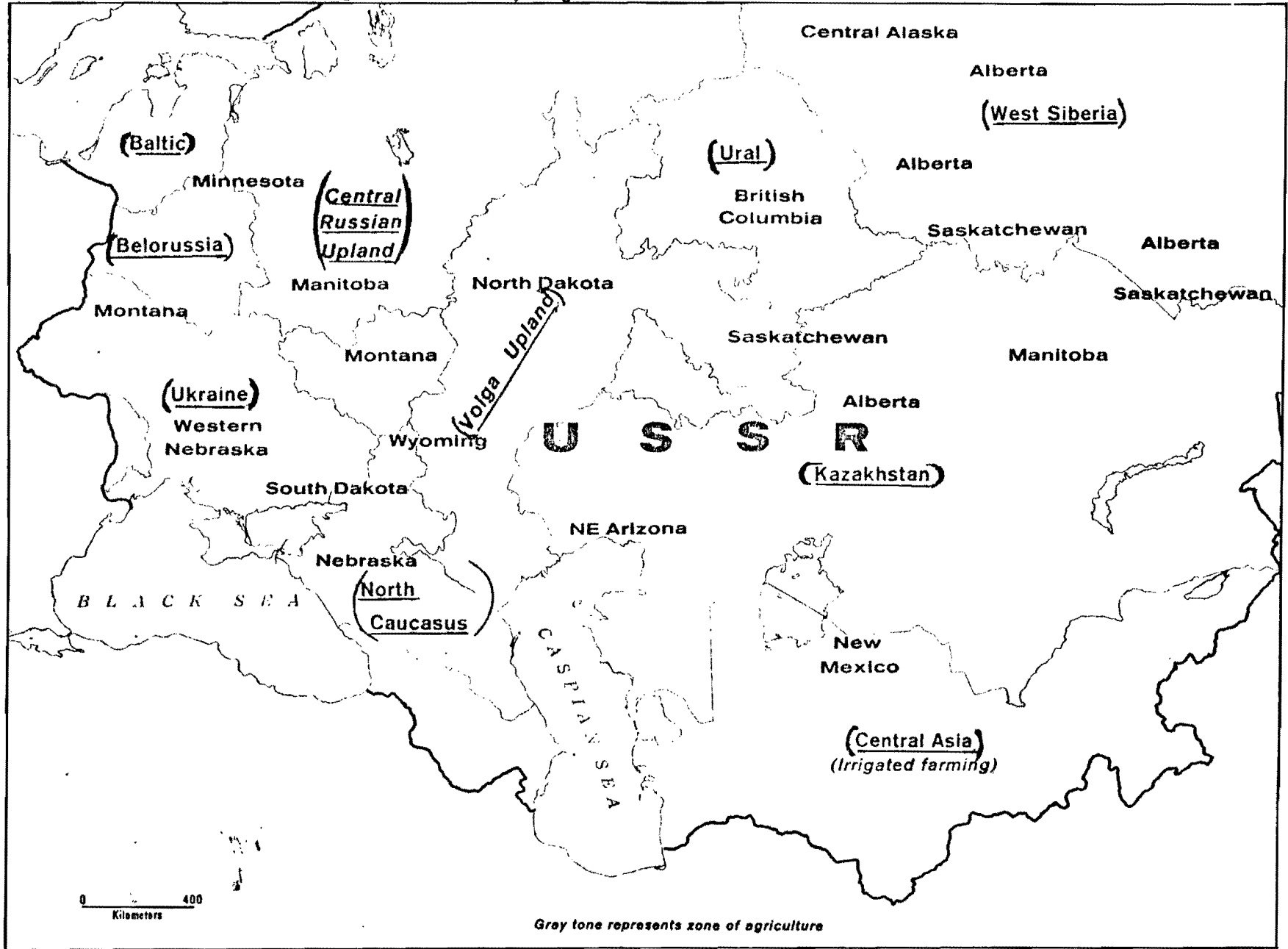
As in analogous areas in North America, the Soviet Union's agricultural land is relatively lacking in adequate amount of heat, moisture, and nutrients. More than 30% of the USSR is too cold for agriculture, and an additional 40% is so cold that only hardy, early-maturing crops can be grown. Only in the southern areas does the available warmth permit a wide range of crops.

The matching of North American climate analogs (as shown on the map, Figure 1) is a useful way of highlighting these environmental characteristics. Gale Johnson found from his study of comparable grain areas in North America that nine-tenths of the Soviet grain area could be fitted in six states and three Prairie provinces.

Not only are there differences between the environmental and technological resources of the US and the USSR institutional differences are also vast. The collectivization of agriculture in the USSR has resulted in the division of farm organizations into two sectors -- the socialized sector, which consists of state and collective farms and which accounts for three-fourths of agricultural production and the private sector, which

Figure 1

**North American Climatic Analogs for USSR Crop Regions**



consists of small private garden plots that account for the remainder of farm output.

The collective farm is organized nominally as a "producer's cooperative" whereas the state farm is organized along the lines of a state-operated industrial enterprise.

There are practically no individual peasants left. State and collective farmers are permitted to cultivate private plots of one-half to one acre and maintain one or two head of livestock. In addition, non-agricultural households frequently cultivate "victory-garden size" plots.

But clearly Soviet agriculture is dominated by the nearly 48,000 collective and state farms. The average indicators shown in Figure 2 are suggestive of the immense size of these enterprises.

#### Inputs, Output, and Productivity

I would like now to turn to the consideration of comparative productivity in the US and Soviet agriculture over the past 25 years.

Since 1950 Soviet farm output has more than doubled. Although progress has been uneven, the average annual rate of growth has been at a highly respectable 3-1/2% per year, more than double that of the US and above the 3% averaged for the rest of the world. As a result of this relatively rapid progress, Soviet output by 1974 was 85% of US farm production compared to roughly three-fifths in 1950.

(See Figure 3.)

Figure 2

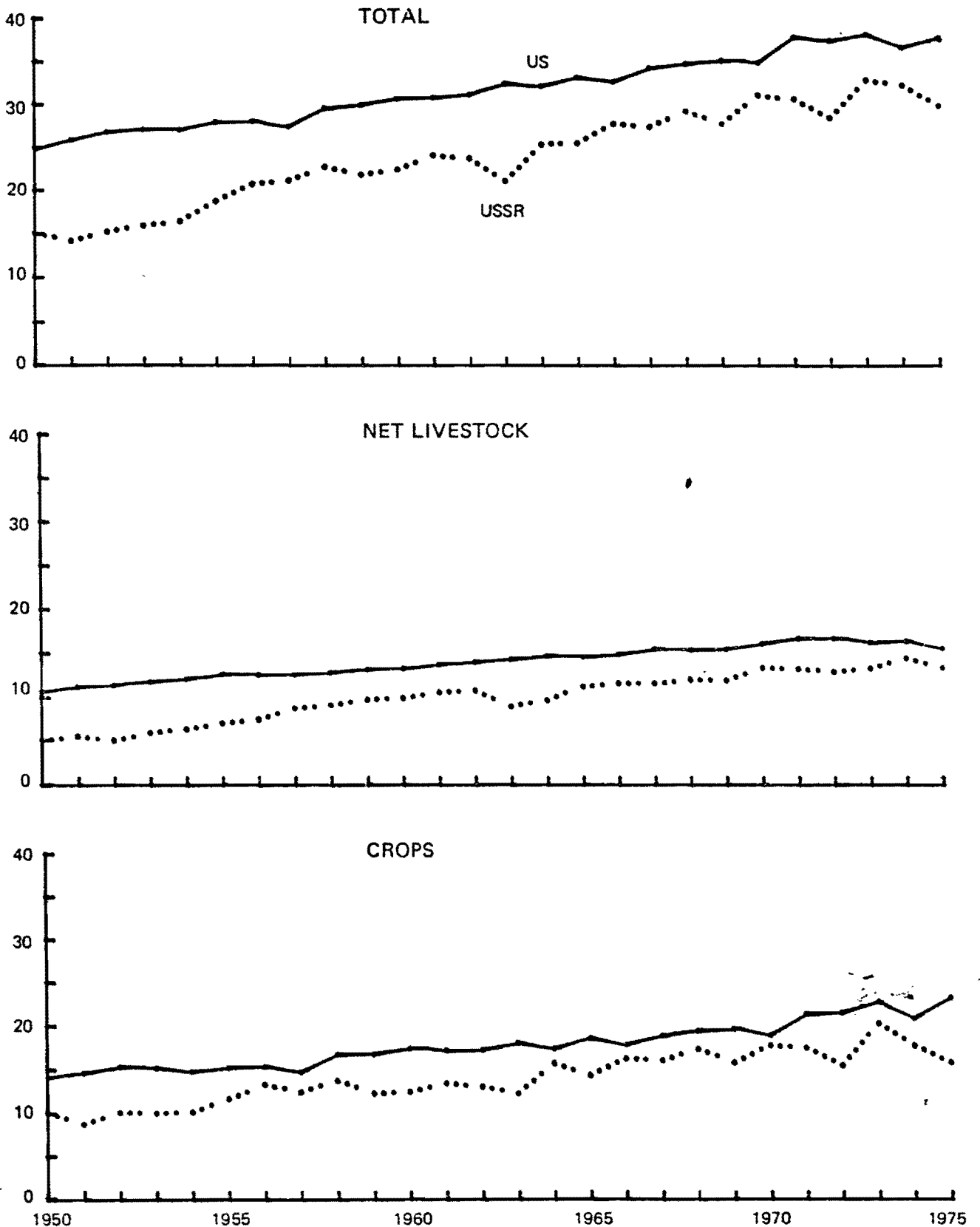
Average Size of State and Collective Farms  
1974

	(Per Farm)	
	<u>State Farms</u>	<u>Collective Farms</u>
Number of workers (annual average)	570	530
Sown area - hectares	6,000	3,300
- acres	14,800	8,150
Cattle	1,955	1,556
Hogs	1,156	1,089
Gross output per farm		
Thousand rubles -- (1965 prices)	1,700	1,300
Thousand dollars (1957-59 dollars)	750	570

Figure 3

US AND USSR: FARM OUTPUT, 1950-75

Billion 1957-59 US \$<sup>1</sup>



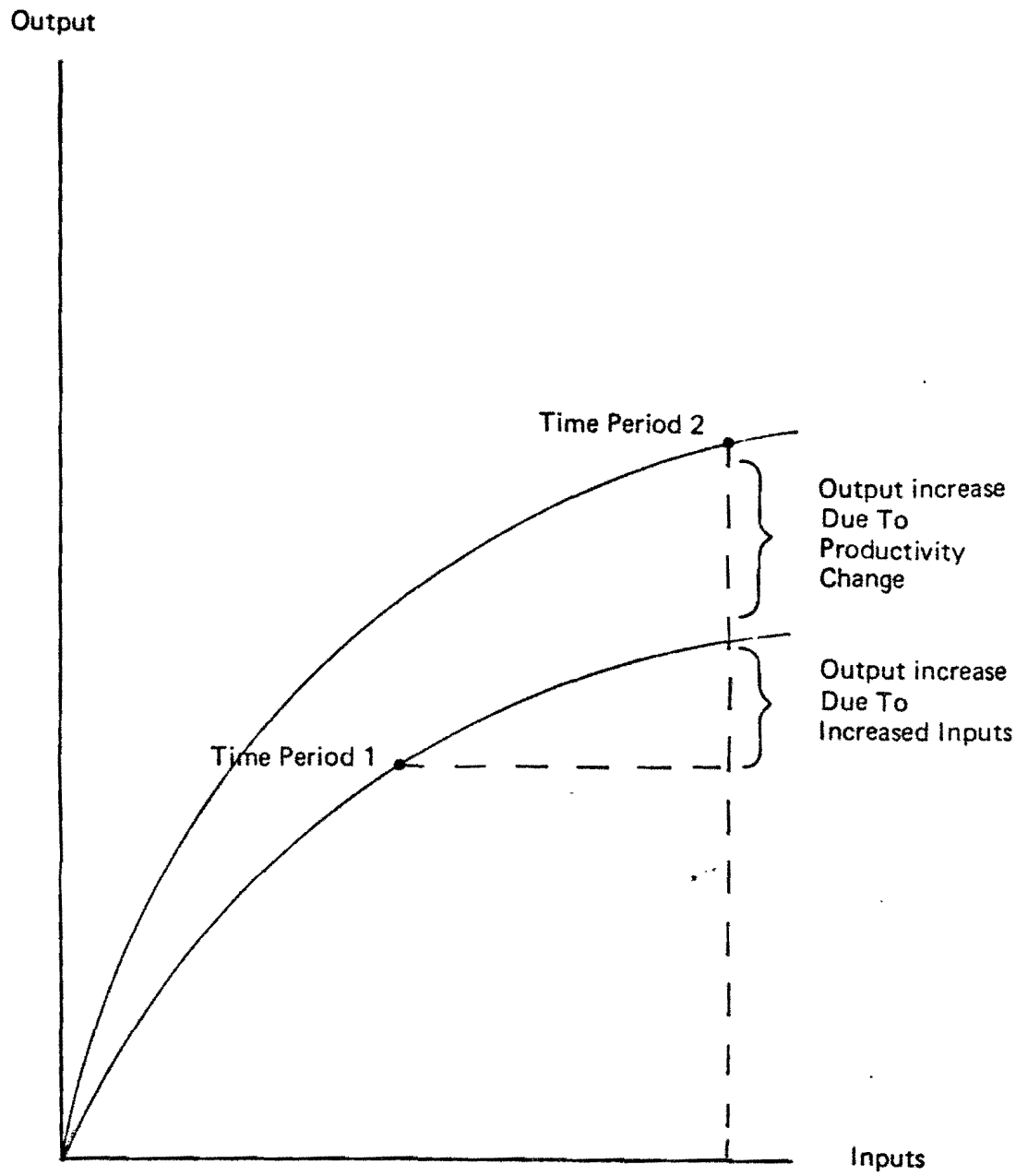
1. USSR data calculated from US output using the geometric mean of comparisons of USSR and US output carried out, alternatively, in dollar and ruble prices.



Also contrary to popular belief, the Soviet regime in this 25-year period has not neglected agriculture. Since 1950 annual inputs into farms have grown by three-fourths and have included costly programs that required heavy support from industry.

The difference between the 130% growth in output since 1950 and the three-quarters growth in inputs is, of course, the effect of the increased productivity of the resources devoted to agriculture. In the 1970s the combined productivity of land, labor, capital and other conventional inputs in agriculture has averaged more than a third greater than in 1950. This means that the package of resources used in agriculture would yield more than a third more output than the same resources used in 1950. For those not familiar with this partitioning of the sources of growth between increases in conventional factors of production and their productivity, the diagrammatic presentation in Figure 4 may be helpful. These "non-conventional" factors in explaining growth have rather intangible characteristics and include such divergent items as new technology, improved management, a higher level of training and material incentives. Nearly all of this gain in productivity occurred before 1970; in the first half of the 1970s increases in output have been attributable solely to additional inputs.

Figure 4



450-013

In contrast to the impressive growth of resource use in Soviet agriculture, inputs on US farms have remained virtually unchanged since 1950. As a result, nearly all of the 50% growth in US farm output is attributable to a boost in factor productivity.

The comparative trends in output, inputs and total productivity are shown in Figures 5 and 5A. Growth in total productivity in US agriculture averaged considerably above that of the USSR for the period under review (1.5% per year for the US compared to 1.0% for the USSR). As a result, while all of the growth in US farm production is attributed to a boost in productivity less than one-third of Soviet growth flows from growth in output per unit of input.

Figures 6 and 7 provide measures of comparative partial productivity for the two countries. While labor and land productivity are by themselves inadequate measures of production efficiency, these partial productivity indicators are helpful in answering questions pertaining to say, the rate of release of labor from agriculture to other sectors or the ability to increase productivity of the fixed factor of land.

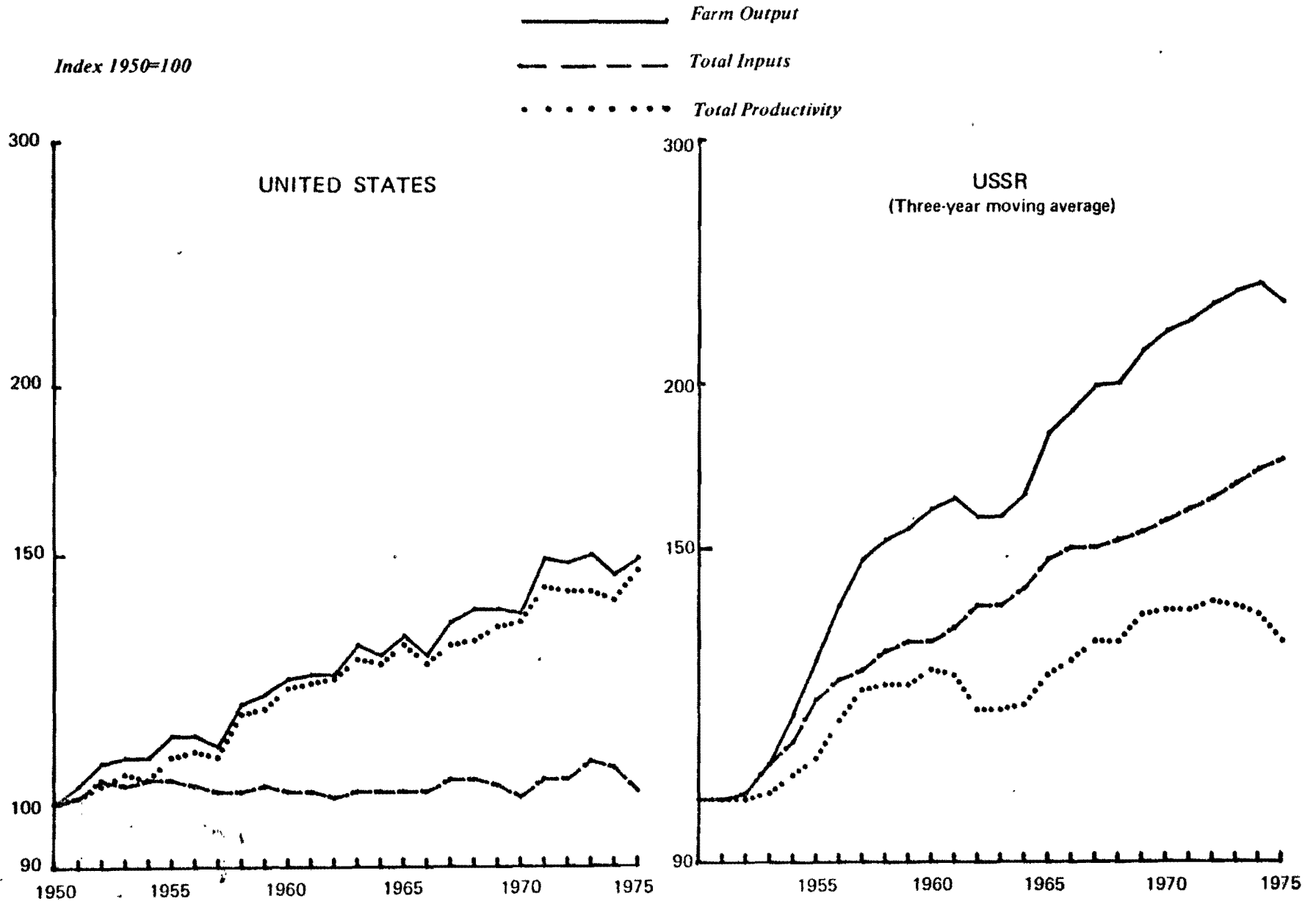
The data in Figure 8 compare labor inputs per unit of output for three crops and three livestock products in the Soviet Union and the US. A little later I will want to refer to this data with reference to comparative costs\*.

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\* A broader menu of comparative indicators is presented in Figure 8A.

US AND USSR: FARM OUTPUT, INPUTS, AND TOTAL PRODUCTIVITY, 1950-75

Figure 5



Output, Inputs and Total Productivity in Agriculture  
1951-75 a/

	<u>Average Annual Rate of Growth (Percent)</u>			
	<u>1951-60</u>	<u>1961-70</u>	<u>1971-75</u>	<u>1951-75</u>
		<u>USA</u>		
Output	2.1	1.1	1.8	1.6
Inputs	0.2	-0.1	0.2	0.1
Total productivity	1.9	1.2	1.7	1.5
		<u>USSR</u>		
Output (3 year moving average) <sup>b/</sup>	4.9	3.0	0.9	3.4
Inputs	2.7	2.0	2.0	2.3
Total productivity	2.2	1.0	-1.1	1.0

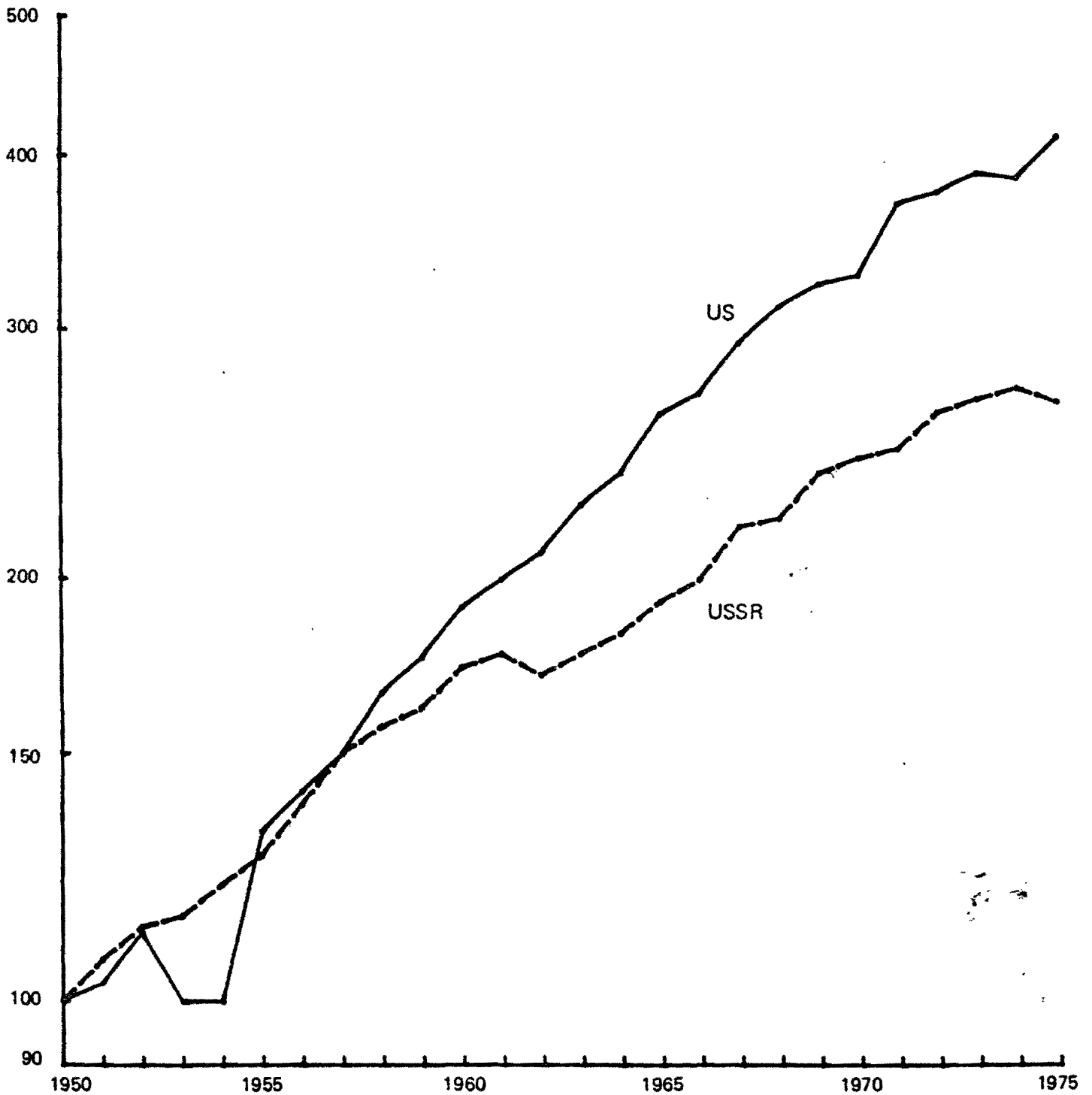
a/ The base year for the calculations shown is the year before the stated initial year of period.

b/ Because of wide annual fluctuations in Soviet agricultural production, a three-year moving average is used.

Figure 6

US AND USSR: PRODUCTIVITY OF FARM LABOR (OUTPUT PER MAN HOUR)

Index 1950 = 100



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US AND USSR: CROP PRODUCTION PER HECTARE

Index 1958 = 100

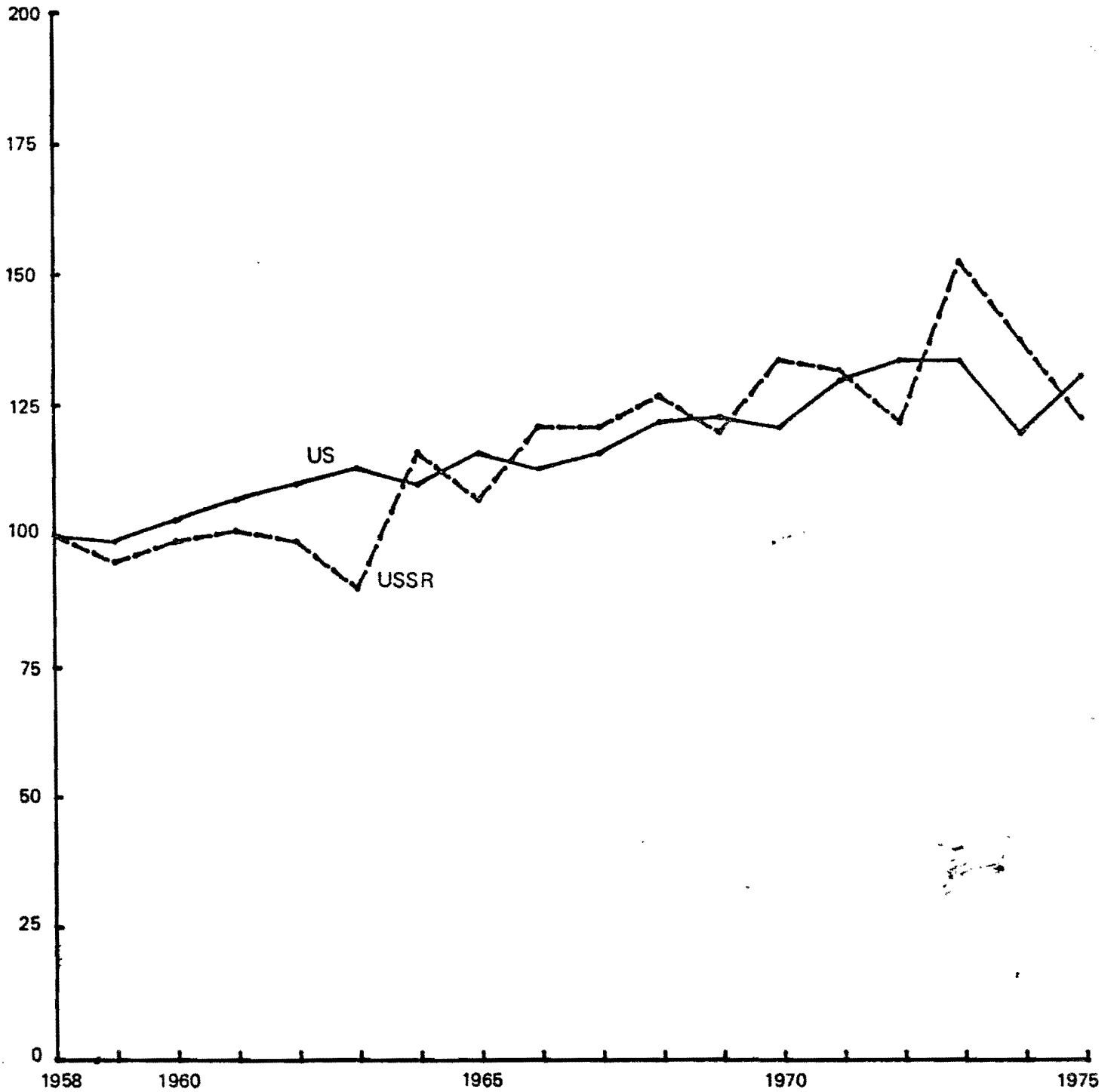
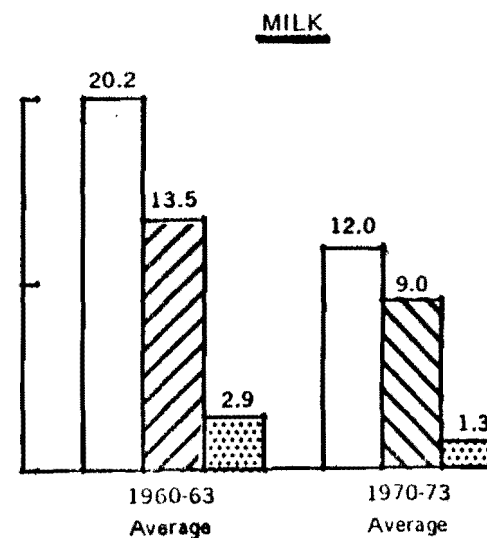
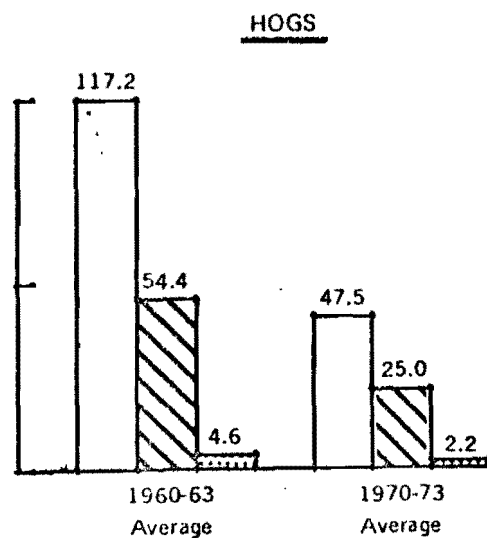
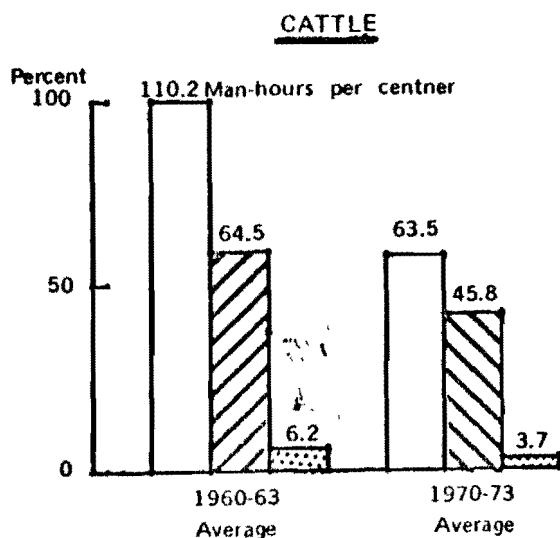
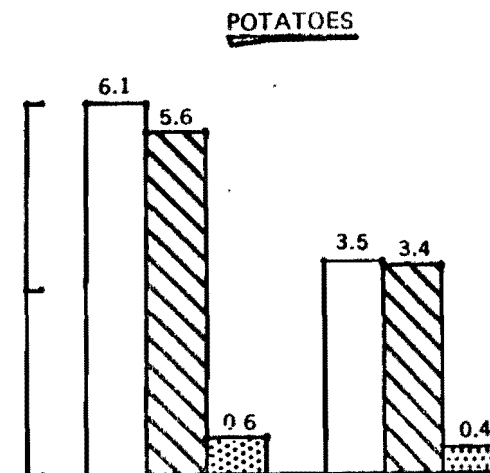
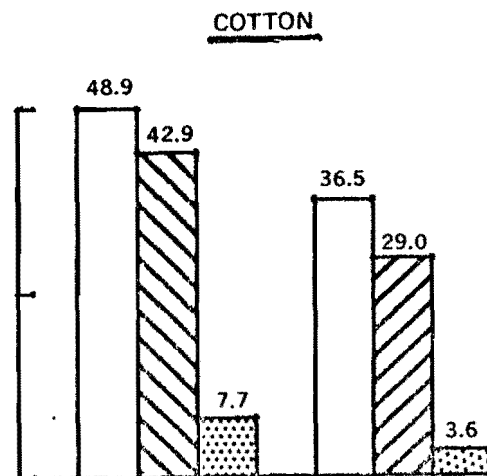
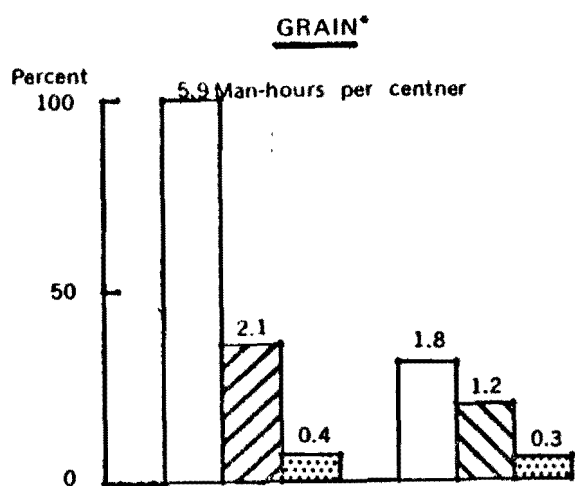
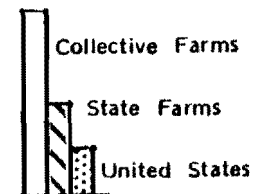


Figure 8

**US AND USSR: LABOR REQUIREMENTS  
1960-63 AND 1970-73 AVERAGES**



\*Excluding corn for USSR, wheat for USA.



Selected Indicators of the Level of  
Comparative Farm Productivity and Resource Use 1/

<u>Indicator</u>	<u>United States</u>	<u>USSR</u>	<u>USSR as a Percent of United States</u>
Total cultivated acreaage (million hectares)	148.5	228.9	154
Share of labor force employed in agri- culture (percent)	4.6	25.4	N.A.
Output per farm worker	\$8,755	\$869 <u>2/</u>	10
Inventories of agricultural equipment (thousands)			
Tractors	4,109	2,400	58
Trucks	2,870	1,402	49
Grain combines	8,655	690	105
Fertilizer nutrients applied to crops <u>3/</u> (pounds/acre)			
Of which:			
Nitrogen (N)	49.9	27.8	56
Phosphorous (P <sub>2</sub> O <sub>5</sub> )	27.8	16.9	61
Potash (K <sub>2</sub> O)	27.7	15.3	55
Livestock yields: <u>3/</u>			
Average live weight at slaughter			
Cattle (pounds)	1,039	730	70
Hogs (pounds)	244	235	96
Eggs per hen/year	231	194	84
Milk per cow milked/ year (pound)	10,286	4,932	48

Selected Indicators of the Level of  
Comparative Farm Productivity and Resource Use 1/  
(Continued)

<u>Indicator</u>	<u>United States</u>	<u>USSR</u>	<u>USSR as a Percent of United States</u>
Crop yields <u>4/</u> (bushels per acre)			
Spring wheat	25.5	13.4 <u>5/</u>	56
Winter wheat	31.5	31.1 <u>5/</u>	99
Rye	23.0	20.2 <u>5/</u>	88
Oats	47.4	31.8 <u>5/</u>	67
Corn	82.9	43.3 <u>5/</u>	52
Barley	40.5	26.2 <u>5/</u>	65
Potatoes (cwt/acre)	242	103.5	43
Sugar beets (metric tons/acre)	17.5	8.7	50
Ginned cotton (pounds/acre)	471	850	180

1/ Based on 1975 data, except as noted.

2/ Calculated from US output using the geometric mean of comparisons of USSR and US output carried out, alternatively, in dollar and ruble prices.

3/ Based on 1974 data.

4/ Three-year average (1973/74/75).

5/ Official Soviet production data minus an estimated 10 percent loss resulting from excess moisture, extraneous matter, and handling losses.

## The Soviet Farm Problem

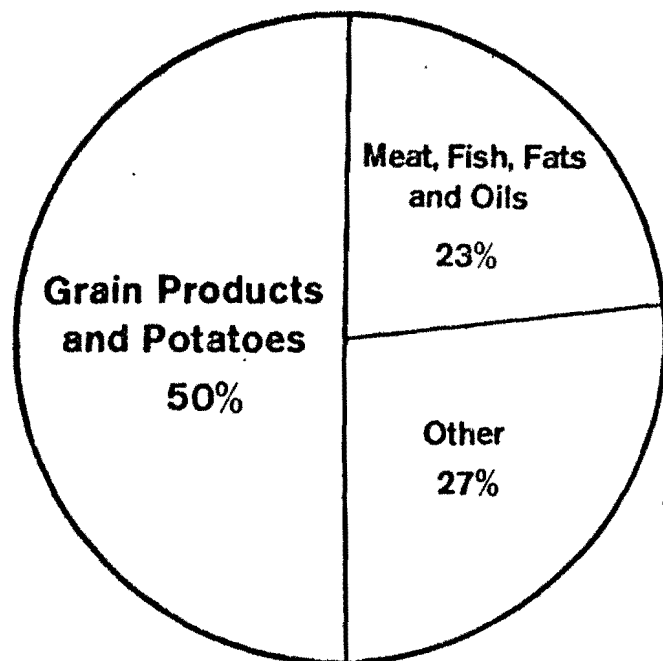
As I indicated earlier, the rate of growth of Soviet farm output has indeed, by international standards, been highly respectable. Why, then, do both the Soviet leadership and foreign observers have a common perception that progress has been disappointing? The central deficiency in the eyes of the regime has been the failure of farm output to keep pace with the growth of demand.

The steady growth in the Soviet population, the continued rise in per capita income and the rapidly rising expectations of the populace have combined to generate high demands on agriculture. A large part of this demand is directed to the reduction in the proportion of starchy staples (potatoes and bread) in the diet and a concomitant rise in the proportion of quality foods (meat, butter, and fresh fruits and vegetables). Thus, the leadership must respond to domestic pressures for a better -- and more costly -- product mix as well as free itself from major dependence on Western sources of food.

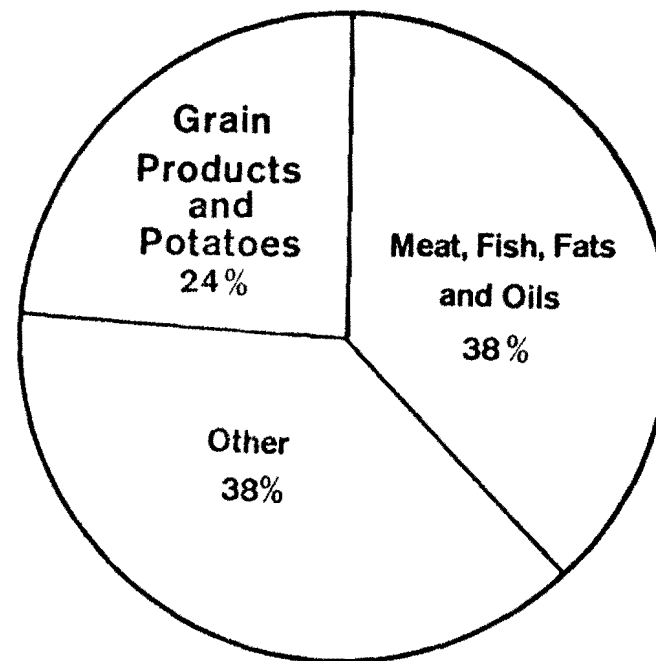
As shown in Figure 9, bread and potatoes currently account for one-half of the calories consumed. The data in Figure 10 indicate that the average Soviet citizen still eats only two-fifths as much meat as his US counterpart and three-fourths as much as the average Hungarian.

## Composition of Diets, 1974

USSR



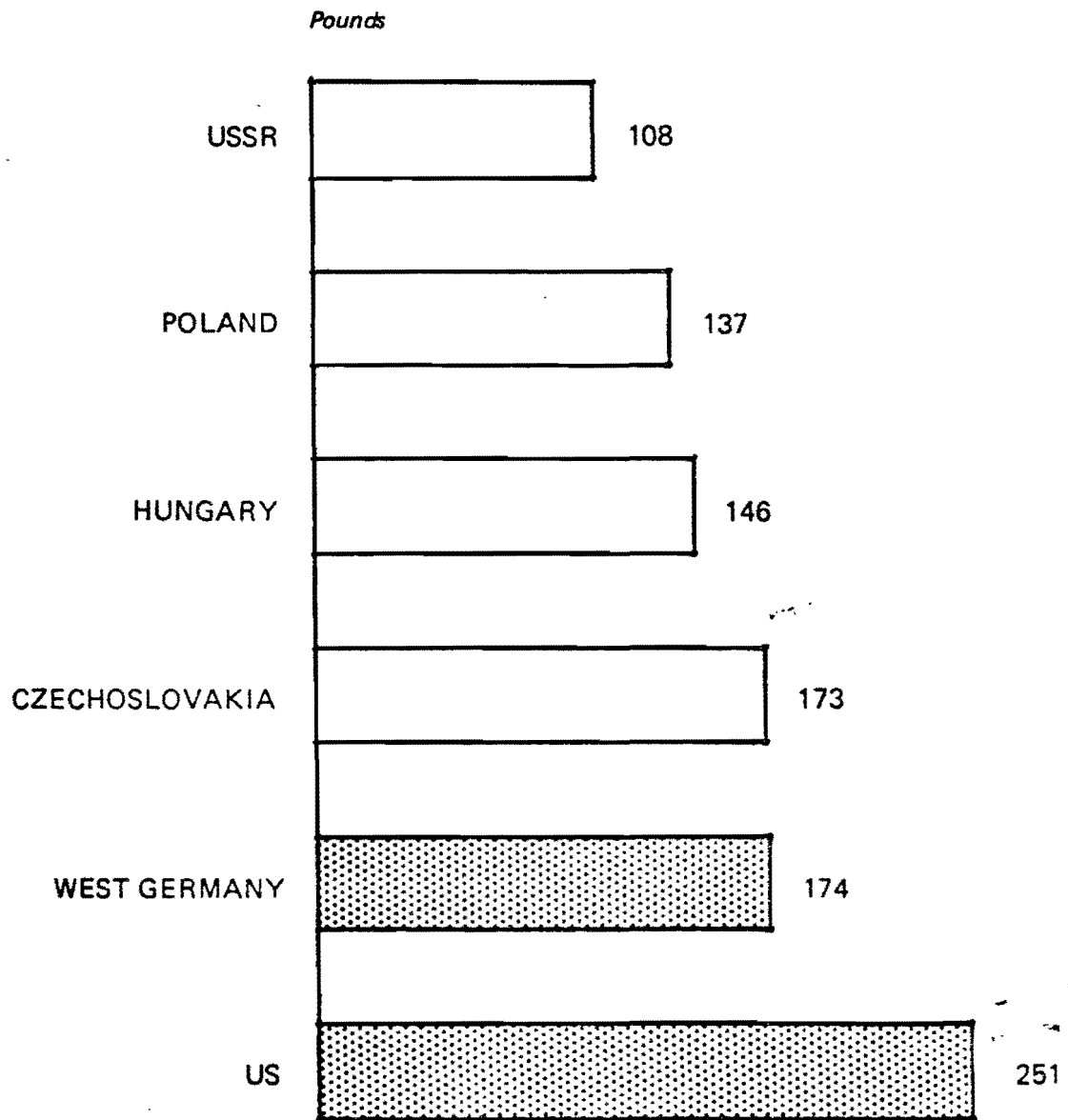
US



3250 — Calories per day per person — 3350

Figure 10

PER CAPITA MEAT CONSUMPTION IN SELECTED COUNTRIES, 1974



Thus, despite a rate of growth of farm output since 1950 that has averaged more than 2 percentage points above the rate of increase in population, the Soviet farm sector has not met the regime's expectations.

Given the leadership's commitment to the population to maintain unchanged retail prices of food in the face of rising consumer disposable income, the USSR has had to turn increasingly to imports of farm commodities. Figure 11 provides the trends in both the US and the USSR in net exports since 1960. Soviet gross imports of farm commodities reached \$9 billion in 1975 -- partially a price effect in recent years, of course. Nearly \$3 billion of net farm imports in 1975 involved hard currency outlays.

#### Some Features of Growth in Soviet Farm Output

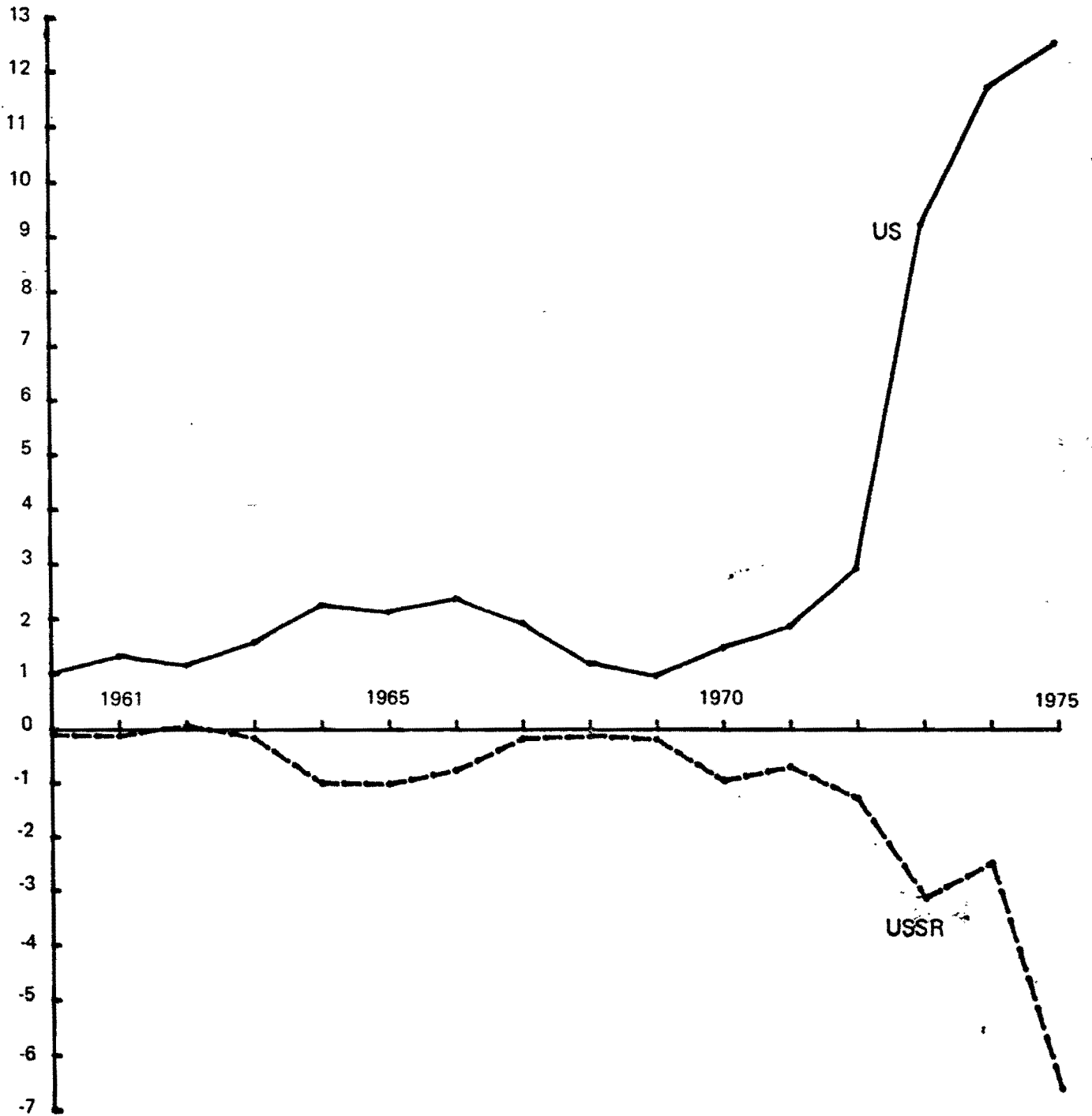
The growth in output that did occur has been characterized by (a) a need for massive investments, (b) high cost per unit of output and (c) instability of year-to-year yields and production.

##### a. Comparative Investment

During the first half of the 1970s annual investment for farm production purposes averaged 20% of total Soviet investment. This can be compared to a share of about 5% of gross investment in the US. In 1975 Soviet investment was equivalent to about \$50 billion compared to US investment of roughly \$9 billion. If investment in all agriculturally

US AND USSR: NET TRADE OF FARM COMMODITIES

Billion US \$



related activity -- farm housing, roads, repair facilities, schools, and other infrastructure -- is included as well as investment in industries supporting agriculture, the share of total Soviet investment related to agriculture, directly or indirectly, in 1975 came to more than 36%.

b. High Cost of Soviet Farm Output

In an attempt to induce farm workers on collective farms to provide more days of participation as well as a higher quality of labor service, prices paid farms have risen by 75% since 1960. If the official exchange rate (\$1.32 per ruble in 1974) is used, by 1974 the average procurement cost per hundredweight of cattle came to \$99; for hogs \$92. These were nearly three times the average prices paid to US farmers in 1974. The relative price movements for farm and industrial products for both the US and USSR are shown in Figures 12 and 13.

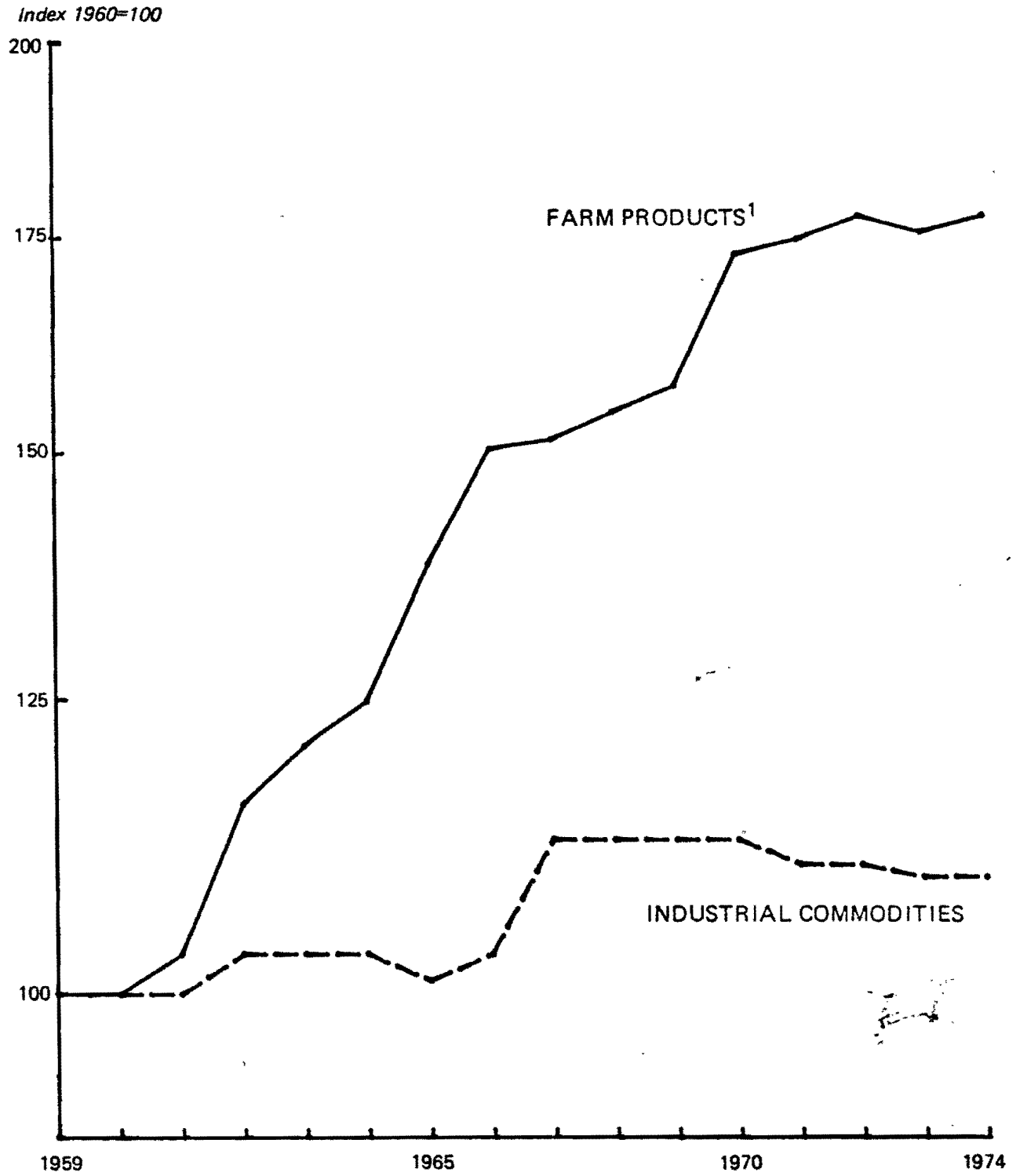
c. Instability of Annual Output

Given the environmental conditions its agriculture is faced with, it is not surprising that instability in output has long plagued the Soviet Union. The data in Figure 14 compares the year-to-year fluctuations in production for the US and USSR.

Somewhat surprisingly the major differences in average annual deviations between North America and the USSR for the country as a whole are also large for analogous areas.



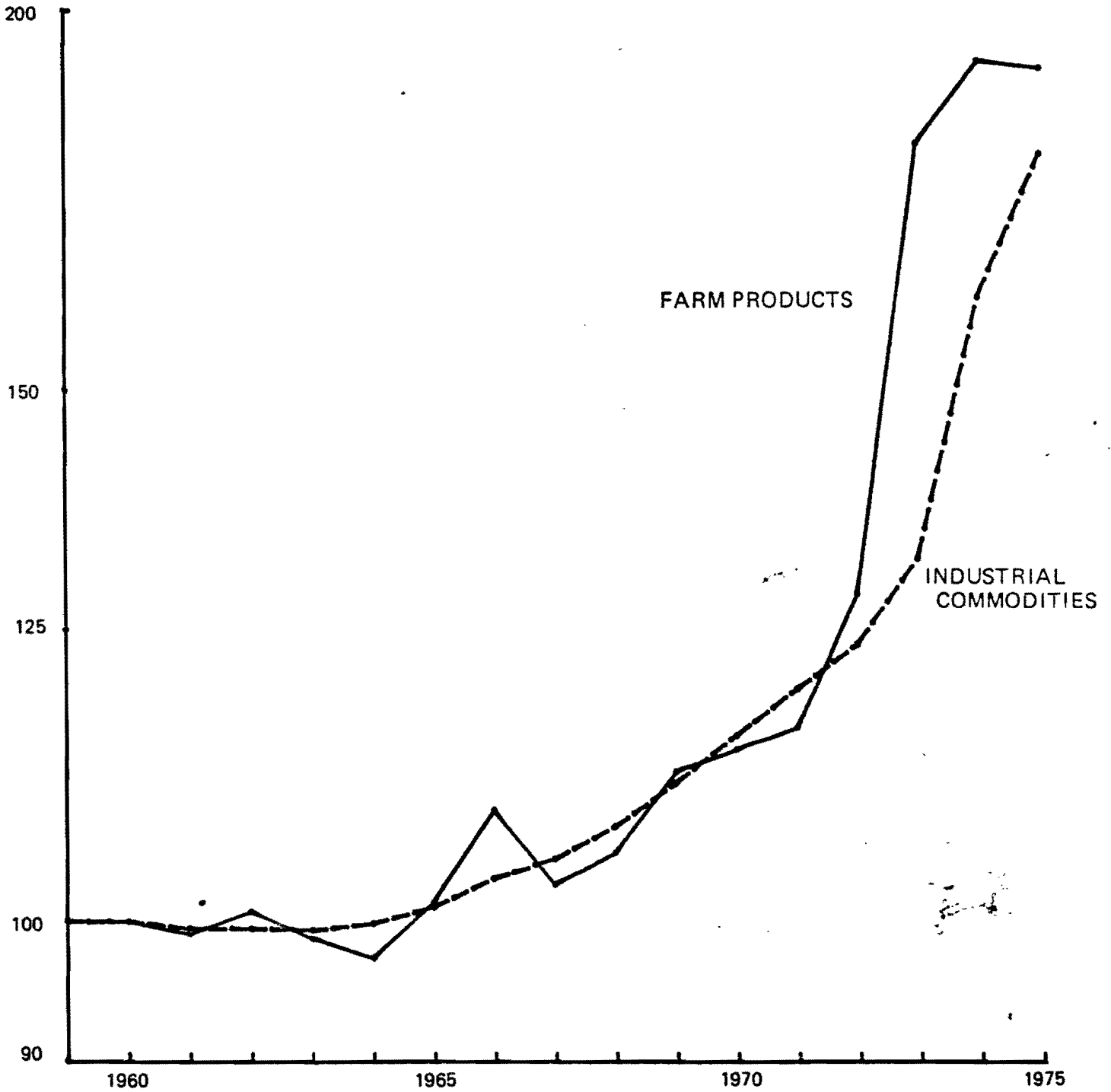
USSR: AGRICULTURAL AND INDUSTRIAL PRICE INDEXES



1. Prices paid to collective farms.

US: AGRICULTURAL AND INDUSTRIAL PRICE INDEXES, 1959-75

Index 1960 = 100



## Annual Fluctuations in Output\*

1950-1975

	Percent	
	<u>US</u>	<u>USSR</u>
Total farm output	1.9	5.5
Total grain	7.8	17.7
Spring wheat	21.0	39.3
Potatoes	2.6	16.2
	<u>Canada</u> (Prairie Provinces)	<u>Kazakhstan</u>
Spring wheat	31.5	78.5

\* Variations in crop production since 1950 are measured by the adjusted annual deviation (AAD). The AAD for each crop has been computed to indicate the standard deviation of percentage changes of year-to-year production not accounted for by a constant growth rate. For example, the adjusted annual deviation of year-to-year production changes for total grain output in the USSR is 17.7% of the production of the previous year.

As indicated in Figure 14 the fluctuation in spring wheat yield in Kazakhstan is 2-1/2 times that for spring wheat yields in the Prairie Provinces of Canada.

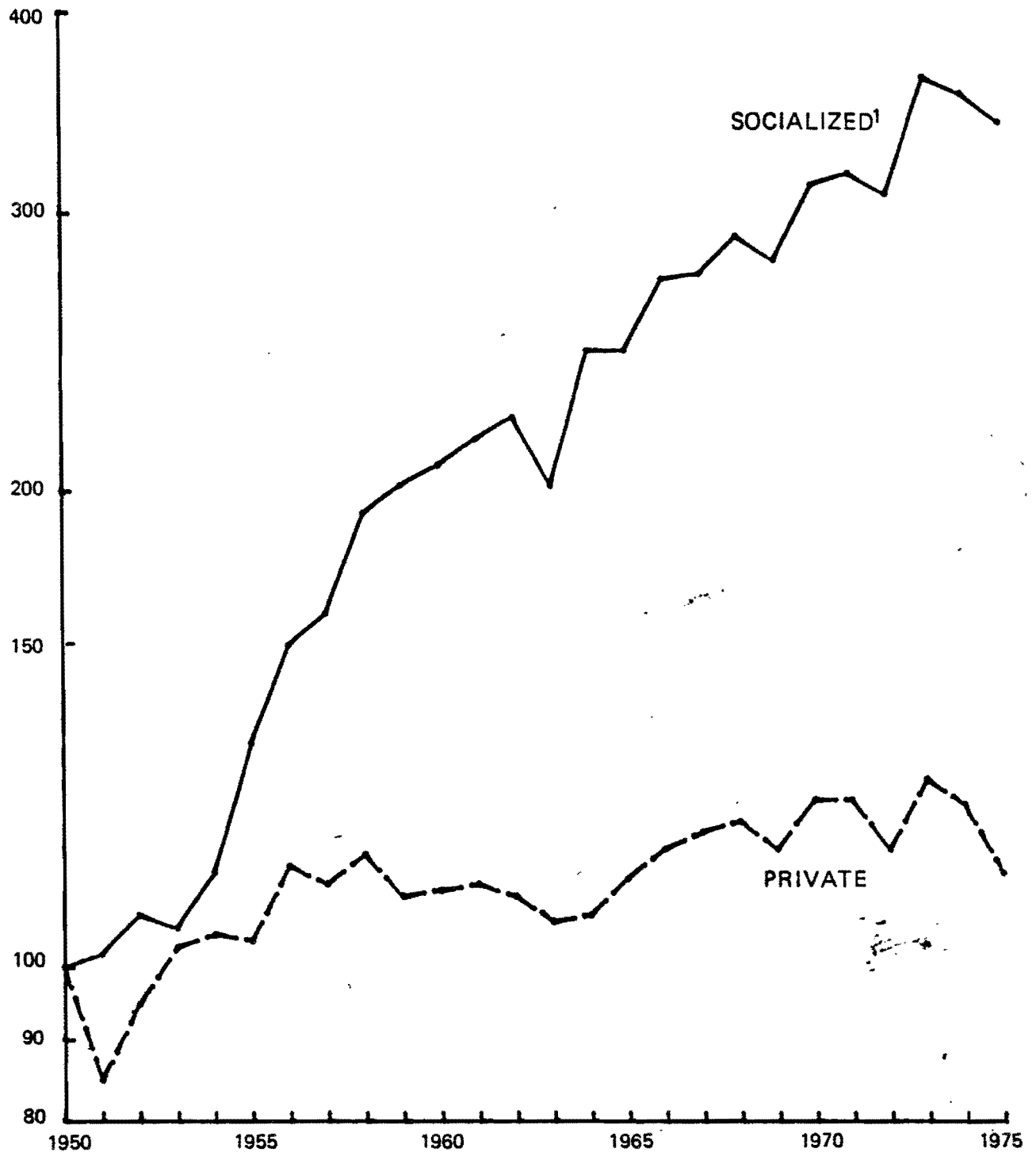
Regardless of the rate of secular progress in increasing output in the future, these high rates of average annual deviations in production of grain and other products accompanied by an official Soviet policy of maintaining fixed prices of food at retail will continue to result in what are referred to as "transitory shocks" to world commodity markets.

Indeed, the degree of instability in production from year-to-year may increase as the socialized sector contributes an ever increasing share of total farm output. Because of the intense use of labor on the private plot -- a hoe and watering bucket type of operation -- the fluctuation in yearly yields is less in the private sector. As is shown in Figure 15 because of official policies, production in the private sector has nearly stagnated in recent years. Although the evidence is mixed, the failure to provide the private sector with the quantity and quality of inputs has tended to erode the advantage in yields once enjoyed by the private sector (see Figures 16 and 17).

I would like to make a few closing observations concerning the Soviet potential for growth in grain output in the context of the North American experience.

USSR: FARM OUTPUT, BY SECTOR

Index 1950 = 100



1. Collective and state farms.

Figure 16

USSR: Milk Yields in Socialized and Private Agriculture

(Pounds/Cow)

<u>Region</u>	<u>1960</u>		<u>1965</u>		<u>1973</u>	
	<u>Collective and State</u>	<u>Private</u>	<u>Collective and State</u>	<u>Private</u>	<u>Collective and State</u>	<u>Private</u>
<u>Ukraine</u>	4,140	3,673	4,524	3,880	5,507	4,403
Index (Socialized = 100)	100	89	100	86	100	80
<u>Belorussia</u>	4,034	3,239	4,180	3,485	5,234	4,455
Index (Socialized = 100)	100	80	100	83	100	85
<u>Estonia</u>	6,113	6,477	6,590	7,183	7,150*	8,168*
Index (Socialized = 100)	100	106	100	109	100	114

\* 1972.

Figure 17

USSR: Potato Yields in Socialized and Private Agriculture

(Centners per hectare)

<u>Region</u>	<u>1958-60</u>		<u>1964-66</u>		<u>1970-72</u>	
	<u>Collective and State</u>	<u>Private</u>	<u>Collective and State</u>	<u>Private</u>	<u>Collective and State</u>	<u>Private</u>
<u>Belorussia</u>	77.5*	139.9*	98.2**	165.4**	119.8	153.4
Index (Socialized = 100)	100	181	100	168	100	128
<u>Estonia</u>	108.0	147.7	153.7	175.0	168.0	160.4
Index (Socialized = 100)	100	137	100	114	100	95

\* 1960 only.

\*\* 1965-66 average.

In a discussion of the future of Soviet agriculture center stage is held by the outlook for grain. Grain is central to the regime's plans for upgrading the diet with increased output of livestock products and is the swing element in Soviet forays into the international commodity markets.

As I observed earlier, the USSR has substantial climatic limitations. Because such a large proportion of grain is grown in areas comparable to the Northern Great Plains of the US and Canada in an area of 16 inches of precipitation or less there is a presumption that yield increases over time will be quite modest. As a result of his analog analysis in the 1950s, Gale Johnson measured the changes in North American yields over a 30-year period for the six states and three Prairie Provinces similar to Soviet regions. As indicated earlier, these regions produce about nine-tenths of grain output. Johnson found a zero change in yields if fallow land is included with the harvested acreage. These results are reproduced in Figure 18.



Total Grain Yields and Percent Yield Increases in North America  
 Climatically Similar to the Soviet Union  
 (Selected Periods)

	<u>1920-29*</u>	<u>1951-60*</u>	<u>Percent Increase</u>	<u>1950-58**</u>	<u>1967-75**</u>	<u>Percent Increase</u>
<u>Centners per harvested hectare</u>						
Area similar to USSR	11.1	14.1	27	15.6	23.6	51
Rest of US	14.6	22.4	54	20.7	36.1	74
<u>Centners per hectare (including fallow area)</u>						
Area similar to USSR	9.9	9.9	0	11.3	15.4	36
Rest of US	14.6	21.0	44	18.7	31.4	68

\* D. Gale Johnson, "Soviet Agriculture", Bulletin of Atomic Scientists, January 1964, p.9. North American area comprises North Dakota, South Dakota, Kansas, Nebraska, Montana, Wyoming, Alberta, Saskatchewan, and Manitoba.

\*\* All of the above areas excluding Kansas and including Minnesota.

We brought the inter-temporal comparison forward to the most recent nine-year period because we wanted to match two recent periods of comparable weather (1950-58 and 1967-75). The results shown in Figure 18 were surprising. There was a major boost in yields in North American areas similar to the USSR during this 17-year interval. Between 1950-58 and 1967-75, average yields on acreage devoted to grain plus fallow increased by 36%. Most of this was attributed to the increase in yields in the six states -- see Figure 19. Indeed, the increase in yields in these relatively "dry states" was nearly the same for the balance of the US. The reasons underlying these comparative trends remain to be explored, especially the relative lack of progress in the Canadian Prairie provinces between the two time periods -- up 24 percent -- compared to yield increases in the climatically analogous areas in the US -- up 71 percent. In addition to other explanatory reasons for the differential rates of growth in grain yields between the US and Canadian areas the following are candidates: (a) differential changes in factor prices (land, fertilizer, labor, etc.) between the US and Canada that could lead to larger boost in fertilizer and irrigation in the six states (relative to other inputs) than in the comparable Canadian areas, (b) differential changes

Figure 19

Average Yields for Selected Grains in Six  
U.S. States, "Remaining" United  
States and the Canadian Prairie  
Provinces

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	<u>1950-1958</u> (c/ha.)	<u>1967-1975</u> (c/ha.)	<u>Percentage</u> <u>Increase</u>
A. <u>Not Including</u> <u>Fallow Land</u>			
Six States <u>1/</u>	16.1	27.5	71
Remaining US States <u>2/</u>	20.8	36.1	74
Canadian Prairie Provinces <u>3/</u>	14.9	18.5	24
B. <u>Including Fallow</u> <u>Land</u>			
Six States	13.1	20.2	56
Remaining US States	18.7	31.4	68
Canadian Prairie Provinces	9.4	10.7	15

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1. Grains included are all wheat, barley, corn for grain, oats, rye and sorghum for grain, for Minnesota, Nebraska, South Dakota, North Dakota, Montana and Wyoming.

2. The United States less the six states previously cited.

3. Grains included are all wheat, barley, rye and oats for the Prairie Provinces of Manitoba, Saskatchewan and Alberta.

in prices by type (or grade) of grain.\*

A comparison of Soviet grain yields with those of similar areas in North America is enlightening. In order to reflect a comparable yield in the USSR, the average yield for the major grain growing regions of the USSR was calculated for the period 1967-74. The average yield for this eight-year period came to 13.8 c/ha about 12% below the harvested yield for similar areas of North America in the 1950-58 period.

Although we need a better understanding of the underlying reasons for the strong surge in grain yields in the US analogous areas (six states) since the Fifties, at first glance the US record surely must be encouraging to Soviet planners. If the upward trend in yields of more than 3 percent per year in the six states between the two periods (1950-58 and 1967-75) could be matched in the future by the USSR in climatically analogous areas, major progress could be made towards what Soviet leaders refer to as the "necessary solution to the grain problem."

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\* For example, Prof. Johnson has suggested (orally to me) that a possible explanation for at least part of the differential change in grain yields between the analogous grain growing areas in the US and Canada could be the pricing practices of the Canadian Wheat Board which discriminated against new high yielding spring wheat varieties with a lower protein content.