Patterns of Techno-Economic and Relevant Socio-Economic Changes in Farm Economy : An Experience of a Retrospective Comparative Analysis (Japan, India, USA, Russia)

DERYUGINA, Irina V. / RASTYANNIKOV, Victor G.

(出版者 / Publisher)
法政大学比較経済研究所 / Institute of Comparative Economic Studies, Hosei University
(雑誌名 / Journal or Publication Title)
Journal of International Economic Studies
(巻 / Volume)
9
(開始ページ / Start Page)
139
(終了ページ / End Page)
171
(発行年 / Year)
1995-03
(URL)
https://doi.org/10.15002/00002128

Journal of International Economic Studies (1995), No. 9, 139-172

Patterns of Techno-Economic and Relevant Socio-Economic Changes in Farm Economy: An Experience of a Retrospective Comparative Analysis (Japan, India, USA, Russia)

Victor G. Rastyannikov*
Irina V. Deryugina**

** D. Sc., Professor in Economics, Chief Research Fellow at the Institute of Oriental Studies, Russian Academy of Sciencies, Moscow*
*** Ph. D. (Economics), Senior Research Fellow at the Institute of Oriental Studies, Russian Academy of Sciencies, Moscow*

First, we give a preliminary remark. What accounts for the present rising interest to the intercountry comparative analysis of macroeconomic dynamics? To our opinion, this phenomenon is based on the integration processes in the world economy that sharply intensified in recent decades[1]. This interest is risen also by the fact of the strengthening breakup of the communist socio-economic system in the large group of former "socialist" countries and their initiated transition to the market economy; the practical assimilation of the world historic experience of the development of the latter is the imperative necessity for the given group of countries.

This article suggests a technique for the specific formalization of the estimates of techno-economic and relevant socio-economic changes in agrarian sphere that enables to perform such intercountry comparative analysis and, particularly, to record the transition from one mode of economic growth to another. We consider that the problem of this transition in agrarian sphere acquires a special sound, because we become the witnesses to the origination of a new system of economy in many countries, formation of the qualitatively new phenomena in the processes of the ecomomic growth in agrarian sphere — the changes that are directly initiated by the scientific and technological revolution (STR) as a factor of the global importance.

This article will discuss the examples of agricultural transformations in four countries, considered via the historic retrospective review. Among the countries, selected for the study, there are Japan and India (Punjab state), where the farmer economy was raised and strengthened virtually before our eyes during several decades, and also Russia, where the transition to the new type of agricultural development is still initiated, and the reproduction parameters of the present type of agricultural system give evidence of its deep crisis caused by the special conditions of its formation. We suppose to discuss all these examples of the economic transformations against the background of the fundamental changes in agriculture

This study is prepared with a partial financial support of the Russian Science Foundation (Moscow Branch)

of the USA, which represented the economically uniform system (properly farmer and capitalist economy) within the total historic period, considered in this article; the dynamics of changes in agriculture of this country (a sort of the "classical" model of changes) enables us to understand much in the dynamics of economic transformations in the agrarian sphere of other countries.

1. Methodology for Comparing Changes in Farm Economy

In the analysis of the evolution of the economic system in agrarian sphere, two trends of changes draw our attention: firstly, the change in the technological mode of production (TMP) and, correspondingly, in the reproduction process; and, secondly, the changes in the socio-economic process. Each of these processes has its own inherent logic, its phases of development; the superstition of the phases of both processes reveals the property, characterizing the state of the economic system at the given stage of its evolution. At the same time, each of these processes can be considered through the historic approach (if the statistical data are available), and then we can determine the intermediate stages of the economic evolution in agrarian sphere.

We represent two aforesaid trends of the study in the matrix form, where the techno-economic stages of evolution, indicating the changes in the technological mode of production, are displayed by the horizontal line, and the socio-economic types of farming, characterizing the steps in the socio-economic process, are displayed by the vertical line (see Fig.1). The intersection of these two lines just gives the

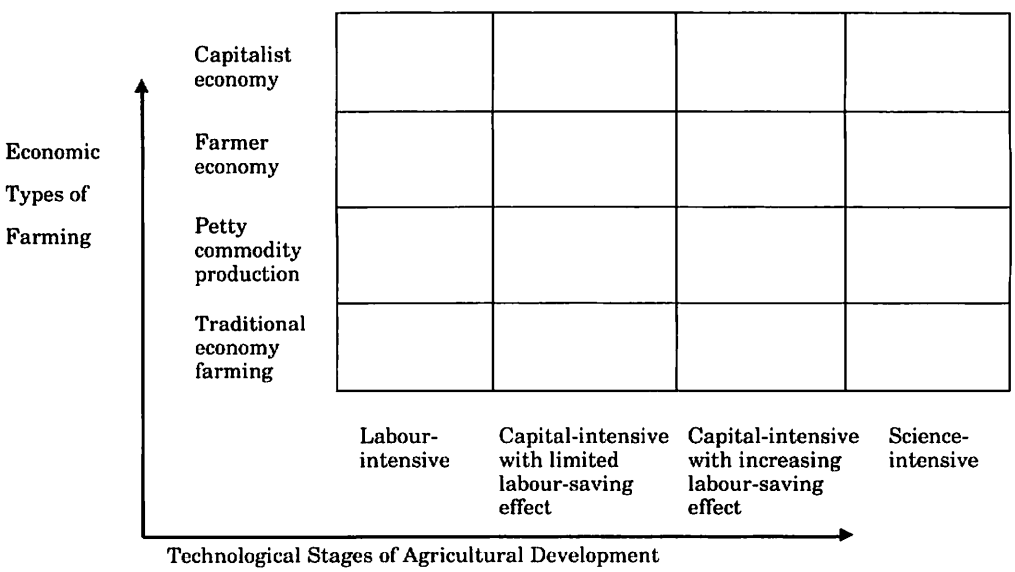

Figure 1 Matrix Scheme of a Developing Farm Economy

characteristic of the state of agrarian sphere. The term "state of agrarian sphere" carries here a special sense: it indicates the integrated estimate for the phases of development both in the economic order and in TMP; within the framework of the matrix scheme, this term denotes the socio-economic type of farming, correlated with particular technological step (stage) of farming, correlated with the particular technological step (stage) of its evolution.

In this scheme, the natural pattern of agrarian evolution — see below — is assumed, and all diversity of farming is arbitrary reduced to four socio-economic types: traditional economy farming, petty commodity production, farmer economy and capitalist economy. Each type of farming is distinguished with the following characteristics:

Traditional economy farming	**Petty commodity production**	**Farmer economy**	**Capitalist economy**
	Motivation of economic activity		
Personal consumption	Partially personal consumption, partially economic benefit	Pure economic benefit	Pure economic benefit
	How much the producer's economy is singled out of collective communality relationship		
In the system of collective (communal) ties	Singled out of the collective (communal) ties partially	Singled out of the collective (communal) ties completely (an individualized farm)	Singled out of the collective (communal) ties completely (an individualized farm)
	Type of interfarming exchange		
Barter-based exchange	Barter-cum-market-based exchange	Market-based exchange	Market-based exchange
	Social type of live labour used		
Family labour added with traditional collective and/or hired labour	Family labour added with hired and/or traditional collective labour	Family labour added, if any, with capitalist hired labour	Capitalist hired labour
	From what sector material input is supplied		
Within the agrarian sector	Partially within the agrarian sector, partially from outside it	Largely from outside the agrarian sector	From outside the agrarian sector
	Type of technology used		
Technology of traditional economy	Partially modernized traditional technology	Full-package technology of the "green revolution"	Full-package technology of the "green revolution"

The techno-economic stages of evolution (i. e., the changes in TMP, see Fig. 1) are connected with the develpment of the productive forces and are divided into labour-intensive, capital-intensive with limited labour-saving effect, capital-intensive with increasing labour-saving effect, science-intensive.

The discrimination of these stages is accounted for by the fact that they together involve two basic versions of the formation of a new TMP in agriculture. The first of them (we refer to it as "eastern") is based on the "land-saving" technology, i. e., the technology, saving the natural resources of production, thus reducing the area of the application of labour, which is abundant. In this case, the means for material reproduction in agriculture, produced beyond its framework (in industry, by the application of scientific knowledge), are realized on the basis of labour, which is manual to a significant extent. Though we can observe the introduction of specific labour-saving means even for this version, the main goal of application of such means is primarily the increase of efficiency of land.

The second version of formation of a new TMP (we refer to it as "western") is the way, passed by all West European and North American countries during the phase of their capitalist development and tried by Russia as a part of the USSR under the supremacy of communist system. For the market system of farming, the dominant goal of application of labour-saving means of production within the framework of this version is primarily the saving of labour for the increase of the surplus product. The land productivity factor as the intrinsic goal of the process of economic growth is introduced into the reproduction process at the further historic stage, and it becomes the most active, as shows the historic experience, with the development of scientific and technological revolution in agriculture (i. e., virtually from the fifties or sixties)[2].

Under the direct influence of STR in the present period, we observe the changes both inside the first and the second versions of formation of a new TMP that result from the assimilation of information technologies. In this case, the "information equipment" of the process of production acquires the greater importance, and the increasing role of science, its concentrated use predetermined the formation of a new stage, which is referred to as science-intensive.

The science-intensive stage differs from other technological stages in the evolution of agriculture, among other things, by the fact that in this case the mechanism of formation and introduction of corresponding technologies into production is qualitatively defferent. The science acts as an autonomous force, independently on the material production, as its specific prerequisite, self-contained preceding stage of human activity. The science-intensive technology, elaborated outside the production, is generally a kind of product, which maximum economic efficiency is determined by the "package-type" integrity of its consumption. The science-intensive stage is characterized by the greatest (as compared to those typical for the preceding stages of TMP) saving of all resources of production — both natural (water, land, etc.) and those produced by the human labour — the saving that is performed on the basis of the qualitatively new principles[3].

In order to estimate with the specific extent of reliability that we referred to as "state of agrarian sphere" of the country or region, we need not only the qualitative parameters, but also the quantitative ones. In this connection, we undertook an attempt to determine the quantitative indicators that could serve as measurable analogues for both quantitative characteristics and the aforesaid steps in the

evolution of TMP, and to use their values for the estimate of the type of economic activity in the agrarian sphere of the countries, chosen for the study.

2. By-Country Comparative Analysis of Changes in Farm Economy

Japan

Analyzing the statistical data, describing the dynamics of changes in the parameters of economic growth in agriculture of Japan from the early twenties (see Table 1), we can discriminate three periods of changes in the model of economic growth.

The first period lasted approximately to the early fifties. In this period, the agricultural farming is characterized by the parameters, corresponding to the petty commodity production at the labour-intensive stage of development. By definition, the petty commodity type of farming is intermediate between the traditional and farmer types. The agriculture of Japan in this period is characterized by the relatively high degree of commercialization (above 40% of total rice output were sold at the market) that was achieved essentially on the basis of application of methods of extra-economic compulsion. By its technological parameters, the agricultural farming was distinguished by the remarkable stability (see Fig.2), characteristic for the economy of traditional type. Thus, the amount of fertilizers applied per hectare, crop yield during the considered period remained approximately at the same level, the mechanical instruments are not virtually applied, the efficiency of labour in the major field of agriculture — rice-growing — was at the lowest limit by its absolute value and did not differ from that in the rice-growing economy of the traditional type, existing in the countries of South-East and South Asia (for more details see: Rastyannikov. 1969. Chapters 2, 4). The agricultural farming of Japan at that time was, as we can say, the classical example of absolute pre-dominance of "land-saving" (consequently, and "labor-wasteful") technologies that, however, increasingly involved industry (Japan Statistics. 1950, p.88; do. do. 1960, p.58). However, the stability of the key parameters (especially, the "output" ones: crop yield and efficiency of labour), observed during such long historic period, conclusively indicated the depletion in the agrarian sphere of Japan of the resources of economic growth on the basis of such technologies that were not yet affected by scientific modifications. Import of great amounts of grain, primarily rice, was an obvious exhibition of the sharpness of the resulting macroeconomic disproportion.

The second period lasted from the middle fifties to approximately the late seventies. This period can be referred to as the period of maturing of the economy of the farmer type that was accompanied by the noticeable changes in the technological mode of production. To the middle fifties, the agrarian reform gave certain result: because of the admission of direct growers to the land ownership, the mass introduction of new technologies became possible; the biochemical stage of intensification of farming began, and the land efficiency factor of production acquired the absolute priority. The marketability significantly increased in agricultural farming, so did the relationship of the agrarian sector with other branches of industry, i. e., the integration of the reproduction process in agriculture to the reproduction process in the industrial sphere; all these facts give evidence of the

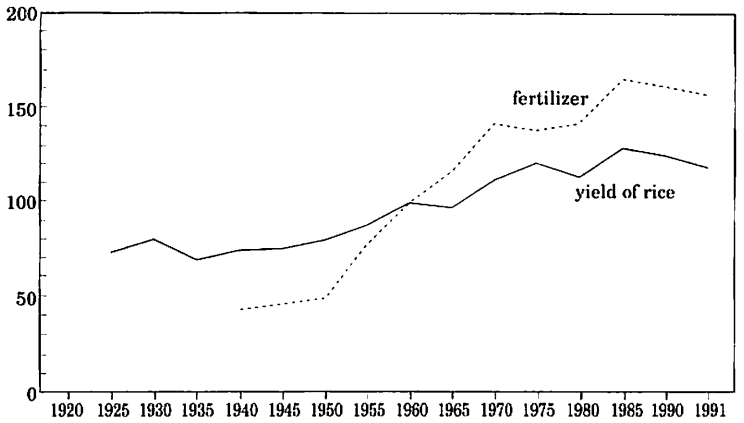

Figure 2 JAPAN
Index of changes in land efficiency factor of agricultural growth (1960=100)
Based on the data from the Table 1

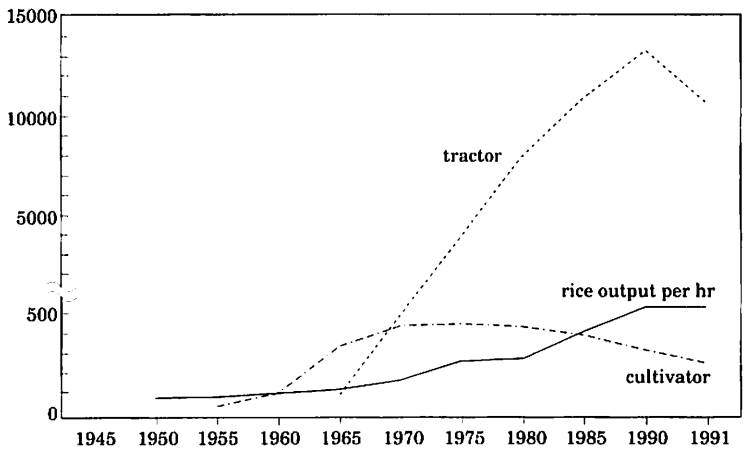

Figure 3 JAPAN
Index of changes in labour productivity factor of agricultural growth (1960=100)
Based on the data from the Table 1

decisive increase of the role of commodity exchange for the process of economic growth in agrarian sphere. Moreover, the massed assimilation of means of minor mechanization by farmers began. However, this process does not yet produce significant effect on the efficiency of labour. The land area was still sprayed between the smallest farmers; only to the middle seventies the average size of the cultivated area in the farming achieved the values, characteristic for the twenties, and the role of family labour in farm economy is increased due to the reduction of employment of the hired one. Apparently, we can consider that at that period the economy of the farmer type in the form of family farming was established on the basis of new, essentially labour-intensive, technologies in the agrarian sphere of Japan. And,

finally, the country was able to provide itself completely with the major grain product — rice — already in the early years of the considered period (in the early sixties), because of the introduction of new technologies.

The third period starts from the late seventies and hitherto goes on. This period was marked by the appearance of the symptoms of transition of the agricultural farming to the new model of economic growth. Perhaps, it is one of the most significant changes: the land factor of efficiency of production give way to the factor of efficiency of labour. The material basis of this process is the powerful stream of technical means, particularly complex engines and mechanisms, assigned to agriculture. What is the most characteristic for this case, the more powerful engines as a source, among other things, of mechanical energy displace the less powerful ones (see the dynamics of the quantity of park of tractors and cultivators in Table 1 and Fig. 3). These processes resulted in some increase in the efficiency of labour, which achieved the values, indicating by our model the beginning of crawling of the agricultural farming in the stage of evolution, characterized above as capital-intensive with the limited labor-saving effect. The structural transformation of the economy itself goes on: from the total rice production 6/7 and more got into the sphere of commodity exchange by the early nineties rather than 4/5 (as was the case in the late seventies). Altogether 83.4% of all agricultural output by cost was realized at the market in 1985 and 84.3% in 1990 (Japan Statistics. 1992, p.413). The enlargement of farming unit was significantly more intensive during this period, primarily, because of the growth of the share of large (above 3 ha and especially above 5 ha) farming. However, the small and smallest (family) farming remain the determining element in the system of economy.

The indicators of the land efficiency factor change in a somewhat different way. The stagnation phenomena (stabilization at the same level) appeared already in seventies for the value of application of fertilizers per hectare; the dynamics of this indicator in the late eighties indicates, apparently, the ultimate saturation of agriculture with this technological mean. The yield of grains with these technologies also achieved its plateau: already from the middle seventies it fluctuates about some constant value (approximately 46–47 hwt/ha), though the demands of the country in grain exceed its gross production by many times (for instance, Japan imported in the late eighties more than 70% of all consumed grain; the feed grain was the major item of deficiency). It is demonstrative that to the early nineties the saturation of the agricultural farming with tractors was accomplished: the growth of tractor stock was completely terminated.

Thus, two following phenomena of the fundamental importance emerged.

On one hand, for the resulting economic restrictions of the mechanism of economic growth that are caused by the predominant petty commodity production in the agrarian sphere of Japan, such resource of growth was entirely locked as the formation of economy of scale, i. e. the advantages of the large production as opposed to the small one that was potentially assumed by the technologies already existing (for more details see: Hayami. 1988. Chapters 4, 5). In this sense, it is not remarkable that the scale growth of power capacity in agricultural farming of Japan (which surpassed far the corresponding indicator for the USA) was not accompanied by the adequate growth of the real productive force of labour (if we consider the grain farming, this process resulted in the miserable actual increase). Moreover, the

relative depth of gap between the dynamic series of indicators of power capacity and such series of labour productivity increased from year to year and achieved the unprecedented scales to the early nineties (see Fig. 3). All these facts indicate that the numbness of the giant fixed capital occurred in the agrarian sphere of Japan, or in other words, the less fraction of this capital, invested in the modern highly productive means of labour, takes part in the actual process of production. Figuratively speaking, the raised wave of labour-saving-based development broke at the cliff named "petty commodity production".

On the other hand, if we consider the land factor of productivity, the system of agriculture in Japan, at least in a series of leading grain branches, exhausted the resource of growth with the application of today's technologies, in spite of the rather significant progress achieved. We suppose that both mentioned phenomena are ultimately the expression of the deep crisis of "land-saving" TMP, even if "modernized", but not susceptible to the radical transformations. And the exhibition of this crisis is so far prevented by the policy of the powerful agrarian protectionism that prolongs the life of the uncompetitive (by the world standards) farming.

As well, we can boldly speak about the termination of the transition of agrarian sphere of Japan to the new type of economy — farmer economy in its version of the family farming that is able to exist under the conditions of market relations only in the specially created environment, and this is the fundamental feature of the Japanese type of family farmer economy. The mentioned period ended at the very first step of the stage of technological development that we referred to as capital-intensive with the limited labour-saving effect.

Under the present conditions, the escape from the mentioned crisis is scarcely possible through the development by the classical version — through the capital-intensive stage with increasing labour-saving effect, because in this case the great concentration of land in the ownership of the limited number of land users is necessary (that could result in the radical enlargement of the farming unit). But such concentration cannot be practically realized due both to social and economic reasons. Apparently, the Japanese pattern of agrarian evolution will assume the large scale assimilation of science-intensive technologies[4] to achieve the saving of labour that is so urgent in agriculture; and in this sense the evolution series with one missed member (capital-intensive stage with the increasing labour-saving effect) may be characteristic for the agricultural farming of Japan.

India, Punjab state

India is another example of the historically formed "land-saving" system of economy based on the technologies of irrigated agriculture. However, because of the great dispersion in the levels of economic development of different states, we chose only one region, namely Punjab state, where the transition to the new pattern of farming and economic growth in agrarian sphere is the most noticeable (see Table 2).

During many decades, virtually until the early fifties, the agriculture of Punjab could be related to the type of primarily traditional economy, which was, according to our classification, at the stage of transition to the petty commodity production. This is indicated by such characteristics as the stability of coefficient of use of arable land (intensity of cropping), very low and slowly increasing crop yield, determined by the traditional technologies, and, certainly, the level of productivity of labour. Although

the marketability of the grain farming (so far the major branch of agriculture of Punjab) was very high, this height was essentially determined by the wide spread of relations of extra-economic compulsion of growers (for instance, between thirties and forties the area, cultivated by tenants-at-will achieved almost the half of cultivated area of the then Punjab province of British India; the payment of the half of gross produce as rent was a rule rather than an exception). From the early fifties, somewhat more productive technologies are gradually assimilated in the agriculture of Punjab. We can say that until the middle sixties the slow accumulation of the resource for changes seems to proceed so as to be realized in the jumpwise transition with the beginning of "green revolution". Thus from the early fifties, the intensity of cropping significantly increases in Punjab agriculture, even in spite of the relative decrease — because of the partition of Punjab in 1947 — of the area of irrigated lands; the extended irrigation development initiated the rapid growth of area of such lands; finally, the significant increase of yield is observed. But all these positive changes still proceed on the basis of improvement of primarily traditional technologies without the participation of means of production of industrial origin in the production process. The efficiency of labour does not undergo any changes. Without the impact caused by "green revolution", this transformation of agrarian sphere would be inert as a whole.

"Green revolution" was a force that realized the radical coup in TMP, it compressed the temporary range of the transition, produced the strongest impetus for the process of formation of market economy of the farmer type characterized by the high productivity. But this process, started in the middle sixties, proceeds so far at its biochemical stage, where the major effect is indicated by the increase in the productivity of land (thus, the intensive growth of yield occurs due to the application of new technologies of irrigated agriculture, based on the use of a great quantity of mineral fertilizers; Fig. 4 characterizes the dynamics of this process rather expressively), and the rationalization of agriculture so far assumes the application of manual labour in massed scale; the volume of employment of manual labour increased by 1.7 times until the early seventies. Thus, we can define the boundary between sixties and seventies as the beginning of transition to the economy of farmer type, with retaining labour-intensive type of development of productive potential of agriculture.

The mechanism of economic growth undergoes principal changes; the significant point of changes, as in the Japanese pattern of changes, consists in the fact that now the process of reproduction of the agricultural farming is strictly determined by the conditions of intersector commodity exchange between the agriculture and industry and other nonrural complexes (in particular, scientific and technological ones).

However, even at this labour-intensive stage due to the more efficient application of labour resources, we can observe some growth in the productivity of labour (by two or three times as compared to very low level of productivity of labour in the traditional farming). Simultaneously (from the late sixties), the significant structural changes take place in the reproduction process; in particular, the commodity yield of the major grain product — wheat — begins to increase. And by the early eighties, the specific weight of the marketed wheat was more than 50% of the gross wheat output in the agriculture of Punjab that testified to the already formed powerful association of the farmer economy.

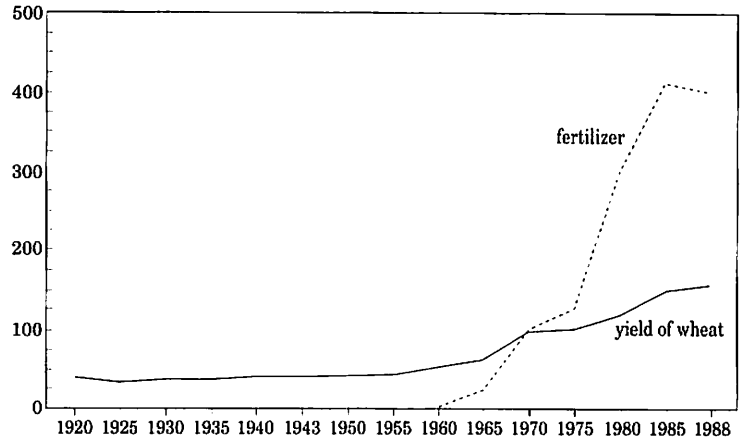

Figure 4 INDIA (Punjab)
Index of changes in land efficiency factor of agricultural growth (1970=100)
Based on the data from the Table 2

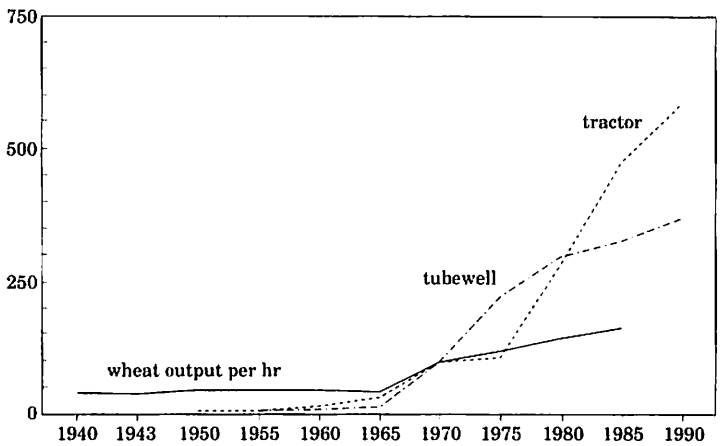

Figure 5 INDIA (Punjab)
Index of changes in labour productivity factor of agricultural growth (1970=100)
Based on the data from the Table 2

In the early eighties, the symptoms indicated the beginning of the transition of the given economy to the higher stage of techno-economic evolution — that of capital-intensive with the limited labour-saving effect. At this time, the process of mechanization in the economy of Punjab became more noticeable, it was accompanied by the growth of productivity of labour, particularly, in the grain farming, and the given process gradually spreads to the more number of agricultural operations. What is characteristic is that the engines are applied not only for purposes of greater yield by the land factor of productivity, but also — in some branches (primarily, in wheat production so far) — for the mere saving of labour.

The curiosity of this phenomenon consists in the fact that it originated on the background of the significantly increased labour-intensity of Punjab agriculture: from the late seventies and especially in eighties, new, rather labour-intensive commodity crops are involved in the agricultural practice, and they are cultivated almost exclusively with the application of manual labour (for instance, rice, which commodity yield is about 90%; tomatoes).

The new technological mode of production was realized, figuratively speaking, at the limit of its technological abilities. For example, the symptoms of "slipping" in technologies of "green revolution" by the land factor of productivity were observed twice during two last decades. The first time was in the early seventies (see Fig. 4 and Table 2), the second time was in the late eighties. But the difference between two periods consists in the fact that the significant reserve still remained in the first case for the increase of the average yield — by the implication of more new areas for high yielding varieties (HYV)[5]; and in the second case, this reserve was exhausted: by the late eighties, the areas of the major grain crops were almost completely occupied with HYV[6]. We can soundly assume that the biochemical stage, based on the present resource-intensive technologies of the "green tevolution", virtually exhausted its potential of growth by the factor of land efficiency[7].

We should specially note the social character of labour. Since old times, Punjab was famous for the fact that the predominant part of labour force, employed in agriculture, consisted of family workers. But the development of highly productive economy within the framework of the modernized version of "land-saving" mode of production would inevitably result in the rapid growth of requirement of human labour, and the farms, independently of their social status, began to employ the hired labour in mass scale. It was the late sixties, when the social structure of labour force used in agriculture started to change: the share of hired workers sharply increased and that for family workers decreased (see Table 2). This process, though less intensive, continued also in seventies, indicating the rapid process of formation of farmer and capitalist economy. We should supplement that, for example, the transition to the scale production of new commodity crop — rice — required the employment of great masses of extraneous labour, which demand was covered preferentially by the labour of migrants from other states.

Thus, in Punjab, as in the case of Japan, the land factor of efficiency of production acquires the absolute priority in the technological transformations at the initial stages of the process of modernization. The shift to the increase of the importance of the efficiency factor of labour and its transformation into the priority factor occurs somewhat later. But in Punjab, which stepped in the way of modern economic growth later, as compared to Japan, both phases of wave of technological transformations are characterized by the greater compression, and in this case the greater trend to the technologies of land efficiency takes place in the late sixties and seventies, and the greater trend to the technologies of efficiency of labour occurs in the late seventies and eighties (and, evidently, nineties)[8]. The changes in the technological conditions of the process of economic growth, naturally, left their imprint on the conditions of formation of farmer and capitalist economy: the latter begins to apply in the greater scale the fixed capital, primarily, in the form of engines and mechanisms, saving the labour.

But the agrarian sphere of Punjab as a whole have not yet escaped from the vice of

TMP, which is essentially "land-saving" (respectively, "labour-wasteful"). Therefore, the farmer economy, as in Japan, can normally exist and operate only under the shield of "protectionist umbrella". And one point more. Rather retarded, repeatedly recorded cycle of change of technologies of the "green revolution", their obsolescence, threatening to the economic interest of the mass of private growers in the development of agriculture as the sphere of productive activity, providing the sufficient standard of income, — all these phenomena only reveal with the new strength the imperative demand of agrarian sphere in Punjab — the demand to place the more stable scientific and technological basis under the process of economic growth that will provide the powerful impetus to the dynamic technological modernization.

However, the technological breakthrough, performed by the economy of agricultural sphere in Punjab, using even rather labour-intensive technologies, produced the strongest effect on the system of food supply in the whole India: it is Punjab grain — wheat and rice — that form the major share (54%, according to the data for 1986/87–1988/89) of the national resources of food grain, accumulated by the state for the purposes of regulation of the food market and solution of the social problems (see basic data in: Gulati, Sharma. 1990). The grain self-sufficiency (which was, however, unstable, if we consider the value of the grain import in individual years of the eighties) was achieved by India due to the "green revolution" even in the late seventies.

Now we turn to the changes, determined by STR, in the system of agricultural farming under the historical "labour-saving" TMP. We consider that we can reveal the example of these changes, classical of the sort, in the agrarian sphere of the USA. Actually, the USA is one of the leading countries in the scientific and technological progress, clearly demonstrating the transformation of the scientific factor into the powerful propulsive agent of economic growth in agrarian sphere.

The USA

The scientific and technological revolution began in the agriculture of the USA from the late thirties after the significant deterioration in the parameters of agricultural reproduction that resulted from both the great depression of the early thirties (see Table 3). The resulting technological transformation of the agricultural farming passed through several qualitatively different stages.

Until the mid-thirties, we observe the stability of the basic characteristics of the farm economy that, if we consider the indicators of the grain farming, impressed rather "monotonous" extensive type of development, but with the minimum technical changes, or even without those by many parameters. Agriculture at that time have already achieved, according to our scheme, the capital-intensive stage with the limited labour-saving effect (in the wheat production, the efficiency of labour achieved the level of 40 kg/hr), but for the level of land productivity that indicated (as compared, for instance, with the period of seventies and, more comprehensively, of eighties) so far the "land-wasteful" type of agricultural practice (at last, in grain farming).

The agricultural farming was represented by the economically uniform system (properly, by farmer and capitalist farming) that was almost completely oriented to the production of commodity for market: the intrafarm (or "home", as it is called in

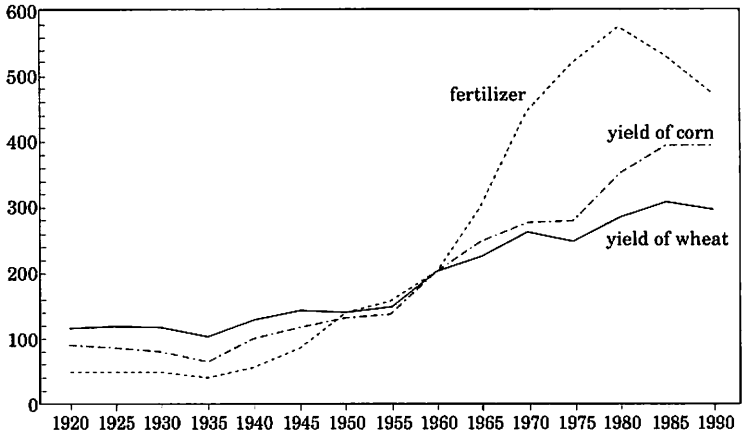

Figure 6 USA
Index of changes in land efficiency factor of agricultural growth (1960=100)
Based on the data from the Table 3

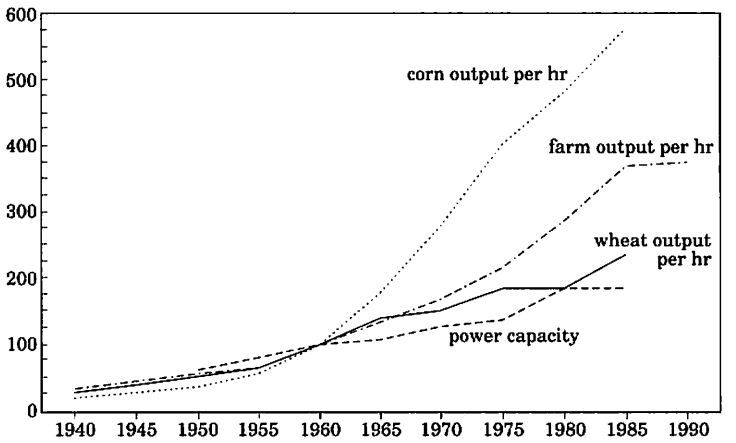

Figure 7 USA
Index of changes in labour productivity factor of agricultural growth (1960=100)
Based on the data from the Table 3

official sources) consumption covered about 1/7 of the reproduced agricultural product (see Table 3).

The first bump of technological transformations in the agriculture of the USA occurred in the forties, when, as compared to the previous period, the indicators by the land factor of efficiency of production were significantly improved, the productivity of labour began to grow far more rapidly (the increase was by approximately two times during the forties). Movement in a circle of "technological linearities" was replaced by the form of movement, where the profiles of technological jerk were clear: the agricultural farming of the USA began to perform the transition to a new dynamic pattern of economic growth, supported by the first achievements of

STR. But the real jerk in the change of technological basis in the agricultural farming occurred from the boundary between the fifties and sixties (see Table 3 and Figs. 6, 7). During twenty–twenty five years, it was radically transformed by all its depth, and by a series of parameters (primarily, by the factor of productivity of labour) it occupied the leading position in the world, became one of the most competitive by many agricultural products. And what is characteristic, the process of massed modernization of farming by the factor of productivity of labour superimposed temporarily on the process of modernization of agriculture by the land factor of efficiency of production. Such combination of technological transformations indicated the intrinsic entirety (as opposed, for example, to the Japanese pattern) of the process of transformation.

The example of technological transformations in the agrarian sphere of the USA convincingly demonstrates also such new phenomenon as that the penetration of the achievements of STR into the agrarian sphere initiates the elimination of the qualitative differences between both historically formed TMP; this process passes in the form, figuratively speaking, of harmonization in the parameters of labour productivity factor and the land efficiency factor of production, but it is clear so far only for the initial "labour-saving" TMP, still slightly affecting the situation in the countries, where the "land-saving" TMP was historicaslly initial.

Actually, the intercountry differences in the scale of technological changes by the land factor of productivity for the different initial TMP impress in the age of STR no less than the differences by the factor of labour productivity (compare the corresponding indicators in Tables 1, 2, 3). Entering the age of scientific and technological revolution with the yield of the secondary (for the USA) grain crop — rice — of only 16.2 hwt/ha (the average for 1936–1940), i. e., the yield that only slightly exceeded the half of that in Japan at that time (see Table 1), the USA in five decades achieved the yield commensurable with the yield of the major grain crop of Japan — 40.5 hwt/ha (1986–1990) that was 4/5 of the Japanese level (see USA Statistics. 1950; USA statistics. 1992). But the major result consisted in the fact that rice became the essential commodity in the agricultural export of the USA (above 50% of the available resources of rice is exported) that far exceeds by its competitiveness the analogous commodity produced by the family farmer economy of Japan. For example, in 1992 producer's price for rice in the USA was 6.9 times lower than that in Japan (see Japan Almanac).

But in the eighties, especially in the late eighties, the process of technological transformations in the agriculture of the USA (if we consider the combination of indicators, represented in Table 3) "slips" more and more at the same position. For example, the crop yield in the grain farming reached the peak values (rather high in some cases, particularly, in the feed crop production) and achieved the plateau; the signs of stagnation appeared in the factor of productivity of labour (from the middle eighties) though, evidently, for the indicators that were the highest in the world.

However, the seeming paradox of this technological stabilization consists in the fact that the economic yield (efficiency of productive activity) in the agricultural farming significantly increases rather than decreases. The vector of changes altered its direction.

Actually, in the late seventies and the early eighties, more symptoms appeared indicating the beginning of the transition of the agrarian economy of the USA to the

new pattern of economic growth. The essence of these changes consists in the fact that the output factor indicators of production in the USA agriculture significantly increase with the sharp decrease of the values of input factor parameters. Thus, according to the calculations of the US Department of Agriculture, the total value of the production expenses in agriculture decreased in the late eighties to 87 points (1988–1989), with 100 points in 1977 and 103 points in 1980 (USA Statistics. 1992). In particular, for the stabilization of the amount of applied fertilizers, the yield of individual grain crops (for instance, corn, rice) sharply increased (compare the data for 1975 and 1990 in Table 3), for the virtual stabilization of power capacity available in agriculture (if we agree that the dynamics of per hectare power capacity provided by tractors gives a clear impression of the dynamics of the total power capacity) the productivity of labour increased (see Table 3)[9]. Figure 7 presents the sufficient expression of the fact that each energy unit, consumed in the agriculture of the USA, provided more and more productivity of labour. It is characteristic that the total expenses for the mechanical energy and engines significantly decreased (their index reduced to 73 points (!) in 1989 as against 100 points in 1977). The index of the gross agricultural product increased by 12 points to the early nineties (1988–1990) (USA Statistics. 1992). Thus, the case was that the yield of product increased with the decreasing capital intensity of production.

If we consider the dynamics of efficiency of production in the agricultural farming of the USA, expressed by the ratio output/input within more or less protracted historic period (since 1950, by the available data), we make sure that the tendency of accelerating growth of the indicator of efficiency is definitely characteristic for the USA, while the strong acceleration of its rate started just from the boundary between seventies and eighties (that is expressed by the appearance of the curve of parabolic type in the graphic display; see Fig. 8). Such phenomenon became possible due to the massed application of the scientific achievements in the agricultural practice.

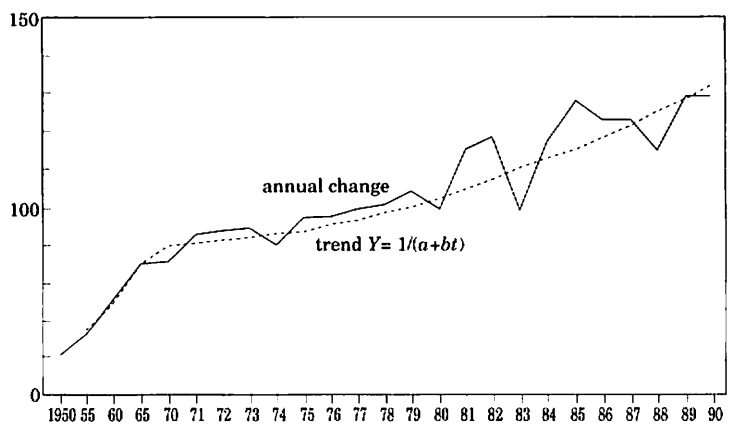

Figure 8 USA
Index of farm output per unit of total input (1977=100)
Based on the data from: *Statistical Abstract of the United States 1965*, 86th ed.; *do. do. 1968*, 89th ed.; *do. do. 1980*, 101th ed.; *Agricultural Statistics 1992* (US Department of Agriculture)

Another characteristic feature of the new pattern of growth is the qualitatively new (significantly more efficient) mechanism of saving of the used resources of production, both man-made and natural, with the significant growth of the yield of product per the unit of expenses. It is the formation of such mechanism of saving, based on R&D, that enables us to speak about the agricultural progress as the development of the determinant effect of the scientific factor in the economic growth that transforms the reproduction process in the agrarian sphere of the USA ever more actively. In our scheme, the forming new pattern of economic growth corresponds to the science-intensive stage in the evolution of agrarian sphere.

We should note two remarkable facts with respect to the socio-economic evolution of the system of farming in the agrarian sphere of the USA. By the early eighties, at the farms of the USA the category of product that was earlier assigned to the intrafarming needs in nature (so called "home consumption") virtually disappears, and the greatest shift in the direction of overcoming of the residues of subsistence economy relations in the USA agriculture takes place within the period until the mid-sixties. Henceforth, all product produced at the farms of the USA (total 100%, by the data for 1990) is sent to the market and all product consumed at the farms (productive and personal consumption) comes from the market. In other words, we can already speak of the formal termination of the process of formation of the market economy in the agrarian sphere in its farmer and capitalist versions.

The second fact concerns the changes in the proportions between these two categories of farming. The sharp increase of the per farm average land area in the farmer economy began essentially from the late fifties. But until the early seventies, this process was not accompanied by the change in the social proportions of the employed labour, basing primarily on the application of own labour of farmer; the latter provided approximately 3/4 of all expenses of live labour in the farming (compare the data on the specific weight of the hired labour in Table 3). It is absolutely clear that this reasult could be achieved only by the intensive mechanization of the agricultural operations. The capitalist farming, based on the hired labour, began to displace the properly farmer one only from the early seventies, when the average size of the farm significantly increased (approximately to 180 ha; see Table 3), and the total expenses of live labour decreased. Until the early seventies, the displacement of the own labour of farmers from the agrarian production in the USA proceeded, on the whole, adequately to the displacement of the hired labour, but since this moment (i. e., since the early seventies) the relationship in the social structure of the employed labour changed in favor of the capitalist farming. In other words, the noticeable shift occurred in the agrarian sphere of the USA from the system of farming, where the typically farmer economy is the predominant element, to the system, where the capitalist economy appears to be such element.

The same changes initiate us to make one more conclusion of fundamental importance: with the spreading of STR in the agriculture of the USA, such economic source of growth of efficiency in the productive activity on land as the application of the advantages of the economy in scale appears more and more actively. It is the optimal enlargement of production, which conditions are formed, among other things, due to the existing system of land relations (free mobilization of land in the required size), that enables to realize the available resources of production in the farmer

economy with the maximum efficiency.

Russia

The analysis of corresponding package of data on Russia represent the specific difficulty. Thus, the considered above indicators on Japan, India (Punjab state) and the USA express only that we could refer to as the *natural type of evolution,* its parameters are determined by the logic of process of development of productive forces in their industrial and postindustrial form, the logic to which, in turn, the logic of the dynamics of the economic system corresponds. In the agrarian sphere of Russia, on the contrary, the natural type of evolution was interrupted (after 1917) by the large scale process of political violence over the economic processes. The gradually strengthening market regulators were replaced by the administrative and command centralized system of agricultural management that suppressed, among other things, the mechanism of its feedback, namely, that which under natural conditions correct and direct the process of the development of farming, being realized through the market. As a result, during all period of supremacy of communist system in Russia (with the partial exception of the short-range period in the twenties), the changes of both technological and socio-economic character in the agricultural farming of Russia were determined to the great extent by the factors lying beyond the market regulation. In such circumstances, the conditions of economic growth in agrarian sphere formed themselves as the funcion with respect to "bare" will of the power itself that appeared as the state system of extra-economic compulsion, or, for example, as the system of "state supervision" embracing all space of agrarian sphere.

In spite of the principal differences between both considered types of economic systems (market economy and "administrative and command" economy), we can perform certain comparisons by the factors of reproduction process.

In Russia, as in the USA, we can discriminate in the considered period (by the character of changes in the major parameters of TMP) several large stages in the techno-economic evolution of the agricultural farming. Until the early thirties, we deal in Russia with the traditional (peasant) farming (which, for example, was referred to as the "semi-subsistence" economy in the CPSU documents of that time). TMP, which was intrinsic to this type of farming, is adequately characterized by all combination of quantitative indicators, given in Table 4, — the indicators of application of technical means, power availability, productivity of labour, crop yield and level of commoditisation of production. The same data indicate that TMP, which was predominant in the twenties, underwent in some components as though the "reverse" evolution: as a result from the large-scale "black reallotment", followed the revolution in 1917 and desrtoyed almost completely all accumulated productive potential of the highly marketable economy, subsistence economy relations got the strongest impulse (for example, in the grain branch of agriculture the share of the marketed produce in gross grain output decreased by more than two times in comparison with the prewar years; see Table 4) that indicated the significant reduction of exchange relations between the industry and agriculture. Nevertheless, it was the semi-subsistence peasant economy that should become the social basis for the formation of the economy of farmer type under the conditions of natural evolution.

With the beginning of collectivization (the boundary between twenties and

thirties) in Russia, an attempt was made to pass "in the shortest time possible" from the TMP, characteristic for the semi-subsistence peasant farming, to the TMP (within the framework of "socialist" relations of production), where the advantages of the economy of scale open up in full measure, i. e., in accordance with our scheme, to the capital-intensive stage with the increasing labour-saving effect. "The shortest possible time" failed — the modernization of agricultural farming by the factor of productivity of labour, though arising (the thirties), started skidding for a long time (essentially, until the late fifties, if we consider the indicators of the most mechanized branch of agriculture — grain farming) at the same position (we should, however, take into account the destructive residual effects of invasion of German fascist troops into the European Russia during the war of 1941–1945). Only at the boundary between fifties and sixties, when the scientific and technological revolution was already gaining fresh energy in the USA farm economy, the stable growth of productivity of labour was clear in Russia's agriculture. The major technological changes, resulted in the increase in the efficiency of land, began to take place only from the sixties (see Table 4). It is this decade, when the most significant (for all history of the "construction of collective and state farming") increase in yield of grain crops occurred[10].

Thus, though the social revolution, which destroyed the individual peasant farming to its ground (compulsive collectivization), was performed less than in a decade, the technological "pretransition" embraced no less than three decades in the agrarian history of Russia, and it revealed itself to the rather moderate extent only in the form of changes by the factor of productivity of labour. The saving of resources of production was still far.

In the combination of factors, characterizing the economic growth in the agrarian sphere, the major achievement of that period was the jumpwise change in the yield of the marketed product in agriculture: for example, in the grain farming the share of marketed produce in gross grain output increased under the influence of the system of extra-economic compulsion in different forms ("obligatory supplies" of the product to the state; understated prices for the grower; gratuitous, i. e., free "social" works, etc.) during ten or fifteen years (the period of "socialist reconstruction") by more than three times — up to 40%–45% (and "froze" at this level during five decades — until the late eighties — see in Table 4 the data on the state procurement of grain, which covered from 90 to 95% of its total marketed volume before the early eighties).

The cycle of technological transformations, initiated in the sixties, continued as the forward motion until the eighties (by different parameters — until the early, middle, or late eighties) as was the case in the USA, but its results with respect to the economic growth in the agrarian sphere were principally different in both countries.

There was no synchronism between two aspects of technological change in the agrarian sphere of Russia. If we consider the data on the major branch of agriculture–grain farming, agriculture in Russia very soon (the early seventies) achieved the stage of "plateau" by the land factor of efficiency of production, and it was necessary to saturate during fifteen years the sphere of grain farming with more massed doses of mineral fertilizers (and other technological means) in order to support this state of "plateau" at the comparatively low level of yield (see Fig. 9, and also the data in Table 4) as was the case with Punjab in the middle and late seventies[11]. (The effect from such increase of expenditure of material resources was,

however, minimum: the annual harvests of grain in the eighties — during the Five-Year Plan period from 1981 to 1985 — were on the average below those achived in the second five-year period of the seventies and they scarcely surpassed this level during the Five-Year Plan from 1986 to 1990.)

The changes by the factor of productivity of labour had their peculiarities. The massed investments into the agrarian sphere in the seventies and eighties sharply increased the capital intensity ("fund intensity" as it is referred to in the "socialist" political economy) of production and, subsequently, resulted in the significant reduction of its capital output ("fund output"). For example, the index of output of agricultural product from the collective farms per each 1000 rubles of fixed capital used in agriculture of the USSR was as follows (in the comparable prices of 1973): 100 (1970), 62 (1975), 45 (1980), 37 (1985), 30 points (1990) (calculated on the basis of: National Economy of the USSR. 1985; do. do. 1990). At the first stages of the industrial growth, such dynamics of capital output normally indicates the situation, where the productivity of labour increases with the decrease of population employed in the process of production in agriculture.

But the following two circumstances just draw our attention. Although the productivity of labour, expressed by various indicators, continued to increase (though rather irregularly during the individual periods) at least until the late eighties (see Table 4 and Figure 10), more energy input were required per the unit of increase in the general productivity of labour (in the grain farming — see Fig. 10 — the transition from the saving type of energy consumption to the "wasteful" type occurred at he boundary between the seventies and eighties). The second circumstance consists in the fact that during twenty years of "industrial jerk"(1970–1990) the quantity of workers, employed by the productive activity on land (in the socialized economy of collective and state farms, and in the interfarming enterprises during last decade), decreased very insignificantly — only by 11.5%, and by 19% during all period of technological transformations (since 1960) (the corresponding data for the agrarian sphere of the USA are 33.2 and 57.2%, respectively).

Apparently, we can make an assumption that both the USA and Russia, initiated the realization of the major part of technological transformation in their agrarian spheres approximately at the same time (since the sixties), later on appeared at the different levels of motion; the vectors of their techno-economic (to say nothing about socio-economic) evolution diverged more and more, very rapidly in the seventies and impetuously in the eighties. Within the framework of the USSR, Russia failed to solve the central problem of industrialization of the agricultural farming — to create the most effective production (allowed by the character of the industrial productive forces). The process developed more likely in the reverse direction: the increasing expenses of material (and financial) resources were not accompanied by the adequate economic output; the efficiency of economy did not increase, but decreased: at least since the late seventies, increasingly more resources of production were virtually spent per the unit of the agricultural product. We can suppose that it is the economic system, resulted from the collectivization of the peasant farm economy, that obstructed the possibility of the adequate economic and technological (productive) realization of already high accumulated productive potential in agriculture (that became especially clear in the eighties). And this is the symptom of crisis of the given system.

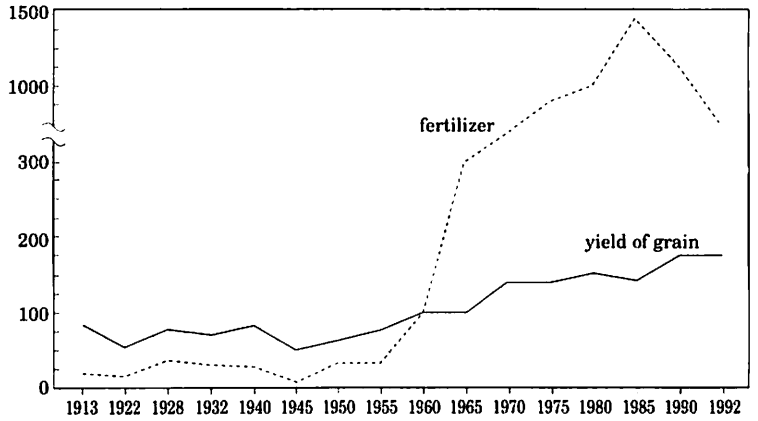

Figure 9 RUSSIA
Index of changes in land efficiency factor of agricultural growth (1960=100)
Based on the data from the Table 4

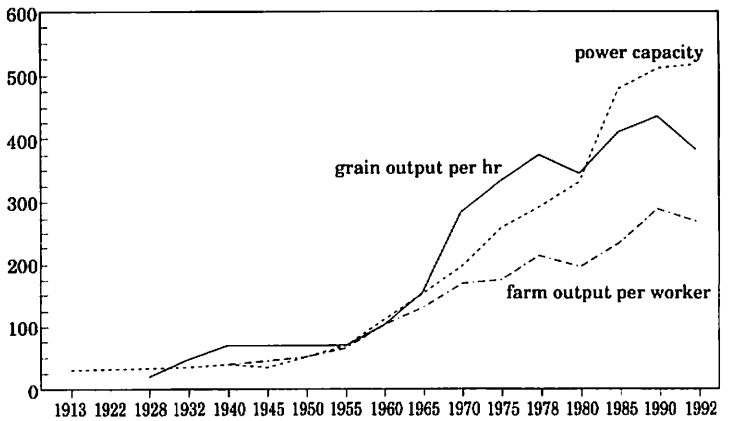

Figure 10 RUSSIA
Index of changes in labour productivity factor of agricultural growth (1960=100)
Based on the data from the Table 4

Since the early nineties (and since the late eighties by some indicators), we observe some shifts in the basic parameters of the economic growth (see Table 4), but they are the subject of a special analysis that is beyond the possibilities of this article. However, we should mention here one phenomenon.

Paradoxical is the fact of stabilization, lengthened by five decades, of the level of marketability of economy in the major branch of agriculture — grain farming that corresponds, according to our scheme, to the parameter, characteristic for the petty commodity production. And this is in spite of the fact that the agrarian sphere of Russia underwent great transformations of the technological basis of agriculture

during this period, it moved forward, though with the wasteful expenses, by the way to the labour-saving stage of development, and the economic growth in its agriculture became firmly dependent on the conditions of intersector exchange[12]. This historic paradox seems to get the full-fledged account only from the special investigation of the terms of trade that involves the agricultural farming. But paradoxical in the agrarian sphere of Russia is also the fact of reduction of power of the all-powerful state, the virtually monopolistic purchaser of the product from the agricultural producers. Since the eighties, the state purchases have the trend to reduction, falling to 26% of the total grain harvest in the early nineties. It is the food problem, this painful center of the social existence, where the crisis of the departing economic system appeared with the greatest sharpness. In fact, it developed against the background of the economy of Russia, which was increasingly dependent on the foreign food supplies (especially grain) during the last decades.

As to the problems of food import, only the data on the former USSR are available to us. They indicate that if in the middle sixties, when the Soviet state performed the massed grain supplies from abroad for the first time after collectivization, these supplies were, according to the data from the Central Statistical Board, only 10.9% of the value of internal state purchases of grain (1963-1966), this share increased up to 40% in 1980, to 60% in 1985 and to 47.3% in 1986-1990. In other words, during the last decade of the USSR, approximately 1/3 of the commodity grain stock, controlled by the state, was formed on account of the foreign supplies of grain.

To Sum up

The abovementioned facts give a clear evidence that the science and technological revolution, that has embraced the agricultural farming since the middle of the current century (in the USA by a decade earlier, and in many developing countries, in India in particular, by a decade and a half or two decades later), performs a profound upheaval in farm economy, transforming it up to its roots. However the country-wise results produced by STR, are far from being identical.

The facts prove convincingly,that the technological potential created through STR can be exposed in its entirety only provided the type of farm economy, adequate to the character of this potential, is formed, which, among other things, could accomplish self-regulation through market mechanism, supported, only in this function, by the state (the corresponding contrasts between the agrarian systems of the USA, on one hand, and Japan, on the other, are a clear example for this). On the contrary where the state starts to substitute its administrative (actually power) activity for economic activity of the private agricultural producer, involved the methods of extra-economic compulsion with respect to the latter (these can include also the performance by the state, of the function of monopsony on the market, to the detriment of the bona fide farmer), the economic environment, adequately corresponding to the requirements, determined by STR, can not take shape. For example, within the framework of the USSR, Russia failed to solve the problems in her agrarian sphere that determined by the very nature of the industrial type of productive forces.

Intercountry comparative analysis reveals also a remarkable regularity for initial "land-saving" technological mode of production, in which zones the scientific and

technical progress paves the path largely through the development of land factor of efficiency of production: the motion of farm economy towards such a fundamental goal as the increase in labour productivity at par with that in other economic sectors producing material product, has been progressing with great difficulties and is distinguished up till now with meagre results (India, Japan). Therefore, since the beginning of the age of STR the gap between different countries involved in the process of STR, by the labour productivity factor of growth becomes, as the course of the technological transformations goes on, ever more wide. Moreover, the consequences aroused by the agriculture falling behind in labour productivity factor of production is felt ever more painful for the society, especially in the context of world economic development.

As for Russia's farm economy, one of the fundamental lessons of her agrarian history for the last seventy years consists of the fact that the regeneration of the motivation to the efficient labour and the productive accumulation becomes the imperative need of the development of her agricultural system; it is this background against which, among other things, the special significance in the transition of today's Russian agrarian sphere to the system of farmer economy is to be estimated.

Notes

(1) For instance, according to the report of UNCTAD, "during the period of the sixties and seventies, the national economies united with each other and with the world market ... the share of export in gross domestic product in all countries of the world, as a whole, increased approximately by two times and achieved 20% ..." (UNCTAD Report, 1987, p.28. Translated from Russian).

(2) E.E.Yashnov was one of the first who suggested (by the example of China) the fundamental theory on of the concept of "land-saving" technological mode of production as opposed to the "western", "labour-saving" analog (Yashnov. 1933; about the theory of E.E.Yashnov see Mugruzin. 1984). Afterwards, many scientists returned to the problem of differences between the technological modes of production of "East" and "West", for example, Seiichi Tobata (Tobata. 1958), G.Murdal (Murdal. 1970), Yujiro Hayami and Vernon W.Ruttan (Hayami, Ruttan. 1971).

(3) For the characteristic technologies of the science-intensive stage in the agricultural development see: Agriculture. 2000.

(4) The detailed analysis of achievements connected with the scientific and technological progress in the agriculture of Japan is given in the study: Markaryan. 1987.

(5) Moreover, in the seventies, as the investigators note, the "green revolution" technologies (of the "first generation") essentially achieved the marginal border in their productivity. In the mid-seventies, the increased cost of production (because of the "price revolution" on the energy resources markets) "became a major concern due to the stagnation in yield levels". "Farmers were trying to maintain their yield levels by applying higher and higher doses of fertilizers" (Gulati, Sharma. 1990). Figure 4 quite clearly displays the extent of efficiency of these efforts.

(6) With respect to the late eighties, the investigators pay their attention to the formation of "showing signs of sluggish growth" both in productivity and production as a whole (Sidhu, Sidhu. 1992); to the "stagnation of farm technology" (Ball et al. 1991).

(7) "It was also found that the operating points in the highly productive areas were nearer to the flattening part of the production surface that means the further growth in such areas demands more of the new technology rather than just making the fine adjustments with the available technology" (Singh, Kaur. 1992). Let us recall the example of Japan: what a striking agreement we see between the problems!

(8) Approximately the same periods are discriminated by K.Singh and K.Kaur (1992), distinguishing them by the type of predominant capital investments in agriculture — "landesque" and "labouresque" that are concentrated around land and labour, respectively.

(9) The passing note. From the branches of grain farming, represented in Table 3, the transforming effect of STR to the greatest extent influenced the corn farming — one of the basic branches of feed production. On the contrary, the wheat producion, which potential of growth is primarily restricted by the state (for example, by means of subvention of farmers under their obligation not to enlarge the planting area under this crop) was significantly less affected by this revolution, especially with respect to the factor of productivity of the crop. Therefore, in the development of farming, producing the crop that is "unsuitable" for the state (it requires the ineffective expenses), the most emphasized is likely to be the factor of productivity of labour, i.e., the reduction of costs of production (because we should keep in mind the extremely strong competition at the world wheat markets).

(10) Here we should make an essential reservation. The indicator of yield of grains changed so significantly during the period from 1965 to 1970 (i.e., virtually from 1964 to 1971) not only as a result of the application of new technological means, but also likely because of the change in the practice of the account for the value of yield: instead of estimating the grain harvests in the category of "storehouse harvest", the estimate of harvest by the "green shoots" was used since 1965.

(11) The dynamics of efficiency of production in the cattle farming was no less remarkable. After Stalin passed away with his plainly terrorist regime of extra-economic compulsion of agricultural producers, during only five years the milk yield per cow increased in the socialized farming by 72% and achieved 2062 kg in 1958, according to the data of the Central Statistical Board. During the next 27 years, the cattle farming of Russia firmly "stuck" at the stage of the "plateau" (and that was with so small average milk yields per cow!): by 1985, this indicator increased only by13%. At the same time, the increase in the milk yield per cow in the socialized economy of Russia was zero during the period from 1970 to 1985!

(12) If we consider the original statistical data on the degree of mechanization of labour in the grain farming, already in the sixties, to say nothing of the eighties, the level of its marketability (40–45%) is in a striking disagreement with the industrial potential accumulated in it.

References

1. Agriculture 2000–Agriculture 2000, *A Look at the Future; A Study by Columbus Division, Battelle Memorial Institute*, Columbus, Richland, 1985.
2. Ball et al 1991–H.S. Ball, K.K. Jain, Bant Singh, "An Economic Analysis of Farm Business in Punjab," in *Agricultural Situation in India* [*ASI*], 1991, Vol.46, No.4.
3. Gulati, Sharma 1990–Ashok Gulati, Pradeep K. Sharma, "Prices, Procurement and Production. An Analysis of Wheat and Rice", in *Economic and Political Weekly,* Bombay, 1990, Vol.25, No.13.
4. Hayami 1988–Yujuro Hayami, *Japanese Agriculture under Siege: The Political Economy of Agricultural Policies*, London, M. Macmillan, 1988.
5. Hayami, Ruttan 1971–Yujiro Hayami and Vernon W. Ruttan, *Agricultural Development: An International Perspective*. London: John Hopkins Press, 1971.
6. Japan Statistics 1950–*Japan Statistical Yearbook 1950*, Tokyo, 1951.
7. Japan Statistics 1960–*Abstract of Statistics on Agriculture, Forestry, and Fisheries*, Japan, 1960 (Ministry of Agriculture, Forestry and Fisheries of Japan, 1961).
8. Japan Statistics 1992–*The 68th Statistical Yearbook of Ministry of Agriculture, Forestry and Fisheries*, Japan, 1991-92.
9. Japan Almanac– *Asahi Shimbun Japan Almanac,* 1994.
10. Markaryan 1987–S.B. Markaryan, *Science and Engineering Progress in Japanese Agriculture*, Moscow, "Nauka", 1987 (translated from Russian).
11. Mugruzin 1984–A.C. Mugruzin, "E.E. Yashnov's view on the Distinctive Features of Chinese Economy and History," in *The Peoples of Asia and Africa*, Moscow, 1984, No.3 (translated from Russian).
12. Murdal 1970–Theme Paper: Cunnar Murdal, "Agricultural Development and Planning in Underdeveloped Countries outside Socialist Sphere," *Fourteenth International Conference of Agricultural Economists, Minsk, USSR, August 1970*, Oxford, 1970.
13. National Economy of the USSR 1985–National Economy of the USSR, *Statistical Abstract for the Year 1985* (translated from Russian).
14. National Economy of the USSR 1990–National Economy of the USSR, *Statistical Abstract for the Year 1990* (translated from Russian).
15. Rastyannikov 1969–V.G. Rastyannikov, *Food for Developing Countries in Asia and North Africa: Socio-economic Approach*, Moscow, "Nauka", 1969.
16. Singh, Kaur 1992–Karam Singh, Kulwinder Kaur, "Growth in Agricultural Production and Nature of Technological Change in Punjab Agriculture," in *ASI*, 1992, Vol.47, No.5.
17. Sidhu, Sidhu 1992–D.S. Sidhu and J.S. Sidhu, "Agricultural Development in Punjab–Post Experience and Future Challenge," in *ASI*, 1992, Vol.47, No.2.
18. Tobata 1958–Seiichi Tobata, "An Introduction to Agriculture of Japan," *Agriculture, Forestry and Fisheries Conference*, Tokyo, 1958.
19. UNCTAD Report 1987–*Promotion of Development, Economic Growth and International Trade: Report of the UNCTAD Secretariat at the 7th Session*, July

9-31, 1987.
20. USA Statistics 1950–*Statistical Abstract of the USA, 1950.*
21. USA Statistics 1992–*Agricultural Statistics, 1992* (US Department of Agriculture).
22. Yashnov 1933–E.E. Yashnov, *Distinctive Features of the History and Economy of China*, Harbin, 1933 (translated from Russian).

APPENDIX: Statistical Tables

Table 1 Japan: factors of economic growth in agriculture

Year	Area of cultivated land, '000 ha	Fertilizer consumption, nutrient content, kg/ha	Yield[1] rice, 100kg/ha	Yield[1] total cereals, 100kg/ha	Use of tractors, units per '000 ha	Use of cultivators, units per '000 ha	Labour productivity, rice[2] kg/hr	Proportion of marketed rice output, %	Expenditure of outside labour as % of total working hours	Average cultivated area per farm, Ha
1925	6017		28.6	25.7						1.08
1930	5867		31.2	27.4				41		1.05
1935	6009		27.1	25.3				41		1.07
1940	5812	112	29.0	26.7				41		1.07
1945	5244		29.2	25.2						0.87[3]
1950	5048	127	31.2	26.7			1.5	49	4.8	0.81
1955	5140	200	34.0	29.9		39	1.8	56	5.3	0.85
1960	6071	258	38.9	35.2		124	2.2	62	5.2	1.00
1965	6004	300	38.2	35.9	3	414	2.7	67	3.9	1.06
1970	5796	366	43.4	40.7	46	552	3.7	74.1	3.2	1.08
1975	5572	357	47.6	46.5	130	571	5.9	80.8	2.5	1.12
1980	5461	369	44.7	43.4	230	547	6.2	80.4	2.2	1.17
1985	5379	430	50.5	48.0	324	502	9.1	84.7	2.7	1.23
1989	5279	441	49.2	46.9	388	502	10.7 (12.0)	85.6	2.9	1.25
1990	5243	420	48.9	46.7	402	417	(12.2)	86.7	2.9	1.37
1991	5204	408	46.9	44.7	378	339	(12.0)	85.9	3.0	1.37
1992	5165				388	345				1.38

Compiled and calculated on the basis of data from: *Abstracts of Statistics on Agriculture, Forestry, and Fisheries, Japan, for 1932/33 to 1991* (Ministry of Agriculture, Forestry and Fisheries of Japan); *The Statistical Yearbooks of Ministry of Agriculture, Forestry and Fisheries, Japan, for 1982-83, 1988-89, 1991-92*; *Japan Statistical Yearbooks for 1950, 1960, 1976, 1991*; *Asahi Shimbun Japan Almanac 1994*, Tokyo, 1993.

(1) The data is calculated as the weighted average for three successive years; for example, the yield of crop for the year 1925 is calculated as the weighted average of the years 1924-1926.

(2) The data in brackets covers commercial farms.

(3) Data for the year 1946.

Table 2 Punjab (India): factors of economic growth in agriculture

Year	Area of irrigated land as % of cultivated land	Cropping intensity, %	Fertilizer consumption, nutrient content, Kg per ha of cropped area	Yield[1] wheat 100kg/ha	Yield[1] total foodgrains 100kg/ha	Use of tractors units per '000 ha of cultivated land	Use of engine operated tubewells units per '000 ha of cultivated land	Electric power consumption, KWT per ha of cultivated land	Labour productivity, wheat, Kg/hr	Proportion of marketed wheat output, %	Agricultural labourers as % to main workers in agriculture
1920-21	44.2	113		8.8	7.1						
1925-26	45.8	114		7.3	6.7						
1930-31	48.3	113		8.4	7.0				1.85[2]		
1935-36	48.3	116		8.5	7.3				1.5[3]	40.0[4]	
1940-41	54.1	116		8.7	7.3				2.1[5]		
1943-44	54.3	116		9.6[6]	7.8[6]	0.06			1.6[7]		
1950-51	38.1	118[8]		9.6	8.3[9]	0.26	0.5	1.2	1.9[10]		12.2[11]
1955-56	45.3	126		10.0	8.7	0.5	3.0		2.0	36.0	
1960-61	49.7[8]	126	1.0	12.3	11.5	1.3	4.2	18.4	1.9[10]		17.3
1965-66	55.1	128	9.0	14.2	13.1	2.8	6.3		1.8[12]	31.8	
1970-71	69.0	140	37.5	22.9	19.9[13]	9.8	46.6	192.2	4.4	52.2	32.1
1975-76	73.8	150	47.2	23.7	21.4	10.9	106.5	345.6		50.8	
1980-81	79.8	161	112.7	27.7	26.0	28.3	141.6	514.4	6.4	54.4	38.2
1985-86	86.9	170	154.4	34.3	32.3	47.5	155.8	719.9	7.5	62.9[14]	
1988-89	90.0	175	151.2	36.1	33.1	58.3	176.0	1233.5[15]		47.7	

Compiled and calculated on the basis of data from:

The Board of Economic Enquiry, *Farm Accounts of the Punjab*, Publication NN 5, 19, 24 (Lahore), 92 (Ludhiana), 107 (Chandigarh); The Board of Economic Enquiry, *Agricultural Statistics of the Punjab*, Publication N 52, part I & II, Lahore;

Government of India Publications: *Economic Survey, Reports for the years 1981-82, 1987-88, 1990-91*; *Census of India 1981*,

Series-1, Paper-3 of 1981, New Delhi, 1982; *All India Report on Agricultural Census for 1970-71*; *do. do. for 1980-81*; *Indian Agriculture in Brief*, 7th ed. (1966), 17th ed. (1979), 21st ed. (1987) (Ministry of Agriculture); *Growth Rates in Agriculture 1949-50 to 1964-65, 1966*, App. 2.12, p. III.9; *Marketing of Wheat in India*, 1963, p.11, 13; *Agricultural Labour Enquiry, Rural Man-power and Occupational Structure* (Ministry of Labour), 1954, p.144;

Government of Punjab Publications: *Statistical Abstract of the Punjab*, Chandigarh, 1968; Record Achievements in Punjab Agriculture, 1983 (Dept. of Agriculture, Punjab); *Report on the Marketing of Wheat in the Punjab*, Lahore, 1939, p.54; *The Growth of Punjab Economy*, Chandigarh: Punjab University, 1960, p. III.9;

Agricultural Situation in India [ASI]: A.J. Singh, "Structural Changes in Punjab Agriculture", vol.45, N4; H.K.Bal, Bant Singh, H.S. Ball, "Analysis of Demand for Farm Labour and Its Substitution with Other Factors of Production for Punjab Agriculture", vol.42, N1; D.S. Sidhu & J.S. Sidhu, "Agricultural Development in Punjab", vol.47, N2; Khem Singh Gill, "Diversification of Agriculture in Punjab", vol.47, N5; B.S. Hausra, J.L. Sharma, "Impact of Green Revolution on Structural Changes in Farm Organization in Punjab", vol.47, N1; see also *ASI*, vol.28, N2, p.118; vol.43, N6, p.557; vol.43, N8, p.680; vol.47, N1, p.9.

Sumit Guha, "Labour Intensity in Indian Agriculture 1880-1970," in: *Economic and Political Weekly*, Bombay, 1990, vol.25, N52, p. A-190;

(1) The data is calculated as the weighted average for three successive years; for example, the yield of the crop for the agricultural year 1920-21 is calculated as the weighted average of the years 1919-20 to 1921-22.
(2) Calculated for the year 1929-30.
(3) Calculated for the East Punjab.
(4) Estimates of the Ad Hoc Committee of the Punjab Government for the years 1926-27 to 1935-36.
(5) Calculated for the Central Punjab for the year 1939-40 (irrigated wheat production).
(6) Average for the years 1942-43 to 1946-47.
(7) Calculated for the East Punjab for the year 1945-46 (irrigated wheat production).
(8) The data for 1950-51 (or 1960-61) onward covers the territory of the reorganized state (1966).
(9) Average for the years 1950-50 to 1952-53.
(10) Calculated for the irrigated wheat production.
(11) Earners and helpers of agricultural labourers families as % to earners and helpers of total families employed in agriculture.
(12) Calculated for the irrigated wheat production for the year 1963-64.
(13) Data for the year 1970-71.
(14) Calculated for the 1986-87.
(15) Data for the year 1989-90.

Table 3 USA: factors of economic growth in agriculture

Year	Area of cultivated land, '000ha	Fertilizer consumption, nutrient content, Kg/ha	Yield[1] wheat 100kg/ha	Yield[1] corn 100kg/ha	Use of tractors: units (weel) per '000ha	Use of tractors: power capacity Hp/ha	Labour productivity[2]: wheat output Kg/hr	Labour productivity[2]: corn output Kg/hr	Labour productivity[2]: total farm output per hr 1960=100	Proportion of marketed farm produce, %	Proportion of hired labourers as % of total workers employed	Average cultivated area per farm Ha
1920	162.7	12	9.1	17.8	1.5						23.7	60.1
1925	157.1	13	9.7	16.9	3.2					85.0	25.4	58.7
1930	167.1	13	9.7	15.8	5.5					86.5	25.2	63.6
1935	162.2	10	8.3	12.5						83.9	21.6	62.6
1940	161.5	14	10.3	20.0	9.7		40	25	31	87.0	24.0	70.6
1945	164.0	22	11.6	22.9						90.5	21.0	78.8
1950	165.5	34	11.4	25.5	19.6	0.6	80	51	53	93.2	23.5	87.2
1955	164.0	40	12.1	27.0	25.5	0.8	101	80	69	94.6	24.3	98.0
1960	158.6	50	16.0	39.1	28.3	1.0	161	137	100	96.5	26.7	122.5
1965	157.2	75	17.8	49.1	29.2	1.1	227	247	137	97.7	26.4	142.3
1970	155.4	111	21.0	53.9	28.4	1.3	250	385	172	98.4[3]	26.0	157.5
1975	158.0	126	19.8	55.2	27.3	1.4	303	555	217	97.7	30.3	177.9
1980	159.8[4]	144[4]	22.9	69.4	29.0[4]	1.9[4]	303	666	294	99.2	35.2	182.0
1985	163.5[5]	133[5]	24.8	77.1	27.7[5]	1.9[5]	389	907	375	99.4	35.2	178.5
1990	161.5[6]	118[6]	23.8	77.0	28.5[6]				383	100	31.6	186.6

Compiled and calculated on the basis data from:

Statistical Abstract of the United States 1928, 50th ed; *do. do. 1930*, 52nd ed; *do. do. 1932*, 54th ed; *do. do. 1939*, 61st ed; *do. do. 1946*, 67th ed; *do. do. 1947*, 68th ed; *do. do. 1950*, 71st ed; *do. do. 1965*, 86th ed; *do. do. 1968*, 89th ed; *do. do. 1977*, 98th ed; *d.o do. 1980*, 101st ed; *do. do. 1988*, 108th ed; *do. do. 1990*, 110th ed; *do. do. 1991*, 111th ed. (US Department of Commerce); *Agricultural Statistics 1992*, (US Department of Agriculture) 1992.

(1)The data is calculated as the weighted average for three successive years; for example, the data for the yield of crop in the year 1920 expresses as the weighted average of the years 1919-1921.

(2)For labour productivity data the following time intervals are taken: 1940 for 1935-1939; 1950 for 1945-1949; 1955 for 1950-1954; 1960 for 1955-1959; 1965 for 1960-1964; 1970 for 1965-1969; 1975 for 1970-1974; 1980 for 1975-1979; 1985 for 1982-1986.

(3)The data for farm marketing cash receipts includes CCC (Credit Commodity Corporation) loans (about 3% to 4% of the total farm marketing cash receipts in 60s and 70s).

(4)Data for the year 1978.

(5)Data for the year 1982.

(6)Data for the year 1987.

Table 4 Russia: factors of economic growth in agriculture

Year	Area of cultivated land, '000ha	Fertilizer consumption, nutrient content, Kg/ha	Yield[1]		Use of tractors		Power capacity in agriculture, Hp/ha	Electricity consumption in agriculture, Kwt/ha	Labour productivity[2]		State procurement as % of	
			wheat	total cereals	actual number	recounted for 15-hp units			cereal output, Kg/hr	farm output per worker 1960=100	wheat output	total cereal output
			100kg/ha		units/'000ha							
1913	79.3	1.3	7.0	8.2			0.20					27.6[3]
1922	52.9		4.3	5.3								13.0[3]
1928	90.5	2.5	7.9	7.6	0.2	0.15	0.20		3.9[4]			13.3[3]
1932	113.2		5.2	6.9	1.2	1.2	0.22					34.4
1940	114.4	1.9	7.6	7.9	3.0	4.0	0.25		12.3[5]	40	53.3	43.5
1945	83.0	0.5	5.1	5.0	3.2	4.1	0.22					46.8
1950	118.3	2.3	6.5	6.0	3.9	5.2	0.32	8	10.9	50	47.1	38.5
1953	121.3	2.3	7.6	7.4	3.9	6.6	0.41		11.2	60	47.7	40.0
1960	132.7	6.7	10.4	9.7	4.3	7.7	0.63	40	22	100	49.3	40.4
1965	133.8	19.8	9.9	9.8	6.3	12.3	0.92	85	32	127	46.4	40.6
1970	134.0	32.9	13.8	13.5	7.6	15.9	1.20	141	62	164	50.4	40.0
1975	134.1	59.9	14.1	13.7	8.9	22.1	1.60		72	172	45.4	36.4
1980	134.3	67.5	16.1 (15.0)	14.8 (13.8)	9.8	28.1	2.06	312	75	191	45.6	40.0
1985	133.6	96.0	14.9 (13.8)	14.0 (13.0)	10.7	33.0	2.97	409	89	230	40.4	38.0
1990	131.5	83.4	19.0 (17.6)	17.1 (15.9)	10.4	36.9	3.19	511	95	283	41.0	32.9
1992	127.6	44.2	19.2 (17.8)	17.2 (16.0)	10.1		3.22	550	83[6]	264[6]	31.3	26.0

Compiled and calculated on the basis of data from (translated from Russian):

Publications by Central Statistical Board, USSR, Russia: *Statistical Abstracts of the National Economy of the RSFSR* (Russian Federation), for 1960 to 1992; *National Economy of the RSFSR for 50 years*, 1967; *National Economy of the USSR in Figures*, 1924; *A Summary for the Decade of the Soviet Power, Statistical Data for the years 1917-1927*; *National Economy of the USSR in 1932*, 1932; *Agriculture in USSR, Statistical Abstracts for 1960, 1971, 1988*;

Russian Federation in Figures: *Statistical Data for 1992*, 1993; *Basic Indicators for the Development of Agrarian and Industrial Complex of Russia in the Year 1993*, Pt I & II. 1994; *National Economy of the USSR during the Great Patriotic War of 1941-1945, Statistical Abstract, 1990*; *Socialist Construction in the USSR in the years 1933-1938*, 1939;

V.S. Nemchinov, *Agricultural Statistics*, Moscow, 1945 (indicators for labour productivity for 1928 and 1940); N.D. Kondratyiev, *The Market for Grains and Its Regulation during the War and Revolution*, Moscow, 1991 (data for yields in 1909 to 1913).

(1)For the yields of wheat and total cereals and for the state procurement the following time intervals are taken: 1913 for 1909-1913; 1922 for 1920-1922; 1928 for 1928-1930; 1932 for 1931-1932 (data for the state procurement only) 1950 for 1946-1950; 1953 for 1951-1955; 1960 for 1956-1960; 1965 for 1961-1965; 1970 for 1966-1970; 1975 for 1971-1975; 1980 for 1976-1980; 1985 for 1981-1985; 1990 for 1986-1990; 1992 for 1991-1993.
Figures in brackets are the original data in terms of the so called "treated grain".

(2)The series of data for productivity of labour express the direct expenditure of live labour on cultivation of land proper rather then that for entire set of operations required in the production process.

(3)Proportion of the marketed grain produce as % of gross grain output.

(4)An individual peasant farm in 1922-25.

(5)A grain production-based collective farm in 1937.

(6)Data for the year 1991.