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Ecological and Economic Prerequisites for the Use of Fallow Land for Organic Production.

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ABSTRACT

For now, the extent of agricultural development and, in the future, the level of the country's food security, public health and quality of life are largely conditioned by innovative solutions in the field of alternative agriculture, as well as preservation of natural resources and primarily the land that is the main means of production. At the same time, both thin organic food market and significant land potential for organic farming provide all the required opportunities for improving the competitiveness of Russian agricultural producers.

Keywords: organic agriculture, organic products, land resources, fallow land, zone-based agro-ecological cluster, land use ecology, food security.

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INTRODUCTION

Modern society has become more aware of the current global environmental issues. Consequently, over the past two decades, there has been an increasing interest among agricultural producers for organic and eco-friendly land use techniques that ensure gradual soil fertility recovery and contribute to maintaining the natural ecosystem balance of the areas (B.P. Akmarov, 2012; V.V. Alakoz, 2013). This agricultural production method is an alternative to modern industrial land use (A.I. Altukhov, 2009; Stukach V.F., 2011). Therefore, relevant issues to be addressed are those related to the eco-friendly farming development prospects, as well as the feasibility of using the fallow land and unused agricultural land for eco-friendly food production.

METHODS

A theoretical and methodological framework for the study is represented by the papers of national and foreign scientists on organic farming problems; land relations development issues, as well as scientific studies and guidelines of the Russian Academy of Agricultural Sciences; laws of the Russian Federation; decrees of the President and regulations of the Government of the Russian Federation; laws and regulations of the federal subjects; EU regulations on the development of environmentally friendly agriculture and IFOAM standards. Background data include agricultural entities' annual reports; records from Rosreestr (Federal Service for State Registration, Cadaster and Cartography) of the RF; data from the Russian Geographical Society, the Federal State Statistics Service and the Ministry of Agriculture; original insights; technical and support literature. A systemic approach has become the methodological framework ensuring the comprehensiveness and purposefulness. Moreover, research methods used in the paper are as follows: analytical; abstract and logical; computational and constructive; economic and statistical; economic and mathematical; and monographic and experimental.

FINDINGS

Summarization of foreign experience in the field of production and consumption of eco-friendly foods allows to make the conclusion that the greening of agricultural production is a red-hot trend. The organic food market situation is as follows: the most developed countries are leaders among the organic food consumers and developing countries are leaders among the producers (E.N. Krylatykh, 2008; Z.Y. Sokolova, 2014).

Despite the organic food market attractiveness, the rate of its development in Russia has so far been insufficient. This fact does not make it possible to carve out a sustainable niche in the global market so far and to use the potential of the Russian organic food market in order to implement "the Food Security Doctrine of the RF" and "the Concept of Sustainable Development of Rural Areas for the period through 2020" approved by the RF Government in 2010.

In Russia, there are all prerequisites for the production of eco-friendly foods, such as long-standing agricultural traditions, rural labor force, huge land resources (often unused) and relatively small use, as compared to economically developed countries, of mineral fertilizers and crop protection chemicals in agricultural production. Organic oriented agriculture is a closed loop production cycle, where instead of chemical crop treatment manual labor is widely used (P. Grzelak; M. Maciejczak, 2013).

Russian agricultural producers of eco-friendly products need a unique food market segment oriented towards consumers who take care of their health and environmental safety (J. Smoluk-Sikorska; W. Luczka-Bakula, 2013). Consumers of environmentally friendly products may include children (baby and dietetic food); people with health disorders; patients under rehabilitation care; food allergic individuals; and people who adhere to healthy eating. In Russia, yet only 30% demand for organic products is satisfied (I.N. Belova, 2014).

Statistics and data analysis

Russia has unique natural resources potential and enormous environmentally friendly production resources. These are 20% of the world's total freshwater reserves, 9% of the planet's arable land (115 mln ha), and 58% of the world's black earth resources. Most of the world's 'green' crops are produced by private farms and subsidiary (auxiliary) household plots. In the Altai Territory, the share of these household types accounts for a third of all arable land; moreover, private farms and subsidiary household plots produce over 90% of the total production of potatoes and vegetable crops (V.A. Kundius, 2011).

Arable land abandoned or unused for agricultural production purposes for over one year is theoretically considered fallow land that in turn can become a significant land reserve on the way to 'green' land use and eco-friendly food production. In the Altai Territory, a large part of the arable land has emerged in former steppe areas destroyed during the reclamation of virgin and fallow land in the middle part of the last century.

There is no doubt that fallow and unused arable land has to play a significant role in agricultural entities' transition to 'green' land use. In the Russian Federation, a large dataset relating to land statistics and land inventory is periodically summarized. The main challenge is that it is impossible to find out the actual area of the fallow land using the data provided by the land inventory. Thus, according to the statistics, 'fallow land' refers to a certain type; however, this type of land includes only a part of the unused arable land that has been officially transferred from 'arable area' to 'fallow land' (L.I. Lyuri, 2010).

We have tried to estimate the actual area of the fallow and unused land using statistical data, particularly a digital dataset of annually provided data on the number and structure of the crop areas in the regions of the Russian Federation. Thus, if you compare the total area of the arable land according to the land inventory with the crop area, you will be able to estimate the uncropped or unused area of the arable land. However, to provide an actual estimate of the total area of the unused arable land, you have to separate the fallow area out of the total uncropped area.

Table 1: Actual estimate of the unused arable and fallow land of the Russian Federation at year-end 2014 with a breakdown by Federal Districts

Federal Districts of the Russian Federation	Arable land area, ha	Crop area, ha	Area of fallow land according to the land inventory	Variation in area values between arable land and crop area	Estimate of fallow area	Unused arable land area	Actual estimate of the unused and fallow land
CFD (Central Federal District)	22,085	14,486	390	7,599	1,883	5,716	6,106
NWFD (Northwestern Federal District)	2,999	1,462	188	1,537	191	1,346	1,534
SFD (Southern Federal District)	16,606	11,355	24	5,251	1,476	3,775	3,799
TCAB (North Caucasian Federal District)	5,388	4,093	23	1,295	533	762	785
VFD (PFD) (Volga (Privolzhsky) Federal District)	34,723	23,314	766	11,409	3,031	8,378	9,144
UFD (Ural Federal District)	7,880	5,393	861	2,488	701	1,787	2,648
SFD (Siberian Federal District)	22,966	15,077	1,704	7,889	1,960	5,929	7,633
FEFD (Far Eastern Federal District)	2,492	1,482	435	1,010	193	817	1,252
Total in the RF	**115,150**	**76,662**	**4,391**	**38,488**	**9,966**	**28,522**	**32,913**

You can use the established pre-reform level indicator as an upper bound of the fallow area indicator. By the beginning of 1990, the share of uncropped arable land was on average around 13% in the major agricultural regions. If we take this value for the upper bound of the technically justified fallow area, we can manage to estimate the actual area of the unused arable land. We have to calculate the difference between the total area of the arable land for the relevant year adding the officially registered area of the fallow land to the obtained value and deducting the area of potential fallows (+13% of the crop area for the relevant year). According to the calculations, we have obtained a value for which we have applied the term 'reserve of land suitable for organic production', where 10% of arable land should be used as fallows (O.Y. Voronkova, 2014).

In Russian regions, the period of the most rapid reduction of the crop areas was in 1990-2000, followed by the three-year stabilization period, followed in turn by a slight reduction again, but reduction anyway, then followed by a short-term extension since 2007; and the recent years of observations show that the crop areas have remained approximately at the same level (A.A. Zhuchenko, 2012; D.V. Khodos, 2009). In fact, since 2003, the crop area in the regions of the Russian Federation has remained at a level of approximately 76.7 mln ha. The uncropped arable land area has also changed little for this period remaining at a level of roughly 38.5 mln ha.

Land potential assessment

According to our estimates, around 10 mln ha of this area can be optimally used as fallows for agricultural purposes. The calculations have shown that the actual area of the unused and fallow land in the regions of Russia reached approximately 33 mln ha by 2014, where the officially registered fallow area reached 4.4 mln ha or around 13.3% of the actual value; and a small percentage of them was officially transferred to 'hayfields' and 'pastures'.

The values provided in Table 1 show that approximately a quarter of the total arable land area in the Russian Federation has not been used for its intended purpose, namely agricultural food production. It can certainly be assumed that primarily low-yield and inconveniently located parcels of arable land have been withdrawn from industrial use; however that is not always the case. However, the analysis performed in terms of the administrative districts of the Altai Territory has shown that there is no clear relationship between the arable land capacity and the arable land use intensity.

According to Vladimir Miloserdov, key agricultural scientist, RAAS (Russian Academy of Agricultural Sciences) Academician, one of the measures required for the protracted crisis recovery of the Russian AIC (Russian Agroindustrial Complex) protracted crisis is the development of neglected agricultural land (V.V. Miloserdov, 2012). Thus, mean values indicate that in every subject of the Russian Federation approximately 28.5% of the arable land currently remains unplowed and unused for agricultural production purposes. However, the gap between certain regions is too wide. In five regions of Russia, from 60 to over 75% of the arable land has become the fallow land. Almost half (43–47%) of the main arable land area is not used for agricultural production purposes in the Volgograd Oblast, the Tula Oblast, the Krasnoyarsk Territory and the Zabaykalsky Territory. It should also be noted that among all subjects of the Russian Federation only in the Republic of Tyva and the Zabaykalsky Territory the unused arable land area is currently greater than the crop area. In these regions of Russia, the reduction of crop areas over the past two decades has shown a kind of negative anti-record - more than 90% in the Republic of Tyva and around 85% in the Zabaykalsky Territory.

Land reserve estimation methods

For the estimation of the actual area of unused arable land, we have introduced methods that make it possible to estimate the extension capacity of crop areas from among parcels of unused arable and fallow land. The introduced methods involve taking into account fallow area according to the scientifically justified standards of agrotechnical requirements in relation to a specific edaphoclimatic zone.

$$Rs = Sp - Sy - Sk + Sz$$, where

Rs - extension capacity of crop areas,

Sp - arable land area reserved for an economic entity, an administrative district, a group of areas (districts), a subject of the RF,

Sy - total crop area reserved for an economic entity, an administrative district, a group of areas (districts), a subject of the RF,

Sk - an upper bound of a scientifically justified standard applied to fallow area in relation to a specific edaphoclimatic zone, and

Sz - fallow land area reserved for an economic entity, an administrative district, a group of areas (districts), a subject of the RF.

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Base-line values for estimating the extension capacity of crop areas from among parcels of unused arable and fallow land according to the suggested methods are provided in Table 2.

Table 2 - Agricultural land area in terms of administrative districts of the Foothill zone of the Altai Territory as on 01.01.2014

Areas	Total area, ha	Agricultural land, ha					
		Total	arable land	hayfields	pastures	fallow land	perennial plants
Zmeinogorsky	152,419	144,119	98,166	8,466	35,616	8,096	288
Kuryinsky	198,008	189,586	99,586	15,502	66,572	1,583	-
Krasnogorsky	170,111	156,564	45,854	54,385	53,777	2,522	26
Ust-Kalmansky	226,337	209,767	119,895	18,099	59,160	12,599	14
Ust-Pristansky	199,885	172,048	111,679	37,396	37,396	1,518	26
Bystroistoksky	106,026	86,436	47,445	12,090	22,711	-	50
Smolensky	154,257	138,453	95,949	11,966	30,153	286	99
Altaisky	207,348	192,219	48,661	35,725	100,986	5,200	1,627
Soloneshensky	236,259	222,471	26,791	45,053	146,413	4,160	54
Charyshsky	248,220	210,795	33,954	53,301	117,264	6,229	47
Total in zone	1,898,880	1,722,458	727,979	261,983	670,049	46,333	2,231
Altai Territory	11,534,234	10,596,995	6,514,430	1,136,318	2,600,776	326,425	19,046
Foothill zone share of the total area of Territory, %	16.5	16.3	11.2	23.0	25.8	14.2	11.7

In order to asses economic efficiency of parallel agricultural production management according to the organic and traditional systems, we have suggested to perform crop area structure optimization using economic-mathematical modeling, where an additional set of organic criterion constraints has been introduced in the value of the objective function: the reserve of land suitable for organic production; gross agricultural output; and organic production costs.

Table 3: Extension capacity of crop areas from among parcels of unused arable and fallow land in the Altai Territory, including Foothill zone areas

Districts	Area of arable land, ha	Cultivated area, ha	Area of fallow land according to the land inventory, ha	Variation in area values between arable land and crop area, ha	Estimate of fallow area, ha	Unused arable land area, ha	Unused arable land share of the total arable land area, %	Extension capacity of crop areas, ha
Zmeinogorsky	98,166	79,251	8,096	18,915	12,761	6,154	6.3	14,250
Kuryinsky	99,586	61,614	1,583	37,972	12,946	25,026	25.1	26,609
Krasnogorsky	45,854	45,064	2,522	790	5,961	-5171	**n/c.c.r.s.**	-2,649
Ust-Kalmansky	119,895	91,128	12,599	28,767	15,586	13,181	11	25,780
Ust-Pristansky	111,679	91,871	1,518	19,808	14,518	5,290	4.7	6,808
Bystroistoksky	47,445	40,101	-	7,344	6,167	1,177	2.5	1,177
Smolensky	95,949	88,653	286	7,296	12,473	-5,177	**n/c.c.r.s.**	-4,891
Altaisky	48,661	42,325	5,200	6,336	6,325	11	**optim.**	5,211
Soloneshensky	26,791	21,330	4,160	5,461	3,483	1,978		6,138
Charyshsky	33,954	30,878	6,229	3,076	4,414	-1,338	**n/c.c.r.s.**	4,891
Total in zone	727,979	592,215	46,333	135,764	94,634	41,130	5.6	87,463
Altai Territory	6,514,430	5,473,540	326,425	1,040,890	833,878	207,012	3.2	533,437

Note: **n/c.c.r.s.** - non-compliance with the crop rotation structure, **optim.** - optimal scientifically justified crop rotation structure.

Based on the estimates of extension capacity values for crop areas in Foothill zone areas in the Altai Territory using the suggested methods, we can conclude that zone-wide 5.6% of arable land on average remains unused for agricultural purposes, whereas the index for Territory is lower, namely 3.2%. However, significant variations have been identified in the land use structure in terms of administrative districts. Thus, in 3 of 10 districts (Krasnogorsky, Smolensky, Charyshsky) scientifically justified agrotechnical requirements to crop rotations have been failed to comply with; i.e. no land has been used as fallow, which causes soil exhaustion and makes a critical anthropogenic impact on the arable land. In 6 districts of the Foothill zone, the percentage of the unused arable land ranges from 2.5% in the Bystroistoksky district to 25.1% in the Kuryinsky district, and only in the Altaisky district the land use structure can be considered optimal; however, there is a crop area extension capacity due the agricultural use of fallow land. Thus, the crop area extension capacity in the Altai Territory is 533.4 thousand ha of arable land, of which 87.5 thousand ha, or 16.4%, are located in the Foothill zone of the Territory (Table 3).

Formation of zone-based agro-ecological clusters

In our view, a gradual transition to organic agricultural production principles and the improved competitiveness of Russian organic farmers seem practicable in terms of establishing local science and innovation agricultural entities (clusters) in the country's agricultural regions; these entities focus on production, processing, storage and sales of AIC eco-products; we have suggested using a term 'zone-based agro-ecological cluster' for them.

Based on general explanations, we have defined 'zone-based agro-ecological cluster' as a local zone-based, eco-friendly, science and innovation agricultural integration entity including agricultural production, processing and marketing organizations; a scientific, educational and production facility of regional research centers and high schools; marketing analytics, laboratory and certification, tourism and recreation, education and culture units; an exhibition center; and a well-developed logistics and storage infrastructure.

Unlike the traditional cluster-based network-centric structures, the zone-based agro-ecological cluster project has justified the establishment of laboratory and certification; tourism and recreation; and environmental education and culture units. We have proved the appropriateness of the 'umbrella certification' of organic products and production systems of the agro-ecological cluster.

In zone-based agro-ecological clusters, one single cycle combines all operations associated with planning, scientific justification, production, processing, storage, sales and certification of AIC eco-products, i.e. from the moment when a business idea is generated until it is implemented in a certain finished product. A zone-based approach to establishing agro-ecological clusters has been used due to significant differences of certain areas of the regions in environmental climatic potential; soil fertility; population density; level of development of infrastructure; road and transport accessibility; availability of product markets; and tourism and recreation potential of the area. In our opinion, the establishment of zone-based agro-ecological clusters is of particular importance for the economic development of the agro-industrial region and raising investments in AIC. Moreover, in this case, public support is very important for the idea of establishing zone-based agro-ecological clusters and understanding their role in the strategic development of the country's agriculture.

The developed zone-based agro-ecological cluster model includes the following key units: manufacturing and processing provision; transport and logistics; service; marketing and sales, which allows for the establishment of the effective chain 'production-processing-sales of organic agricultural products. In order to ensure the viability of the zone-based agro-ecological cluster and the development of its complementary activities, the following units have been highlighted: management; coordination; finance and human resources; innovation, science and education. The project on zone-based agro-ecological cluster structure has suggested establishing laboratory and certification; tourism and recreation; and environmental education and culture units.

The establishment and development of organic oriented agriculture based on a gradual involvement of the unused and fallow arable land resources in agricultural activities seem practicable in terms of advancing organic agricultural technologies, alternative farming practices and agricultural innovations through the network of agricultural information and advisory centers; arranging organic products presentations; running advertising campaigns; participating in trade fairs both at the country and regional levels.

We believe that the activities of zone-based agro-ecological clusters can have a significant positive effect on the level of economic, social and environmental development of rural administrative territorial entities of the region through encouraging both organic and traditional regional agricultural product markets; using the land resources in a comprehensive and environmentally sustainable way; developing innovative agricultural solutions; improving the rural employment rate; encouraging the agro-ecotourism sector; establishing the environmental infrastructure of the area; extending the taxable field; improving the sustainability of agricultural organizations; and increasing the innovation activity level in the region.

Climate and environmental conditions of the Altai Territory have predetermined the development of agricultural production, where soil is the main resource. Arable land abandoned or unused for agricultural production purposes for over one year is theoretically considered fallow land that in turn can become a significant land reserve on the way to organic (eco-friendly) agricultural food production.

Economic-mathematical model

Relatively positive environmental situation of the Foothill zone in the Altai Territory, tourism and recreation as well as land resource potential of this area have become the main criteria for selecting this area when developing the project on zone-based agro-ecological cluster. In the course of the scientific research, it has been proven that the establishment of organic oriented agriculture doesn't mean canceling industrial agriculture. According to this conclusion, we have developed an economic-mathematical model of zone-based agro-ecological cluster "Altai Foothills" operation based on parallel functioning of both traditional industrial land use system and environmentally friendly, i.e., organic system.

It seems appropriate to prepare three scenarios of the economic-mathematical model of the agro-ecological cluster "Altai Foothills". The first scenario provides for the optimization of the existing structure of crop areas keeping the traditional cropping management system fully functional. The second scenario involves adding 50,000 ha of the land reserve suitable for organic production to the structure of crop areas. The third scenario is as follows: involvement of the whole reserve land area of 87,463 ha in the Foothill zone in the Altai Territory suitable for organic production in agricultural activities. The second and third scenarios provide for harvesting organic products from the land reserve area suitable for organic production (Table 4).

The performed calculations involving the additional set of organic criterion constraints when calculating the economic-mathematical model allow us to conclude that only through optimizing the structure of crop areas in terms of the traditional agricultural production system an increase in the level of profitability up to 17.3% has been observed compared to 14.9% in 2013.

Table 4: Project on the structure of crop areas of the agro-ecological cluster "Altai Foothills" in terms of the industrial use of the reserve of land suitable for organic production (economic-mathematical model)

Indicators	Option 1 - Optimization of the traditional agricultural production system		Option 2 - Additional allocation of 50,000 ha from the reserve of land suitable for organic production, ha (parallel management)		Option 3 - Additional allocation of 87,463 ha from the reserve of land suitable for organic production, ha (parallel management)	
	ha	%	ha	%	ha	%
Cereals	456,988	62.8	462,454	59.4	489,287	60.0
Industrial crops	75,671	10.4	76,925	9.9	65,238	8.0
Potatoes and vegetables	10,475	1.4	11,227	1.5	12,232	1.5
Fodder	141,752	19.5	165,135	21.2	167,173	20.5
Fallow	43,093	5.9	62,238	8.0	81,548	10.0
Total number of crop areas	727,979	100	777,979	100	815,479	100
Reserve of land suitable for organic production, ha	87,463		37,463		0	

The second scenario - with the partial involvement of the land reserve suitable for organic production in agricultural activities - has shown 22.9% profitability; and the third scenario - in terms of full involvement of the land reserve suitable for organic production in agricultural activities - has approached 40% (Table 5).

Table 5: Financial performance of the agro-ecological cluster "Altai Foothills" achieved by optimizing the area structure and using the reserve of land suitable for organic production (economic-mathematical model)

Indicators	Actual (2013)	For Option 1	For Option 2	For Option 3
Revenue, mln. rubles	1,413.8	1,549.8	1,728.6	2,914.7
Cost, mln. rubles	1,230.0	1,314.7	1,406.7	2,086.4
Profit, mln. rubles	183.8	235.1	321.3	827.6
Profitability,%	14.9	17.3	22.9	39.7

The estimate of the three scenarios for the economic-mathematical model has shown economic efficiency of the gradual transition to organic oriented agricultural production. When calculating economic-mathematical models, we have developed and applied the parallel method for crop area structure optimization under the traditional system of organic oriented agricultural production management. The estimate of the suggested crop area structure optimization scenarios - including both partial and full involvement of the land reserve suitable for organic production in agricultural activities - involves feasibility of the suggested zone-based agro-ecological cluster "Altai Foothills" project.

DISCUSSION

The gradual transition of some agricultural enterprises to the organic agricultural production principles requires high-performance experience of enterprises engaged in organic production, as well as AIC innovative solutions that can be implemented through the system of zone-based agro-ecological clusters at the regional level. All of the above stated seems practicable with an adequate level of coordination of participants' activities and effective organizational economic facility of state support and encouragement of agricultural business focused on organic production that in turn should be considered as a critical component of the structure of the domestic organic product market that has been rapidly developing (E.G. Lysenko, 2004, 2008; A.A. Lukyanchikova, 2012).

Actual fallows, or unused arable lands that haven't been treated with chemicals for a long time are the important strategic agricultural capacity of the Altai Territory that can be used for eco-friendly and safe food production. With a smart marketing strategy focusing consumers' attention on ecologically clean environment and nature of Altai, products from Altai farmers will be in demand even outside the region. The economic efficiency of 'green' land use is due to higher consumer prices for certified eco-friendly (organic) products as compared to those produced by using the traditional technologies. The gradual involvement of the fallow land in agricultural activities will make it possible to have a positive multiplier effect in such AIC sectors as agriculture, processing and distribution. Thus, the unemployment rate will partially decrease in the region; many agricultural producers in the Territory will be able to find their places in the eco-friendly food market; moreover, consumers will be able to buy healthy food.

It is reasonable to consider the land use greening as an integral part of the sustainable agricultural development and environmental protection systems. Organic ('green') agricultural products are the products with a technological production chain - from the preparation of raw materials to the last processing operation - that shall comply with the environmental requirements provided for in the environmental standards (Z.V. Nikitina, 2005). Therefore for the successful development of the organic product market the national eco-friendly (safe) food certification system that would be harmonized with the international standards should be established.

We consider necessary developing and introducing a facility of state support of domestic agricultural producers who are engaged in environmentally friendly food production in the framework of the WTO "green box". Indirect support can be provided through facilitating certification procedures for organic products; performing laboratory researches; providing information and advisory services; financing scientific innovations; insurance; soil remediation and fertility improvement actions; and environmental protection (I. Sycheva, E. Permyakova, N. Kuzmina, 2015). According to the WTO requirements, the scope of this support is unlimited.

CONCLUSION

We believe that an important task of the modern agricultural economics is comprehensive justification of forming the process of developing a new type of agricultural economics that is more efficient and organic oriented and is an essential component of the national economy. In our opinion, the comprehensive development of organizational and economic principles of gradual involvement of the unused and fallow arable land in agricultural activities - towards ecological and economic sustainability of land use - will make it possible to improve the country's national food security and will give local agricultural producers the chance to enter overseas organic food markets.

Focusing land, material, financial and labor resources on the development of organic oriented agricultural production makes it possible to increase volumes of domestic organic food production, and, besides, facilitates the reduction of import dependency, promotes quality and environmental safety of products as well as the development of diversification in agriculture and related rural industries.

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