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Review

Current Status of Iranian Agricultural Mechanization

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ABSTRACT

Iranian agricultural mechanization continues to experience a lack of expert management. The objective of this study was to estimate farming power and the inventory of agricultural equipment at the farming household level, and to present the current status of Iranian manufacturing, sales, and services and also the constraints and opportunities for improvement, particularly in agricultural mechanization and production. There are two main farming systems in Iran; irrigated and rain fed. The main crops produced are wheat, oats, peas, alfalfa, and rice. There are three types of farming power namely, human, animal and motorized. For agriculture mechanization development, the government must support more research and development opportunities, hire qualified youth and willing graduates and increase international cooperation. Greenhouse automation should be considered. Increased financing of agricultural machinery manufacturing is also necessary along with the distribution of tractor power based on regional, technical needs. A program of expansion and education should be also developed. Government policy that hinders development in rural areas at the expense of the migration of human resources must be avoided.

Key Words: Agricultural mechanization; Agricultural machinery; Tools; Development

INTRODUCTION

Iran has over 14 million hectares of agricultural land, 12 million under annual crops and approximately two million hectares of horticultural trees. The two main farming systems practiced are: (i) irrigation (44%) and (ii) rain fed or dry land (40.3%) (Ministry of Jihad-e Agriculture, 2000). Iran covers an area of 1,648,000 km^2 with a wide range of topographic features and climatic conditions in southwestern Asia (Statistical Center of Iran, 1998a). The elevations range from below sea level to more than 5,000 m above sea level. The temperatures fluctuate between -30ºC to 50ºC and annual precipitation varies from about 25 mm in the Central Plateau to over 2,000 mm in the Caspian Coastal Plain with an average of 250 mm. Approximately 90% of the country is arid and semi-arid. Central Iran is a steppe-like plateau with a hostile climate, surrounded by desert and mountains; the Zagros Mountains on the western border and Alborz Mountains to the north. Underground water irrigates the oases where a wide variety of grain and fruit trees are cultivated. The shores of Caspian Sea have a humid climate and are suited to tropical and subtropical crops (cotton, rice, and tea). The annual evaporation loss is high, ranging from about 700 mm along the Caspian Sea shores to over 4,000 mm in the Central Plateau and the southern part of the Khuzestan and Southern Coastal Plains in southwest, amounting to 16 times the average annual rainfall (Ministry of Jihad-e Agriculture, 1999; Statistical Center of Iran, 1998b).

In 1997, the total wheat production of the country (grain) was 10,045,000 mt, harvested from 2,230,000 ha of irrigated land and 4,030,000 ha rain fed area with an average yield of 1,600 kg/ha. The averages under irrigated and rain fed agriculture were, 150 kg/ha and 730 kg/ha, respectively (Ministry of Jihad-e Agriculture, 1998a; Moameni, 2000). The average yield of wheat in Iran was 1,600 kg/ha in 1997 (irrigated and rain fed). This amount is far below the records obtained in leading European countries (7,590 kg/ha) and is 40% below the world average (2,634 kg/ha) (Ministry of Jihad-e Agriculture, 1998b; Moameni, 2000). Under irrigation farming, the actual average yield of wheat was 3,150 kg/ha, which is about one-fifth of the wheat potential yield (about 14,700 kg/ha). Wheat yield in rain fed areas is also very low, on average 730 kg/ha at the national level. Since Iran is a drought-prone country, yields fluctuate widely in rain fed areas having varied climatic conditions. However, the average of long-term yield averages (730 kg/ha) signifies the status of agricultural productivity under rain fed conditions. The data published by Ministry of Jihad-e Agriculture (1998b) shows that during the past two decades, there has been a real increase in wheat yield under irrigation farming, achieved through better managing of manageable problems.

Tools, implements and powered machinery, are essential and major inputs to agriculture; it can be argued that they are one of the most important. The term "Mechanization" is commonly reserved for the overall description of the application of these inputs. Generally, there are three sources of farm power utilized for these tools; (i) machines and equipment, (ii) manual (human) and

animal draft, and (iii) motorized power. In many developing countries up to 80% of farm power is provided by human beings (Clarke, 2000). In most developed countries human beings are used less and less as a source of power and more for machine operation and control.

In most cases, in a situation where the expansion of agricultural land is limited, the application of advanced tools and machines does not, by itself, lead to increased unit yields. However, the full benefit achieved through the use of many advanced crop husbandry inputs such as improved seed, fertilizer, and pesticides, as well as increased use of irrigation water cannot be realized without the use of improved tools and machines. In situations where land is not a constraint, increased farm power can lead to direct increases in production by simply increasing the land area or animal numbers that one man can handle (Clarke, 2000).

In the past, misunderstood concepts and inappropriate selection and use of certain mechanization inputs (mainly tractors and heavy machinery) have, in many parts of the world, led to heavy financial losses and lowered agricultural production as well as contributed to environmental degradation. In many developing countries, ambitious politically motivated heavily subsidized tractor schemes have often become a burden to the national budget and the farming community rather than being a productive input. In such cases these government run services have failed to provide timely and profitable mechanization inputs to farmers.

The type and degree of mechanization should be decided by the producer to best suit his business and his own particular circumstances, and the choice of suitable methods will therefore be just one of a number of choices that the farmer has to make.

Iran has an overall agricultural force of 23,026,293 (Agricultural Expert Group, 2001). The people engaged in agribusiness increases at a rate of about 15% annually. However, since the urban population increased 42.6% over the past 10 years, it is evident that people are moving out of rural areas to the cities. Reasons for this migration are the occupational opportunities, social services and the development of a thriving black market. Also, the cost of living for farmers is frequently higher than their annual income. Iranian population has increased 3.1% over past 10 years, however the percent employed has not increased at the same level, indicating an 18.9% increase in the unemployed. The agricultural sector contributes 20% of the gross national product, which is relatively low with respect to the service sector (Mojtahdi, 1996; Ministry of Jihad-e Agriculture, 1998-2001; 2000a).

The total area under cultivation and the timeliness and efficiency of crop husbandry is strongly influenced by the amount of available farm power and its efficient use. The increased usage of farm power for cultivation creates increased demand for agricultural machinery for harvesting and storage and generates employment opportunities in the agricultural service industry. According to Plan and Budget Organization (1999), currently, about 20% of the total population of Iran suffers from food insecurity. If the needed actions are not taken, the future generation will probably suffer more from underfeeding. It is therefore important to establish the quantity of available farm power and its application in various agricultural activities (soil preparation, sowing, weeding, spraying, harvesting, processing, etc.).

The key objectives of this study were: (1) To identify the farming power sources in the country (manual, animal and motorized), their relationship to farming systems, and how they are expected to change in the near future, (2) To estimate the inventory of agricultural equipment at the farming household level and (3) To identify the number of agricultural equipment that are manufactured locally or imported and the available service facilities.

METHODOLOGY AND RESULTS

Current economic and social situation. In Iran the average farm land is about 5 ha with annual yield of 3500 kg of wheat/ha, which sells for about 11.76 million Rials; barely subsistence level. Farmers will increase their incomes with the sale of other goods or with a second job to make ends meet. Some farmers have cash crops, which amount to 30-40 million Rials per year. There has been some export of agricultural commodities, about 969 thousand tons, with a value of $683 million. This reflects a 5% increase relative to 1999 (Ministry of Jihad-e Agriculture, 2000a; 2000b). There have been 2-3 years of drought, which has strongly affected agriculture. Agricultural costs have increased sharply, which has put such a high on the production of some crops as to make them unreasonable to produce. There has been a definite increase in greenhouse production recently (Omid & Shafaei, 2004).

Overview of Iran Agriculture. There are two type of farming systems, irrigated and rain fed for annual and perennial crops. Out of 14.302 m ha of farmland, 12.24 m ha are under annual crops and the rest are horticultural crops. The main crops are wheat, oats, peas, alfalfa and rice, each utilizing more than 500,000 ha (Ministry of Jihad-e Agriculture, 1997). There are three types of farming power available in Iran: human, animal and motorized both single and twin axle tractors (Tabatabaeefar, 1998).

Crops and area under cultivation: Wheat, oats, peas, alfalfa and rice have average yields, in both farming systems, of 1.83, 1.42, 2.37, 7.44, and 4.0 tons/ha respectively. Citrus fruits, apples, pistachios and dates are the main horticultural crops (Ministry of Jihad-e Agriculture, 1997; Personal Interviews, 2001). Khorasan province has the highest percentage of annual crops, with 14.18% of total cultivated area, followed by Khuzestan, Azarbaijan, Fars, Loristan, and Kordestan provinces. These six provinces account for 47.52% of total cultivated land. Tehran, Isfahan, Mazanderan, Kerman, and Gilan provinces have higher yields per land area. Total annual crop production was 47.62

million tons, 87.19% from irrigated land and the rest from dry land farming. Other provinces have lower outputs (Ministry of Jihad-e Agriculture, 1998; 1997; 2000a, 2000c; 2001). The central provinces yield about 4 million tons of grain, with Lorastan province having the highest yield.

Farming systems. Irrigated and dry land crops total 44 and 40%, respectively, as shown in Table I. Under both farming systems small farm holdings, tenant farming, share cropping, cooperatives, and government-industrial cooperatives exist.

Table I. Share of principal farming systems (Year 2000)

Principal Farming Systems	Area (ha)	% of total arable area
Irrigated	5541	44
Dry land (rain fed)	4726	40.3
Permanent crop (horticulture)	1977	15.7
Total	12244	100

Farming systems and farming households. There is small, medium and large scale farming areas. Small-scale farmers rely more on manpower and less on other sources of power. The average-farming households are 1.3-5 people. Small scale farming (less than 2 ha) accounts for 7-83% with about 35% irrigated farming and 25% dry land (Tabatabaeefar, 1998; Personal Interviews, 2001).

Farming systems, power sources and conservation agriculture. Irrigated farming uses all the three power sources, but mainly the tractor twin axial as shown in Table II. Single axle tractors are extensively used in paddy fields. There is some traditional agriculture; however, the trend is towards less human and animal power and more tractor power in annual crop agriculture. In irrigated farming, the average wheat yield is about 3195 kg/ha (Ministry of Jihad-e Agriculture, 2000). Conservation agriculture is not strongly considered in Iran. There is a hope for future, since production is not increasing and the soil is becoming less fertile. Dry land farming system uses all the three power sources since some farmland is steep or hard to reach and the distribution of farmland is non-uniform. In these cases, there is more reliance on human power. Principal dry land farming will show an increase in the use of twin axle tractors in the future. There has been some indication of this from 1995-2000 that shows a decrease in human power sources. The average wheat yield is about 593 kg/ha in dry land farming (Ministry of Jihad-e Agriculture, 2000).

Greenhouse opening. Greenhouse automation builds strong and successful foundation of mechanization (Omid, 2004). They provide higher income and higher yields in a smaller area. Presently about 4820 ha of various flowers, crops, strawberry, banana and other types are grown under common greenhouses. The government is willing to expand greenhouse business. However, crops are sprayed up to 20 times to be protected against disease and other methods of caring must be investigated. The high percentage of human power in greenhouse crops (64%) will be replaced by motorized power, i.e. the greenhouse industry is becoming more and more automated and mechanized. But, true automation encompasses more than mechanization. Automation involves the entire process, including bringing material to and from the mechanized equipment. It normally involves integrating several operations and ensuring that the different pieces of equipment talk to one another to ensure smooth operation (Omid 2004; Omid & Shafaei, 2004). Many times, true automation requires reevaluating and changing current processes rather than simply mechanizing them. One of the key concepts in greenhouse automation is differentiating between mechanization and automation.

Inventories of farm power sources, axle tools and equipment. All types of tractors, from single axial to crawler tractors exist in the country. The majority of tractors

Fig. 1. (a) Tractor power and (b) tractor model distribution

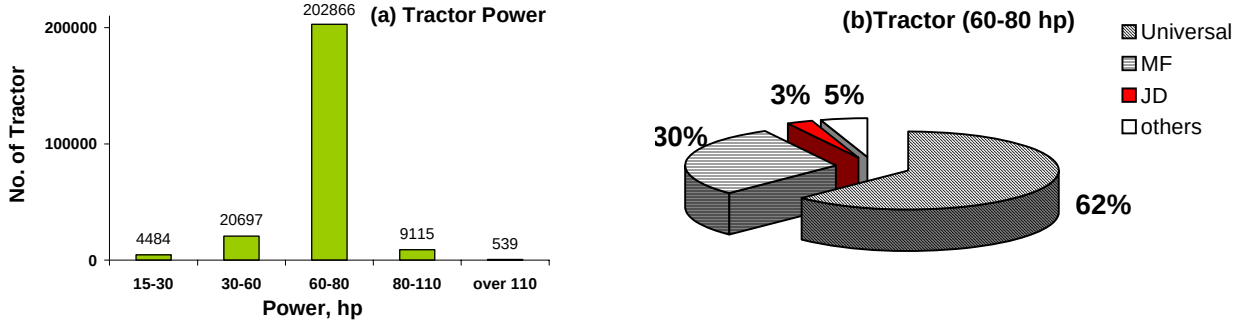


Table II. Principal irrigated farming systems

Year	Proportion of arable area in each farming system cultivated by power source (%)					Proportion of arable area under conservation agriculture
	Hand	Draft animals	Tractors Single axle	Tractors Twin axle	Total	
1995	14	5	3	78	100	
2000	12	3	2	83	100	Almost none
2005	10	1.5	2	86.5	100	
2010	8	0.75	1.75	89.5	100	About 15%

are 60-80 hp, as shown in Fig. 1a (Ministry of Jihad-e Agriculture, 2001), and are 4-18 years old (Tabatabaeefar *et al.*, 2002). Some new tractors have recently been distributed. Universal tractors account for 62% of the available tractors (Fig. 1b), 30% are Massy Ferguson models and a few are John Deere (Ministry of Jihad-e Agriculture, 2001).

About 35% of the population works in agriculture, 86% of them male (Agricultural Expert Group, 2001). A large number of different types of animals are available to the farmers (Agricultural Expert Group, 2001). Five to 20 kW diesel engines are primarily used for irrigation. A limited number of processing machinery is available. It is very likely that this will increase because of the decreasing human and animal labor pool. On small farms, most of the processing is done by human labor, but this trend will change and more processing machinery will be used. About 98% of the primary tillage in some agricultural crops is presently being by machine (Ministry of Jihad-e Agriculture, 2001; Tabatabaeefar, 2004).

Farm power sources. In year 2000, 7474 tractors, 363 combines, 230 self-propelled harvesters, 1024 tillers, 733 moldboard ploughs, 138 disks, 388 seed broadcasters, 141 deep seeders, 281 sprayers, 31 choppers and 52 milking machines were distributed (Ministry of Industry and Minerals, 2001; Ministry of Jihad-e Agriculture, 2000). Khuzestan province received 8.7% of the moldboard ploughs and Ilam province received 13.5% of the combines distributed. Of the tractors distributed, 82% were MF 285 models and 0.7% was Darvana models (Ministry of Jihad-e Agriculture, 2001). Power distribution during 1989-2003 is shown in Fig. 2. The trends for distribution of tractor and combine are encouraging. The trend in tiller distribution, despite of its critical role, is decreasing.

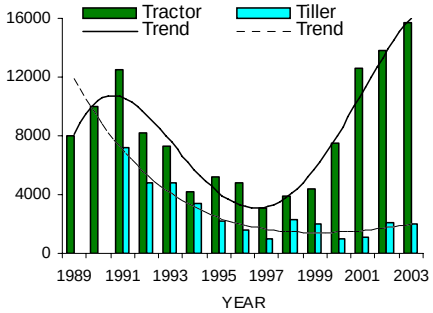
Tools and equipment at the farming household level. About 87% of farmers own twin axle tractors with soil inverting implements and hand tools for primary tillage and 92% do secondary tillage with tractor driven implements. Also about 87% own manual planting equipment (Ministry of Jihad-e Agriculture, 2001; Personal Interviews, 2001).

Overall percentage of farming households owning items. For manual primary tillage, about 72% of farming households own hand tools, 22% own draft animals and hand tools, and 6% own single-axle tractors as well as hand tools. The total of primary tillage hand tools were estimated at 4601. Farms owning twin axle tractors and hand tools for tractor-drawn primary tillage soil inverting (moldboard plough, disk plough) and soil non-inverting, (chisel plough) totals 230,573. Iranian farmers most frequently use carried sprayers. Operator-carried spray equipment totaled 77,587 number and 59% of farms owning tractors and hand tools have carried sprayers. About 77% of FOTATH [1] have tractor-operated spray equipment, totaling 15,709 households. About 8,750 self-propelled combine harvesters are primarily for hire. A strong union in Shiraz harvests from the south to the north of Iran over a three-month period, but most of these combines are old. There are 6,627 John Deere combine harvesters, 686 Class combines and 940 other types. Motorized post harvest equipment accounts for 59% of FOTAH (52,614). Most transport is hired, but a good percentage, 66%, of FHODAH [2]. FHODAH use manual transport. A total of 405,558 (82%) FOTATH use irrigation pumps. Surface irrigation is common, covering 7,593,600 hectares. Sprinkle and drip irrigation has recently been introduced, but with little success. Parts and filtration systems and the cost of layout are the main obstacles (Personal Interviews, 2001).

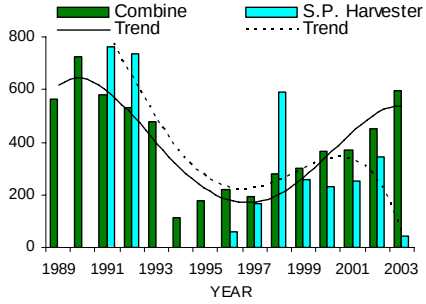
Tools and equipment of typical farming households. About 15% of human power is used in areas with steep slopes and hard to reach areas. About 2% of farms use animal power and the rest use mechanical power (Tabatabaeefar, 2004). However, a good percentage of the farms using human and animal power needed tools that are made locally, especially threshers. Single axle tractors with the needed accessories have recently been manufactured in Iran. Farming households owning tractors are about 65% and most moldboard ploughs, disks, planters, tractor-drawn sprayers and harvesters are made locally.

Equipment at typical village level. In 2000, agricultural machinery distributed totaled 3,068 units, whereas in 1993, the total was 18,859 units (Ministry of Jihad-e Agriculture, 2001). The number of tillers declined from 1,054 to 21 units because the area of the arable land has not changed and is

Fig. 2. Power model distribution during 1989-2003



(a) Tractor and tiller



(b) Combine and S.P. harvester

[1] farms owning twin axle tractors and hand tools
[2] farming households own draft animals and hand tools

Table III. Record of power sources manufactured locally (Year 2000)

Motorized power sources			Number manufactured in country	Number sold in country	Average price in Rails[a]	Total value of items sold in country
Tractors	Single Axle		21	21	8,800,000	18.4 x 10^6
	Twin Axle up to 40 kW		216	16	40,000,000	64.0x 10^6
	Twin Axle 40 - 100 kW		1040	3	60,000,000	18x 10^6
	Twin Axle above 100 kW		1	1	100,000,000	10x 10^6
Motors for Irrigation[c]	*Diesel motor*[b]	*Above 10 kW*	120	-	4,500,000	54.0 x 10^6
	Electric	5 - 20 kW	83	-	6,700,000	55.6 x 10^6
		20 – 50 kW	42	-	9,500,000	39.9 x 10^6
		Above 50 kW	20	-	12,000,000	24.0 x 10^6
	Diesel	20 – 50 kW	114	114	5,500,000	62.7 x 10^6
		Above 50 kW	99	99	7,000,000	69.3 x 10^6

[a]$1 = 8,800 Rials (proposed rate for 2004); [b]Diesel motor for processing machinery; [c]Estimate of pumps manufactured / sold)

Table IV. Record of tools and equipment manufactured locally (Year 2000)

Tools and equipments	Number manufactured in country		No. formal items sold	Average Price of formal items in Rials	Total value of formal items sold
	Informal sector	Formal sector			
Tillage Equipment					
Tractor drawn: Soil inverting	950	1285	1370	2,500,000	342.5 x 10^6
Soil non-inverting		85		1,800,000	15.3 x10^6
Tractor operated	455		455	3,900,000	179.7 x 10^6
Planting and Seeding Equipment					
Tractor drawn Conventional	1102	998	455	6,800,000	1489.2 x 10^6
Tractor drawn Zero-tillage		218	141	3,300,000	71.95 x 10^6
Spray Equipment					
Operator carried		533	-	-	-
Tractor-operated/self-propelled		1879	281	2,300,000	64.6 x 10^6
Airplane		30	12	-	-
Harvesting Equipment					
Tractor-operated harvest equipment	271	159	86	30,000,000	258 x 10^6
Self-propelled combine Harvesters		267	36	13,130,0000	472.6 x 10^6
Post-harvest Equipment					
Motor/electric powered		2518	1100	8,000,000	880.0 x 10^6
Irrigation Equipment					
Pumps		1712	-	3,850,000	-
Motor/electric/renewable		517	-	3,850,000	-

not needed. The number of sprayers distributed was 5,333 units in 1993. In 2000, it was 281 units (Ministry of Jihad-e Agriculture, 2001). The government instituted two five-year development programs, which are known as the second and third five-year programs (Ministry of Jihad-e Agriculture, 2001). The third five-year program ends in 2005. The core of the mechanization development plan aims at a higher degree of mechanization through the production and advertisement of machinery and the pursuit of internal governmental support. The degree of mechanization for planting was 26% in 2000 and the third five-year program aims to increase that to about 50% (Ministry of Jihad-e Agriculture, 2001). This program is progressing slowly.

Manufacturing, imports, exports, sales and servicing. There are over 1,500-farm machinery outlets (Ministry of Jihad-e Agriculture, 2001) with adequate inventory and reasonable prices. Producers must lower both the quality and price of their products in order to make them attractive for sale. Some farm machinery plants have tried exporting goods, but have met with little success. Farmers receive loans through Keshavarzi Bank to buy machinery. There are three factories that produce tractors, two producing engines, two producing tillers and one producing self-propelled and tractor-drawn harvesters. Depending on the factory, most important parts (5-95%) are imported (CKD[1]) and the machine is assembled in Iran. In 2000, about 628 motor pumps were sold (insufficient information on power type). There are about 3797 stationary and 629 mobile maintenance and repair shops (Ministry of Jihad-e Agriculture, 2001).

Count and value of agricultural power sources, tools and equipment. Tractors of 7.5-80 hp are mostly produced in Iran, some by joint venture. Higher horsepower tractors are ordered through the license and CKD system. Electric motors are mainly imported, although some are made in Iran, but diesel motors are mainly made in Iran (insufficient information on engine types). All prices are coded in Rials at the official rate of $1 = 8,800 Rials. This price may change when the official rates increases, as has been proposed. The total value of power sources sold over one year was $547.2 thousand dollars as shown in Table III. Agricultural equipment and tools sales were $4,965.6 thousand dollars, as shown in Table IV.

Ways ahead Iranian agricultural mechanization. The Centre for Development of Agricultural Mechanization has tried through the five-year programs and other plans to

[1] completely knocked down

support mechanization. They have observed testing of new foreign or Iranian-made machinery. They have provided education and extension services. There is still a need for serious planning, testing, teaching, and training cycles. A serious drawback to the agricultural machinery production system is cash flow. The farmer cannot get a quick loan to buy what he needs and may not be able to make payments in lean years. The government should consider supporting the farmer through the purchase of goods and subsidies.

CONCLUSIONS

The Centre for Development of Agricultural Mechanization is working toward a better degree of mechanization by producing the needed machinery and advertising mechanized farming systems and instituting government support for production. In 2000, the degree of mechanization for planting was 26% and the Centre believes it will be 50% after the conclusion of the third five-year program. These programs are progressing slowly.

A few factors strengthen agricultural mechanization, such as ample fossil fuels and solar energy sources, suitable human resources, a variety of climate, water and soil resources and marginal waste of land. However, the lack of farm-based policy for mechanization development, lack of proper extension services, the distribution of governmental decision-making bodies responsible for agricultural development, and the inefficient use of agricultural machinery have made the two five-year programs only partially successful.

For agricultural mechanization development, the government must support more research and development opportunities, hired qualified youth and willing graduates, and increase international cooperation. In recent years, there is a growing interest in mechanization and automation to save labor and allow the large-scale greenhouse operation. The greenhouse industry is becoming more and more automated and mechanized (Omid, 2004). But, true automation encompasses more than mechanization. Many times, true automation requires reevaluating and changing current processes rather than simply mechanizing them. One of the key concepts in automation is differentiating between mechanization and automation. Increased financing of agricultural machinery manufacturing is also necessary, along with the distribution of tractor power based on regional and technical needs.

A program of expansion and education should be developed. Government policy that hinders development in rural areas at the expense of the migration of human resources and capital investment must be avoided.

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