

The Fate of Agriculture in the Semi-arid Regions of Western Iran - A Case Study of the Hamadan Region

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Abstract : The semi-arid regions of Iran are under increasing pressure to supply the staple grains required by the steadily growing population. The Hamadan plateau, an ancient area at the foot of the Central Zagros mountain (354 m asl at the Alwand peak), was chosen to carry out an analysis of the agricultural systems (traditional vs modern) and to assess their sustainability. Several indicators from the ecosystem and sociosystem were implemented to compare the two systems. Like many other places in Iran, also in the Hamadan region agriculture is undergoing a fast change from subsistence to an advanced level. The resulted changes in social structure, which caused the disruption of the co-evolutionary equilibrium reached over long time by the traditional systems, are analysed.

Key words : Hamada region, land use, nomadism, livestock, crops, sustainable agriculture.

The semi-arid regions of Iran are under increasing pressure to supply the staple grains (wheat and barley) required by the steadily growing population of the country. A population of 150 million is expected in thirty years time, which means that thirty million tons of cereals will be needed. The present production of wheat is about 5.5 million tons and that of barley amounts to 2.5 million tons, almost all produced in semi-arid conditions. The Hamadan region is one of these areas where the agricultural frontier is expanding very fast, but at the expense of the environmentally-sound management of water and soil.

The Hamadan plateau (1750 m asl), located at the foot of the central Zagros mountain range (3574 m asl at the Alwand peak) about 400 km southwest of Tehran, has a semi-arid steppic climate with mild summers and very cold winters. The mean annual rainfall ranges between 320 and 350 mm. Winter precipitation is mainly snow, lasting some six to eight months in the mountainous areas and one to two months on the plateau. The rest of the precipitation is provided by scarce spring and fall rains. The mean monthly temperature in Hamadan varies from -5°C in January to 24°C in July, with an annual mean of 11°C . Mean extreme temperatures are respec-

tively -10°C and 36°C . Over centuries and millennia, the local people belonging to tribes of different origin (e.g. Persian, Turkish, Kurdish, Lorish) developed dry-farming and irrigation techniques to adapt to the above climatic constraints.

The objective of this article is to analyse the agricultural systems and their sustainability in the Hamadan region where agriculture is undergoing a fast change from subsistence to an advanced level.

Prevailing Land Use Systems

Although the surface area of the Hamadan province is only 1.5% of the whole country, its role in the production of cereals and other agricultural goods is remarkable. According to the agricultural census of 1976 (Booker, 1978), though rather outdated, the relative importance of the main regional products in relation to the national production is as follows : beans 10%, wine orchards 7%, dry-farmed cereals 6.1%, potatoes 5.4%, wheat 5%, alfa-alfa 4.5%, sugar beets 4.3% and barley 4.1%. Meat production from livestock amounts to 3.5 % of the production of the country. The total surface area of pastures, all qualities combined, is about half a million hectare.

Table 1. Land use and land cover in the Hamadan province

Major kind of land use		Physiographic position and land use type	
Extensive grazing	Total nomadism	Mountains	
	Semi-nomadism	Piedmont acrees Level plains	
	Secondary pastoralism	Piedmonts and plains	
Crop cultivation	Rainfed (dry-farming)	Piedmont acrees Gently sloping to sloping piedmonts	Traditional ¹ perennials Annual crops * traditional * semi-traditional Perennial crops * semi-traditional
	Irrigated	Plains and (very) gently sloping piedmonts	Perennial crops * semi-traditional Annual crops * traditional (basin irriga- tion) * semi-traditional - basin irrigation - furrow irrigation * improved - basin irrigation - furrow irrigation
	Mixed	Gently sloping piedmonts	Annual crops * traditional * semi-traditional * improved

¹ Traditional systems have disappeared in the region, except for a few remote locations. The Table corresponds to a land use map prepared on the basis of aerial photographs flown 40 years ago.

Prevailing land use systems in the region are classified according to a scheme adapted from Ruthenberg (1976). Emphasis is put on soil-water relationships and the dominant type of agricultural practices (from traditional to modern) in different physiographic environments (Table 1). Natural forests exist only in the higher parts of the mountains.

Extensive grazing

Nomadism, a kind of adaptation to climatic seasonality and a response to low permanent carrying capacity of natural grassland, is still practiced but with adjustments to a changing environment. The Hamadan province has 503,000 ha of pastures from which 420,000 ha, 44% of the surface area of the province, are considered of reasonably good quality (Tehran-Pazhoohesh, 1989). During the period from May to July, the scattered green slopes of the Alwand mountain

are occupied by large herds of sheep and goats, moving from exhausted highlands of the Kermanshahan and other neighbouring provinces. Every year, the same areas are occupied by herders of the same tribes (mainly Torkashwand, Jomhoor and Shahsawan). Black tents made from goat-wool are striking features in the landscape throughout the province, on mountain slopes (Alwand mountain), on piedmonts and in some depressed plain areas (east of Bahar and north of Hamadan). The tribes settling on slopy areas are the most traditional in their way of moving and living.

Others who graze the steppes, as for instance north of Hamadan, travel from neighbouring regions using cars and lorries. Small huts with minimum facilities, including the provision of drinking water, have been constructed by governmental authorities in a fixed part of the area, where people settle for a few months letting their sheep and goats graze the scarce grass

vegetation. Although animal husbandry is the main occupation, some tribesmen have arable lands, where they grow fodder and also annual and perennial crops (vineyards), both irrigated and rainfed. The poorer pastures in the surroundings of the villages are used by local pastoralists, who are comparatively more sedentarized than the above mentioned nomadic and seminomadic groups.

Crop cultivation

As in many other arid and semi-arid regions, water is vital to crop production. Three major cultivation types can be distinguished on the basis of water supply. Full rainfed farming is practiced on slopy areas, whereas irrigated farming dominates in the valleys and lower parts of the piedmonts. In the semi-rainfed system, rain-water shortage is compensated by complementary irrigation.

In all cases, cultivation practices vary from traditional to semi-traditional and improved, though real traditional practices are vanishing. In a traditional management system, water is supplied from underground tunnels (ghanat), springs (cheshmeh) and runoff harvest (e.g. in Shahrestaneh, Sobhaneh and a few other villages of Tooyserkan), no chemicals are applied, and tillage uses animal-drawn wooden plough. Areas irrigated by ghanat water are mainly level to nearly level surfaces. Flood irrigation is the traditional type of water application. Over the last three decades, irrigation has expanded to sloping areas using (semi-) deep wells. Flood irrigation is applied to alfa-alfa, cereals and peas, and furrow irrigation to potato, cucumber and melon.

Orchards, mainly of wine trees in the close surroundings of the villages, were irrigated in the past by ghanat water. Wine orchards were plowed with ridges of about 50-70 cm high, on which trees were planted, and irrigated every two weeks. Irrigation intervals used to vary from village to village, depending on the number of ghanats, quantity of water and traditional conventions. In winter time, furrows in vineyards were filled with water exposed to freezing. This technique, called yakhaub (yakh = ice; aub =

water) was believed to be useful against pests. Nowadays, the supply of water from deep wells allows for flexible irrigation intervals. Application of chemicals replaces the traditional way of pest control. In addition, village expansion leads to orchard extinction.

Traditional Versus Modern Agriculture

Disruption of the traditional agriculture

Farming based upon production factors and practices used by farmers for generations is called traditional agriculture (Schultz, 1983). Production factors of a traditionally managed cropping system in the Hamadan area include irrigation water supplied from underground tunnels, springs and, to a lesser extent, harvested runoff; the use of manure in place of artificial fertilizers; and manual tillage using animal-drawn wooden plough. A traditional agricultural system is not confined to cropping but also includes the livestock and farm household. Activities such as meat, leather, milk and craft production, in a given frame of social values, community norms and land-ownership, are integrated with and control the farming system (Fig. 1).

Traditional agroecosystems are backed by a long history. They represent thus well harmonized and co-evolved models for particular environments. Farmers produce a variety of basic products and many side-products. Thus a failure in targeted products such as cereals does not lead to a complete breakdown and starvation, because it is compensated by other products such as milk and meat, ensuring economic autarcy.

A traditional farmer is a generalist, able to fulfil all the functions of the production unit, from animal husbandry through crop cultivation to the production and marketing of food, fibres and rural handicrafts (Fig. 2). A traditional system is thus polyfunctional, well organized and strongly integrated at the household level, including cropping, livestock and handicraft. The household belongs to a spatial organization integrating hierarchically the village (deh), the district (dehestan), the town (shahrestan) and the province

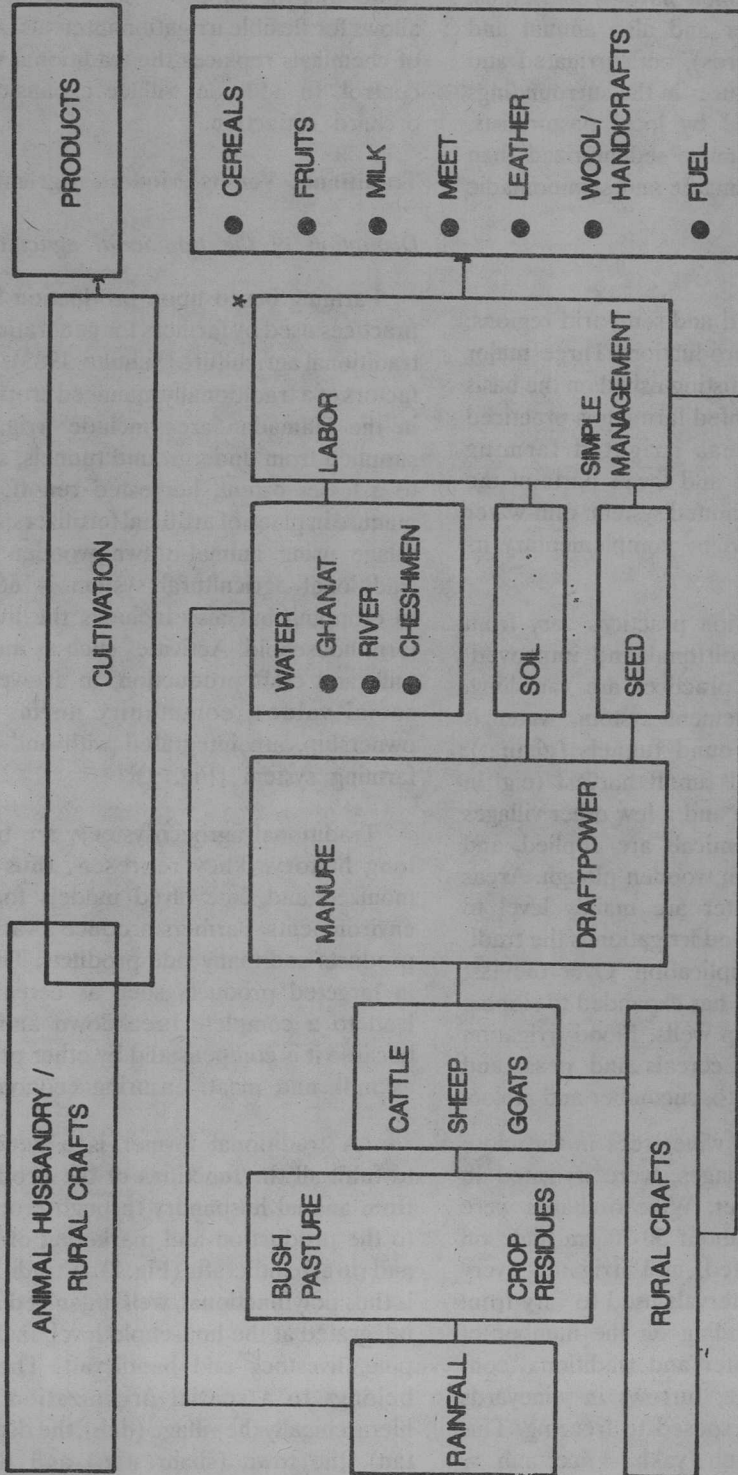


Fig. 1. A model of the traditional agricultural system based on the integration of crop farming, animal husbandry and handicraft production at household level. Labor and simple management represent most of the aspects of the "human resources" (see Table 2).

(ostan) in the domains of water management, defence, mutual aids and community activities.

This functional and spatial structure results from a co-evolutionary process between eco- and sociosystems, generating reciprocal responses of the two closely interacting systems and aiming at mutual, long-term sustainability (Norgaard, 1981 and 1984; Farshad and Zinck, 1993). Fast growing population and a radical change in the political context led recently to an alteration of the social and economic structures. Measures such as land reform, nationalization of pastures and forests, and mechanization of the main farming practices have undermined the structural cohesion of the traditional agricultural system and disrupted the sustainable equilibrium reached between eco- and sociosystems.

Towards a new agricultural paradigm

The introduction of new sources of energy, technology and machinery has changed the relationships between inputs and outputs of the agricultural production system (Fig. 2). Crop production and livestock are no longer interdependent but separate activities. Rural industries are taken out of the farmers' hands. The market-oriented crop production sector has become specialized, expensive, management demanding, severely risk-prone and groundwater dependent. It lacks self-sufficiency, leading to low food security. The recycling chain of by-products, which promoted interdependency of population groups and economic activities in the traditional agriculture, is broken down into specialized and independent production sectors for the sake of efficiency.

The sustainability issue

Population growth and urbanization require a considerable increase of grain, meat, milk and wool production, which cannot be satisfied by the traditionally managed systems. The latter are no longer economically viable, nor socially and politically acceptable. Simultaneously, the new agricultural model raises many issues about the

availability of water and soil resources, the suitability of the new technology and the environmental soundness of the system. Irrigation water is provided by deep aquifers, not fully renewable because of the rainfall deficit. In recent years, the excavation of wells led to the drying-out of many ghanats and cheshmehs. The current groundwater depth in the Hamadan-Bahar plain (60 to 65 m) is dropping locally at a rate of 2 to 4 m per year. Some deep wells of 120 m have already been excavated to anticipate or compensate for the depletion of the aquifers.

Good soils are increasingly used for non-agricultural purposes, in particular for brick fabrication or as building lots in the fringes of the main towns. Soils are also degraded by the overuse of mineral fertilizers and heavy machinery. The carrying capacity of the provincial pastures is 71500 cattle units per month. Thus the 2.5 million cattle which presently graze for about 6 months cause excessive pressure on pastures, leading to land degradation (Djamab, 1990).

Selected indicators from the ecosystem and sociosystem were implemented for comparison of the traditional and the emerging (advanced) agricultural systems (Table 1). The role of changes in the social structure and of the population growth is highlighted. These two factors contributed substantially to the disruption of the co-evolutionary equilibrium reached over long time by the traditional systems.

Conclusions

The fate of agriculture in the Hamadan region is uncertain in the medium and long run. On the one hand, the traditional agriculture is vanishing because its structural cohesion, inherited from a long co-evolution between eco- and sociosystems, is being disarticulated by fast changing economic and social conditions. Traditional systems were based on a sustainable management of surface and near-surface water resources, but are increasingly unable to satisfy the needs of a fast growing population. On the other hand,

What is the fate of agriculture in the Hamadan region : sustainability or casual survival? Is the present trend conducing to increasing desertification? It might be too early to answer these questions but not too early to face the alarming challenge they raise.

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Traditional values and norms	Not required	Available, but not efficient	Community life	Imported western norms disrupt community life
Resources distribution mechanism	Community is the production unit	Land reform causes the disappearance of landlords; farmers own the land, but community investment is lacking	the use of land and water	landform and community regulate the use of land and water
Technology	Simple homemade tools	Simple homemade tools remainable water management without providing the necessary inputs to farmers	Technology	new technology introduced, but farmers are unable to manage it
Codes	Common way of life where rules are no necessary	Available, but often breaks and rules are not strictly followed	Codes	rules are no necessary
Health	Minimal need for medical services	Minimal need for medical services; traditional healers provide most of the health care	Health	Minimal need for medical services
Population dynamics	Very stable	Very dynamic, sometimes in the form of seasonal labor flows	Population dynamics	Very dynamic, sometimes in the form of seasonal labor flows
Organization	Social structure does not change	Commons structure and organization of farmers are changing	Organization	Social structure does not change

The large-scale and high-external-input agriculture developed over the last few decades looks unsustainable because it degrades the land by extensive use of machinery and leads to groundwater depletion beyond the natural recharge capacity of the aquifer. In brief, while the traditional systems are disappearing, the new systems have not yet proved their sustainability.