RUNOFF AGRICULTURE IN THE HIGHLANDS OF SAN LUIS POTOSÍ STATE, MEXICO

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SUMMARY

Dryland farming means to cultivate semiarid fields without irrigation, using only water coming from rainfall. In Mexico, this type of agriculture is known ambiguously as rainfed (temporal farming), as if all dryland farming were practiced only with the rains fallen directly over the cropland, although elsewhere it is named dryland farming (cultivo de secano). The study of the traditional methods of dryland farming in this region is relevant because 1) the large surface where it is practiced, 2) the great number of peasant communities that employ this type of agriculture as their main source of food and income, and 3) it is a method where farm soil is used in an uncertain and unproductive way (at least from the marketing point of view), which is the reason why it has received minimal scientific and technological support. The aim of this work was to characterize and explain the dryland crop production systems based on runoff management in the highland of the San Luis Potosi State. It is concluded that, in the area, the runoff agriculture systems are supported by an ancient and solid empirical knowledge, and they are similar to those practiced in other regions of the world with similar ecological characteristics. Runoff management and tillage practices used to provide and to conserve residual moisture, respectively, increase substantially the availability of water for crops; however, they require further improvement.

A general description of runoff agriculture comprises variants such as those that are carried out in basin bottomlands, in alluvial fans and hillsides and in the beds of watercourses.

Agriculture in basin bottomlands

As early as 4000 years ago, the inhabitants of the Negev desert in Israel, practiced agriculture with runoff management over small valleys. For this, they eliminated the vegetation from hillsides with the purpose of increasing the superficial runoff, and built dikes to store it and to take the water to the lower cultivation area. The farms had catchment areas of 10-50ha. These basins were divided into small areas of water reception of 1-3ha; in these, canals were built to conduct the superficial runoff to the crop fields; the fields were terraced and had stone spillways, designed in such a way that the exceeding water from one plot was diverted to the lower ones. This system allowed the development of civilizations in regions that had an average rainfall of 100mm per year, which is considered inadequate for modern agriculture (Evenari *et al.,* 1971; NAS, 1974).

Agriculture in alluvial fans and hillsides

These systems are located at the base of the hills of the mountain ranges, at the mouth of the streams, where there are runoff and fertile soils for agriculture. The alluvial fans and hillsides had some difficulties for crop production, because the streams can sweep the soil instead of depositing it; furthermore, the streams can change their course over the alluvial fan from one year to another. The task for the peasants consists on making sure that some bifurcations of the stream carry water in the upcoming rains, which implies the construction of a system of dikes that direct the water through the bifurcations towards the crop fields (Walton 1969). In the croplands, dikes are built of soil and branches of bushes; dikes also break the erosive force

KEYWORDS / Dryland Farming / Runoff Management / Traditional Agriculture /

Received: 08/31/2009. Accepted: 08/18/2010.

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of the water and prevent damages to the crop plants (Nabhan 1979). This type of runoff management allows the soil fertility to naturally regenerate by the deposition of the sediments from the over-land flows (Nabhan and Sheridan 1977). Additionally, runoff agriculture in hillsides, in small plots along intermittent streams, is applied in peasant communities of Ahualulco, Armadillo de los Infante, Guadalcázar, Mexquitic de Carmona, Moctezuma, San Luis Potosí, Santa María del Río, Soledad de Graciano Sánchez, Tierra Nueva, Villa de Arista, Villa de Reyes, Villa de Zaragoza and Villa Hidalgo counties of San Luis Potosí State in Mexico (Gálvez *et al*., 1941; INEGI, 1999).

Agriculture in the beds of watercourses

The stream floods are braked and dispersed by stone dikes or shrubs branches dikes in the beds of the watercourses; then the alluvial soil is retained between these dikes and constitutes a suitable means for harvest production. Each new flow becomes a new alluvium deposit that restores soil fertility. In order to prevent that the floods destroy the dikes, the latter are arranged in tandem throughout the watercourse bed. Native tribes of Southwestern USA and Northwestern Mexico practice this runoff management (Walton 1969, Arnon 1972, Nabhan 1979).

Concerning the San Luis Potosí highland in Mexico, Aguirre (1983) considers that the physiographic and climatic conditions favor the presence of two variants of runoff agriculture: a) Agriculture in basin bottom lands, which takes place in an area of extended low hills where the runoff concentrates in depressions or valleys, characterized by deep permeable soils, with a good capacity of preserving moisture and without severe salt problems. This area is located in rural communities of Moctezuma, Venado, Charcas, Santo Domingo, Villa de Ramos and Salinas counties in San Luis Potosí State (Medina, 1969, 1977; Labarthe and Aguillón, 1986, 1987; Labarthe and Jiménez, 1991; INEGI, 1999). b) Agriculture in alluvial fans, which is practiced in the base of the hills of mountains ranges. In these lands the undefined stream watercourses have formed alluvial fans, and it comprises deep fertile soils. The area of the alluvial fans is located in the counties of Ahualulco, Charcas, Guadalcázar, Matehuala and Villa de Guadalupe, in San Luis Potosí State (Gálvez *et al*., 1941; Gómez, 1973; INEGI, 1999). In the Potosinian highland, runoff agriculture had its origins in colonial times, when its main purpose was to guarantee the self-supply of food for peons of the *haciendas*; these farms also supplied meat, mezcal, skins, fat for lighting and animals for labor in the mining places of the region (Bazant 1980, Velázquez 1987). Since the Agrarian Reform took place (1917-1990), the interest of peasants for this type of agriculture increased; nevertheless, little advantage has been taken of previous experience and constructions.

The study of runoff crop production is of relevance due to the large surface where it is practiced in the region, to the large number of rural communities that have in this type of agriculture its main source of food and income, and to the fact that since apparently in these agricultural systems water and soil resources are used in a erratic and unproductive way, they have received minimal scientific and technological support. The purpose of this study was to characterize and explain the runoff crop production systems the Potosinian highland.

Study Region

The study region is located in the north and western portions of the State of San Luis Potosí, Mexico, where altitude is 1350-2200masl. The weather is dry and temperate, with the rainy season in the summer, and sporadic early and late frosts from autumn to winter. The ranges of average rainfall and potential evapotranspiration are 258.3-469.3 and 1153.4-1221.2mm, respectively; which results in a hydric deficit of 751.9-895.1mm/year (Campos, 1993). The cultivable soils total 395,833ha, from which 56,623 (14.3%) are irrigated and 339,210 (85.7%) are managed under dryland conditions. Considering the way rainfall water is used, the dryland area is divided in two main systems: a) rainfed agriculture (called *temporal*) which depends only on the humidity of the rains fallen *in situ* and covers an area of 27,829ha, and b) three variants of runoff agriculture, which occupy 311,381ha. In one of these variants, rain-water running dispersed towards the bottom of small closed basins called *bajíos* is used; in another the runoff is concentrated in mountain ephemeral streams and utilized in alluvial fans; and in the last variant, the runoff is concentrated on stream and diverted over their banks or flood plains, or it is retained in the terraced beds of the watercourses (INEGI 1994).

Materials and Methods

The method employed consisted of three groups of actions: *i*) Observation, record and analysis of peasants' empirical knowledge about the process of runoff crop production. *ii)* Review of the literature about systems of runoff agriculture in similar parts of México and the rest of the world. *iii*) Contrast and synthesis of traditional and bibliographical knowledge and that obtained directly by field work. The actions taken were: 1) Selection of localities to be studied. Official scale of 1:50000 cartography (CETENAL 1971, 1972a, b, c, d, 1973a, b) was used to identify the possible study areas for each runoff agricultural variant, according to its size, accessibility, and closeness. After that, exploratory and corroboratory field trips were made to verify cartographic information, to improve the questionnaire for obtaining information, and to establish a relationship with possible informants. Finally, the following areas were chosen: for bottom lands Los Remedios (Venado county), Cerritos de Bernal and Villa de Santo Domingo (Santo Domingo county), and for alluvial fans Santa Rosa la Masita (Villa de Guadalupe county) and San Antonio de las Barrancas (Matehuala county). 2) Survey among the peasants in the selected localities. A guide or questionnaire was made based on topics regarding to ecological, technological and economical elements, without any specific questions included. The interviewed peasants were selected according to their better understanding of the decision-making process, experience, easiness of conceptual expression, and social ranking (advisers of the community). 3) Description and explanation of the agricultural practices. In these descriptions the main features of target practice were outlined and compared with other descriptions. For each practice, the peasant explanation and the interviewer interpretation were recorded separately. 4) Elaboration of a file for each interview. Information from the field notebook was first cleansed, ordered, and finally unloaded on files, within three days following the interviews. The files were classified by agricultural practice and community order. 5) Synthesis of the information. When a given practice was totally explored, a general synthesis was prepared, based on the files, bibliography, interpretations and additional recordings of the interviewer. Then, several trips were made to the studied communities to verify the information previously gathered and to explore new variants of runoff agriculture. Finally, a review of censuses and complementary bibliographic information was also carried out.

Results and Discussion

During the *haciendas* period, the best available lands were basin bottomlands, alluvial fans, and soils in or close to watercourses, and were dedicated to dryland farming. In these places hydraulic works of different characteristics and magnitude were constructed for managing and using runoffs for crop production, as can be observed in the former *haciendas* of San Francisco Javier de la Parada, Santa Teresa (Ahualulco and Mexquitic counties), La Morena, La Sauceda (Villa de Zaragoza county), San Francisco (Villa de Arriaga county), and San Antonio de las Barrancas (Villa de Guadalupe county). Furthermore, historians have recurrently mentioned runoff agriculture (Velázquez, 1987). However, no statistical information exists for those times. As a result of the Agrarian Reform, the *ejidos* increased their crop surface in 124,263ha (57.8%) after deforestation and ploughing of rangelands, eliminating the most important forage species: *Bouteloua* spp., *Opuntia* spp., *Agave* spp. and *Prosopis* spp. Most of the ploughed land (91.2%) belonged to sites where runoff agriculture took place (Table I). Field observations show that some hydraulic infrastructure from the *hacienda* times is still in use (Figure 1), although these constructions have gradually deteriorated due to lack of maintenance. At the same time, a change can be observed from masonry structures, which required low maintenance, to ephemeral works of wood stakes, shrubs, soil and stones which need to be repaired annually or after severe rain storms.

TABLE I
TREND OF THE SURFACE USED FOR DRYLAND FARMING IN POTOSINIAN HIGHLAND

Type of agriculture	Census year		
	1930 *	1970 **	1994 ***
Runoffs	196,668ha (91.5%)	272,640ha (93.0%	311,381ha (91.2%)
(Residual moisture)	(3280)	(1755)	
Rainfed	18,278ha (8.5%)	20,657ha (7.0%)	27,829ha (8.8%)
Total	214,946ha (100.0%)	293,297ha (100.0%)	339,210ha (100.0%)

Sources: * DGE (1937), ** DGE (1975), *** INEGI (1994).

Variants of runoff agriculture

Agriculture in basin bottomlands

These small closed basins usually lack well developed drainage systems, so the runoff usually spills and runs down the hills. Due to the lack of drainage and the dominance of sedimentary substrates, the soils of the bottomlands are fine in texture and the lower plots can have a high salinity. In the surrounding hillsides, the peasants dig gutters or furrows, diagonally to the slope (Figure 2), with the purpose of intercepting and channeling the runoff and reduce losses by hillside infiltration, and to ensure its advent to the bottomlands. In the bottomlands, the peasants build derivations of the gutters toward different parts of the field, where they build soil and stone dikes, perpendicularly to the slope, so they can hold water levels up to 50cm. When the water held infiltrates the soil and the superficial layer reaches the right conditions, the peasants sow immediately, if it is opportune to do so. The gutters and the stone and soil dikes are mended annually, just before the start of the rain season. This type of runoff management is analogous to the one found by Evenari *et al.* (1971) in the Negev desert; it might have been introduced to Spain by the Arabs and then to the north of Mexico by the Spaniards. However, in the Mixteca region of Oaxaca, there are evidences of pre-hispanic practices for induction of runoff, as well as of soil erosion from hillsides towards the bottomlands (Spores, 1969).

Figure 1. Hydraulic infrastructure from the *hacienda* times still in use.

Figure 2. Intercepting and channeling the runoff from the surrounding hill side towards the fields in the bottomlands.

Agriculture in alluvial fans

The peasants take advantage of the over-land flows that run down from the ranges. To regulate them, spontaneous bifurcations from the fan are maintained and, using small dikes of wood stakes and stone, water is discharged through handmade canals toward plots of cultivated land. The water arrives with strength to the plots, where it is held and distributed through long straight dikes made of stakes and interwoven branches; these are placed perpendicularly to the slope. These plots with dikes are known as *enlamados* (silted upland) or *estacados* (stockade plots), because their dikes are made with wood stakes (Figure 3). Each stockade consists of a line of wood stakes placed every 40-50cm, combined with interwoven branches; their height can reach up to one meter, measured from the lower next parcel, and their length can be up to 100m, but it depends on the size and shape of the plots. They are arranged in tandem, with distance between them of ~15m. The wood stakes and branches are from *mesquite* (*Prosopis laevigata*), *granjeno* or desert hackberry (*Celtis pallida*) and *huisache* (*Acacia farnesiana*), species that are abundant inside and outside the alluvial fan. The dikes and discharge control canals are repaired annually, in March and April; by then, the plant species used to build them have completed their new foliage, and the livestock that grazes in the fields has been moved to the rangelands. Dikes hold and spread the water, which favors sedimentation and water infiltration, and at the same time reduce the loss of soil and water. This process leads to the formation of terraces, but their persistence is seriously affected by the deficient way the dikes are constructed;

furthermore, their lifespan is short and are often brought down by large water loads, with severe erosion damages. This system of alluvial fans is similar to the one Walton (1969) described for the Middle East.

Agriculture on banks of intermittent streams

Along the streams, dikes to divert the flow are constructed alternatively on both sides (Figures 4 and 5). Each dike releases the water to a handmade canal directed to the crop fields; once in the fields, water is dispersed through smaller dikes that are constructed of soil, wood stakes, and interwoven branches, which are arranged perpendicularly to the slope. These dikes are similar to the ones used in alluvial fans. In the *hacienda* times, the dikes were made of stone masonry, but now they are made of soil and stone, or of wood stakes and interwoven branches. In places of gentle slope and deep soils, out from the influence of streams that run down the mountain ranges, there are numerous cultivated fields, isolated or in groups, which are fed by the runoff from different size basins. In order to capture this water, the peasants dig canals diagonal to the slope; these canals hold and divert the water towards the crop fields (1-4ha). In the plots, water is held and dispersed by stockades placed perpendicular to the slope. In this case, the stakes are separated by greater distances, since due to the gentler slope the water flows with less force.

Figure 3. Dikes of wood stakes and stone built perpendicularly to the slope.

Figure 4. Divertion dikes constructed along a stream.

Figure 5. Dispersion of water through smaller dikes built of soil and stone.

Regional agricultural practices

Fallow and tillage

Fertile soils, a high capacity of moisture holding, and concentration of runoff in the fields allow better and safer crop production. Thus, fallow becomes unnecessary, as even in the bad years some harvest is obtained. In the basin bottomlands, after picking up the crop, in November and December, the ridges of the furrows are broken with a plough in order to loosen the corn stumps and prevent the creation of big clods. This work, to a depth of 20cm, is carried out using a moldboard plough pulled by a yoke of mules. Then, closed ploughing is performed to loosen and turn over the soil without making furrows, so as to favor water infiltration and plant rooting. When ploughing is over, wooden beams or *mesquite* (*Prosopis* sp.) branches are used to flatten the soil surface, a practice that prevents the loss of moisture caused by the wind and the sun. These three labors not only prepare the soil, but preserve the residual moisture that remains from the previous season, which is used in sowing of the upcoming year. The peasants call these practices as wrap up of moisture. In alluvial fans and stream banks, the works are only furrow ridges elimination and closed ploughing. These are carried out using a moldboard plough, pulled by an oxenteam or mulesteam. The field preparation is usually done when soil moisture conditions are unfavourable. This causes the formation of big clods; however, this fact does not hinder a good soil preparation, since the clods favor greater conservation of infiltrated water; furthermore, the clods are disintegrated at the first flood, so they are not a problem for sowing. The preparation of fields starts in January and ends in March.

Typical alternatives and cultivars

The common alternatives in the basin bottomlands are the monoculture of maize (*Zea mays*) or bean (*Phaseolus vulgaris*), and maize associated with beans (Figure 6), squash (*Cucurbita* sp.), and sunflower (*Heliantus annuus*). The alternatives in the alluvial fans and stream banks are the association of maize-beans-squash-sunflower, and the monoculture of maize; nevertheless, barley (*Hordeum vulgare*), broad bean (*Vicia faba*), wheat (*Triticum aestivum*), chickpea (*Cicer arietinum*), lentil (*Lens esculenta*), and pea (*Pisum sativus*) are sown marginally. All variants of these crops are traditional cultivars. A description of the most relevant ones follows.

Maize. Based on the length of the life cycle, the peasants distinguish three types of maize cultivars: big maize or five months maize (*maíz alto*), maize of four months (*maíz cuatrimestral*), and maize of three months (*maíz tremesino*). Maize of five and four months occupy most of arable soils; in the basin bottomlands they are used for "moisture sowing" (i.e. crop establishment is based on residual moisture remaining from the previous cycle). In the alluvial fans peasants sow when the first floods occur, in March, April or May; these maize variants are very drought resistant, with some kind of latency. When there is no residual moisture anymore and rain is delayed, the plants roll up their leaves and stop growing, resembling onion leaves. Then, when it rains, they may continue their growth and development, without a significant reduction in the yield. In years of scarce rainfall, with only the residual moisture or only one flood, they can produce a small amount of grain and forage. The three-month maize does not stand long droughts; thus, it is sown when the rainy season starts in June-July. In the basin bottomlands it is sowed in the upper parts, where the soils are shallow and their capacity for preserving moisture is lower.

Figure 6. The most common crop alternative in the basin bottomlands (maize associated with bean).

Common bean. There is a great diversity of races from this crop species, and the peasants prefer the climbing indeterminate growth variants because they resist inundations better. The main land races sown are *pinto*, *bayo*, *canario*, *flor de mayo*, *canelo*, *amarillo*, *mantequilla* and *rebocero*.

Squash. This crop also presents a great diversity; the young twigs and fruits, as well as male flowers, are consumed as vegetable. Ripe fruits are used to make candy and as forage, while the toasted and salted seeds are eaten as tidbit. This crop is sown mainly for self-consumption, but seeds are sometimes marketed.

Sunflower. Two land races are sown, one with black seeds and the other one with white seeds; this crop is quite resistant to drought, and it is harvested even if the other crops are lost. The toasted seed is eaten as snack or tidbit, and it is used to prepare a dense hot drink (*atole*).

Barley and wheat. The name of the cultivars is unknown; the peasants buy the seeds in the local grain and seed stores. Barley is used as forage and wheat is sown for self-consumption food.

Peas, broad beans, chickpeas and lentils. These crops are sown in small areas, and the names of the cultivars are unknown. In general, it could observed that the crops variants used are well adapted to the ecological conditions of the dryland farming.

Sowing

In the basin bottomlands, two types of sowing are practiced. If residual moisture has been preserved from the previous cycle, cultivars of four- and five-months maize are sown in monoculture or associated with common bean, squash, and sunflower. This is done through the works previously described. The period of sowing goes from March 25 to April 30; until the end of March late frosts may occur and if the residual moisture is not taken advantage of, it is lost by evaporation, as in May the hottest season of the year begins. This sowing is known as sowing in row (*siembra a raya*), because at the same time that the plough is making a furrow the seed is deposited in the soil through a long funnel attached to the moldboard plough. This permits seeding in a moist soil at 3-5cm below the bottom of the furrow. After this, a wooden beam or some *mesquite* branches are used to flatten the field, so as to prevent that the sunrays and the wind drying up the soil. This procedure allows the seeds to remain at a depth of ~15cm. This type of sowing is similar to the one Arnon (1972) describes for the Middle East. The residual moisture sowing is safer than the rainy season sowing, because not only it takes advantage of the residual moisture, but also uses up the rainfall when it occurs. Rainy season or temporal sowing uses only water from the rain; variants of three-month maizes and beans are sown in June and July when the rainy season or *temporal* is taking place. This other way of sowing is known as covered sow (*siembra a tapa*). In this procedure the ploughman opens a furrow and behind him a sower places the seed in the bottom of the furrow. When the furrow is finished the ploughman returns and covers the seeds by opening other furrow. At the end of this furrow he meets the sower, who starts planting the seed in the new furrow, and the ploughman follows him to cover the seed. The procedure is repeated until the whole field has been sown. In alluvial fan and stream bank fields, maize, bean, squash, and sunflower are sowed with mule or oxenteam, similarly to the rainy season sowing in the basin bottomlands. To start sowing here depends only on the beginning of the rainy season and the happening of floods, because frosts may occur from October. Maize is sown with a distance of 70cm between holes, two or three seeds per hole, in furrows separated by 70cm. Bean, sunflower and squash are irregularly sown between the maize. Barley and wheat are broadcast sown in either prepared or unprepared fields; then, the seeds are covered using the moldboard plough and *mesquite* branches. The seeds left deeper than 8cm are completely lost, and the same happens with the ones that remain on the surface, because birds eat them or they do not germinate because of lack of moisture. These disadvantages are similar to the ones Mela (1966) points out for broadcast sowing in which the Roman plough is used.

Other practices

Fertilization. Soils of basin bottomland, alluvial fans, and stream bank do not present any fertility problems because year after year the runoff scatters and deposits on the fields a large amount of sediments that not only restore nutrients, but also increase the soil thicknesses. Walton (1969) and Arnon (1972) report this type of ancient natural fertilization in the Middle East and in the South-West of the USA.

Weeding. For maize cultivation two weedings are usually carried out, the first one 30 days after the sowing, when the soil is covered with weeds, and the second one a month later. The last one is not only carried out to eliminate the weeds, but also to provide soil support to the plants, although some peasants only weed once. Russell (1988) points that weeds that grow in the first periods of crop development are the ones that reduce production the most. Therefore, weeding should be done when the largest amount of weeds can be wiped out, or when they cause more damage. However, the number and time of weedings do not exclusively depend on the weed stand but also on the economical possibilities of each peasant.

Pests. Pests that affect maize the most are fall armyworm (*Spodoptera frugiperda* J.

E. Smith), when a drought period occurs, but it disappears with the rains; wireworm (probably *Limonious* sp.) causes problems since the plant germinates until it reaches a height of 20-30cm, and it is fought through tillage, because in this way the worms are exposed to birds and the cold temperatures of winter; white grubs (*Phyllophaga* spp.) is fought in the same way that wireworms; although granary weevil (*Sitophilus granarius* L.) damages a lot the stored grain, it is not fought. Among the pests that attack common bean are Mexican bean beetle (*Epilachna varivestis* Mulsant) and the green house whitefly (*Trialeurodes vaporariorum* West). In spite of severely damaging the crops, no measures are taken to control these plagues, because the harvest is uncertain itself and usually there is not money to buy pesticides.

Diseases. No disease of economical interest could be observed in the crops; probably due to the fact that the races have evolved some resistance to disease through time.

Elimination of maize spikes. When maize flowering coincides with a strong drought period, peasants cut the male inflorescences of most of the plants and leave only that necessary to pollinate the plots. This practice, according to the peasants, is done with the purpose that the water and energy that the plant uses up to form and to sustain the spike be used in filling the grain of the female inflorescence. In effect, Barrales (1979) experimentally found that the removal of spikes renders a yield increment, especially when the environmental conditions are adverse to the crop.

Harvest. To harvest maize peasants take six furrows and cut the plants with a sickle at a height of 10-15cm above ground; the plants are stacked in small bunches and placed in transverse ways on the ridges of the furrows. A week later, the peasants join the bunches and form a stack of conical shape known as *mogote*. These maneuvers are done early in the morning in order to reduce the lost of leaves and maize ear. The conical shape given to the *mogotes* reduces the damages caused by rain, facilitates transportation of the harvest, and permits to empty the land in a shorter time for livestock grazing. After 15 days or a month, the peasants transport the whole plants to the backyard of their houses. The transport is done on a cart pulled by oxen or mules. The plants with the maize ears are stored in a square heap known as *hacina*. To build a *hacina* the plants are placed horizontally in interwoven layers, with the spikes to the center and the bases to the sides. When the *hacina* reaches an expected height, the width of the layers is gradually decreased, the spikes are placed sideways with the bases facing the center; the process is repeated until it comes to a width of about a meter, like a ridged roof. With this arrangement the damages caused by rats and domestic animals can be prevented; at the same time, the water from the rain is prevented from entering the *hacina*. In this way, the harvest can be stored for several years. To harvest beans the plants are pulled out and rows of small heaps are formed. After that, the heaps are moved to the edge of the plots, and on firm ground one or more bigger heaps are made. Then, the threshing floor where the plants are to be extended is prepared; next, the plants are threshed with a tractor or with mules or donkeys. When thresh is over, the stubble is separated and the grain is piled up, still mixed with soil and straw. Finally, when it is windy, the grain is winnowed. The clean grain is then packed in sacks and is taken home; the straw and chaff are stored in *hacinas* and used to feed the cattle.

Marketing. Most of the harvest is used for self-consumption; however, when there is an abundant harvest, people store enough grain for self-consumption and the remains are sold. The remaining grain is sold gradually, because the peasants sell the yield when they need cash to buy supplies, to pay for medical services or to get their implements fixed. When the amount of grain to be sold is small (1-70kg), it is sold in the local stores at a very low price. If the amount is larger, the peasants sell it to out-of-town middlemen who come and buy it, offering better prices than the local stores; or they go to the near-most city in the region and sell in cereal stores that pay a better price.

Conclusions

In the studied area, the practiced variants of runoff agriculture are based on a solid empirical knowledge and are similar to those practiced in other semiarid regions of the world with similar environmental characteristics. The traditional cultivars used are well adapted to the conditions of residual moisture and intermittence of floods, as well as to the height of water levels that occur in basin bottomlands, alluvial fans and stream banks. Tillage operations used to increase and preserve residual moisture favor substantially the availability of water for the plants; however, they require further improvement. Crop production can also be made more efficient by improving the current infrastructure to manage water and soil.

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AGRICULTURA DE SECANO EN LAS TIERRAS ALTAS DEL ESTADO DE SAN LUIS POTOSÍ, MÉXICO

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RESUMEN

La agricultura de secano es el cultivo de las tierras semiáridas basado únicamente en el agua de lluvia. En México este tipo de agricultura se conoce ambiguamente como de temporal, como si se tratara solamente de producción basada en la precipitación caída in situ, aunque en otras partes del mundo la agricultura de secano representa un concepto más amplio. El estudio de los métodos tradicionales para la obtención de cosechas de secano adquiere relevancia si se considera 1) la gran extensión de tierra donde se practica, 2) el alto número de núcleos de población que tienen en este tipo de agricultura uno de sus principales medios de subsistencia, y 3) que se trata de una forma de uso del suelo sumamente aleatoria y poco productiva (al menos desde el punto de vista mercantil), por lo que ha recibido mínimo apoyo científico y tecnológico. El objetivo de este trabajo fue caracterizar y explicar los sistemas de producción de cosechas con manejo de escorrentías en el altiplano potosino. Se concluye que en la región de estudio la agricultura de escorrentías se basa en conocimientos sólidos tradicionales y es similar a la que se practica en otras regiones del mundo con características ecológicas similares. El manejo de escorrentías y la labranza para arropar la humedad incrementa la disponibilidad de agua y su conservación en las parcelas de cultivo, pero ambos tipos de prácticas requieren ser mejoradas.

AGRICULTURA SECA NAS TERRAS ALTAS DO ESTADO DE SAN LUIS POTOSÍ, MEXICO

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RESUMO

A agricultura seca é o cultivo das terras semiáridas baseado únicamente na água da chuva. No México este tipo de agricultura se conhece ambiguamente como de temporal, como si se tratase somente de produção baseada na precipitação caída in situ, ainda que em outras partes do mundo a agricultura de secano representa um conceito mais amplo. O estudo dos métodos tradicionais para a obtenção de colheitas secas adquire relevância se consideramos 1) a grande extensão de terra onde se pratica, 2) o alto número de núcleos de população que tem neste tipo de agricultura um de seus principais meios de subsistência, e 3) que se trata de uma forma de uso do solo sumamente aleatória e pouco produtiva (pelo menos desde o ponto de vista mercantil), pelo qual tem recebido mínimo apoio científico e tecnológico. O objetivo deste trabalho foi caracterizar e explicar os sistemas de produção de colheitas com manejo de escorrentias no altiplano potosino. Conclui-se que na região de estudo a agricultura de escorrentias é baseada em conhecimentos sólidos tradicionais e é similar daquela que se pratica em outras regiões do mundo com características ecológicas similares. O manejo de escorrentias e a lavoura para proteger a umidade incrementa a disponibilidade de água e sua conservação nas parcelas de cultivo, mas ambos tipos de práticas requerem ser melhoradas.