Agriculture in arid and semi-arid regions of Morocco : Challenges and prospects

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Abstract

Arid and semi-arid regions of Morocco lie in the northeast, high plateau and Moulouya valley, the centralwest and in the southwest in the Souss region. They cover respectively 27 % and 87 % of the whole country and arable land. They comprise 60 % of cereals acreage and produce 55 % of cereal production. More than 50 % of moroccan population lives in these areas. Nevertheless, these regions face severe water shortages with limited and highly erratic rainfall. High risk of drought occurrence over and within years is common. Temperature regimes, shallow eroded soils and cropping of marginal lands aggravate moisture deficits. Farming systems are complex and heterogeneous combining crops and livestock. Traditional cultural practices are often inappropriate. The lack of adequate and appropriate infrastructure to make agricultural inputs available and to store excess production limits progress of technology. The potential of increased agricultural production and farm income does exist and it is far from being realized. This situation clearly indicates the importance of agricultural research and development and transfer of technology for alleviating problems of arid and semi-arid zones, and achieving sustainable agriculture that will feed future generations.

Key words : Water, cropping systems, dryland farming

Résumé

L'agriculture dans les régions arides et semi-arides du Maroc : Défis et persectives

Les zones arides et semi-arides au Maroc couvrent les hauts plateaux et la vallée de la Moulouya au nord-est, les plaines atlantiques centrales et la région du souss au sud-ouest. Elles représentent 27 % et 87 % de la superficie totale du pays et de la surface agricole utile respectivement. Les céréales y occupent 60 % de la SAU et contribuent 55 % de la production nationale. Plus de 50 % de la population marocaine vivent dans ces régions. Cependant, ces zones font face à des déficits hydriques chroniques dus à des pluviométries faibles et aléatoires. Des sécheresses intra et inter-annuelles sont communes. Les régimes de températures, les sols érodés et la culture des terres marginales aggravent les déficits en eau. Les systèmes de production sont complexes et reposent sur l'intégration des cultures et de l'élevage. Les techniques culturales traditionnelles ne sont plus adaptées. L'insuffisance de l'infrastructure de disribution des intrants et de stockage des excès de production constitue un frein au progrès technique. L'écart entre les potentialités et les rendements obtenus par les agriculteurs est encore important. Cette situation souligne l'intérêt que revêt la recherche agronomique pour le développement de technologies appropriées et leur transfert par des voies adéquates afin de résoudre les problèmes des zones arides et semi-arides marocaines, et garantir ainsi la pérrenité de l'agriculture pour les générations futures.

Mots-clés : Eau, systèmes de production, aridoculture

ملخص

الزراعة في المناطق البورية المغربية : تحدي و افاق

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تغطي المناطق الجافة و شبه الجافة في المغرب الهضاب العليا لوادي ملوية في الشمال الشرقي والسهول الأطلسية الوسطى وناحية سوس في الجنوب الغربي. تمثل هذه المناطق 27% و87% من مجموع مساحة البلاد ومن مجموع المساحة الفلاحية المستثمرة على التوالي. تحتل زراعة الحبوب في هذه المناطق 60% من المساحة الفلاحية المستثمرة و تساهم ب 55% في الإنتاج الوطني. أكثر من 50% من سكان المغرب يعيشون في هذه المناطق في حين أن هذه الأخيرة تواجه نقصا حادا في المياه إثر التساقطات القليلة والغير احتمالية. جفاف داخل وبين السنوات عامة، الأنظمة الحرارية، الأراضي العارية وزراعة الأراضي الهامشية تحد نقصان الماء. الأنظمة الإنتاجية معقدة و تتوقف على دمج الزراعة بتربية المواشي. التقنيات الزراعية العقيقة لم تعد مواتية. النقص في البنية التحتية لتوزيع المدخلات الزراعية العقيقة لم تعد مواتية. النقص في البنية التحتية لتوزيع المدخلات الزراعية و تخزين الزيادات الإنتاجية تكون رادعا للتقدم التكنولوجي الملائم لنقلها بطرق ناجعة لحل مشكلات المناطق الجافة والشبه جافة المغربية، و بهذا تضمن ديمومة الفلاحة للأجيال المقبلة.

الكلمات المفتاحية : ماء، نظم الزراعة، الزراعة البعلية

Regional setting

Arid and semi-arid regions of the world are found in all continents. Their climates are of mediterranean, tropics and continental types. Rainfall is either concentrated in winter or in summer with mild, cold or hot temperature regimes. They are characterized by a high solar radiation as well as a high evaporative demand. However each region has its specifities. But the constant constraint is the high variability and risks encountered by the producers and developers in these regions.

Moroccan arid and semi-arid regions are of mediterranean type with winter rainfall and mild temperatures and a long period (5 to 6 months) of dry hot summer (Ionesco 1965). They lie in the northeast (high plateau and Moulouya valley) the central-west (Casablanca, Beni mellal, Marrakech, Essaouira) and in the southwest in the souss region. They cover 27 % and 80 % of the whole country and arable land respectively. They comprise 60 % of cereals acreage and produce 55 % of cereal production. Most of barley and maize are produced in these regions. Livestock is very important. Hence, 56 %, 45 % and 51 % of respectively sheep, cattle and goats herds are concentrated in the arid and semi-arid regions of Morocco (El Mourid et Sefrioui 1991).

Challenges

Biophysical challenges

The arid and semi-arid regions of Morocco face severe water deficits. Average annual rainfall is limited and highly erratic in amount (200-450) as well as in distribution within the year and from region to region (El Mourid and Watts 1994). These regions are characterized by a high risk of drought occurrence over years. In the last 50 years, Morocco has experienced four cycles or 11 years of drought (Lahlou 1986), and the most drastic drought ever faced was from 1980 to 1985. During these five years of drought, average rainfall deficits or departure from average rainfall varied from 20 to 51 % depending on the years and regions, with extremes of 85 % in 1982-83 and 1983-84 cropping seasons (Belkheir *et al.* 1987). Morocco experienced an other two- year drought (1991/92, 1992/93) where the lack of rainfall lasted 120 days which was never seen in the country. This latter drought has been well documented (Derkaoui *et al.* 1992; Benaouda 1994; Bendaoud 1994; Herzenni 1994). Nicholson and Wigley (1984) showed that 1) when droughts occur in Morocco, they tend to affect quite wide areas; 2) a long period of drought during summer with no rain from the end of may to october 3) an occurrence of drought during the last part of the growing season (march-april), and an erratic drought at the beginning of the cropping season (november to january), where short term seasonal lack of moisture is common (El Mourid and Watts 1994). The temperature regime with high temperatures during cereal grain-filling (Mekni and El Mourid 1987), high evaporative demand and shallow and eroded calcareous soils (more than 80 %) aggravate the lack of soil moisture (El Oumri *et al.* 1994). Foliar diseases (rusts, septoria,...) and insects (hessian fly, green bug, sowfly...) are wide spread and affect crop yields. With all these environmental characteristics, the crop and livestock productions are very low and highly irregular, and years of marginal crop production are quite common.

Socio-economic challenges

Agriculture is an old tradition in moroccan arid and semi-arid regions. Farming systems are complex and heterogeneous (Moore *et al.* 1994). The increase in the human population and changes of nomadic or semi-nomadic systems have resulted in greater pressure on marginal lands that were reserved essentially to grazing. Cereal monoculture is increasing with a tendency to abolish fallow (Benaouda *et al.* 1993), to cultivate marginal lands and to overgraze natural pastures. Furthermore, land tenure, size of holding, as well as the complex ownership limit the progress of technology. Cropping is combined with livestock production, primarily sheep and goats. The livestock component is well inserted into the system and plays an important role as insurance and bank for the farmer.

Dry farming techniques of growing cereal crops have been developed and practised for centuries. Cereals constitute the main crop and are grown in rotation with fallow, food legumes and maize. Barley dominates in areas receiving less than 300 mm (Gibbon 1981). Techniques for producing cereal crops consist of waiting for the first rain before planting in order to destroy weeds. Seed is broadcasted and covered by an off-set disk plow (often custom hired), so that seed is distributed at various depths through the soil. Rates of seeding range from 150 to 250 kg ha^{-1} for both barley and wheat. Fertilizers are not generally used and most applications are inadequate for the crops' needs. In many cases weeds are left to grow, then hand pulled and fed to livestock. Cultivars used are susceptible to foliar diseases (septoria, rusts, helminthosporium) and pests, essentially hessian fly (Mayetiola destructor Say.).

After harvest, straw is stored for winter and stubble is overgrazed by livestock through the dry summer. Some barley is grazed during early growth. The most used tool for seed bed preparation is the off-set disk plow commonly called "cover crop", and mechanization that is well adapted for more favorable rainfall areas is frequently inappropriate for semi-arid dryland conditions, because it wastes scarce moisture. This is to say that crop production is a precarious business in the arid and semi-arid areas and the risk is inherently great.

The lack of adequate and appropriate infrastructure to make seeds, fertilizers, pesticides, farm equipment, spare parts loans available and to store excess production during good years explains the under-investment in these harsh environments. Nonetheless, many farmers are isolated in their villages and cannot market their production under favorable conditions or have access to social facilities (schools, Hospitals...).

The traditional extension approaches have been unsuccessful in convincing farmers to adopt innovations (El Mourid and Gillard-Byers 1993a 1994b). Farmers have not been involved in decision-making and farmers organizations (professional associations, chambers of agriculture) are just emerging. Literacy rates in the rural areas are still high (more than 70 %). Within this context, the agricultural research scientist facing the same climatic constraints as the farmer, is obliged to develop and test technology over a longer period of time than is required in more favorable areas, in order to be assured that recommended practices will be both productive and economically viable.

Prospects

The potential of increasing cereal production in these areas does exist and presently it is far from being realized. Yields of 2,000 to 2,500 kg ha^{-1} are possible in more favorable regions (300 - 400 mm) and up to 1,500 kg ha^{-1} in the areas receiving 200 to 300 mm rainfall per year (Mara/Fao, 1982) by employing only the technology already available. Even though this might be argued and questioned as Crawford and Purvis (1986) did, there is already a strong indication that the potential for improvement in crop production is real, and that sustained progress can be made in identifying and solving problems that limit production (El Mourid et Sefrioui 1991; PPO aridoculture 1994; Sefrioui *et al.* 1994).

In Morocco, since early 80s, after the most severe drought that concerned all Morocco, a political awareness has developed. International awareness about environment protection (Kergreis 1994) has helped too. Many government actions aimed at alleviating drought effects : Livestock funds, agricultural development funds, integrated development projects (Safi, Oujda, Settat), measures to fight drought effects (1993) and lately the willingness to establish farm risk insurance. All these programs aimed at spreading social solidarity and equity among different population categories as it is stipulated in the moroccan constitution. The new strategy of the ministry of agriculture emphasizes environmental issues and sustainability of agriculture.

The concentration of rainfall in the cooler half of the year, during winter, when evaporative demand is low offers advantages for improving water use efficiency and increasing biomass. Moreover , deep soils (vertisols) can store water that can be used later in the season.

Farming systems of arid and semi-arid regions of Morocco have evolved into an integration of crops and livestock. Indeed, farmers have diversified their productive and income generating options in order to balance immediate returns with a long-term viability (Moore *et al.* 1994). Strategies of farmers in the mixed farming systems are designed to cope with highly erratic climatic conditions (Boyce *et al.*,1991). Animal and plant genetic resources existing in these environments are very important and might be used in breeding programs.

Research around the world as well as in Morocco has developed expertise, methodologies and technologies targetted to arid and semi-arid zones (Squires and Tow 1991; Unger *and al* 1988; Dregne and Willis 1983; El Mourid and Karrou 1994). This interest resulted in better diagnosis of problems, setting research as well as development priorities, targetting technology transfer.

In Morocco, strategies for agriculture production in arid and semi-arid regions should be founded on the mix productivity, stability and sustainability. The challenge is to have a balance between all three qualities. Productivity is usually expressed per unit of area, per person, per unit of energy input or per unit of capital investment. Stability is the reliability or consistency of farm production. Sustainability is defined as the ability of an agroecosystem to maintain productivity when subject to a major disturbing force (salinity, erosion, declining market...). It concerns whether a given level of productivity is mantained over time (Squires 1991). Summarizes crop and livestock production orientations in the arid and semi-arid agroecosystems of Morocco.

Crop production objectives in these drought-prone regions are to improve, stabilize and sustain yields through selection of species, and cultivars and cultural practices that will reduce yield fluctuations and permit stable production. The emphasis should be placed on the interrelationships of environment and soil and crop management factors on crop productivity, which are limited not only by low and uncertain rainfall, but also by high extreme temperatures and shallow soils. Privileged means of reducing these stresses are the application of sound agronomic practices as well as modification of cultivars (Harris *et al.* 1987). Many interesting reviews on ways to understand, improve, and stabilize crop production in moisture limiting environments are available (Evans 1987; 1985; Cooper *et al.* 1987; Harris *et al.* 1987). These reviews pinpoint strategies for increasing and stabilizing crop yield. They mainly involve 1) evaluation of genotypes-environment interactions, 2) soil and water conservation through appropriate soil and crop management systems; 3) water use and water use efficiency; and finally 4) better understanding of yield processes and determination in relation to phenological stages, agronomic practices, and environment. Hence, one can infer that all breeding programs and improved agronomic practices should claim the efficient use of the limiting resource, water, by avoiding its waste, by improving the capacity of soil water storage and the choice of crops which are best adapted to these conditions, as well as the agrotechnical practices that lead toward increased soil moisture availability for crops (El Mourid et Karrou 1994). In other words, the task is to devise very efficient water-use cultural practices and highly efficient crops and cultivars. Using the available water more efficiently may mean fewer crop failures and thereby stabilize yields.

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