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Agriculture in Iraq: Resources, potentials, constraints, research needs and priorities

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Abstract

The agrarian sector in Iraq witnessed a number of drastic measures during the last 40 years. Estimates of cultivable land areas vary from 5-8 million ha; however, no more than 3.5 million ha (47% irrigated and 53% dryland farming) have been actually cultivated. Renewable fresh water resources are estimated at about 2,000 m^3/person/year; however, Iraq faces huge water problems; these are caused by geographic, topographic and management factors. Prior to 1990, Iraq produced about one-third of its annual basic food needs and spent about US$ 2 billion to import the balance of its requirements. Since then, despite emphasis on increasing food production, the country continues to face deterioration in the agricultural sector. Agricultural production remains constrained due to lack of quality seed, herbicides, insecticides, fertilizers, animal vaccines, machinery, irrigation equipment and spare parts. Moreover, water resources in the drylands are declining due to a severe drought which devastated crops on 70% of the rainfed arable land in the country. Farmers in Iraq are struggling to produce under poor environmental conditions with few tools for coping with drought, salinity, pests, and shortages of inputs and lack of appropriate technologies. Iraqi cereal production dropped sharply in the past decade due to problems with its seed multiplication system, leading to degradation of seed quality and productivity. Land degradation, salinization, and declining crop yields due to mismanagement of land resources and lack of inputs, are serious problem, especially in the irrigated lands. The country's rangelands and forest resources are deteriorating mainly as a result of overstocking what are essentially fragile ecosystems and because of deforestation for fuelwood and charcoal. The livestock sector experienced serious problems during the last decade because of shortages of feed, veterinary services and vaccines. Number of farm animals declined during the last decade, and in spite of the government's efforts to boost livestock production, meat and milk production declined by 24% during the late 1980s as compared to the 1970s. Iraq faces serious problems of environmental degradation that must be addressed immediately because failure to act now will greatly compound the cost and complexity of later remedial efforts, and because environmental degradation is beginning to pose a major threat to human well-being, especially among the poor. To deal with the multiple challenges imposed upon it by internal and external factors, the agricultural sector in Iraq has to structurally adjust itself to address socio-economic, land-use, livestock production and feed resources, water resources, agro-ecology, environmental protection, and research and extension components in a holistic, multidisciplinary and long-term manner.

Key words: Iraq, Agriculture, development, research needs.

Introduction

The land area of Iraq is 438,317 km^2, with a population of 22.8 million and a population density of 52 per km^2. Arable land as percentage of total land is relatively small (12%) and agriculture, in 2001, contributed 6.1% to the GDP[1]. More than half (53%) of the arable land is rainfed, nearly all of it in the northern uplands; however, most of the agricultural production comes from the more intensively cultivated areas of the irrigated plains[1].

In the decade from 1977, Iraq was self sufficient in cereals, and agricultural imports amounted to 22% of total imports. During recent decades, however, Iraq has shifted from net food exporter to food importer[2]. This shift was prompted by several factors, including population increase, a rising standard of living, increased industrialization, migration of farm workers to urban centers, and loss of soil productivity in poorly drained irrigated areas of the south. Prior to 1990, Iraq had one of the highest per capita food availability in the Middle East, because of its relative prosperity and capacity to import large quantities of food, which met up to two-thirds of food requirements. After 1990, however, Iraq's ability to import food was significantly constrained[2]

Agricultural development will be a great challenge over the next two decades in Iraq[3]. Food requirements will double as the population continues to grow at 3.0% annually. There is an estimated 8million ha of cultivable land, but only 4-5 million ha is cultivated in any one year, and the land area under high-value vegetables and fruits is relatively very small (< 0.5 million ha). In order to achieve self sufficiency in cereals, Iraq has to grow wheat and barley on 8.1 million ha. This paper presents overviews of agricultural resources and institutional constraints on agriculture in Iraq; and outlines research needs and priorities for this important sector of the Iraqi economy[3].

Regional Patterns

Iraq lies between 29°15'N, and 38°15'N, 38°45 and 48°45'E, and is located entirely within the north temperate zone where it enjoys stimulus seasonality of climate. Iraq, with a total area of 438,320 km^2 including 924 km^2 of inland waters, is shaped like a basin, consisting of the Great Mesopotamian alluvial plain of the Tigris and Euphrates[3]; it is surrounded by mountains in the north and the east, which can reach altitudes of 3,550 m above sea level, and by desert areas in the south and west, which account for over 40% of the land area. The climate of Iraq is mainly of the continental, subtropical semi-arid type. Rainfall is highly erratic in time, quantity and locations, and ranges from less than 100 mm in the south and southwest to about 1,000 mm/year in the north and northeast. The substantial variation in amount and distribution of rainfall increases the risk to rainfed crop production[4,5]. The combination of rain shortages and extreme heat makes much of Iraq a desert. Because of very high rates of evaporation, soil and plants rapidly lose the little moisture obtained from the rain, and vegetation may not survive without extensive irrigation. Some areas, however, although arid, do have natural vegetation in contrast to the desert.

For example, in the Zagros Mountains in northeastern Iraq there is permanent vegetation, such as oak trees, and date palms are found in the south.

Land and Water Resources

It is estimated that 11.48 million hectares, or 26% of the total area of the country, are cultivable[3]. The total area estimated to be used for agriculture is 8 million ha, which is almost 93% of the cultivable area. However, due to soil salinity, fallow practices and the unstable political situation it is estimated that only 3 to 5 million ha are actually cultivated annually. In 1993, the area actually cultivated was estimated at about 3.73 million ha, of which 3.46 million ha consisted of annual crops and 0.27 million ha consisted of permanent crops[6]. Historically the most significant types of land use and food production in Iraq have been irrigated agriculture, which requires substantial investment and is an intensive form of land use; and pastoralism, which requires relatively little investment and is extensive. These have been combined with dryland farming in the semi-arid areas of northern Iraq[7]. Although these basic types are technologically very different, they have been closely interrelated, socially and economically, for thousands of years.

Environmental problems in development generally derive not from basic technologies such as types of irrigation or grazing, but from the scale of the productive activity in relation to the resource. Before the first attempt to develop irrigation in modern-day Iraq, irrigation had already served as the basis of vast agricultural projects, and had environmental effects which reduced productivity seriously. Perennial irrigation in Iraq, which requires storage and gradual release of the water through the period of minimum flow, is largely the introduction of the 20th century. Such irrigation has allowed major increases in areas under cultivation and intensification of cropping but it also magnifies the adverse effects of irrigation: soil salinity and waterlogging develop faster and some of the adverse effects are more difficult to reverse[6-8]. Water resources in Iraq are controlled by the twin rivers, the Tigris and the Euphrates. Both are international rivers originating their source in Turkey. The Tigris river basin in Iraq has a total area of 253,000 km², or 54% of the total river basin area. The history of irrigation started 7500 years ago in the land between the Tigris and the Euphrates when the Sumerians built a canal to irrigate wheat and barley. Irrigation potential was estimated in 1990 at over 5.5 million ha, of which 63% in the Tigris basin, 35% in the Euphrates basin, and 2% in the Shatt Al-Arab basin. Considering the soil resources, it is estimated that about 6 million hectares are classified as excellent, good or moderately suitable for flood irrigation. With the development of water storage facilities, the regulated flow has increased and changed the irrigation potential significantly, since it was estimated at 4.25 million hectares only in 1976. However, irrigation development depends to a large extent on the volume of water released by the upstream countries[7].

Land Degradation

More than 50% of Iraq's land area is desert, and an increasing part of the permanent pasture areas is subject to erosion because of reduced vegetation cover. Additionally, much of the cropland is losing its inherent productivity due to poor agricultural practices and over exploitation. The direct loss of agricultural land is most acute around urban centers, where established agricultural land is being lost to alternative uses, including urbanization, industrialization, and transport infrastructure[9]. To compensate for this, new land is being brought into production through reclamation. The productivity of the reclaimed land, however, is in many cases only a fraction of the old, and new land is being brought into production more slowly than old land is being lost. Overgrazing in desert areas is a major cause of plant cover loss, particularly in the semi-desert, which suffered a particularly severe loss of vegetation as a result of overgrazing, off-road vehicles, construction, and tourist activities[3,9].

Salinity

Salinity has always been a major issue in both old Mesopotamia and modern-day Iraq and it was already recorded as a cause of crop yield reductions some 3,800 years ago. By 1950, approximately 60 per cent of Iraq's agricultural land was estimated to be seriously affected by salinity; and 20-30 per cent had been abandoned with the rate of loss estimated at 1 per cent per year. It was estimated that in 1970 half the irrigated areas in central and southern Iraq were degraded due to waterlogging and salinity[10-11]. The absence of drainage facilities and, to a lesser extent, the irrigation practices used (i.e., flooding) were the major causes of these problems. In 1978, a land rehabilitation program was undertaken, comprising concrete lining for irrigation canals, installation of field drains and collector drains. By 1989, a total of 750,000 ha had been reclaimed at a cost of around $US 2,000/ha.

Soils of Iraq

Geologically, most of Iraq is underlain by rocks of the Cretaceous and Eocene eras, mainly limestone, with bands of salt and gypsum. On the lowland plains of the twin rivers, the surface is covered by fluvial deposits and alluvium. In these latter areas azonal, alluvial, hydromorphic, irrigated soils are found. In the west and south, zonal desert-steppe soils are found, sometimes stony, sometimes sandy and often calcareous. The mountain soils of the north are varied – red, brown, and chestnut forest soils – and in places are merely skeletal where rock outcrops occur. Gypsum is often present in the red and brown soils of the plains and foothills[10,12]. The area of gypsiferous soils in Iraq was estimated at 12,503,000 ha or 28.6% of agricultural soils in the country (or 6.7% of all gypsiferous soils in the world). Gypsiferous soils are well represented in the Euphrates river basin in Iraq, where three groups of gypsiferous soils can be distinguished; these are: soils with less than 10 percent gypsum (slightly gypsiferous) suitable for all crops; soils with10-15 percent gypsum (moderately gypsiferous) suitable for limited number of crops, and soil with 25-50 percent gypsum (highly gypsiferous) not suitable for irrigated agriculture. Data on gypsiferous soils in Iraq indicated that a 3 to 10 percent of gypsum content does not interfere significantly with soil characteristics such as structure, consistency and water holding capacity; while in soils containing 10 to 25 percent of gypsum, the gypsum crystals tend to break the continuity of the soil mass[11,13].

The Agrarian Structures

Iraq is one of the least densely populated countries in the Middle East, but has the greatest agricultural potential. Unfortunately, the physical developments of irrigation schemes, crop innovations or introductions of the "green revolution" have failed to produce a brave new world for agriculture in Iraq and other countries in the Middle East[3]. During most of the 20th century, the skewed nature

of land ownership was well documented in Iraq; and the combination of uneven distribution of land and a farm management structure that frequently divorced owners from day-to-day operations kept cultivation techniques at an apparently primitive level[4,14].

Share-cropping practices varied greatly depending on the cultural regime, whether dryland or irrigated farming was in question, and depending on how many factors of production – land, water, seed, draft animals and labor — the land owners provided. The share-cropper may end up taking as little as 20% of the crop he cultivated.The key to solving problems of Iraqi agriculture in the 1950s was felt to lie in the introduction of land reform by which the cultivated area could be redistributed or consolidated and the sector opened up for modernization. Moreover, political objectives were considered, including destruction of the power of landlord classes and the imposition of central control on the rural population[3,4]. However, in 1981, the Iraqi government appeared to change its policy and reduced direct government involvement in farming. In conclusion, Iraq's system of land tenure and inefficient government implementation of land reform contributed to the low productivity and the slow growth of the agricultural sector. By 1987, the government expressed disappointment at the slow pace of agricultural development, conceding that collectivized state farms were not profitable and announced plans to privatize agriculture by leasing or selling state farms to the private sector[4,5].

Biodiversity

Four vegetational zones are recognized in Iraq: the desert, the steppe, the mountain forest and the Alpine regions. However, desert and steppe regions are not readily discernible. Low rainfall plays a dominant role in the formation of the short-lived herbaceous plants in the last two zones. Arboreal types are practically absent in the steppe and deserts of Iraq. The northern part of the country, with its mountains and available rainfall, sustains virgin forests, man-made forests, and a large number of crop plants and their wild relatives[15]. Over cutting and overgrazing in the Zagros Mountains have reduced some of Iraq's oak forests to scrublands. Stands of other trees – maple, hawthorn, and pistachio, for example – remain, however. Alpine plants that can survive harsh wether appear at higher elevations. Indigenous plant and animal life in Iraq is under increasing threat due to the impact of development. Overgrazing and mismanagement of rangelands have led to the loss of natural plant cover. Deforestation is now a major concern in the northern highlands and mountains[3].

The northern part of Iraq is a rich center of diversity for a number of stone fruit trees, both wild and domesticated. Evergreen fruit trees, including date palm, predominate in central and southern Iraq. The date palm enjoys a favorable status in Iraq. In the early 1980s, an estimated 30 million date palm trees were growing in Iraq, but the number has declined dramatically since then[16]. Major efforts have been initiated for the proper conservation and propagation of the more than 700 varieties of date palm in Iraq. Traditional (offshoots) and modern propagation methods, including tissue culture, have been utilized to maintain and, finally, to enhance the genetic diversity and promote the cultivation of this ancient tree.

Crops

Most farming in Iraq entails planting and harvesting a single crop per year. In the rainfed areas the winter crops, primarily small grains, are planted in the fall and harvested in late spring or early summer. In the irrigated areas of central and southern Iraq, summer crops predominate[17]. Even with some double or triple cropping, the intensity of cultivation is usually on the order of 50 percent because of the practice of leaving about half the arable land fallow each year. In the rainfed region, land is left fallow so that it can accumulate moisture. The fertility of fallow land is also increased by plowing under weeds and other plant material that grow during the fallow period. On irrigated land, fallow periods also contribute some humus to the soil. Small grains, primarily wheat and barley, are Iraq's most important crops. Up until 1990, domestic grain production accounted for only about 30% of total consumption, with the balance covered by imports. Rice, grown in paddies, was Iraq's third most important crop as measured by cultivated area. Lentils, chickpeas, and to some extent, broad beans, are an important part of the Iraqi diet. However, production of these legumes declined dramatically in the 1990s. A number of other crops are grown, but acreage and production were limited. With the exception of tobacco, of which Iraq produced 17,000 tons on 16,500 hectares in 1985, cash crop production declined steeply in the 1980s. Probably because of domestic competition from synthetic imports and a declining export market, production of cotton was only 7,200 tons in 1985, compared with 26,000 tons in 1977. Production of sugar beets was halted completely in 1983, and sugarcane production declined by more than half between 1980 and 1985. Iraq may have cut back on production of sugar beets and sugarcane because of an intention to produce sugar from dates[3].

Vegetables

Vegetable production also increased, particularly near urban centers, where a comparatively advanced marketing system had been developed. Vegetable gardening usually employed relatively modern techniques, including the use of chemical fertilizers and pesticides. Vegetables and fruits have assumed increasing importance in the diet of the people. As a result, demand for and prices of vegetables have increased generating more attractive profit margins. Reflecting this development, there has been a renewed emphasis on vegetable production. The area devoted to vegetables has increased from about 8 per cent of the total cultivated area in 1989/90 to about 9 per cent in 1994/95. But the increase in area was largely offset by a decrease in yield and lower quality of the produce. Non-availability of vegetable seeds is by far the most important constraint, followed by a lack of plant protection chemicals and spray pumps, herbicides, and fertilizers mainly of compound[3,15].

Fruit Trees

The estimated number of fruit orchards including citrus, date palm, and a variety of other fruits in 1989 was 84,000 (with average numbers of trees per orchard of about 832 in 1989) compared to 219,000 in 1978. The estimated productive number of orchards in 1995 is about the same as in 1989, but the annual production has since increased, ranging from 1.1 to 1.2 million tons during 1990–1994. The total production in 1995 was about 1.3 million tons. Farmers put in extra efforts to manage their orchards during the 1990–1995 period, but to little or no avail. In the absence of necessary machinery and chemicals, farmers cannot do much against increasing weeds and infestation by insects and pests. In some areas also, orchards are suffering from waterlogging and salinity[14,15].

Date Palm

Dates, of which Iraq produces eight distinct varieties, have long been a staple in the local diet. The most abundant date groves are

found along Shatt al Arab. More than 30 million date palms existed in the early 1960s. In the mid-1970s, the Iraqi government estimated that the number of date palms had declined to about 22 million, at which time production of dates amounted to 578,000 tons. The devastation of the Shatt al Arab area during the Iran-Iraq War hastened the destruction of date palm groves, and in 1985 the government estimated the number of date palms at fewer than 13 million. Date production in 1987 dropped to 220,000 tons[15]. Dates are the most important fruit in Iraq. Prior to 1990, about 400,000 tons of dates were exported annually. In addition, it is an important component in the food intake of the Iraqi people. Although export of dates is currently negligible, there is a strong domestic demand for them in view of their value as a supplementary food. Available statistics show that the number of date palm trees were damaged and reduced from 21.403 million in 1981 to 15.911 million in 1991. The estimated number of trees in 1995 is about 18 million. Under the current conditions of food shortage, there have been attempts by farmers to improve the management of date palm trees; they cannot, however, do very much as they lack machinery and spare parts, insecticides and herbicides[16,18].

Basra, in southern Iraq, is the major date palm growing area in the country; approximately 13 million date palm trees of over 400 varieties are grown here and cover an area of about 50,000 ha, the largest date palm "forest" in the world. Date palm trees were, and still are, integral components of the farming systems in arid and semi-arid regions, especially in the oases of the Middle East whether in small farm units or as large scale plantations. The tremendous advantage of the "tree of life" is its resilience, its long term productivity, and its multiple purpose attributes. In Iraq, most date plantations are intercropped with vegetables, cereals or fodder crops in the first few years and subsequently with low growing fruit trees and grapevines. The fruits, depending upon the variety and growing conditions, vary in weight from 2 to 60 grams, in length from 2 to 11 cm and in width from 1 to 3 cm, offering a wide scope for selection. Date palm trees are very productive and the fruit yield may be as high as 100-200 kg per tree[15]. Constraints to date palm production in Iraq include: drought, high salinity, aged trees, diseases, and genetic erosion[18]. Date palm groves in Iraq are aging; almost one-third of productive date palm trees are beyond the limits of their productive years. Economic and social factors have decreased the diversity of date palm groves in Iraq and the composition of these groves as to the number of varieties witnessed a sharp decline in the recent years.

Crop Protection

There are no exact data on crop losses caused by plant pests and diseases of Iraq's major field crops, fruit trees and vegetables. However, agricultural diseases infected 50-80 percent of Iraq's agricultural crops and fruits. Weeds infested the date palm fields and are harboring insects/pests such as Humaira and Dubas. This is adversely affecting the production of dates[17].

Seed Industry

Iraqi cereal production dropped sharply in the past decade due to problems with its seed multiplication system, leading to degradation of seed quality and productivity. Planting low-quality seeds during the 1980s and 1990s led to problems such as weeds and pests, low productivity and an inability to use seed-processing machinery efficiently. Lack of high-yielding seed has reduced farm efficiency and often forced poor farmers to abandon their lands. To help Iraq improve seed quality, UNDP launched an initiative in 1998 at the request of the government to restore the seed multiplication program. The U.N. Food and Agriculture Organization (FAO) is implementing the US$1 million project, building up stocks of healthy, genetically pure seeds for multiplication, based on modern agricultural standards[14,17].

Natural Forests

The highest ridges of the Zagros Mountains contain Iraq's only forests, some of them quite extensive, preserved by the isolation and ruggedness of the area. Most of the mountain slopes permit only grazing; lower and more gentle slopes support fruit and nut trees[3]. Historically, deforestation and over-grazing in the Armenian highlands (eastern Turkey) is believed to be the source of the silt load that is considered to be the root cause of the decline of the Mesopotamian civilization and the irrigation system on which it depended[15,19]. The main value of these forests is for the fuel they can produce. Iraq's forests have undergone heavy cutting in recent years to supply charcoal and firewood to urban markets. It is estimated that the total yield from the country's forests annually is about 10,000 tons of charcoal and 20,000 tons of wood fuel[3].

In the Zagros Mountains, over cutting and overgrazing have reduced some of Iraq's oak forests to scrubland. Stands of other trees - maple, hawthorn, and pistachio, for example - remain, however. Release from grazing alone is sufficient to secure a very marked improvement in erosion control, and since the forests are all more or less heavily grazed, it would seem that the improved management of forest range is likely to become the most important aspect of future forest policy in the mountain catchments. Regulating the cutting of forests for fuel and charcoal still remains a problem. The charcoal trade, with its urban centers in the lowlands, has been prohibited altogether recently, though the Forest Service still cannot prevent entirely the flow of contraband charcoal; there is little doubt that a considerable reduction in charcoal consumption has ensued. More attention is being given to problems of watershed management, especially in the catchments of the huge new flood storage reservoirs planned or under construction in the mountains[3,4].

Rangelands

Rangeland or steppe, which provides essential feed resources for sheep and goats make up about 50% of the total area of Iraq; however, this vital resource is being damaged at a catastrophic rate, not only by desertification, but also by over-exploitation to supply urban centers with animal products[3]. Moreover, the vegetative cover is being exploited as a source of fuelwood. Research on fuelwood gathering in Iraq in the late 1960s suggested that a nomad tent of 10 persons would consume 3.5-4 tons of dry wood a year of the contemporary above-ground biomass in the rangelands of 200-500 kg per hectare. Overgrazing is an important part of the degradation process of Iraqi rangelands; however, opportunistic barley cultivation in the steppe and semi-desert in years of above average rainfall, contributed to the process. Four decades ago, the rangelands of Iraq supplied 60-80% of the small ruminants' diet; at present, however, they can barely meet 5-10% of these requirements[5,15].

Rangelands of Iraq are resources that require the most collective action in their management. The wide areas they cover and the poverty of the people living in these areas have always pushed successive Iraqi governments to consider rangeland development as their main turf because pastoral communities were perceived as lacking the financial, technical and institutional capacity to control and manage rangeland resources [5]. Rangelands in Iraq continue to face three important issues: (1) the need for a policy framework that would improve the performance of the livestock sector, (2) the legal framework that would support collective action and foster community and individual stewardship for better management of rangeland resources, and (3) the needs to transform or improve existing institutions to match the needs for technical innovations that would improve the efficiency of livestock production systems[17].

In the low rainfall areas of Iraq, small ruminants (sheep and goats) represent the principal economic output and contribute a large proportion of the income of farmers and nomadic or semi-nomadic herders. The country has experienced substantial increases and decreases in animal numbers over the last four decades. Prior to 1990, livestock producers were encouraged to increase flock sizes by the increased demand for animal products combined with favorable price ratios between livestock products and barley, the principal livestock feed; feed subsidies and other measures intended to mitigate the effects of feed shortages, especially in drought years have provided further incentives to retain greater numbers of animals[1,8].

Expansion in flock size and flock numbers has been particularly noticeable in rangelands, where more native pastures are open to free grazing. A generation ago, the native pasture vegetation in these rangelands provided a large proportion of the feed needs of the small ruminant population. Today, however, the natural rangelands can no longer provide such a high component of animal feed needs. As livestock numbers have grown, so has supplemental feeding, mainly of barley grain, straw, and industrial crop by-products (feed blocks have been recently introduced). The contribution of natural grazing as a proportion of total feed resources in Iraq has declined from around 70% in the 1950s to only 10-25 % at present. Not only are rangeland resources insufficient to meet current demand, the absolute level of this feed source is falling due to overgrazing, removal of vegetation through plowing or for fuel wood, and soil erosion. The decreasing contribution of rangelands in sheep diets has resulted in heightened concerns about the needs to improve and conserve rangeland resources. Unfortunately, institutional reforms have, in most cases, eroded the capacity and strength of traditional pastoral institutions. Such a situation precluded the Iraqi Bedouins from taking over the roles that are being sought for them both in terms of rangeland conservation as well as improvement[3,8].

Though, Iraq, for many decades, has been exploring new ways to further enhance the decision-making environment under which pastoral communities and their local institutions make their production decisions, the main challenge of this process has been striking the right balance between the rights and roles of traditional pastoral communities and those of the state and its institutions. The perceived difficulty of defining the roles and rights of pastoral communities is generally based on the nature of the extensive production system and the multitude of rules and conventions governing resource access and use. As such, there have been very little attempts during the past forty years, during which the state was undertaking most of the agricultural policies including rangelands, to integrate customary institutional frameworks and range management practices in policy formulation[5,17].

Inadequate and poor quality feed sources (especially during the dry season) is the most serious constraint to sheep production in Iraq. The prospects for the future are not encouraging. According to a recent study by the International Centre for Agricultural Research in the Dry Areas (ICARDA), the projected feed deficit in Iraq is expected to double every ten years (years 1992, 2000 and 2010) in response to the increase in livestock population. With the encroachment of cropping in the grazing areas and disappearance of dry season grazing reserves, sheep production has become very dependent on the availability of crop residues and by-products and purchased feed, especially during mating and early pregnancy (June - September). In most parts of Iraq, it has become necessary to all producers (large or smallholder) to access supplemental feeds (barley, wheat bran, straw and crop residues) or to abandon sheep production. For example, the smallholders are forced to purchase up to 50% - 70% of the feed needed. The small herders face difficulties of raising sheep if the cereal crop fails due to drought[17].

Rangeland degradation is the most extensive among the three major land uses in Iraq, i.e., irrigated farming, dryland farming and grazing. It is estimated that more than 70% of Iraq's pastoral lands are degraded. Overgrazing by livestock is the principal land problem, coupled with cutting of woody species as a fuel source. This high percentage of the country's rangeland that suffers from overuse stems from the extensive, low intensity character of pastoral land use, the slow response to land management changes in arid climates, and the social and economic problems associated with reducing livestock numbers on heavily used rangelands[6,7].

Livestock

Iraq's rich and distinctive livestock population is largely a result of being in the center of origin from which the most common farm animal species came. However, productivity and feeding conditions of these animals, naturally limited by the land's pasture potential, are not optimum. Ancient traditions in rural communities that are significantly involved in animal husbandry still survive and maintain the diversity of Iraqi cattle, sheep, goats and buffalos. However, in some cases these practices have been greatly modified, especially after the massive import and dissemination of foreign livestock and the extensive crossing with local breeds[1,17]. Livestock contributed about one-third of Iraqi rural families' income prior to the 1960s. In the past, a substantial part of the rural population had been nomadic, moving animals between seasonal grazing areas. Sheep and goats were the most important livestock, supplying meat, wool, milk, skins, and hair. A 1978 government survey estimated the sheep population at 9.7 million and the goat population at 2.1 million. Sheep and goats were tended primarily by nomadic and semi-nomadic groups. The 1978 survey estimated the number of cattle at 1.7 million, the number of water buffalo at 170,000, the number of horses at 53,000, and the number of camels at 70,000. According to 1990 statistics, there were 1,500,000 cattle, 8,300,000 sheep, 2,350,000 goats, and 145,000 buffaloes in Iraq; however, the animal population in Iraq has declined dramatically since 1990. Between 1990 and 1995, the number of cows declined by 34 per cent, the number of buffaloes by 46 per

cent, the number of sheep by 42 per cent, and the number of goats by 81 per cent[5,17].

The animal disease situation in Iraq has been aggravated by the collapse of the veterinary infrastructure and disease investigation, surveillance and diagnostic services in the country. The government has been unable to adequately monitor and control the spread of these diseases, partly because of the difficulties it has in obtaining equipment and supplies, particularly vaccines[8,20]. Foot-and-mouth disease, for example, has long been a major constraint to intensive livestock production in Iraq, and in spite of vaccinations—twice or even three times a year—the disease has caused serious economic losses in some of the large dairy herds in the country. Generally poor access to veterinary service, high cost of drugs and vaccines, lack of skills, knowledge or interest in disease surveillance and reporting, and the absence of trained auxiliaries limit livestock production. However, disease constraints are more pronounced.

The National Agricultural Research System (NARS)

The Iraqi NARS currently has about 2,100 scientific and technical staff; expressed as Full Time Equivalents (FTE), it adds up to 671 FTEs. The faculty and staff of Iraqi universities represent ~ 50 % of the human resources. However, this number is insufficient to work on the highly diverse and compounded agricultural problems arising from ~20 years of insufficient funding and changing priorities. It is obvious that there is a need for highly qualified and well trained human resources in the agricultural research sector. However[21], agricultural extension services and vocational agricultural education are in need of major improvements.

The governmental investment in the extension services in Iraq is very weak, at best. Budget allocations for the extension services dropped from 10% of total agricultural budget in the 970-1975 period, to 3% in the 1975-1980 period and down to 2 % in the 1980-1983 period. The relative and actual decline in the budget of extension services are indicators of the need for highly qualified and motivated extension personnel capable of planning, developing and carrying out extension services in Iraq's diverse socioeconomic and agro-ecological farming sector[14]. The number of extension workers in 1990 was less than 200; in ratio to the number of farmers, this meant that one extension worker was serving approximately 10,000 farmers. These extension workers have the responsibility of assisting farmers in adopting new technologies, identifying specific or regional agricultural problems, communicating recommendations as to management practices and adoption of new varieties.

Funding for agricultural research is mainly provided through government allocations for research centers affiliated with Ministries of Agriculture and Irrigation and for Colleges of Agriculture and Veterinary Medicine. Additional funds, although marginal, are being secured through research contracts with developmental organizations, the private sector or through sale of improved seed. Actual funds for research comprise a small fraction of budgets allocated for these research institutions, with very limited allocations available for operational and capital expenses[17,21]. Physical resources are deteriorating due to inability of NARS to purchase necessary equipment or afford high expenditure. A large portion (70 %) of the scientific staff, educated during the 1970s and 1980s, is underemployed or unemployed.

Up until recently, linkages between the NARS institutions and the different agencies involved in agricultural research and extension were weak; they were limited to participation in joint committees of different research programs. Agricultural research was mostly undertaken without an overall coordination or joint planning. Similarly, the linkages between the extension services, developmental organizations and farmers, on the one hand, and research institutions, on the other, were very sporadic and ineffective.

However, in 1995, a national strategy for agricultural research and technology transfer was adopted, and stronger linkages between different parts of the Iraqi NARS were developed. Researchers from the different institutions started participating in research planning and evaluation, holding joint field days, seminars, and writing joint publications. Working relationships with farmers, the extension services, and developmental agencies were highly improved. Adaptive research, in farmers' fields, is being conducted not only by extension agents, but also by faculty members[17,21].

International linkages are very limited; however, a number of regional (Arab Center for the Studies of Arid Lands and Dry Areas, ACSAD), and international research centers (The International Center for Agricultural Research In Dry Areas, ICARDA) [17] and organizations (Food and Agriculture Organization of the United Nations, FAO) are being involved in agricultural research and development in Iraq, especially during the last decade.

Research Needs and Priorities

Agricultural research currently makes a modest contribution to national goals in Iraq. This may reflect wartime attitudes towards information and openness, rather than the priorities or capacities of the different organizations involved in agricultural research. Indeed, many of the staff of the Iraqi NARS earned strong research degrees in different fields of the agricultural and veterinary sciences, however, the internal efficiency and external relevance of NARS, at the present, are inadequate. Therefore[21], it might be necessary to (1) develop institutional innovations independent of the existing research and extension system, (2) develop institutional innovations within the research and extension system, or (3) improve the functioning of the existing institutions with emphasis on accountability. A strong and productive agricultural research and extension system in Iraq requires a coherent research policy designed to meet national development goals; an organization compatible with the objectives and functions the government assigns to research; an integrated set of management processes allowing the system to effectively mobilize and use the required resources; and the ability to communicate effectively with its clientele, its partners in the scientific community, and the country's policy makers.

Capacity Building

The importance of research capacity building is now so widely recognized that there are a number of excellent models to consider, and a number of international research facilities capable of providing assistance to Iraq. Building research capacity is, however, a long-term and costly endeavor[4,21]. Iraq no longer has an extension corps in direct contact with its farmers. At a time when the farmers are expected to make their own decisions on what crops to plant, there is no direct link with them to either guide their decisions or understand the basis for the decisions they make. Field research is needed to understand the factors that affect the choices farmers make and the outcomes they achieve, the absorp-

tion of labor by agriculture and off-farm employment opportunities, agricultural credit and marketing problems, the availability of inputs, and land management and conservation practices. Capacity building of agricultural research and strengthening of the national agricultural research system can be accelerated through open access of the Iraqi NARS to the regional and international research community. Agricultural research managers[21] in Iraq will need to become acquainted with various methods of organizing research programs, developing skills in research proposal development, familiarizing themselves with a wide range of research methodologies, and establishing links with sources of research expertise abroad. The need to strengthen the role of universities in Iraq's NARS has two underlying assumptions. The first is that universities have an underutilized potential to contribute efficiently, effectively, and sustainably to national agricultural research. Second is that the mobilization of universities' research potential together with the strengthening of the linkages between universities and other components of the NARS will provide benefits to society.

Research Needs and Priorities in the Rainfed, Irrigated, and Rangeland Production Systems of Iraq

Farmers in Iraq are struggling to produce under poor environmental conditions with few tools for coping with drought, salinity, insects, weeds, and diseases, and shortages in inputs (fertilizers, improved seed, etc.), and lack of appropriate technologies and machinery. After almost one decade of stagnant agricultural research, farmers need help to reduce their risks, improve their productivity, and protect their natural resources[17,21]. Yet the kind of agricultural research that will benefit these farmers is, as yet, severely under-funded. The gains to society and to farmers, however, are high. Social rates of return to most investments in agricultural research, in some developing countries, have exceeded 20 percent a year. For Iraq, this is a most worthwhile investment. Increased funding for agricultural research is particularly critical in Iraq. Despite this nation's heavy dependence on food imports, the public expenditures on research generally total less than 0.5 percent of its agricultural gross domestic product. By comparison, industrialized countries spend 2 to 5 percent.

Besides the technological tools for producing more agricultural goods, Iraqi farmers also require sound and supportive public policies. Trade, macroeconomic and sectoral policies must not discriminate against agriculture and must favor poverty reduction and food security. Policies must also provide incentives for sustainable natural resource management, such as secure property rights for small farmers. Above all, farmers must participate in making decisions and implementing programs that affect their livelihood[4]. Research needs and priorities for Iraqi agriculture[3,6,21] can be classified under the following major research themes: (1) Crop improvement and germplasm enhancement, with an overall objective of increased yield and stability through genetic and agronomic improvement of the major (wheat, barley) and minor (food legumes, forage legumes, etc.) crops in the rainfed and irrigated lands of Iraq; (2) Production systems management, with a farming systems perspective, to integrate crops and livestock production, and to properly manage soil and water resources for the purpose of optimizing crop and livestock production in rainfed and irrigated areas; (3) Rehabilitation and improved management of native pastures and rangelands in the dry areas, and improvement of natural and sawn pasture in rangelands and under irrigation, as sources for livestock feed, and; (4) Natural resources management to promote efficient, integrated, and sustainable use of land, water and agro-biodiversity resources in different agro-ecological zones of Iraq.

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