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CWANA CHAPTER TWO
HISTORICAL AND CURRENT PERSPECTIVES OF AKST

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KEY MESSAGES

1. **In CWANA region the major factors (risks) contributing to agricultural production and vulnerability are the following:** (1) the limited availability of natural resources (land and water) and their degradation, (2) the extreme climate variability, recurrent and severe drought episodes aggravated, (3) recent and rapid changes in the organization of input and output markets (privatization, trade liberalization).

2. During the last 50 years and despite these constraints, agricultural production and yields increased mainly in the irrigated sector. In the rainfed crops sector, the yields' increase has remained far away from the world average and is characterized by high inter annual variability.

3. This trend has been associated with major environmental and NR degradation Insufficient consideration of rainfed agriculture in AKST policies and the development of mono cropping systems has led to the reduction of the number of crops and species cultivated in the area and has resulted in important loss of diversity, thus threatening the environmental and social sustainability of farming systems. In the irrigated sector, environmental problems are expressed in overexploitation of water resources, soil degradation and pollution resulting from the misuse of chemicals.

4. **Most countries in CWANA have become water scarce during the last 50 years and this trend will intensify in the future**. Agriculture is the first consumer of this resource (from 85 to 97% according the countries). In addition to adoption of water saving or water reuse measures CWANA countries have to:

- Increase water use efficiency at different levels: irrigation techniques, choice of crops, crop management and cropping systems.
- improve water policies at national and international level as water resources depend on trans-boundaries watersheds,
- revise dams management as there is great variability in the performance of hydraulic infrastructure,
- study the development of middle and small size hydraulic works as complementary or alternative to large dams;

5. The problems of water quality deterioration are expected to intensify in CWANA due to anthropogenic interventions and increasing possibility of extreme events of climate change (saline water intrusion is projected to increase from sea level rise and over exploitation of groundwater in costal zones. At present more than half of the major rivers in CWANA are seriously depleted and polluted. A majority of lakes (natural or artificial) are presenting eutrophic condition due to diffuse pollution or urban waste water.

6. **The arable land resources CWANA have been pressured by overgrazing combined with extension of the cropped area, loss of soil organic matter and depletion of**

nutrients, and by the salinization caused by irrigation. Rangeland reduction resulted in increased erosion and loss of fodder crops with consequences on animal production. Farm land is also being lost due to urbanization processes. This situation is aggravated by the lack of appropriate regulation aimed at protecting farm land.

7. Unique agrobiodiversity in CWANA region is in danger and according to IUCN red list, around 1500 plant and animal species, including biological diversity relevant to food and agriculture are threatened for various factors. This diversity refers to genetic variability in cultivated plants and domestic animals and their wild relatives, at genetic, species and ecosystem level in support of food production and food security, or for the promotion of natural resources based activities, such as medicinal plants, etc…

8. Agricultural risk management policies in the CWANA region have mainly consisted in the implementation of emergency measures, especially to cope with the consequences of drought and epidemiological situations, as well as in programmes aiming at improving farm production techniques. **However what is at stake for most countries of the region is the design and implementation of a comprehensive and pro-active risk policy, which would include the establishment of early warning systems, development of crop insurance schemes, improvement of public investment in public works, in water management, in agricultural and extension, implementation of policies that protect the environment and discourage cultivation of marginal land, the reinforcement of marketing systems and the promotion of farmers' organizations**

9. The countries of CWANA region vary significantly in terms of per capita income, living standards and economic performance. With regard to the nutritional status of the population, countries of CWANA region made a significant progress in raising per capita food consumption in terms of Kcal/person/day. However, under nutrition and hunger are still prevailing in some regions, including in rural areas. This situation appears to be closely related to the insufficient attention given to food security objective at farm household level.

10. Agricultural activities in CWANA are undergoing major changes, due to movement of liberalization and reorientation of public policy, which reduce public investment and support mechanisms in favor of farm production. This has negative impacts on small and medium size farms, which play a major role in agricultural production, rural employment, including female employment, and in the reduction of urban drift. What is then at stake is the social sustainability of the new agricultural development orientations, including AKST development.

11. **National governments seek to promote human welfare by helping to increase productivity in agriculture while sustaining the resource basis. One potentially efficient way to increase productivity is to foster an environment that enable private firm to invest in R & D and product delivery**

In CWANA, a low total rainfall and its erratic, unreliable distribution constrains the achievement of a stable and sustainable agricultural production system which would provide people with satisfactory and low-risk production systems. Although the region (18.5 million km2) occupies about 14% of the total area of the world and supports about 10% of the world's population (almost 600 million), it has only about 2% of the total renewable water resources. The arable land proportion (7% in total area) is lower than the world average (% 10.5) although the area of land devoted to agriculture (41%) is higher than the world average (37%) (FAO Database, 2006). CWANA countries need to attain food sufficiency. However, population growth has already outpaced agricultural production, resulting in a gap between demand and supply. If some countries of the CWANA region are self sufficient, with most of their products being exported to other countries, national and international efforts are required to ensure food security for all people across CWANA.

In addition to these demographic and natural resources related constraints, the agricultural sector is confronted with major challenges, linked to international trade liberalization, and agricultural products of the region will have to face in the near future an increased competition on the global market. At the same time that trade liberalization may contribute to foster agricultural exports of the region, it has also the potential to threaten local products for which the countries of the region do not have a comparative advantage.

2.1 Natural Resources, Agricultural Production and Infrastructure

2.1.1 Land use and land cover

Agricultural land. In CWANA countries, agricultural area covers between 3 and 80 % of country areas. Highest proportion of use of agricultural land is observed in CAC countries. During the last 50 years, an increase in the area of agricultural land has been observed but it seems that it has reached a plateau in most countries or even it is decreasing in some countries.

Agricultural land is mainly devoted to **permanent pasture** and rangeland. For the whole CWANA region, the proportion is 83%, the lowest proportion being in South West Asia (55%) while the highest proportion is in the Arabian peninsula (98%) where an almost twofold increase of permanent pasture was observed during the last 50 years.

Proportion of agricultural land used for **arable land** is less than the world average and just a few countries control the majority of the arable land area: Turkey, Khazakstan, Pakistan, Sudan, Iran and Morocco have all together 62% of arable lands of the CWANA region. With Morocco, Afghanistan, Algeria, Iraq, Uzbekistan, Syria, Saudi Arabia, Egypt and Tunisia, these 14 countries control over 90% of arable lands of CWANA countries. The other countries have 1% of the arable land of the whole region or even less.

Irrigated land occupy a variable proportion of agricultural area, the largest concentration of irrigated lands being in the South West Asia with 23% of the agricultural area corresponding to 14% of the world irrigated area. In the other regions, it varies between 2 and 5%. During the last

50 years, the irrigated area increased in all the sub-regions and the related proportion to the world varied only slightly except in the Arabian peninsula where it doubled.

2.1.2 Cropping patterns and productivity in CWANA

The main crops grown by farmers depend on climatic and soil conditions, country priorities and needs, irrigation situations and also the relative profitability of various kinds of agriculture. Cropping patterns changed distinctly from 1961 to 2005. CWANA depends increasingly on expanding yields of rainfed crops and cash crops in irrigated areas.

Climatic factors and climate change play an important role. Land use and land-cover characteristics are affected by a changing climate and increasing climate variability and they affect the biogeochemical cycles and ecosystems biodiversity and the many important goods and services they provide to society including carbon sequestration.

2.1.2.1 Cereals

Among the agricultural products produced in the CWANA region, cereals are and have been one of the most important crops in the agricultural production. Cereals represent over 35 % in crop rotation systems in CWANA and mostly exist alongside fallow in most areas. Wheat is the most widespread crop (27 %) overall and barley follows wheat. In dry areas, sorghum and millet are as well important. However, while the area harvested in wheat doubled and the area in barley increased by 45 %, the area of land devoted to other cold season cereals - oat and rye- has fallen two-fold over recent years.

During the last 50 years, cereal production increased in volume from 51 Mt in 1961 to about 173 Mt in 2005 and the related increase in yield depends on the sub-region (see Table 2.1.2.1.a ; Figure 2.1.2.1.a and 2.1.2.1.b). Yet production is not stable and year-to-year variations are high and could be related to climatic conditions as these countries have high year to year variation in the rainfall both in its timing and amount.

However, although an increase in yield has been observed, yields are still low, even when the year is good. When compared to world average yield (Table 2.1.2.1.a; Figure 2.1.2.1.b), it can be seen that cereals yield in CWANA are lower and although an increase in yield was observed during the last 50 years, it is less important than the increase at world level. Other limiting factors like mineral nutrients, weeds and diseases limit seed yields. Only in countries were cereals are irrigated, is the yield high and stable.

It is instructive to examine each sub-region of CWANA separately in order to gain a clearer understanding of what is happening in the cereal sector (see table 2.1.2.1.b):

- South West Asia is producing about 60% of the cereals grown in CWANA region, which is responsible for 4.6% of world production. Rapid production increase (35Mt in the sixties to more than 100 Mt in 2005) in South West Asia can be attributed to both an increase in yield (1.0 to 2.2 t/ha) and in the area harvested (35 to 44 Mha). However, some countries observed high increase in yields (Turkey) while others made less progress.

- In North Africa, production increased mainly due to an increase in yields, the area in cereals having reached its maximum. Yield year-to-year variations (Figure 2.1.2.1.b) are high and yields are still extremely low during dry years. These countries have high year to year variation in the rainfall both in its timing and amount. Drought is considered as a permanent risk and is the first limiting factor to yield. When rainfall is not limiting, these countries have still low yields.
- In other countries and in some of the Mediterranean countries for part of the production, irrigation allows a more stable yield and the increase in yield can be observed since the beginning of the 1970s.
- In the Nile valley and Red Sea, a high increase in cereal production can be observed. This is related mainly to an increase in the area harvested, but also to an increase in the yield. In this region yields were around 1.6 t/ha in the sixties whilst they are now around 2 t/ha
- In the Arabian Peninsula, the area under cereals is small, but yields are far above the world yield with yields around 4.3 t/ha, due to the use of irrigation.
- In CAC countries, yields are around 1.9 t/ha but some countries are having regular increase during the last years like Uzbekhistan.

2.1.2.2 Irrigated land rice, maize, industrial and legume crops

In irrigated areas maize and rice are the most important crops. The largest rice area is in South West Asia. Oil crops such as groundnut, sunflower and sesame are significant. Cotton is an important irrigated crop in most Central Asia, covering over 3.8 Mha. (**% arable land?)

With respect to legume crops, the most important ones in the region are chickpea, lentil and dry beans. Their area increased by about 50 % while the yields increased from 0.62 t/ha to 0.87 t/ha. This increase in the production was achieved mainly through the increase in the South West Asia production while in other parts of CWANA, yields are lower. Legumes are part of the production systems and they could play a major role in rainfed production systems where about 30 million hectares of land is left fallow in CWANA every year. If 70 percent of this land could be sown to forage legumes, it would produce enough feed for 80 million sheep. Moreover, there would be an entry of 1.4 million tones of nitrogen from symbiotic nitrogen fixation per year.

2.1.2.3 Horticultural and vegetable crops

Horticulture and vegetable crops also exist in the cropping systems in the region. Potato and tomato in vegetables, grapes, almonds, apples, olives and oranges are the most important crops in the CWANA countries. Permanent crops under irrigation (dates, citrus, other fruits, olives) are present in almost all countries of North Africa, the Arabian Peninsula and South West Asia.

During the last 50 years, the production of **vegetables** in CWANA has increased from about 20 Mt in the sixties to 96 Mt in 2005 which represent 11 % of world vegetables production mainly concentrated in South West Asia (6 % of world production) (Figure 2.1.2.3.a and 2.1.2.3b). This increase was made possible through an increase in the area harvested and through an increase

in absolute yields (Figure 2.1.2.3.c). Across the region, yields are above the world average, apart from in North Africa where they are slightly less.

CWANA produces about 11.4% of world **fruit** production in the world with yields slightly below the world average (Figure 2.1.2.3.d). Increased production (Figure 2.1.2.3.e) in the region has depended mainly on an increase in the area harvested. Overall yield did not increase evenly across the region. In the Nile Valley and the Red Sea fruit yields are the highest with an average value about 13 t/ha, whilst the world average yield is around 10 t/ha (Figure 2.1.2.3.f). South West Asia demonstrated the highest increase in yield from 4.3 t/ha in 1961 to near than 10 t/ha in 2005. Conversely, in North Africa, fruit yield has slightly decreased during the last 50 years.

2.1.2.4 Crop-livestock-range systems

Crop-livestock-range systems are the most widespread form of agricultural production in CWANA. They are the least intensive in terms of land and water use. The key distinguishing features are in the use of arable crops and natural rangeland to feed small ruminants - the principal economic output of the system. Although cropland and animals are generally associated with strong systems of private property, with smallholders the predominant production unit, property regimes associated with rangelands are less well defined. The problem of open and uncontrolled access to rangeland often results in extreme overgrazing.

Crop-livestock-range systems are mostly located on the margins of the major rainfed and irrigated cropping zones and are often associated with seasonal movement of animals and households. The integration of crops and livestock is a promising agricultural system for low-income small-scale farmers. A great advantage of crop-livestock integration is that it uses diverse resources such as fodder legumes, crop residues and livestock manure in a system of nutrient recycling. Livestock provide a high level of profit per unit of labor input, plus valuable manure for use as soil improver. Livestock also have the great advantage of being relatively easy to market compared to harvested crops. There is a steady demand for livestock products, with relatively high and stable prices.

Increasing population, urbanization and incomes in CWANA are leading to a growth in demand for animal products which opens opportunities for poor farmers in domestic and export markets. However, these farmers face the challenge of producing for a competitive market. The role of technology in this respect is to promote the adoption of improved animal health and nutrition practices, genetic enhancement and better handling are essential for achieving higher small ruminant productivity. Plant species adapted to the dry areas can increase feed supply particularly during dry years with barley, vetches, oats or other forage crops can improve the supply and quality of feed resources and prevent soil erosion especially on hillsides. Spineless cactus or shrub (Atriplex halimus) alone or intercropped with other forage crops can also improve the supply and quality of feed resources.

Multi-nutrient feed blocks made from agro-industrial by-products and other ingredients are a low-cost source of feed and nutrient supplementation that can increase animal productivity. Early weaning of lambs is another way to increase milk production. Improved rams can be distributed to producers to improve flock performance. Lamb fattening dairy processing into high-value

commodities and targeting of niche markets with specific products can help increase earnings from small ruminant enterprises (ICARDA, 2005).

Irrigated fodder crops are important in Egypt, where berseem represents over 20% of the cropped area, and are present in each single country of the Arabian Peninsula, occupying between 12% (Saudi Arabia) and 32% (Qatar) of the cropped area. In Kyrgyzstan fodder crops represent 37 % of the irrigated cropped area.

2.1.2.5. Use of inputs

During the last 50 years, fertiliser use has increased significantly across CWANA (Figure 2.1.2.5 a). Fertiliser use stands at about 7.5 percent of the world consumption while it was only 1.7 percent. This increase is still occurring in South West Asia, though in the other sub-regions the use of fertiliser has slowed significantly or even fallen (as in North Africa and in the Arabian Peninsula).

The balance between the elements has also changed in some of the areas. In North Africa, P used to be the main element applied, while currently the balance between the elements is closer to the world average balance. In the Nile valley and red Sea region, the major element applied is, and always has been, N for the last 50 years. In the Arabian Peninsula, an increase in the use of K is observed. While this element was almost absent 50 years ago, it now represents about 9 percent of the use of fertiliser.

Herbicides and pesticides are also used in the area and they allowed part of the increase in yield. However data on their use are not available for long periods in the different countries of the area. It can be observed that weed resistance to the use of pesticide is observed and is becoming a threat. Work on Integrated Pest and Disease Management is starting in some countries and should be encouraged.

2.1.2.6 CWANA case studies

In order to understand of how cropping patterns have changed across time, five countries have been selected for detailed examination. They are Turkey, Pakistan, Iran, Morocco and Egypt.

- **Turkey**

Turkey is in the self-sufficient countries in food and also the largest exporter of agricultural products in CWANA. Turkey has the largest arable land in the CWANA (11th in the world) and generally has the highest yield capacity due to suitable climatic conditions.. Turkey lies within the region where a number of crops originated. All field crops, including aromatic plants, different fruits and vegetables can easily be produced. While oats, ryes and forages are declining in importance, chickpea and lentils have replaced fallow areas. Cash crops such as grapes, maize, hazelnuts are being grown in both rainfed and irrigated areas, as Table 2.1.2.6a demonstrates.

- **Pakistan**

Pakistan has the 2nd arable land (22 percent) in the region. The climate is arid with low rainfall and humidity and high solar radiation over most parts of the country. Most areas receive less

than 200 mm annual rainfall, except for the high altitude northern mountains, which receive more than 500 mm annually. Due to these unsuitable conditions for agriculture, crop yields are very low and similar cropping patterns have existed in Pakistan in last 40 years, as shown in Table 2.1.2.6 b.

- **Iran**

Iran is one of the largest countries in CWANA, half of which is unproductive land. The diversity of climate in Iran provides a good opportunity for producing variable agricultural and horticultural plants. Water shortages are compounded by the unequal distribution of rainfall. Similar to Turkey, wheat and barley exist mainly in the cropping patterns (Table 2.1.2.6 c). Chickpea and lentils in the fallow areas and pistachios replaced with dates and watermelon in dryland and other areas.

- **Morocco**

Morocco is extremely dependant on its agricultural sector. Over 90percent the country's agriculture is rain-fed, thus output is unreliable. Although this is a very important sector in Morocco, only 19percent of the country's land is cultivated. Agriculture products are barley, wheat, citrus, wine, vegetables and livestock in Morocco (Table 2.1.2.6 d). Almost like other countries, there have been no big changes in cropping systems in Morocco in the last 40 years. However, the land area devoted to olives and sunflower has increased in recent years.

- **Egypt**

The total agricultural land of Egypt is about 3.28 million ha, of which 3.02 million ha are in the Nile Valley. Almost all agricultural lands are almost entirely dependent on irrigation. Around 840 000 ha in Egypt are classified as salt-affected, mostly cultivated lands in the North Delta. In the last century, the arable area increased by only about 1million ha, while the country's population increased nearly six fold, from 11.2 to 65 million. Clover for animal use increased proportion in rotation system in last 20 years (Table 2.1.2.6 e).

2.1.3 Water resource development and management

The CWANA region remains an arid to semi-arid area on three quarters of its territory. This region can be defined by the scarcity of its water resources and by a pronounced climate variability in space and in time. Water is an essential factor for the development of the agricultural, industrial, and tourism sectors and is vital for the supply of potable water. Continuing economic growth remains dependent on water, a factor that is both limiting and limited.

2.1.3.1 Internal Renewable Water Resources

Rainfall conditions in CWANA are far from uniform. One may distinguish four groups of countries according to the average annual rainfall:

- Countries receiving more than 500 mm per year with 120 days of rain, and places surpassing 1500 mm: Kyrgyzstan (533 mm), Armenia (562 mm), Turkey (593 mm), Lebanon (661), Tajikistan (691 mm)
- Countries receiving 300 to 500 mm of rain with 60 to 100 days of rain: Afghanistan (327 mm), Morocco (346 mm), Sudan (416 mm), Republic of Azerbaijan (447 mm), Pakistan (494

mm)

- Countries receiving 100 to 300 mm of rain with 40 to 70 days of rain, Jordan (111 mm), Kuwait (121 mm), Oman (125 mm), Turkmenistan (161 mm), Yemen (167 mm), Tunisia (207 mm), Iraq (216 mm), Djibouti (220 mm), Islamic Republic of Iran (228 mm), Syrian Arab Republic (252 mm), Somalia (282 mm),
- Countries receiving less than 100 mm with less 30 days of rain: Egypt (51 mm), Libyan Arab Jamahiriya (56 mm), Saudi Arabia (59 mm), Qatar (74 mm), United Arab Emirates (78 mm), Bahrain (83 mm), Algeria (89 mm), Mauritania (92 mm).

According to the area of each country, and depending on evapotranspiration, which is higher in countries where the rainy season is in summer, the total internal renewable water resources vary from about 0 for Kuwait to 227 10^9 m3/year for Turkey (Figure 2.1.3.1.a).

An irregular distribution over time adds to this poor spatial distribution of rain. As an example, the variation in annual rainfall of the Tunis station is presented in Figure 2.1.3.1.b. Drought is a recurrent phenomenon across CWANA. Mitigating the impacts of droughts is an important issue for all CWANA and especially for the sub regions: West Asia and North Africa (See § XX).

2.1.3.2 Global Water Resources

The actual potential of water resources for the CWANA region is given in Table *2.1.3.2.a.* In each region, some countries are very dependant on their neighbors. Their water resources depend on transboundary watersheds. For example in North Africa, Mauritania depends on Senegal for 96.5 % of its water and in the Nile Valley and Red Sea region, Egypt depends on the Nile for 97% of its water.

The River Nile is the main source of water for Egypt, with an annual allocated flow of 55.5 km^3/yr under the Nile Waters Agreement of 1959. Internal surface water resources are estimated at 0.5 km^3/yr. This brings total actual surface water resources to 56 km^3/year. The Nubian Sandstone aquifer located under the Western Desert is considered an important groundwater source. The volume of groundwater entering the country from the Libyan Arab Jamahiriya is estimated at 1 km^3/yr. Internal renewable groundwater resources are estimated at 1.3 km^3/yr, bringing total renewable groundwater resources to 2.3 km^3/yr. The main source of internal recharge is percolation from irrigation water in the Valley and the Delta. The total actual renewable water resources of the country is thus 58.3 km^3/yr (Source FAO).

FAO considers that 500 m^3/inhab/year is a threshold under which the lake of water resources are a handicap for development. In North Africa three countries are under this threshold: Algeria (373.2 m^3/inhab/yr), Libyan Arab Jamahiriya (110.2 m^3/inhab/yr) and Tunisia (472.3 m^3/inhab/yr). In the Nile Valley and Red Sea region: Djibouti (432.9 m^3/inhab/yr) and Sudan (163.6 m^3/inhab/yr) are in this case. All countries of Arabian Peninsula are under 500 m^3/inhab/year, the best situation is in Kuwait with 356 m3/inhab/year. In south and East Asia water scarcity strikes Jordan (165 m^3/inhab/year) and Palestine (not given).

The potential of CWANA water resources per habitant has decreased in the time (Figure *2.1.3.2.a*) due to the important increase of population. The y axis has been represented with a

logarithmic scale to emphasize the threshold of 500 m^3/inhab/year and to show when a country has reached it.

The potential of CWANA exploitable water resources is not well known and statistics are missing. For countries where statistics are available, we can see that potential exploitable water has undergone a considerable revolution since the 1970s and particularly in the last decade of past century. For example, the water resources that Tunisia can mobilize increased from 2.6 billion cubic meters in 1990 (or 57% of the resource) to 3.6 billion cubic meters in 1999 (or 79% of the resource). These resources were 3.85 billion cubic meters in 2001 (or 84% of the resource) and 4.1 billion cubic meters in 2004 (or 90% of the resource). Many new hydraulic infrastructures, now under study, will be realized during the next decade. These include 11 large dams and 50 retention dams or lakes. The water resources that can be mobilized represent 81% of surface water resources and 50% of total water resources. The potential of Tunisian water resources does not exceed 4.570 billion cubic meters per year:

2.700 billion cubic meters/year represent run off water that is mobilized by dams, retention dams, and works for the controlled spreading of flood waters; and

1.870 billion cubic meters/year will replenish every year the water tables constituting renewable underground water resources.

2.1.3.3 The demand for water

Table 2.1.3.3 a shows the different demands for water and the part of agriculture. The poorer the country, the bigger is the part of agriculture in demand for water. Figure 2.1.33a shows total water withdrawal versus total renewable. For some countries total water withdrawal is bigger than the renewable resources. The supplementary water comes from:

- Depletion of renewable groundwater resources
- Abstraction of fossil groundwater
- Non conventional resources: Desalinated water, treated waste water

Table 2.1.3.3 b shows the gap between available internal renewable water resources and the amount of withdrawal water (22 times more for Kingdom of Barhein). We can say the important part of agricultural water withdrawal in this gap. When statistics are available, Table 2.1.3.3 b gives the origin of the supplement water.

Water withdrawal, expressed as a percentage of internal renewable water resources, is an indicator of the sub-region's or country's capacity to rely on its own, renewable, sources of water. Values above 100% indicate that either renewable water flowing into the sub region or country from outside, or fossil, or non conventional sources of water are used in addition to the internal renewable water resources.

The evolution of agricultural water withdrawal has increased very fast over the past few years. Agriculture seems to be the sector where water must be saved in the next few years. Figure 2.1.3.3 b shows the evolution of agricultural water consumption from the 1970s. Just a few countries (for example Tunisia and Uzbekistan) demonstrate a slowing down in the water consumption for agriculture, as a consequence of the introduction of water saving policies in agriculture.

2.1.3.4 Water resource management strategies

2.1.3.4.1 Development of water conservation techniques

Water conservation remains a principal component of water resource management. The total loss between the production of the resource and its use was estimated to be more than 25% in a majority of countries. If one adds the various waste related to the poor or under utilization of the resource, one may put the amount of water actually wasted at an estimated 40% to 50% of the global volume of the resource. Several attempts to conserve water are used in different CWANA countries.

For the agricultural sector:

the modernization of water canals and irrigation networks;

the improvement of plot water management: irrigation techniques, for example the use of drip irrigation; for example, in Tunisia the government currently is financing between 40 to 60% of the cost of materials used for irrigation that has water conservation as an objective;

the introduction of new techniques to regulate irrigation (irrigation initiated by automatic measurements of water levels in the soil, ferti-irrigation that allows the most efficient use of fertilizers, the control of fertilizers in the soil,…);

the encouragement of farmer associations aiming to share and manage water.

For potable water:

the modernization of canals and water distribution networks such as the instauration of leak detection and control systems.

the improvement of sanitary accessories (faucets, flush toilets)

consumer education, starting with the largest consumers (hotels, government offices, factories,…)

the revision of water rates: progressive rates as a function of the volume consumed. In Tunisia, a study conducted by the National Society for Water Distribution noted that between 1984 and 1994, a large number of large consumers (> 150 m^3/trimestre) became medium or low quantity consumers (<70 m^3/trimestre) (Figure 2.1.3.4.1.a).

2.1.3.4.2 Water harvesting

Water harvesting is the collection of runoff for productive purposes. Instead of runoff being left to cause erosion, it is harvested and utilized. In the semi-arid areas, it is practised since ancien times, and it is a directly productive form of soil and water conservation. Various forms of water harvesting (WH) have been used traditionally throughout the centuries. Some of the very earliest agriculture, in the Middle East, was based on techniques such as diversion of "wadi" flow onto agricultural fields. An overview of the main Water Harvesting systems is given in the section on “indigeneous knowledge”.

In CWANA arid and semi arid areas, more than one million of ha are managed to harvest water for agricultural purposes mainly in West Asia and North Africa sub regions.

2.1.3.4.3 Use of fossil water

Several countries, in North Africa, Arabian Peninsula and Nile – Read Sea regions, that have few renewable water resources, overlie important non-renewable (fossil) groundwater basins, partly shared with neighboring countries. In several countries (Algeria, Tunisia, Lybia, Egypt, Saudi Arabia, or the United Arab Emirates) fossil water, is an important resource. Libya exploits 3.7 billions of cubic meters per year in the fossilized ground water. However, although groundwater reservoirs may allow storage of huge quantities of water accumulated during the pluvial periods of Quaternary, its development cannot be considered sustainable in the long term, as the lack of present recharge would result in the slow depletion of the aquifers. Moreover, the water level decline and the resulting increase of the cost of pumping, as well as the deterioration of the water quality in some areas may also make the abstraction of fossil water less attractive with time.

2.1.3.4.4 Reuse of treated wastewater

The development of urbanisation, tourism and industry pushed authorities in some countries to undertake adequate measures to protect wastewater collection sites from likely medium to long term pollution. The creation of purification plants around the principal urban and tourism centers has become an imperative as a prevention and risk reduction measure. With the installation of purification plants in diverse regions, the volume of purified discharge water is becoming increasingly larger. These waters currently constitute a significant resource for the creation of irrigated perimeters. Recycling large quantities of water in agriculture (fodder crops and selected fruit crops) is a judicious solution. The re-use of this treated wastewater will lead to capital benefits for agriculture (by taking advantage of fertilising elements in wastewater for plants) and for the environment (by eliminating treated wastewater presumed to be still dangerous for certain receptor environments).

For example in Jordanie the produced wastewater was estimated at 232 million m³/year in 1993 and the quantity of reused treated wastewater reached 50 million m³, of which 48 million m³ for irrigation and 2 million m³ for industrial purposes. The re-use of treated wastewater in Jordan reaches one of the highest levels in the world. The treated wastewater flow in the country is returned to the Search river and the King Tall dam, where it is mixed with the surface flow and used in the pressurized irrigation distribution system in the Jordan valley. The importance of re-used wastewater is an essential element of Jordan's water strategy.

Figure *2.1.3.4.4.a* shows the volumes of waste water produced and treated (10^9 m3/yr) for counties where a policy for reuse of trated wastwater is available.

2.1.3.4.5 Desalinated water production

The use of desalinated water is important in the Arabian Peninsula and in Egypt. Three countries, Saudi Arabia, the United Arab Emirates and Kuwait, are by far the largest users of desalinated water with 71% of the total for the CWANA region, with Saudi Arabia alone accounting for 42%. Figure *2.1.3.4.5.a* gives the annual production between 1992 and 2000 for countries which adopted a desalinated water production in CWANA.

2.1.3.4.6 Reuse of ground water

Ground water constitutes a significant resource. Irrigated surface areas in the CWANA region are estimated at 30 million ha which represent 7% of the usable agricultural surface area, mobilizing nearly 130 billion cubic meters of irrigation water per year. Roughly 13 billion cubic meters of irrigation water could be recuperated, monitored (in regards to quality), and re-used.

2.1.3.4.7 Water transfers

Many countries face the problem of a disjuncture between the water consumption and water production sectors. There is sustained agricultural development in diverse regions of the country and the urbanisation of neighboring zones has accelerated. Water transfers are destined to correct uneven spatial distribution and to reduce the gap between demand and supply by according priority to the satisfaction of potable water needs and on obtaining the maximum return from each cubic meter of water. To facilitate the flexible management of the entire set of works, two main principles guided their conception: the possibility of interconnection between dams (situated in the same catchment area) and the possibility of transfers from one catchment area to another. This concept optimizes management by:

- avoiding as much as possible having dams discharge towards the sea and to thus stock the maximum amount of water;
- improving the quality of water used by the possibility of mixing the contributions of tributaries with different water quality.

At the international level, the debate about water diversion has become a heated issue, both nationally and internationally. Numerous water transfer projects have already been made in many more or less developed countries in CWANA region; an increasingly growing resistance for further developments of this kind can be noted. The people who live in the water-abundant areas are becoming increasingly more reluctant and disturbed about proposals to divert part of “their water” to water-scarce another regions, even when the projects promote economic development, poverty alleviation and environmental protection. Examples of water transfer huge project in CWANA region can be quoted: the Southeastern Anatolia Project in Turkey, the Nile River initiative, and water resources management in the Jordan River region.

Interestingly, but perhaps not surprisingly, the technical issues of this projects are not considered as the main problems for their implementation. On the contrary, environmental and social issues become the main constraints for the acceptance and the implementation of these projects.

The general global view at present appears to be that first water must be used in an efficient manner for the development of the regions, with appropriate considerations of overall economic, social, institutional and environmental consequences. New projects should be considered only after water use efficiencies and demand management practices have been taken into account.

2.1.3.5 Impacts of global changes on water resources

Climate change will have major effects on precipitation, evapotranspiration, and runoff - and ultimately on water resources. Climate-induced changes in the water cycle likely will affect the

magnitude, frequency, and costs of extreme weather events as well as the availability of water to meet growing demand. Recent reports (IPCC[1], Pew Center on Global Changes) show that climate change is likely to increase the number of days of intense precipitation and the frequency of floods in northern latitudes and snowmelt-driven basins. The frequency and severity of droughts could also increase as a result of a decrease in total rainfall, as well as more frequent dry spells and greater evapotranspiration.

In the relatively arid and semiarid areas of CWANA, modest changes in precipitation can have proportionally large impacts on water supplies. In mountainous watersheds, higher temperatures will increase the ratio of rain to snow, accelerate the rate of spring snowmelt, and shorten the overall snowfall season, leading to more rapid, earlier, and greater spring runoff.

Temperature projections of climate models are less speculative than the projections of precipitation. The heart of the scenario "problem" lies in the scale mismatch between global climate models (data generally provided on a monthly time step at a spatial resolution of several tens of thousands of square kilometers) and catchment hydrological models (which require data on at least daily scales and at a resolution of perhaps a few square kilometers). In CWANA region very few studies on scenarios about effect of climatic changes are available presently, CWANA region being out of GEWEX[2] experiment. The coming program HYMEX[3] will cover a part of the CWANA Region.

2.1.3.6 Conclusion

Large differences exist between the five sub-regions comprising CWANA, and between countries in the same sub-region. North Africa and the Arabian Peninsula have very limited water resources, and suffer severe water scarcity, with values per inhabitant varying between 200 and 700 m³/year. In contrast, Central Asia and Caucasus, West Asia and Nile Valley and Red Sea show much higher values, mostly thanks to the abundant flows generated in the mountainous areas of Turkey and in the Himalayas, or by the Nile. Turkey with the Euphrates and the Tigris rivers, Kyrgyzstan and Tajikistan with the Amu Darya and the Syr Darya can be qualified as "water towers".

Syria and Sudan are intermediate countries in that they depend to a large extent, around 80%, on upstream countries for their renewable water resources (mainly the Euphrates from Turkey and the Nile from Ethiopia) but on the other hand they are located upstream from other countries depending on the same rivers (Iraq and Egypt respectively). Five countries depend for over 90% on other countries for their renewable water resources: Turkmenistan, Egypt and Mauritania for surface water and Kuwait and Bahrain for groundwater. Already 13 countries in the CWANA are under the threshold of 500 m^3/inhab/year.

[1] Intergovernmental Panel on Climatic Change
[2] Global Energy and Water Experiment
[3] Hydrological cycle in Mediterranean Experiment

Afghanistan is the country with the largest percentage of water withdrawal directed to agriculture (99%), Djibouiti, with 1%, is the country with the lowest percentage. Central Asia and Caucasus represents over 55% of the total water withdrawal for the CWANA, Pakistan alone withdrawing 30%. The water withdrawal per inhabitant varies from 20 m³/year in Djibouti (1985) to over 6 000 m³/year in Turkmenistan (1989). At sub-regional level, the water withdrawal per inhabitant in Central Asia (1300 m³/year) is on average 3.6 times the water withdrawal per inhabitant in North Africa (360 m3/year). The global amount of water withdrawal directed to agriculture is increasing. The agriculture sector is the sector where the more important saving of water is possible.
New strategies are adopted to fight water scarcity. Some are sustainable as water harvesting, reuse of treated wastewater, few can be onely temporary as utilisation of fossilized water. Production of desalinated water appears as a solution for countries with very few water resources and endewed with energy resources. A general agreement appears on the fact that water must be used in an efficient manner and that new huge projects to mobilize or to transport water should be considered only after water use efficiencies and demand management practices have been taken into account.

Sciences and technologies help to the inventory of the main water resources in the CWANA region. Surface resources were well known since the beginning of the 20th century following the works of geographers. An important effort was done since the 60th to evaluate the ground water resources. In the 70th the important (PNUD / UNESCO) project on fossilize water resources evaluated saharian groundwater resources. The isotopic methods allowed characterizing this very important resource. Presently some progress remains to be made in the knowledge of the karstic water tables and of the submarine fresh water sources.

Research on water resources has mainly to focus on water management, water saving, and new sustainable process to reuse wastewater and to desalinize salty water.

2.1.4 Infrastructure

2.1.4.1 Infrastructures related to water management

The control of water always has been a powerful factor in the development of civilizations (Job, 1992). Since ancient times, different hydraulic systems have been built to augment the efficiency of rain and to collect, store, and transport water (El Amami, 1983; Prinz, 1996; Khouri et al, 1995). From simple cisterns in the ground, vital instruments for the survival of families in arid zones, to large dams that are part of national policies to guarantee water supplies to the greatest number of people, water storage always has been a primary preoccupation of CWANA governments which face recurrent droughts and limited water resources (Hamdi & Lacirignola, 1994; Jaber, 1997; ESCWA, 1998).

The earliest recorded dam is believed to have been on the Nile River at Kosheish, where a 49-foot- (15-metre-) high masonry structure was built about 2900 BC to supply water to King Menes' capital at Memphis. Evidence exists of a masonry-faced earthen dam built about 2700 BC at Sadd-el-Kafara, about 19 miles (30 kilometres) south of Cairo; this dam failed shortly after

completion when, in the absence of a spillway, it was overtopped by a flood. The oldest dam in use is a rock-fill structure about 20 feet high on the Orontes in Syria, built about 1300 BC (Encyclopedia Britannica).

Dams have been built for thousands of years - dams to manage flood waters, to harness water as hydropower, to supply water to drink or for industry, or to irrigate fields. By 1950, governments were building increasing numbers of dams as populations increased and national economies grew. Today nearly half of the world's rivers have at least one large dam. But the last 50 years have also highlighted the performance and the social and environmental impacts of large dams. They have fragmented and transformed the world's rivers, while global estimates suggest that 40-80 million people have been displaced by reservoirs.

2.1.4.1.1 Large dams

Since the 1950s CWANA Region has built a great number of dams, some of which are among largest in the world (Table *2.1.4.1.1 a*). In November 2000, the World Commission on Dams published an overview on dams and development (Clarke, 2000). This study is based on 150 case studies, 13 of which are in CWANA: Morocco, Tunisia, Iran, Pakistan, and Turkey (Clarke, 2000). While there is great variability in the performance of the large dams, the majority of dams in the CWANA Region under-perform with respect to the achievement of intended benefits and delivery of services. In some instances, though, benefits occurred for much longer periods than predicted in the studies and still continue. Adverse impacts on ecosystems occur frequently and a significant number of these adverse impacts were unanticipated in planning and decision-making.

Irrigation components fall well short of targets in terms of the irrigation command area developed, actual irrigated area achieved and to a lesser extent, the cropping intensity. It is difficult to find data on predicted versus actual crop values. A high degree of variability is observed between projects with actual achievement closer to targets 30 years from commissioning. Yet, data obtained on smaller dams suggested greater consistencies in performing closer to targets than larger ones. In contrast to irrigation, the hydropower performance of large dams is on average closer to target. But as with irrigation dams, the variability in performance across the projects is significant.

Larger than necessary reservoir storage may also reflect over-estimates of water demand, or high reserve capacities for anticipated drought events. With regard to single and multipurpose projects, emerging patterns suggest higher variability and lower average performance of multipurpose projects when compared to targets.

When a new dam is built, there is systematic underestimation of the number of families and people physically displaced and involuntarily resettled. The lack of enumeration of social records for reporting these aspects also remains a contested issue that continues to fuel controversy in the large dams debate. Many ecosystem impacts (both positive and negative) resulting from the large dams remain unanticipated even in the 1990s. Mitigation is the most widely practised response to ecosystem impacts for the large dams. Mitigation has failed or worked only sporadically in the case of most dam-induced ecosystem impacts.

Participation and transparency in decision-making processes was neither open nor inclusive through to the 1980s. There has been a growing emphasis on transparency and participation in decision-making involving large dams, especially in the 1990s. Many dams projects still do not plan for the public participation of affected people. The trend for participation of NGOs is more present in the projects by the 1990s.

2.1.4.1.2 Small dams

CWANA countries have, over varying lengths of time, had a policy of constructing small dams that appear as very specific structures designed not only to mobilize the surface water resources but also to control erosion. The dikes of these dams are between 5 and 15 m high (lower limit for large dams established by the International Commission on Large Dams). They are constructed of rubble and located in small rural catchments in areas of moderate relief. They have rustically designed lateral spillways with a discharge capacity of some tens of cubic meters per second or even, in some cases just over 100 cubic meters per second. Some but not all have a have a sluice gate and their unit cost is around 500,000 euros, sometimes far less. Their reservoirs are relatively small in area (a few hectares) and have a holding capacity ranging from a few tens of thousands to 1 million cubic meters (Albergel et Rejeb, 1997). Using examples in two sub regions of CWANA North Africa and South East Asia where four countries took part in the HYDROMED research program "Hill reservoirs in the semi-arid zone of the Mediterranean periphery" (HYDROMED, 2001), this paragraph describes the role of small dams in the development and conservation of agricultural land.

In Tunisia, the construction of more than one thousand small dams in the northern part of the country between 1990 and 2000 was planned as part of the program "Aménagement des terres en pente, mobilisation des ressources en eau, entretien et sauvegarde des aménagements"[4] and incorporated in the 8th State Plan. These projects have become the keystone of the national soil and water conservation strategy (Sources: Ministry of Agriculture, Directorate of Water and Soil and Conservation). The objectives of the strategy are (Talineau *et al*, 1994):

- to reduce losses of agricultural land (estimated at 10,000 ha per year);
- to reduce dam siltation (25 Mm^3 per year in 1990);
- to increase water table recharge;
- to mobilize as much as possible of the 500 mm^3 of water lost to the sea or to the Sebkhas;
- to create points for the development of irrigated cropping.

In Morocco, the period of drought in the early 1980s, considered to be the longest ever experienced, marked the start of a policy of very labor-intensive small dam and hill reservoir construction. The works were primarily designed for irrigation, livestock watering, flood protection or the supply of drinking water to rural areas that had no readily exploitable underground water

[4] Sloping land development, water resources mobilization, maintenance and preservation of hydraulic structures

resources. The reservoirs are naturally poisoned, and a few attempts at fish-farming were noted in the basins downstream of the dams. Morocco built itself a large-scale hydraulic infrastructure in the 1970s and 1980s. Virtually all the large dams are affected by significant inputs of sediment. Numerous small dams have been built to slow down siltation. For example, the largest dam in the Kingdom, the Al Wahda Dam on the Ouergha River in the province of Sidi Kacem (88 m high, with a capacity of 3.4 10^9 m^3), is protected by numerous small dams located in the upstream part of the catchment and designed to retain the erosion products coming from the steep marly slopes of the Rif. Some have already been constructed while others are at the project stage. Erosion from the Ouergha catchment, estimated at 98 T/ha/year over an area of 6150 km^2, causes the dam to lose a volume of 60 Mm^3 per year (Maroc Agri, 2001).

Small dams have been known in Syria since ancient times, with the dam on the Nahr El Asi near Homs having been constructed in the reign of Seti 1 (1319 - 1304 BC). Many were built at the start of the Christian era (Badieh Dam on the road to Palmyra). Numerous ruins testify to their presence in the dry steppes. Some still exist but are completely filled with sediment. The first small dams built using modern techniques were those constructed during the 1960s in the province of Swaida to supply drinking water to villages on a basalt plateau that has no underground water resources. These reservoirs are usually poisoned and are used for fishing. Near large towns, there are holiday homes at the sites of these projects and the lakes are used for leisure activities. Such is the case with the small dam at Al Corane, not far from Damascus in a small high valley. In the Middle East, the idea of the hill reservoir is not as well defined as in the Maghreb, but numerous very small reservoirs have been constructed to create reserves of water for the cattle of the nomadic Bedouin tribes.

In Lebanon, as part of the country's reconstruction program, the Green Plan has launched a study for the construction of about a hundred small dams, essentially in the piedmont areas of the mountain ranges adjacent to the Bekaa Plain (www.greenplan.gov.lb). The purpose of the dams in this semi-arid zone, dominated by the mountain ranges of Mount Lebanon and the Anti-Lebanon, is to control floods, which can be very violent. In the mountains of Lebanon there are also a multitude of small reservoirs used to capture the underground water and the meltwater. These catchment reservoirs feed chains of reservoirs positioned at different levels on the slopes. Their water is used for orchard irrigation.

Small dams objectives:

Erosion control and infrastructure protection function

World experience assesses the rate of loss of volume of dams by sedimentation at 1% per year and the cost of recovering the mobilizable volumes of water lost in this way at 130 10^9 euros (Mahmood, 1987). In Tunisia, where large dams represent a mobilizable volume of 1,612 million m^3, the loss is estimated at 1.6% (Habaïeb et Albergel, 2001). The idea is thus to capture the sediment, which essentially comes from the upstream mountain zones, in small and relatively inexpensive reservoirs. The construction of small dams at different points on the oueds attenuates the flood wave and reduces the erosion dynamics of the runoffs, which are often violent in the Mediterranean region.

A monitoring was conducted on small dams in North Africa region (Albergel et al, 2005) showed a total loss of storage capacity of 4.6% per year in average for 24 small dams (similar to that quoted by Gazzalo & Bassi, 1969, for small dams in Italy). The average erosion captured by the small dams is thus approx. 16 t/ha/year.

A model to reconstitute the solid transport flood by flood provided a better understanding of the erosion and of its consequences for the siltation of the reservoirs of small dams. Figure 2.1.4.1.2.a, b shows the results of this model for Kamech Dam in Tunisia. It can be seen that the siltation is associated with extreme events. Three floods were responsible for 50% of the solid transport over this 9–year period (Albergel *et al*, 2003).

Water mobilization and conservation for local development function

The runoffs that fill these small dams are generated by heavy rainfall. It often needs only a single rainfall event to fill the reservoir. In the Mediterranean climate, these most often occur in autumn and winter, but a strong summer storm can generate enough runoff to cause a discharge. The high rate of evaporation from the lakes, together with their shallowness, do not allow the water to be kept long. Moreover, the submerged banks are often permeable and significant infiltration occurs. Figure 2.1.4.1.2.c shows, for Syndiané Dam in Syria: (i) the daily precipitation, (ii) the levels of the water in the dam and (iii) the level of siltation at the foot of the dam. The spillway level and that of the top of the dike are indicated, making it possible to highlight the discharges. Note the low storage level in 1999, a very dry year throughout the Middle East (Albergel et Claude 2001).

The temporarily stored water can be used in a number of ways. Table 2.1.4.1.2.a shows the result of a survey conducted in 1997 into the use of the water of the small dams in countries covered by the HYDROMED program. The availability of this water opens the door to new and very profitable speculative activities (in particular, market gardening and fruit-growing) with a gross profit margin up to 10 times as high as that of traditional extensive cereal-growing. This optimum use of the water from the hill reservoirs is the source of major additional income, reflected in better living conditions and speculation in land adjacent to the reservoirs. However, the rapid siltation of some reservoirs has disappointed sometimes the farmers.

Recharge of water table

As the interannual stocks of water held in these storage reservoirs are extremely variable, the idea has been to use them to recharge the phreatic water tables.

When some reservoirs were filled, a rapid recharge of the downstream alluvial water table was noticed (Nasri, 2002). Montoroi *et al*, 2002 provide geochemical evidence of efficient recharge of the alluvial water table by the small dam and explain the recharge mechanism by the strong infiltrations when the dam is in flood and the water reaches the permeable alluvial terraces. The dam forces the natural system of recharge of the alluvial water tables in the semi-arid zones. Recharge occurs mainly through inundation of the main beds of the waddis.

Environmental impacts of small dams

A water quality study conducted on small reservoirs in North Africa Sub Region (Rahaingomanana, 1998) assessed the variability of the salinity in relation to the geological

nature of the catchments under different types of rainfall event. The measured salinities are generally satisfactory for a variety of uses.

An analysis of the risks of pollution by agricultural effluents was conducted in the catchment of the small dam at Kamech (Cap Bon, Tunisia) (Vateau, 2003). No molecules of pesticides used by the farmers were found in significant quantities in the water analyzed in early summer. Pollution by nitrogen fertilizers is within acceptable limits. These results can be extrapolated to all reservoirs in a rural environment other than those where intensive poultry farms have been established near the banks.

The General Directorate of Land Development and Farmland Conservation of the Tunisian Ministry of Agriculture has a project to study the risk of transmission of stagnant water related diseases in collaboration with the Institut Pasteur in Tunis. To date, public health surveys do not indicate any new outbreaks or the appearance of new illnesses associated with these dams. Diseases transmitted by mosquitos are monitored very closely.

The aquatic vegetation that grows in the reservoirs provides a suitable habitat for wetland fauna (batrachians, water snakes, water tortoises, shellfish). The principal plant species encountered are *Juncus spp* and *Potamogetum pectinatus* in the shoreline zones exposed at low water levels, *Typha angustifolia* and *Phragmite communis* in the submerged zones. The reservoirs themselves and their banks, often replanted with trees, are nesting and protection sites for birds.

The environmental risks most often mentioned for dams are the consequences of dam failures. Despite their low load, small dams have a mean failure rate of the same order as for large dams. And as there are at least fifty times as many small dams as large ones, a few dozen small dams are destroyed each year (Lemprière, 1993).

2.1.4.1.2. Conclusion

This retrospective of results obtained by the HYDROMED research program shows that small dams are structures that have their own characteristics and that can supplement a policy of water resource mobilization. They have an important role in the development of agricultural land and the focal points for local agricultural development.

Storage reservoirs are good sediment traps. They protect downstream infrastructures and can prolong the life of a larger dam located downstream. Recharging the alluvial water table is in many cases a realistic objective, but an appropriate dam site must be chosen.

Rapid silting of the reservoirs acts as a brake on agricultural development. In the Mediterranean countries, they are perceived as a water resource to be used. Development of the slopes increases their life expectancy.

From an environmental point of view, the impacts are positive provided that water quality is maintained by paying attention to possible effluents. They are usually located in rural environments with a low population density, so they are adequately protected. They are small wetland areas, contributing to biological diversity and the protection of birds and other animals. The major environmental risk is dam failure.

2.1.4.2 Infrastructures for water harvesting

Large numbers of population are living in the arid and semi-arid belts in the CWANA region

where rainfall is limited and very irregular. Reduced rainfall or prolonged dry spells are leading immediately to crop failure. Irrigation would be the logic solution but water scarcity and the high cost of irrigation infrastructure are major handicaps. Alternative solutions have been set up to increase the quantity of water on farmers' fields since ancient time in many places of CWANA. Water harvesting is a proven technology to increase food security in drought prone areas. Erosion control and recharge of ground water are additional advantages of water harvesting techniques. Although it consists in very old technologies (Nasri et al. 2004); it has been observed that in most countries, extension and irrigation staff have often very limited knowledge about the various water harvesting techniques and the associated socio-economic implications. ICARDA is providing in CWANA region, dissemination and adoption of water technologies and training for field staff (Oweiss et al, 1998, 1999).

Three main kinds of infrastructure for water harvesting are distinguished (Prinz, 1996, Prinz and Wolfer, 1999, Prinz et al, 1998)

1. Rainwater harvesting: These infrastructures are done for inducing, collecting, storing and conserving local surface runoff for agriculture in arid and semi-arid regions (Boers & Ben-Asher 1982). Three types of water harvesting are covered by rainwater harvesting :

a. Water collected from roof tops, courtyards or treated surfaces and used for domestic purpose or garden crops.

b. Micro-catchment water harvesting is an infrastructure of collecting surface runoff from a small catchment area to feed the root zone of an adjacent infiltration basin. The adjacent basin is planted with a tree, a bush or with annual crops.

c. Macro-catchment water harvesting, is an infrastructure which conveyed runoff from hill-slope catchments (i) to a cropping area located at hill foot (ii) or to a tank (artificial pound) for watering cattle.

2. Flood water harvesting, also called 'large catchment water harvesting' or 'Spate Irrigation', can be defined as the collection and storage of flow during floods in intermittent waddies for irrigation use. Flood water harvesting, may be classified into following two forms:

a. Floodwater harvesting within stream bed : the water flow is dammed and stored in reservoirs or let inundate the valley bottom of the flood plain. In the second case the water is forced to infiltrate and the wetted area can be used for agriculture or pasture improvement.

b. Floodwater diversion, the wadi water is forced to leave its natural course and conveyed to nearby cropping fields.

Relevant from the two important types of floodwater harvesting, various technologies exist and have different names (see § on traditional knowledge). Pakistan has more than 1.5 million ha under floodwater harvesting. The irrigated area under floodwater harvesting in North Africa and Middle East regions is increasing.

3. Groundwater harvesting : this term cover different infrastructures allowing to concentrate and to extract ground water using few energy or only gravity. Qanat systems, underground dams and special types of wells are few examples of the groundwater harvesting infrastructures.

a. Qanats, widely used in Iran, Pakistan, North Africa and even in Spain, consists of a horizontal tunnel that taps underground water in an alluvial fan, brings it to the surface due to gravitational effect. Qanat tunnels have an inclination of 1-2% and a length of up to 30 km.

Many are still maintained and deliver steadily water to fields for agriculture production and villages for drinking water supply.

b. Groundwater dams are other examples groundwater harvesting. Subsurface Dams are built in the waddi beds and obstruct the flow of ephemeral streams. The water is stored in the sediment below ground surface and can be used after the floods. A more sophisticate infrastructure is the Sand Storage Dams. It consists in a sand filled reservoirs watered by the waddy flow. This subsurface water storage presents the following advantages:

(1) Evaporation losses are reduced,

(2) no reduction in storage volume due to siltation,

(3) stored water is less susceptible to pollution, and

(4) health hazards due to mosquito breeding are avoided.

As land pressure rises, more and more marginal areas in the CWANA are being used for agriculture. Much of this land is located in the arid or semi-arid belts where rain falls irregularly and where risks to human beings and livestock occur when rains falter or fail. While irrigation may be the most obvious response to develop agriculture on theses areas, it has proved costly and difficult to set without risks of soil degradation. There is now increasing interest in a low cost alternative - generally referred to as "water harvesting".

Water harvesting can be considered as a rudimentary form of irrigation or storage of water for animals breeding. The difference is that with water harvesting the farmer (or more usually, the agro-pastoralist) has no control over timing. Runoff can only be harvested when it rains.

A growing awareness of the potential of water harvesting for improved crop production arose in the 1970s and 1980s, the stimulus was the well-documented work on water harvesting in the Negev Desert of Israel (Evanari et al. 1971).

2.1.4.2 Irrigation Infrastructures

Irrigation covers about 48 million hectares in CWANA region. Central Asia represents 59% of this total, although it covers only 21% of the total area of the region. Pakistan alone, covering a little over 4% of the region, accounts for 33% of the irrigated areas. By adding Iran Turkey, Iraq and Egypt, 72% of the areas under irrigation are controlled by five countries in the CWANA region.

Figure 2.1.4.2.a shows the progress and the importance of irrigation in the CWANA region:

Surface irrigation is by far the most widely used technique, practiced on 88% of the total area. Sprinkler irrigation is practiced on 11 % and micro-irrigation on 1.4% of the total area. In Libya and Saudi Arabia, sprinkler irrigation is by far the most predominant, while in Cyprus, Malta, Jordan and the United Arab Emirates, micro-irrigation is the most widely used technique, being practiced on over half of their full and partial control irrigation areas. In Kuwait and Lebanon sprinkler irrigation and microirrigation techniques together are practiced on more than 37% and 39% of their full and partial control irrigation area respectively. In particular the arid countries, without large rivers, choose to develop more intensively the micro-irrigation and sprinkler irrigation techniques to save water (AQUASTAT Data base).

Arid areas in CWANA region are sensitive to salinization problems because the volume of rainwater dissolving the salts generated by the soil is low. CWANA is a region subject to salinization and the problem has been known and recognized for a long time. However,

assessment of salinization at national level is a difficult enterprise and very little information on the subject could be found. Furthermore, no commonly agreed methods exist to assess the degree of irrigation-induced salinization. More information on salinization will probably become available and strategies to improve the situation should be defined, as this has been recognized as a priority by most of CWANA countries. All countries are reported as having salinization problems, varying from 3.5% in Jordan to over 85 % in Kuwait.

One of the measures necessary to prevent irrigation-induced waterlogging and salinization in arid and semi-arid regions is the installation of drainage facilities. Drainage, in combination with adequate irrigation scheduling, allows for the leaching of excess salts from the plant root zone. Figures on drained areas are available for 13 of the CWANA countries in the FAO AQUASTAT data base. About 34% of the irrigated areas in these countries have been provided with drainage facilities, varying from 0.6% in Iran to over 90% in Egypt.

2.1.5 Land Degradation and Water Quality Deterioration

The evidence of degradation of arable land resources is as old as the history of irrigation and human settlement. A well-documented case occurred in Mesopotamia, within the present boundaries of CWANA, where between 4000 and 2000 BC secondary salinity affected the land and water resources in the Tigris and Euphrates valleys of Mesopotamia. History has repeated itself in the last century in many other countries of the region.

Land degradation is closely linked to population density (Roose, 1996). In fact it has been established that in a given agrarian system, if the population passes a certain threshold, land starts to run short, and soil restoration mechanisms seize up. For example, in some dry zones, when the population exceeds 20-40 inhabitants per km², the fallow period is shortened to the point of ineffectiveness. When the population reaches about 100 inhabitants per km², the zone is rated as a densely populated degraded area. A rapidly growing population and limited land resources mean that combating desertification will be difficult for the developing nations and poor countries.

2.1.5.1 Land degradation

Processes and causes of land degradation have been studied since the beginning of the 20th century. The international community and national organizations have strongly contributed to assess land degradation in CWANA region. Land degradation remains an important issue for the 21st century because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life. Productivity impacts of land degradation are due to decline in land quality on site where degradation occurs (e.g. erosion) and off site where sediments are deposited. According to the Global Assessment of Soil Degradation (Oldeman, 1988), land degradation is linked to both climate variation and unsustainable human activities such as overgrazing, deforestation, and poor agricultural management practices (Figure 2.1.5.a). The data concerning major soil constraints and vulnerability are available for CWANA region countries (Table 2.1.5.a).

Land degradation means reduction of or loss in the biological or economic productivity and complexity of rain-fed cropland, irrigated cropland, range, pasture, forest, or woodlands

resulting from land uses or from processes arising from human activities, habitation patterns and climate variation. So, when land degrades, it represents a diminished ability of ecosystems or landscapes to support the functions or services required for sustaining livelihoods.

Mechanisms that initiate land degradation are numerous and include physical, chemical, and biological dimensions. Important among physical processes are a decline in soil structure leading to crusting, compaction, and erosion. Significant chemical processes include acidification, leaching, salinization, pollution and fertility depletion. Biological processes include reduction in total and biomass carbon, and decline in land biodiversity. These processes can operate individually, simultaneously, successively, or in varying combinations and implicate the sustainability of natural resources. In rainfed areas, soil erosion is the principal problem.

Overgrazing by livestock refers to the practice of allowing a much larger number of animals to graze at a location than it can actually support, this leads to decreases vegetation, exposing the soil to water and wind erosion. In addition, livestock trample and thereby compact the soil, reducing its capacity to retain moisture. This problem is observed in almost all Middle East and North Africa countries (Nsar, 1999).

Common agricultural practices such as frequent plowing, insufficient use of fertilizers or shortening the fallow periods in shifting cultivation can lead to a loss of nutrients. However, excessive use of fertilizers can lead to soil acidification. Frequent tillage decreases the organic carbon by favoring the mineralization process. Cultivating hillsides without adequate preventive measures leads to water erosion. Leaving soil exposed during fallow periods often results in wind erosion. Use of heavy machinery compacts soil and results in physical damage.

The Global Assessment of Soil Degradation (GLASOD) is the first baseline study using a consistent methodology to estimate global soil degradation (Oldeman, 1988). The assessment remains the only uniform global source of land degradation data. GLOSOD has prepared country maps of land gradation at an original scale of 1:10,000,000 and datasets. The estimates of the extent affected are very rough estimates and should not be used as precise measured data (Table 2.1.5.b). These estimates, however, provide a good overview of the situation addressing land degradation. There is a need for the national authorities concerned with land degradation to update and refine the present estimates and mapping.

Land Degradation Assessment in Dry Areas (LADA) is another international initiative, supported by the Global Environment Facility (GEF), United Nations Environment Program (UNEP), Global Mechanism of the United Nations Convention to Combat Desertification (UNCCD), and Food and Agriculture Organization (FAO).

Considering the role of LADA, this UN initiative is expected to provide more land degradation data in the future. In addition to LADA, some regional studies have been carried out, such as the Assessment of the Status of Human-induced Soil Degradation in South and South East Asia

(ASSOD) (Van Lynden and Oldeman 1997) and the World Atlas of Desertification (Middleton and Thomas, 1997).

Land quality is directly linked to quality of life; specifically, social and economic equity, and thus should be addressed in the socioeconomic context for sustainability. It is extremely difficult to quantify the social costs of the degradation of land resources, which causes occupational or geographic shifting of the farming communities relying on these resources. In most cases, the poor are the most dependent on agriculture in CWANA, so they are hit hardest by land degradation.

Salinization is one of the main land degradation problems in irrigated agriculture. Salinization involves a number of interrelated processes occurring in the soil; for example waterlogging, increasing salt content, and sodication, in which some nutrients can no longer be absorbed due to the increasing pH of the soil (Qadir and Schubert, 2002). This problem is caused by the overuse of water through unsuitable irrigation techniques, accompanied by inefficient drainage systems. Salt-prone land degradation is common under irrigated agriculture in many countries of CWANA.

The salinization of land resources in CWANA has been the consequence of both naturally occurring phenomena (causing primary or fossil salinity) and anthropogenic activities (causing man-made or secondary salinity). The contribution of anthropogenic activities to the salinization of land and water resources is much greater than primary salinity. Excessive irrigation, caused by either lack of information on actual crop water requirements or a recognized need to apply leaching water, has resulted in rising groundwater levels and secondary soil salinization. For instance, nearly half of the irrigated lands in Central Asia are affected by varying levels of salinity (Kijne, 2005). Salt-prone land resources are a major impediment to the optimal utilization of crop production systems. The largest part of salt-affected soils and saline waters exists in the lower reaches of Amu-Darya and Syr-Darya Basins, where salinity is one of the main factors threatening food production (Box 2.1.5a). Salinization has been exacerbated by the lack of safe disposal of large volumes of saline drainage water, the mismatch between demand and supply of irrigation water, and the lack of adequate maintenance of irrigation and drainage networks.

Soil erosion is an important degradation problem in many CWANA countries. However, the range and concrete effects related to this subject depend on a large series of variables which refer to complexity and diversity of soil and climate all along the country. Land pressures must somehow be relieved, and that can only be accomplished by raising productivity and yields per unit area. A start can be made with presently available knowledge, but research and training will be needed to broaden the knowledge base and to provide guidance to the pastoralists and cultivators.

2.1.5.2 Water quality deterioration

Water quality deterioration is a global problem, which has been exacerbated in dry regions. The research on water quality deterioration mobilized later than land degradation in CWANA region.

For a long time technical services as research institutions focused more on quantity and use of the resource than on quality. They considered that good-quality water was mostly necessary for dinking. Since the 1980s, this tendency reversed with an increased attention on the productivity of irrigated agriculture and the environment. Declining water quality has also increased water supply problems, especially under drier climates, where pollutants have greater opportunity to accumulate during dry periods with low or negligible rainfall. A heavy reliance on irrigation in some areas has compounded the problem (UNEP, 2002). The problems from water quality deterioration are expected to intensify in CWANA due to anthropogenic interventions and increasing possibility of extreme events of climate change (IPCC, 1998). In addition, saline water intrusion is projected to increase from sea level rise and over-exploitation of groundwater in coastal zones, and salt-prone water and land problems that will increase in arid and semi-arid regions.

Wastewater (generated from household, municipal, and industrial activities), agricultural drainage water (containing residues of agro-chemicals including pesticides, fertilizers, and/or soil and reaction products of amendments) and over-exploitation of brackish groundwater are the major contributors to water quality deterioration in CWANA. In addition, drought — a recurrent phenomenon across CWANA — has a negative influence on aquatic and land ecosystems and on the quantity and salinization of surface and groundwater resources.

2.1.5.2.1 Wastewater

Water diverted for household, municipal, and industrial activities generates wastewater containing different types and levels of undesirable constituents, which vary to a large extent, depending on the source from which wastewater is generated and the level of its treatment. In general, apart from wastes generated by agro-industries, industrial wastewater contains higher levels of contaminants, such as metals and metalloids, than domestic wastewater, and needs greater input on treatment before use or disposal. In contrast, domestic wastewater generally contains larger amounts of pathogenic content.

The volume of wastewater increases with increasing population, urbanization, improved living conditions, and economic development. In most countries of CWANA, urban drainage and disposal systems are such that domestic wastewater is not segregated from industrial wastewater and other activities. The resulting wastewater is often discharged untreated into open drains, sometimes gets mixed with storm or freshwater, and is then channeled into the natural water bodies or used in agriculture. In some cases, wastewater undergoes treatment. Nevertheless, most wastewater treatment plants are of simple design and/or not adequately functioning in the region. Wastewater is diverted to farmers' fields in treated, partly treated, diluted and/or untreated form where it is used by urban and peri-urban agriculture to grow a variety of crops but vegetables are the most common across the CWANA region. This is because wastewater is mostly available close to urban centers and farmers using it target markets for high-value crops such as vegetables specially where restrictions are lacking or not enforced (Lazarova and Bahri, 2005). Additionally, grain crops, fodders, and industrial crops are

also cultivated but as a secondary preference. In addition, parks, sports grounds, and road plantings are irrigated with wastewater. Examples of wastewater aquaculture are also found in countries such as Kazakhstan. The use of untreated, partly-treated, or diluted wastewater in agriculture has environmental and health implications.

Instead of using as an irrigation source, the disposal of untreated or partly-treated wastewater into freshwater bodies also impacts environment and human health. In Central Asia, wastewater is discharged into streams, rivers, lakes, or natural depressions, causing significant pollution of the ecosystem and threatening human health. Owing to water contamination, water-borne diseases such as typhoid fever and bacterial dysentery are the most common among infectious diseases in the region (Fayzieva et al., 2004).

Despite some governmental restrictions in CWANA countries and potential health implications, the farmers who have access to diluted, untreated or partly treated wastewater tend to use it despite the health risks. In many cases they rather prefer its use because: (1) wastewater is a reliable or often the only water source available for irrigation throughout the year (2) wastewater irrigation often reduces the need for fertilizer application as it is a source of nutrients, (3) its use down the gradient due proximity to wastewater source involves no or low energy input as compared with pumping of groundwater from deeper aquifers and (4) additional benefits such as greater income generation from cultivation and marketing of high-value crops such as vegetables, which create year round employment opportunities (Keraita and Drechsel, 2004).

Except for a few comprehensive national assessments, scattered information exists on volumes of raw or diluted wastewater currently produced and used in agricultural production in CWANA. In some cases, information regarding agricultural use of wastewater may actually be available, but not easily accessible due to government policies, or because it is found in grey literature in local/national languages. Although water quality management is reported to be a high priority and a major concern of the governments in CWANA region, most countries do not have sufficient resources to avoid the pollution of water bodies. However, with increased investment and awareness, the use of recycled wastewater has been on the increase in recent years in several countries (Karajeh et al., 2004).

2.1.5.2.2 Saline and Sodic Water

Under irrigated agriculture, increases in cropping intensities, excessive use of agro-chemicals, inappropriate irrigation methods, and use of salt-affected soils for crop production contribute to increased salt content of drainage water (Skaggs and Van Schilfgaarde, 1999), which is collected in artificial drains or natural drainage systems, or penetrates through the soil profile to become a part of groundwater. Water scarcity in several countries of CWANA has led to the reuse of agricultural drainage water and over-exploitation of groundwater to produce food, fodder, and wood. The development of groundwater resources over the years reveal that the areas characterized by water scarcity have most often naturally occurring aquifers of marginal-quality. Unsustainable exploitation of saline aquifers for irrigation can result in salt-prone land

degradation, which impacts crop growth and yield, and increases the investments needed to bring the land back to the productive state.

The changes in river runoff have direct implications for the changes in river water quality. More than half of the major rivers in CWANA are seriously depleted and polluted, degrading surrounding ecosystems and threatening the health and livelihoods of the people, depending on these water resources. In Central Asia, Amu-Darya and Syr-Darya are the major source of irrigation. Long-term monitoring of water quality of the rivers shows that in the 1950s, the salinity of these rivers varied around the year within the range of 0.33 to 0.72 g L^{-1}. Other river water quality parameters such as major cations and anions, organic compounds, pH, and pesticide levels were also within the safe limits during 1950s. Since 1970s, the levels of salts in river water have increased steadily as a result of a decrease in the flow of Amu-Darya and Syr-Darya and an increase in the discharge of return water, particularly drainage water from irrigated schemes back into the rivers. Consequently, there has been a significant increase in river water salinity since 1980s.

Although return flow of water to the rivers is an additional reserve for use, it has become a source of environmental pollution in Central Asia (Altiyev, 2005). About 95% of total return water is collector-drainage water, which contains elevated levels of salts as well as residues of pesticides, herbicides, fertilizers, and other chemicals used in agriculture. It is estimated that annually about 140 million tons of salt are discharged into the drainage water, 75% of which is the salt brought in by the irrigation waters. About one-quarter of the total salt in drainage water is the extra salt that is mobilized from the subsoil by mineral dissolution. Some estimates reveal the average age of mobilized salts at 40% of the total salt discharged into the drainage water (Kijne, 2005). About 51% of the total return flow of water is disposed to rivers, about 33% to depressions, and 16% is reused in irrigation. As a result of return water disposal to natural depressions, hundreds of water bodies have been formed. Since these water bodies do not outflow, their water quality has been deteriorating every year because of massive evaporation.

The Aral Sea, which is fed by two main rivers, Amu-Darya and Syr-Darya, is situated in the center of the Central Asian deserts and functions as a gigantic evaporator. The Sea, which was the fourth largest inland lake in the world before 1960, is now the largest inland body of salty reservoirs. It has become synonymous with environmental catastrophe representing one of the world's worst ecological disasters. In the Soviet era, massive quantities of water from Amu-Darya and Syr-Darya were diverted for irrigation of cotton with consequent decrease in river water inflow to the Aral Sea. This led the Aral Sea to shrink dramatically. This seemingly irreversible process has continued, as the overall irrigated agricultural acreage expanded, while also hydropower generation increased (Box 2.1.5b).

The disposal of agricultural drainage water containing elevated levels of salts and agro-chemicals into freshwater bodies such as canals and rivers disperses salts and potentially toxic substances to a much larger scale. For instance, in the Euphrates basin within Syria, about 1

billion m^3 of saline drainage water are disposed back to Euphrates River, resulting in doubling the salinity levels in the river water (from ~ 0.5 to 1.0 dS m^{-1}) when it enters downstream Iraq. Inappropriate water management in lower Euphrates basin impacts land and water quality in Iraq. In Jordan, water quality in Amman-Zarqa Basin and Jordan Valley has been impacted over the past few decades with consequences for the downstream irrigated agriculture (McCornick et al., 2003). Anticipated increases in the basin's population and growth in economic activity are expected to further affect the situation. Understanding the past dynamics and developing scenarios for the future that account for the major water quality constituents that will affect downstream users have been facilitated in the basin because national agencies have gathered extensive datasets, including water quality data over multiple years from strategic locations (Grabow and McCornick, 2007).

2.1.6 Agriculture and carbon sequestration

2.1.6.1 Assessing of soil organic stock and the potential of carbon sequestration

Soils of WANA are characterized by low soil organic carbon (SOC) content, ranging from 0.2 to 0.8% (Lal, 2002) as have been reported for soils of Pakistan (Rashid et al, 1988), Iraq (Aziz et al, 1988), and elsewhere in the WANA region (eg : ICARDA, 1991; Ryan and Matar, 1988). However, When rainfall is high, soil humification allows a better nutrient status and a higher SOC. In this case, some soils may have higher SOC around 1.5-2.0 %as reported by Yurtserver and Gedikoglu, 1988b. With increased aridity, organic content is lower.

The SOC pool of most soils has been and are being depleted by soil degradation and widespread use of subsistence and exploitative farming systems. The rate of depletion of SOC content is accentuated by soil erosion, because of breakdown of soil aggregates, exposure of carbon to climatic elements, mineralization of organic matter in disrupted aggregates and redistributed soil, transport of
sediments rich in SOC downslope into protected areas of the landscape, and sequestration of C with sediments in depositional sites as dams reservoirs (Albergel et al, 2005)

The historic loss of a SOC pool for the soils of the WANA region may be 6-12 Pg. Assuming that 60 % of the historic loss can be resequestered; the total soil-C sink capacity of the WANA region may be 3-7 Pg over a 50 year period (Lal, 2002; Cole, 1996). This potential may be realized through adoption of measures to control desertification, restore degraded soils and ecosystems, and improver soil and crop management techniques that can enhance the SOC pool and improve soil quality. The strategies of soil carbon sequestration include integrated nutrient management and recycling, controlled grazing, and growing improved fodder species on rangeland (Lal, 2001, 2002, 2006). In Morocco, Bessam and Mrabet (2001) show that switching from normal tillage to no tillage practices could increase CO_2 sequestration by 13.6% after 11 years. In Central Asia, the carbon studies component of the Livestock Management and Rangeland Conservation Tools project is providing data on rangeland carbon flux. First estimates in Northern Kazakhstan (Wylie et al., 2004) show that rangelands had an average of 1.27 Mg C ha^{-1} sequestration of CO_2 during the 2000 growing season. Table 2.1.6 a showed the potential of

soil carbon sequestration in different ecosystems through desertification control and restoration of degraded ecosystems. The total potential is 2.0 – 5.1 Pg C overs 50 year period (Lal, 2002).

The data in Table 2.1.6b give the soil carbon sequestration potential for the global dryland ecosystems and the WANA region. Soils of the WANA region have a potential to reach an annual C sequestration rate of 0.2-0.4 Pg C, accounting for 24-30% of the potential of global dryland ecosystems. This potential rate of carbon sequestration can be maintained over 25-50 year period, provided that coordinated efforts are made to adopt appropriate land use and recommended soil, water and crop management technologies. However, agricultural intensification involves carbon-based inputs including tillage, pesticides, fertilizers and irrigation. Emission of carbon in all these inputs needs to be considered in evaluating the net SOC sequestration.

2.1.6.2 Incentives for land use change

Promoting changes in land use practices that would increase the carbon sequestration rate will benefit the international community and governments, international NGOs and private companies are now paying for these services. Opportunities of funding CO_2 sequestration through land use change activities are limited to reforestation/afforestation activities under the Land Use, Land Use Change, and Forestry (LULUCF) window of the Clean Development Mechanisms (CDM). This might explain why it is not very popular yet in the dry areas of the world (90% of the CDM projects are located in Latin America and Asia/Pacific). Morocco and Egypt have registered several CDM projects (21 for Morocco and 28 for Egypt), however those focus on clean energy, transport and waste management and only 1/5 concerns afforestation/reforestation activities.

However, as the carbon market is growing, new opportunities might raise through emerging carbon management programs or voluntary carbon markets (Tayiab, 2005). In addition, other environmental services (biodiversity, desertification control, water quality) produced through sustainable land use practices are better valuated and should also be considered in the region.

2.1.7 Agro-biodiversity in CWANA

2.1.7.1 Changes in agrobiodiversity and agroecosystems

The preservation and enhancement of biodiversity poses a major challenge for agricultural policy decision makers, as world population and demand for food increase. It is estimated that, with current population trends, food production will have to increase by 24 per cent by the year 2020 just to maintain the existing levels of food consumption and without any significant expansion of agricultural area. Policy makers will therefore need to find ways of minimizing the conflicts between expanding production and maintenance of biodiversity, enhancing the many complementarities between agriculture and biodiversity, and finding ways to prevent the loss of biodiversity on agricultural land (Pagiola and Kellenberg, 1997).

The effects of agriculture on biodiversity are of considerable importance because farming is the human activity occupying the largest share of the total land area for many CWANA countries.

Even for countries where the share of agriculture in the total land area is smaller, agriculture can help by increasing the diversity of habitat types. The expansion of agricultural production and intensive use of inputs over recent decades in CWANA countries is considered a major contributor to the loss of biodiversity (FAO, 1996a). At the same time certain agricultural ecosystems can serve to maintain biodiversity, which may create conditions to favor species-rich communities, but that might be endangered by fallowing or changing to a different land use, such as forestry. Agricultural food and fiber production is also dependent on many biological services. This can include, for example, the provision of genes for development of improved crop varieties and livestock breeds, crop pollination and soil fertility provided by micro-organisms.

Most agricultural policy affects, directly or indirectly, biodiversity. For a growing number of CWANA countries, protecting and enhancing biodiversity is becoming an important part of their domestic and international agri-environmental policy objectives and actions. These policy actions are in response to a growing public concern over the increasing pressure and harmful impacts on natural and semi-natural ecosystems brought about through a variety of causes, including agricultural activity. In practice, governments policies towards biodiversity involve balancing the trade-offs between socio-economic values and biodiversity conservation. Typically policy target options with a low level of ambition (Table 2.1.7.1 a, b, c). for list of endangered species), can avoid short-term costs but may potentially lead to costs over the long term, such as risks to agricultural production due to genetic erosion. Different policy options and targets with a higher level of ambition toward biodiversity conservation will require scientific research, including developing biodiversity indicators. Indicators can help support the decision-making process by providing information about the risks and degrees of sustainability associated with these different options.

2.1.7.2 Introduction of modern varieties, case studies on wheat

For thousands of years, small farmers have grown food for their consumption- planting diverse crops in healthy soil, recycling organic matter, and following nature's rainfall patterns. The trend of switching over from traditional agriculture to cash crop agriculture has become obvious in the last decade. Even in the marginal areas, the cultivation of cash crops is leading to a decline in local crops and varieties. At present minor crops are maintained by farming households on a small scale to meet the needs of their traditional food cultures.

Harlan (1951) noted that “crop germplasm in Vavilovian Centers are vulnerable to loss due to technological and economic changes.” This became evident in the late 1960s as a consequence of the “Green Revolution”, when high yielding varieties was introduced and replaced the local landraces. One of the main features of the “Green Revolution” was the use of uniform and input-efficient high yielding varieties. Such technology was suitable for the most favorable arable land where water and soil fertility were secured. The "Green Revolution" of the 1960s gradually replaced the traditional farming systems with monocultures heavily dependent on mechanization, chemical fertilizers, pesticides, and herbicides. This caused the lost of traditional knowledge, traditional farming, and traditional old varieties and local landraces.

Good farming relied upon the farmers' accumulated knowledge of the local physical and social environment. Until the 1950s, most of the CWANA agriculture was practiced in this way. At the end of 1960s local varieties started to be gradually replaced. Without extension, without a national planning and policies and local training for the awareness on maintenance of unique local varieties and a wide range of ecological problems associated with the technique are caused the environmental pollution and biodiversity lost. At the end of 1960s the introduction of improved wheat varieties in the region caused the lost of old and traditional wheat cultivars in the region especially in the areas that were suitable for extensive agriculture. Having the first national program and the storage facilities Turkey carried an intensive survey and collection program in 1968 and 1969 at the coastal regions to maintain the local wheat cultivars which were being replaced rapidly by improved Mexican wheat varieties (Sencer, 1975).

Replacement of old cultivars with the new ones is on going process in the region. Most of the CWANA countries reported that the replacement of local varieties or landraces by improved and/or exotic varieties and species is the major cause of genetic erosion. As old cultivars or and races in farmers' fields are replaced by new high yielded varieties, genetic erosion frequently occurs because the genes and gene complexes found in the diverse local varieties are not contained entirely in the modern variety (FAO, 1996a).

2.1.7.3 Expansion of agriculture and crop and plant diversity change

The globalization of world economy affects the farming communities, especially the traditional farming communities which depend only on agriculture. There are difficulties in finding new land that could be exploited for agricultural production. Cultivated area expanded mainly at the expenses of forest and rangeland.

CWANA has mainly the dryland and mountain ecosystems. Both are fragile and open to rapid decline of biodiversity. The expansion of agricultural production into formerly uncultivated mountain lands or forest, reduces the habitats for other species and leads to a decline or deterioration of ecosystems, particularly where the lands are only marginally suitable for agriculture. There is no longer sufficient land available for the cultivation of all crops, and farmers' preference is for expansion of cash crops. The threat to traditional crops will increase as the amount of cropland available per household is reduced (Tan, 2002).

The degradation of habitats and the loss of related biodiversity are already leading to irreversible situations responsible for migration of local communities, desertification and increasing mass poverty. Land degradation has now become a major threat to the sustainability of world food supply. This loss arises from soil erosion, salinization, water-logging, and urbanization and related development, such as road construction etc. Nutrient depletion, over-cultivation, overgrazing, acidification, and soil compaction contribute as well. Many of these processes are caused or are changed by poor agricultural management practices. Taken together or in various combinations, these factors decrease the productivity of the soil and substantially reduce annual crop yields, and, more important, will reduce crop productivity for the long term. Almost all arable land that is currently in crop production, especially marginal land, is highly susceptible to degradation. It is difficult to separate those social factors causing to habitat degradation and from economical ones since social and economical factors are interrelated and have similar

consequences. Some of the important ones for Turkey can be listed as: (1) location of the country, (2) agricultural activities (traditional agriculture and animal husbandry, (3) overexploitation of natural resources, (4) population growth and large population living close to natural resources, (5) unregulated grazing and over grazing of pastures and high meadows, (5) forest and stubble fires, and (7) incomplete cadastral works for determining ownership of lands (Kaya, 2003)..

Overgrazing and extensive woodcutting in addition to the intensive agricultural practices have caused a major threat to wildlife in Jordan through destroying natural habitats and caused led to soil erosion in some parts leading to more habitat destruction. Despite of the economic importance of mining for in Jordan, unplanned mining and quarrying can lead to destructive results to the wildlife in general by destroying habitats (http://www.biodiv.org/reports/)

2.1.7.4 Marketing and Industrial effects (processing and use and preference) (positive and negative effects)

The change in consumer and market demand and the loss of interest in some of the by-products of local cultivars are some of the contributory factors. When farmers become integrated into the market economy, farmers change to land races/local cultivars of many crops and fruits with higher outputs of products. The market demands for medicinal and aromatic species, traditional edible wild plants for local food, ornamental species are very high with very attractive prospective both for the national market and for the export, thus creating options for additional income to the low-income rural population. In Turkey there is a long tradition of food uses of edible wild plants. A recent study on wild medicinal plants of Turkey identified 346 taxa of commercially traded wild native plants. At the household level, many medicinal, aromatic, and ornamentals species are under priced and over exploited. Villagers generally sell products without processing, and the added value of the product is then captured elsewhere. Low producer prices encourages over harvesting. Higher producer prices would likely encourage more sustainable management by local communities, as they would ensure constant or higher revenues from lower harvesting levels. Where resources are undervalued, price-related market or policy corrections could have an immediate beneficial effect (Ozhatay et. al, 1997). So, those plant species are over harvested from nature without production. To avoid the over exploitation of nature, some countries in the region have either legislations especially related to CITES, or some project. For example, in Turkey, The Regulation on the *Collection, Production and Export of Wild flower Bulbs* (1995, The Turkish Official Gazette, No: 22371, pp. 5-11).

The market demand for uniform varieties suitable for industrial processing is another negative cause for decreasing the farming of local varieties. However land races are generally better suitable for organic farming, therefore there is an increased request from market for some land races (Tan, 2002).

Case study. 1. Enhancing the multiple uses of underutilized species.

Various projects in the region are ongoing. For example, a pilot project in Syria has the aim to assess socio-economic aspects related to the production and marketing of selected neglected and underutilized species (NUS) in the country and shed light on current challenges and opportunities encountered in promoting the economic exploitation of these species. The study

looks at the market channel and product development of NUS in order to identify the causes limiting their full deployment in the country, along with the needs required in their sustainable use. The investigation concentrates the attention on actions to promote production, processing and marketing with a special focus at the needs of rural communities, where these species can become a valuable instrument to enhance income generation (**www.ipgri.cgiar.org**).

Case study 2. Design, testing and evaluation of best practices for in situ conservation of economically important wild species. GEF- UNEP Funded Project. (Egypt, Lebanon, Morocco, Turkey). **http://www.gefonline.org/projectDetails.cfm?projID=1626**

The objective of the 5 year full project are

- to be fully elaborated with the PDF B funds requested herein
- to facilitate the *in situ* conservation and management by the participating countries of wild or semi-domesticated species identified by them as important to agriculture or forestry or having other economic importance, (such as medicinal or aromatic species) in natural or semi-natural habitats and in traditional farming systems through the implementation of three components detailed below:
- development of National Strategies and methodologies based on best practice, for the inventory, selection, *in situ* conservation management and monitoring of wild species of economic importance
- Implementation of demonstration projects
- establishment of long-term monitoring and evaluation systems.
- information dissemination
- Effects of infrastructural change

Unbalanced water use and unplanned water extraction from surface and underground water resources are threatening many parts of the region (Jordan) and consequently affecting the habitats and micro ecosystems of both animals and plants. On the other hand pollution of surface and underground water resources and aquifers due to agro-chemicals, sewage discharge and solid waste disposal caused more threat on the presence and ability of reproduction of many faunal species.

Case study 3: Azraq Oasis, Wetland Reserve, Jordan

The Azraq oasis was described in the past as a unique green paradise. The oasis is located in Jordan's eastern desert near the border with Iraq. It once supported a rich biodiversity and was a stopover for hundreds of thousands of migrating birds. But increasing demand for water in the greater Amman area (home to half of Jordan's 5.5 million people) led to large-scale pumping of the Azraq basin in recent decades. By 1993, after more than 20 years of intensive extraction, the underground springs giving life to the oasis had dried completely. Today, the Azraq ("blue" in Arabic) wetlands are staging a remarkable recovery thanks to a multifaceted project co-financed and managed by the United Nations Development Programme (UNDP), in its capacity as an implementing agency for the Global Environment Facility (GEF). Other partners include various Jordanian Government agencies and the country's Royal Society for the Conservation of Nature

(RSCN) (www.gefweb.org/Outreach/outreach-PUblications/ Project_factsheet/Jordan-cons-1-bd-undp-eng-ld.pdf, accessed on June 6, 2006).

The construction of dams, replacing the farming system from dry farming to irrigated farming change the cropping pattern and decrease the local varieties and weedy forms adopted to dry farming conditions. This was the case for Turkey. But with a planned and intensive collection missions those varieties wild relatives and weedy forms of many species are collected and conserved as *ex situ* (Tan, 1998). The *in situ* conservation of wild progenitors of legumes and cereals are also managed (Karagoz, 1998).

2.1.7.5 Change in rangeland composition

Because livestock is the major user of primary production in agrobiodiversity system of arid and semi-arid regions, degradation has always been attributed to this sub-sector (Sidahmed and Yazman, 1994; Squires and Sidahmed, 1997). Over grazing is main affect for the change in rangeland composition for the maintenance of the actual composition and the diversity of rangelands. The countries like Turkey and Syria set up policies for the management of range lands (**http://www.ifad.org/photo/region/pn/tr.htm**).The grazing pressure in the rangeland should be in balance. The absence of grazing livestock also has some negative effect to vegetation. When grazing of cattle or goats in agro-forest ecosystem cause dense growth of under shrubs in the forest, hence, preventing the regrowth of forest. Presently, there is a government supported programs for maintaining the original forest landscape with the help of goats. Goat keepers are paid, per day and per head, for grazing their goats in the forest in some countries.

2.1.7.6 Effects on animal breeds

The large number of indigenous livestock breeds that are also threatened like plant species and other components of agrobiodiversity. Sometimes the local breed and local plant diversity lost contribute, sometimes contradictory to each others. The wildlife and livestock often symbiotically co-exist and plant biodiversity may decrease with the absence of grazing livestock. The replacement of local breed by exotic breeds is the main reasons for breed's extinction. Additionally there are other factors affect the existence. One of the main reasons leading to the extinction of breeds is the expansion of crop cultivation and irrigation into marginal zones and conversion of former pastures into protected areas. As a result of those practices, livestock keepers are often loose their traditional pastures then the grazing livestock. Absence of market demand and lack of competitiveness with Improved Breeds is another important factor. When communities become integrated into the market economy, animal keepers switch to breeds with higher outputs of milk, meat or eggs. If there is no more demand for the breed, related knowledge can vanish quickly within a generation. Habitat lost also causes lost of breeds. The wetland decline resulted buffaloes were evicted. The habitat lost also affects the wild animal. For instance, disappearance of nesting habitats for some of the migratory birds.

Conflicts and disasters are another possible factor to affect the lost of breed and wild animals. Wars and natural disasters can cause massive loss of livestock. Aid agencies often try to help by

restocking and importing animals from developed countries. Possibly there will be some effects of War in Afghanistan and Iraq, earthquake in Pakistan.

2.1.7.7 Maintenance and Conservation of Agrobiodiversity in CWANA

The future of global food security depends on the success of our efforts in the conservation and enhancement of agrobiodiversity. The biodiversity in agricultural systems is under pressure worldwide. The loss of plant and animal biodiversity and its declining use in modern agriculture has generated much concern about future vulnerability of agricultural production and related pest and disease risks, food security and environmental stability. Various international conventions have addressed the sustainable use and conservation of agrobiodiversity which is on the top of the international development agenda.

The main focus of policy actions in the area of biodiversity has been to protect and conserve endangered species and habitats. Some CWANA countries such as Turkey, Pakistan, Morocco, Jordan, have introduced legislation for the protection of specific endangered species and habitats, and also designated certain areas as biosphere reserves, nature parks, and other protected sites. Most countries have lack of legislations for the protection of agrobiodiversity. In some countries the legislation prepared but not adopted or not became into force (**http://www.biodiv.org/reports/**). Turkey for example has various legislations to protect biodiversity related directly or indirectly to the preservation of agrobiodiversity, maintenance of plant genetic resources. The most important direct legislations ones are: (1) The Regulation on the *Collection, Storage and Use of Plant Genetic Resources* (1992, The Turkish Official Gazette 21316:4-8 pp.), and (2) The Regulation on the *Collection, Production and Export of Wild flower Bulbs* (1995, The Turkish Official Gazette, No: 22371, pp. 5-11).

In 1950s and early 1960s FAO was one of the major organization to promote collecting and conserving the genetic resources in world wide. The 1961 Technical Meeting on “Plant Exploration and Introduction was the first initiative on a multilateral basis to recommend the establishment of exploration centre in the regions of greatest genetic diversity. A pilot exploration centre was established in 1964 at Izmir Turkey, with an agreement between FAO and Turkish Government within the framework of a joint project of United Nation Development Program (UNDP). This Crop Research and Introduction Centre (CRIC) than with the inclusion of agricultural research, Agricultural Research and Introduction Centre (ARIC) acted as first regional centre of South West (SW) Asia for collection, conservation of SW Asian plant genetic resources (FAO/UNDP, 1970; Frankel, 1985; Kjellqvist, 1975, Tan and Inal, 2003). This initiative was, of course, very good opportunity of the region to preserve the unique agrobiodiversity at the first gene bank of the region established in Turkey. But for some reason ARIC (the recent name is Aegean Agricultural Research Institute, AARI) was not continued to act as regional centre, but successfully began to work at national level at the middle of 1970s and are still the coordination Centre of National Plant Genetic Resources/Plant Diversity National Program of Turkey (Tan, 2000; Tan, 2001). In the countries of region, except for Turkey, plant genetic resources activities are not yet fully organized in an integrated national program. The plant genetic resources conservation activities are mainly implemented through breeding and selection programs within

Research Institutes and Universities and also the Departments of Forestry and Livestock within the Ministry of Agriculture. Because of lack of national policy and special budget, plant genetic resources are not receiving enough support. Moreover, there is often no coordination among different institutions at the national level (**www.ipgri.giar.org**). Although most countries do not yet have a systematic and coordinated national plant genetic resources program with an action plan and national strategy. In some countries in addition to the National programs a wide spectrum of organizations are also involved in the conservation of plant and animal genetic resources. Non Governmental Organizations (NGOs) are active mainly in biodiversity conservation and do not take a key role in plant genetic resources activities in most countries. Some CWANA countries have begun to develop national biodiversity strategy plans (**www.biodiv.org/reports**) which usually incorporate the agricultural sector as a key player in biodiversity conservation. These strategy plans set out the relevant policy objectives and targets for managing and sustaining biodiversity. The issue of species loss, treats and the need to address it through integrated program of *in situ* and *ex situ* conservation are being addressed by most countries and highlighted in their National Biodiversity Strategy and Action Plans and National Reports (**www.biodiv.org/reports**) prepared under the terms of Article 6 the CBD and, as regards species of importance to agriculture, in the Country Reports prepared for the Fourth International Technical Conference on Plant Genetic Resources. The Moroccan Country Report to the International Technical Conference highlights the diversity of wild species of significance for forestry and grazing and those that are crop relatives, and the importance of their *in situ* conservation as a national need. The Turkish Report includes in their strategic actions the fostering of *ex situ* and *in situ* conservation action that involves identification, monitoring and management of wild and cultivated species land races), by both government and non-government agencies. Almost all countries prepared their country report for the preparation of The State of the World's Plant Genetic Resources for Food and Agriculture (FAO, 1996 a) as an element of FAO. Turkey as member of OEDC has some activity report for both animal and plant diversity indicators which are policy relevant biodiversity indicators to measure the performance of national policies and help monitor progress in fulfilling international obligations. (Tan, 2001). Agricultural research and development institutions of The Arab League –namely ACSAD (The Arab Center for Agricultural Research in the Dry Lands and Arid Zones) and AOAD (The Arab Organization for Agricultural Development), COMSTECH-OIC (The Scientific and Technical Committee of the Organization of Islamic Conference), the CIS (The Commonwealth of Independent States among Central Asia and Caucasus countries) and the OAU (The Organization for the African Unity) are the principal intergovernmental bodies for international and regional collaboration in the region. AARINENA and the Research Forum for Central Asia and the Caucasus co-sponsored by FAO**,** ISNAR and ICARDA are now the major regional agricultural research and development networks in CWANA. They play an important role for the region within the Global Forum for Agricultural Research.

However, the way these conservation efforts are organized varies across countries, ranging from involvement of governmental and non-governmental organizations, and from amateur collections to commercial companies. Some countries have national genebanks, others have several

specialized agricultural research institutes responsible for the maintenance of agricultural genetic resources, while some countries work together in regional genebank networks. The crop and regional networks are also function related to agrobiodiversity protection. The Central Asia and Trans-Caucasus Network on Plant Genetic Resources (CA-TCN/PGR, established in 1996), The West Asia and North Africa Network on Plant Genetic Resources (WANANET, established in 1992) are two active networks in the region for the collection conservation and sustainable utilization of unique agrobiodiversity of the region. The other regional network for rangeland seed information was established in the region, with two sub-regional nodes: the Mashreq countries (Iraq, Jordan and Syria) and the Maghreb countries (Algeria, Morocco and Tunisia). Turkey is also member of European Cooperative Program for Plant Genetic resources (EC/PGR).
The International Technical Conference on Plant Genetic Resources placed emphasis on the need for complementarity between *in situ* and *ex situ* approaches and the Global Plan of Action (GPA) agreed by 150 governments at the Technical Conference identifies the promotion of *in situ* conservation of wild crop relatives and wild plants for food production as one of its 20 priority activity areas (FAO, 1996b). Those activities are the excellent guide to the national programs of the region.

At the international level a range of agreements and conventions are also important in the context of agriculture and biodiversity, most notably the International Convention on Biological Diversity (CBD) agreed at the UN Conference on Environment and Development at Rio in 1992. Recognition has been given by the CBD to the significance of biodiversity for agriculture. This has led the FAO to request member countries to negotiate, through the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA), the revision of the international undertaking on plant genetic resources in agriculture, International Treaty for Plant genetic resources for Food and Agriculture (ITPGRFA came into force on 29 June 2004; few countries of the region participated, **www.fao.org)** in harmony with the CBD. In addition, within the overall context of the CBD, the Biosafety Protocol was agreed over 130 countries. This was the first major international agreement to control trade in genetically modified organisms (GMOs), covering food, animal feed and seeds. Other related international conventions include, for example, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973, www.cites.org), the Convention on Wetlands (Ramsar Convention, 1971, www.ramsar.org). Some of the countries of the region are signatory to those of the agreements and completed the ratification. The awareness of the countries of the region to the participation of those agreements is not fare enough. The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1971, **www.coe.int/T/E//Cultural_Co-operation/Environment**) is only signed by Turkey and enforced with various project (Tan et al., 2003). Additionally, some countries are members of the World Trade Organization (WTO, www.wto.org) and bound to its rules, the World Intellectual Property Organization (WIPO, www.wipo.int) and the Patent Cooperation Treaty. The Uruguay Round Agreement of negotiations under the General Agreement on Tariffs and Trade (GATT, www.wto.org) produced the Trade-Related Intellectual Property Rights (TRIPS) Agreement, which commits all members of the WTO to adopt and enforce minimum levels of protection for IPR. Article 27.3(b) of the

Agreement on TRIPS calls for members to develop Plant Variety Protection legislation (www.wto.org).

IPGRI's work in the Central & West Asia and North Africa region (CWANA) started as early as 1977 with a FAO project jointly conducted with the Aegean Agricultural Research Institute (AARI) in Izmir, Turkey. The IPGRI regional Office for the WANA region was located in Aleppo in 1992, Syria, at the International Center for Research in the Dry Areas (ICARDA). In 1997 the Office broadened its mandate to include also Central Asia and changed its name accordingly into CWANA. A sub-regional office was opened in Tashkent, Uzbekistan in 1998 at the ICARDA Facilitation Unit for Central Asia. The ultimate goal of IPGRI CWANA is the strengthening of the capacities at national and regional level to achieve an effective conservation and sustainable use of plant genetic resources. Other five CGIAR centers (**CIAT, CIMMYT, CIP, ICRISAT** and **IRRI**) have sub-regional offices in the region and carry out activities on plant genetic resources on their respective mandated crops and Agrobiodiversity conservation activities.
Ex situ conservation has been the predominant approach for the conservation of plant genetic resources for food and agriculture (PGRFA) in the region. In recent years, however, the need for integrated conservation strategies for PGRFA based on the complementarity of *in situ* and *ex situ* approaches has become clear. The first attempt on *in situ* conservation in the region was the project implemented by Turkey in multiple site and multi species approach. In fact there are various projects now in the region for both *in situ* conservation of wild relatives of crops and on farm conservation of the traditional crops in agrobiodiversity and some in ecosystem level. The documentation of biodiversity has also become important and national programs, formal and informal institutions of the CWANA countries have started to create database on various topics related to agrobiodiversity. In Turkey a comprehensive and complementary data base management system linked with geographical information system (GIS)system exist for all related activities and for better understanding of agrobiodiversity (Tan and Tan, 1998a; Tan and Tan, 1998b).

In the region related to *in situ* conservation of plant diversity and agrobiodiversity , including forestry, UNEP (United Nations Environmental Program) and World Bank are present with a global program on biodiversity and genetic resources and has mobilized funds across CWANA, through GEF (Global Environmental Facility), to support the development of biodiversity country strategies along with a number of major *in situ* conservation projects, such as "*In situ* Conservation of Genetic Diversity in Turkey" (Tan and Tan, 2002), "Design, Testing and Evaluation of Best Practices for *in situ* Conservation of Economically Important Wild Species, with demonstration in Egypt, Lebanon, Morocco, Turkey" (UNEP,2003; www.gefonline.org/projectDetails.cfm?projID=1626) . UNDP (United National Development Program) regional office for the Near East has approved an important regional collaborative project in 1998 on "Agrobiodiversity *in situ* Conservation", involving Jordan, Palestine, Lebanon and Syria, and which was coordinated by ICARDA, with technical back stopping by IPGRI and ACSAD (Arab Center for the Studies in Arid Zones Dry Areas, Syria) and supports through GEF a regional Date Palm project for the Maghreb Oases.

Case study 1: *In Situ Conservation of Genetic Biodiversity of Turkey* (GEF (World Bank) sported Project) (Tan and Tan, 2002). This five-year project (associated with the Bank's Eastern Anatolia Watershed Rehabilitation Project) started in 1993 and worked to address Turkey's natural resource degradation through *in situ* and *ex situ* conservation and supported by GEF, World Bank.

Project Goals: -Permit genetic evolution through *in situ* conservation

- . Protect in site the genetic resources and wild relatives of important crop and forest tree species. The southeastern, southern central Anatolian, and Aegean regions have been identified as important biodiversity centers for wild relatives of cultured crops.
- Complementary conservation ex situ and *in situ* wild relatives of selected crops, fruit and forest species
- *Ex situ* conservation of associated species of target species in the selected sites
- Establishment of natural reserves (gene management zones, GMZs) for target species
- Management plan for selected GMZs
- Preparation of National Plan for *in situ* conservation
- Creation of comprehensive data base management system linked with GIS applications
- Activities ; Conducted surveys and inventories to help identify and assess suitable sites in Turkey containing wild crop relatives and progenitors of wheat, chickpea, lentils, pea and barley as priority species but also including other herbaceous and woody species.
- . Conducted a species specific inventory at various sites for species abundance, distribution, and management needs
- . Collected samples for *ex situ* conservation to support a complementary approach for *in situ* and *ex situ* conservation
- . Selected several types of reserves for management of GMZs which represented the ecogeographic ranges needed for targeted diverse wild relatives to support sufficient environmental heterogeneity for wild crop woody and nonwoody species.
- Prepared management plan for long term management of designated GMZs and monitored species incidence and diversity and evaluated different approaches to gene management for particular species and ecosystems.
- . Strengthened institutions focusing on professional development and training of implementing agency staff, Turkish scientists through workshops, technical assistance, and training courses in topics related to *in situ* conservation.
- . Developed a data management system linked with National Plant Genetic Diversity Data base and GIS applications for present and future implementation and monitoring of natural reserves.
- Developed a National Plan for *In situ* Conservation for Turkey (Kaya et al., 1998).
- . Held an international symposium to share the the project findings to scientists with scientific community of the world (Zencirci et al., 1998).
- Benefits:Developed a strong collaboration in national partners and rural peoples
- Provided public awareness on conservation of natural resources

- . Provided a model and technical information for *in situ* gene conservation to other countries,
- . Contributed to the broader objective of conserving sustainable agrobiodiversity and agroforestry systems, a key element of Watershed Rehabilitation Project.

Case study 2: Strengthening The Scientific Basis of In Situ Conservation of Agricultural Biodiversity on Farm (Jarvis and Hodghin, 1998; Jarvis et al., 2000a).

In 1995, IGPRI and its nine national partners (Burkina Faso, Ethiopia Hungary, Mexico, Morocco, Nepal, Peru, Turkey and Vietnam) formulated the Project to strengthen he scientific basis of in situ conservation of agricultural biodiversity on farm. The nine partner countries are all within regions of primary diversity for crop genetic resources with world-wide importance. The countries all have national programs organized to conserve crop genetic resources, including *ex situ* conservation facilities, additionally all have a strong interest in developing the national capacity to support *in situ* conservation. The project serves to strengthen the relationships between formal institutions and farmers and local-level institutions.

- Project objectives:-to develop global and national management frameworks for the implementation of *in situ* conservation

to collect and analyze information to define the genetic diversity in farmers' fields and to develop the criteria for the successful maintenance of existing diversity

- to broaden the use of agricultural biodiversity and the participation in its conservation by farming communities and other groups.
- The IPGRI CWANA group is closely involved in the implementation of this Project which has two participating countries from the CWANA area – Two CWANA countries, Morocco (Birouk et al., 1997) and Turkey (Tan, 2002). Project has carried out various activities, including:
- Standardization of methods and tools for data collection

Identification of key factors that determine the maintenance of genetic diversity
Gathering and analyses of integrated data from country components
Identification of local Public Awareness channels to communicate about agrobiodiversity
Adaptation of participatory and empowering methodologies for on farm PGR management
Documentation of case studies to show the importance of agrobiodiversity for agricultural development
Documentation of case studies to show adding value options:

- Support to training programs

Publication and distribution of training materials on in situ conservation for research and extension workers
Facilitation of exchange of experiences and organization of scientific meetings at the global level
Establishment of strategy planning committee
Establishment of linkages with relevant partners through joint workshops, joint publications, joint subactivities, training, exchange of publications etc.

- Creation of comprehensive data base management system for each national project.
- Benefit: provided a model to other countries for future projects.

- *A Training Guide For In Situ Conservation OnFarm* produced (Jarvis et al., 2000b) and it is tested through the GEFUNDP Project on Conservation and Sustainable Use of Dry land Agrobiodiversity in Jordan, Lebanon, Syria and the Palestinian Authority.

Case study 3: Conservation and Sustainable Use of Dry land Agrobiodiversity (www.icarda.org/Gef/P1.html)

The five year project was launched in 1999 with a view to promote *in-situ* conservation and sustainable use of dryland Agrobiodiversity in Jordan, Lebanon, the Palestinian Authority and Syria, with financial support from the Global Environment Facility (GEF)/UNDP. In addition to the country institutions ICARDA, IPGRI and ACSAD are also involved in to implement the project. Genetic erosion of some animal breed has been occurring at unabated rate due to lack of incentives for conservation and driving factors such as population pressure, ecological changes, natural catastrophes and adverse economic conditions. This depletion contributes immense threats to the livelihoods of the local pastoral communities. Thus conservation efforts of these important animal genetic resources (AnGRs) by governments and other stakeholders would ensure not only the well-being of the pastoralists but also prevent losses in genetic materials for future use. Conservation of animal genetic resources is also essential to enable farmers to adapt to changing environmental conditions and consumer demands. Conservation of animal genetic resources is also essential to fully realize the investment that has been made over many human generations in developing these resources. Also, ensuring the conservation of wild species will provide opportunities to further develop and expand the livestock sector. FAO has been leading efforts to sustainably use, develop, and conserve animal genetic resources, and since 1993 has been engaged in the preparation of the Global Strategy for the Management of Farm Animal Genetic Resources. The Global Strategy is intended to serve as a strategic framework to guide international efforts in the animal genetic resources sector.

Preparation of the *First Report on the State of the World's Animal GeneticResources* has been initiated as an essential element of the Global Strategy. For this purpose countries, in March 2001, were invited by FAO to produce and submit government endorsed Country Reports (www.fao.org, www.dad.fao.org). The first Report on the State of the World's Animal Genetic Resources will provide a comprehensive review of the current status of global livestock diversity and direction for better future management of that diversity. Country Reports and the first *Report of the State of the World's Animal Genetic Resources* will provide a strategic planning framework for the animal genetic resources component of agricultural biological diversity, supporting the development and implementation of national, regional, and global polices and programs for this sector. This document will contrasts opportunities, challenges, biological characteristics, institutional infrastructure and operational considerations influencing management of plant and animal genetic resources. It will also include main threats to livestock genetic resources and outlines areas of greatest opportunity for better management of these resources. Some countries in the region prepared their country reports and they set up various project to conserve the farm animal genetic resources.

2.1.7.8 Exploitation and utilization of agrobiodiversity,

Exploitation and utilization of genetic resources postulate knowledge and evaluation of the characters expressed by the genome of the samples and the identification of desirable characteristics for the breeding. As indicated in Global Plan of Agriculture for the Conservation and the Sustainable Utilization of Plant genetic Resources for Food and Agriculture (GPA) “the broadening of the genetic base of crops will contribute to increasing crop stability and performance (FAO, 1996b). In most crop species, exploited populations have been reduced dramatically as a result of subsequent breeding and selection. Since the development of breeding exploitation of available genetic diversity is poor. For years, plant breeders of the region have limited their programs to a relatively small part of existing diversity of the region. However over a similar timeframe, considerable amount of genetic diversity of the region, such as wild relatives/ancestors, old varieties, land races weedy forms were collected from different institutions and maintained in the national, regional and CG centers Genebanks. Since the importance of the region’s genetic diversity, those material very valuable, but relatively unexploited as source of genetic variability. The intention for the broadening the genetic base and enhancing the ability to responding to abiotic and biotic stress needs systematic evaluation and utilization the existing and/or maintained genetic diversity of the region In the Countries of CWANA with well organized National Programs the collaboration with national breeding programs the evaluation and utilization of genetic diversity in practice (FAO, 1996a). . In turkey many varieties are released from national collections (Tan and Inal, 2003). The collaboration with the CGIAR centers in the region or operate in the region are also had lead the countries to exploit and utilize their own genetic diversity which are readily adapted even to the extreme conditions of the countries in the region.

Participatory variety selection and participatory plant breeding are effective ways to identify new material adapted to farmers’ conditions, preferences and needs. Participatory methodologies allow farmers to participate in the selection of new materials, enhancing diversity in production systems where traditional cultivars have been lost

Participation of farmers in the initial stages of breeding, when the genetic variability created by the breeders is untapped, will fully exploit the potential gains from breeding for specific adaptation through decentralized selection by adding farmer’s perception of their own needs and farmers’ knowledge of the crop. Therefore, farmers’ participation has been the ultimate conceptual consequence of a positive interpretation of genotype x environment interactions, i.e. of breeding for specific adaptation.

Participatory variety selection and participatory plant breeding programs have been established in a number of countries in the region by a number of agencies and ICARDA.

There is a wide range of possibilities for enhancing the traditional management of varieties. Farmer participatory breeding has an important role to play in some environments. The opportunities for interaction and complementarity between formal breeding work on-station and farmers' expertise need to be fully explored. Research is also needed on the transfer of appropriate technology between farming systems known to manage great diversity. Research

support is needed for traditional seed production, with an emphasis on the role of the farmer and natural selection pressures (e.g. insect pests, diseases, storage conditions, soil fertility factors etc.).

Participatory plant breeding also allows the farmers diversity to be maintained on farm. So this approach is one of the main components of *in situ* on farm conservation program In Morocco, the agro-morphological characterization based on farmers' perceptions and data acquired from farmers' crop fields,

Case Study: Decentralized-participatory barley breeding, ICARDA

At ICARDA, the gradual change from centralized non-participatory to decentralized-participatory barley breeding was implemented in Syria between 1997 and 2003 in three steps, and the model and concepts developed during these developments were gradually applied in Tunisia, Morocco, Eritrea, Yemen, Jordan and Egypt.

The first was an exploratory step with the main objectives of building human relationships, understanding farmers' preferences, measuring farmers' selection efficiency, developing scoring methodology, and enhancing farmers' skills. The exploratory work included the selection of farmers and sites, and the establishment of one common experiment for all participants (Ceccarelli et al. 2000, 2003). The second step was mostly about methodologies and consisted in the implementation of the breeding plan, in the choice and testing of experimental designs and statistical analysis, in the refinement of farmers' selection methodology, and eventually in initiating village-based seed production activities.

One of the most common findings of PPB programs is that different farmers in different communities select different varieties. Data collected on barley seem to suggest that farmers' selection may have the same narrowing effect on the biodiversity available in the original breeding material. However, because different farmers select different material, the biodiversity over the total area is maintained or even increased (Ceccarelli and Grando, 2002).Through PPB several farmers are becoming aware of the value of landraces and more interested in their conservation.

2.2. POLICIES, INSTITUTIONS AND REGULATIONS

2.2.1 Development strategies and agricultural policies[5]

In the CWANA region as in other developing countries of the world, agricultural development strategies have been characterized by successive shifts since the late fifties.

In the early post-independence era (late 50s to the early 70s), development strategies were strongly influenced by the "import substitution model", which was the dominant development paradigm and which aimed at promoting rapid industrialization. This was translated in heavy taxation of the agricultural sector (taxes on agricultural commodity exports, overvalued currency exchange rates, high import tariffs).

However, many governments attempted to correct the bias against agriculture by intervening in agricultural output and input markets through price measures, compulsory state monopolies and the provision of basic services to the sector (e.g. credit, essential inputs, technical and market information, and marketing and distribution infrastructure) (FAO, 2005a).

[5] This section draws

In the early 80s, growing current account deficits, external debt problems and foreign exchange crises imposed a shift in development strategies and the implementation in most developing countries of structural adjustment policies.

From the 19880s to the 1990s structural adjustment policies involved import tariff reduction, market deregulation, privatization and fiscal stabilization pursued through currency realignments and significant budget cuts. For agriculture, the primary objective was to make the sector more market-oriented. Specific budget cuts were often made in subsidized credit and inputs, extension systems and in investments in research and infrastructure.

Agricultural reforms typically involved the reduction or elimination of state trading, the elimination of domestic price controls and the gradual removal of state procurement programmes (FAO, 2005a).

These policies had mixed economic results and differentiated impacts on the agricultural sector. While allowing for an increase of agricultural exports, as well as for the intensification of farm production systems in some countries of the region (Tunisia, Morocco, Egypt, Turkey), they translated in major market disfunctioning and resulted often in the deterioration of food security and in increased poverty in many other countries.

While still focusing on the objective of improving the competitiveness of the farming sector (through farm productivity growth, a better integration of farmers in supply chains, the development of standards and labels), current development policies are also increasingly integrating poverty reduction objectives. Also the need for development policies taking into account and adapted to the diversity of farmers' situations is increasingly recognized. Still the current situation of the farming sector in the CWANA region is facing major constraints at national and international level, in particular unfavourable markets for products, persisting subsidies in the North, growing technological divide between the north and the south and increasing environmental risks.

In this context agricultural development strategies in the CWANA (Table 2.2 a) are faced with major challenges. Major issues at stake are the following: How can agriculture ensure economic development objectives (food self-sufficiency, better position on the international market), while ensuring rural poverty reduction and environmental protection? What should be the linkages between agricultural policies and rural development policies, especially in a context where the growing market orientation and the intensification of farm production systems are reducing the agricultural labour force. How can the need to promote a multifunctional approach to agricultural development, taking into account the social and environmental functions of agriculture and the need to diversify economic activities in rural areas) can be translated in policy action?

2.2.2 Land tenure including agrarian reform

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2.2.3 Trade policy (international and regional agreements, WTO, etc.)

Markets and trade are considered as a cross-cutting theme in the CWANA-IAASTD for their relevance in determining the access to and adoption of AKST. The demand (adoption) of AKST depends on output (commodities) markets as long as the former is derived from the demand of the final output products. As such, the output markets and AKST markets are interlinked. The

access to output/input markets is the first condition to access AKST. It is through markets that agricultural policies pass through. Trends in agricultural markets and marketing policies would influence the access to and adoption of AKST. For example, protectionist policies would not encourage the adoption of certified seeds, while liberalization and appropriate marketing policies may be accompanied by the adoption of more productive technologies and improves efficiency and economic growth.

Trade arrangements

Although trade liberalization globally represents the goal of multilateral trade negotiation under the auspice of WTO all WTO members have entered into regional or bilateral agreements. This somehow shift from WTO objectives is due to the failure of WTO to achieve global consensus about trade agreements but also is due to the relative ease of regional blocs' formation. The CWANA region is not an exception. It has seen the emergence of many regional and bilateral trade agreements among neighboring countries. For instance Egypt has concluded 30 to 40 agreements[6]. The gulf countries have established in 1981 the Gulf Cooperation Council to enhance intra-regional trade and cooperation. And in February 1989 the Arab Magreb Union has been established in Marakesh. By joining WTO the central issue for these countries and regional blocs is the compatibility with the requirements of multilateral trading principles. According to article 24 of GATT the purpose of regional blocs is to facilitate trade between the members of the bloc without restricting trade with other WTO members. The main concerns of these countries with respect to their provision with WTO are i) the compatibility of the common tariff rates with the bound rates committed by joining WTO, ii) the revision of specific binding restrictions in the area of market access, domestic supports and exports subsidies, iii) the establishment of common market in accordance with GATT provision for regional blocs to foster their position in current and future multilateral trade negotiations, and iv) the revision of tariff structure under the most favored nation status in previous bilateral or regional trade agreements.

Intra industry trade is also growing among regional trading groups. Such a trend is an indication of economic integration and economic diversification and development. Intra industry trade within the regional trading blocs occurs mostly between countries of proximity and with similar demand structure. Transportation and transaction costs are among the constraints that hamper the development of intra industry trade within the region. Policy and institutional changes are required to follow these developments and overcome some current constraints.

Since the 1990s many countries of the Mediterranean region (namely North African and Middle Eastern countries) have signed partnership agreements with the European Union (EU). These countries are liberalizing their economies under the Euro partnership conditions, a process which is strongly influenced by the EU-common agricultural policy (CAP). By examining concerns before and after CAP reforms as well as the current WTO negotiations we can anticipate that the above concerns may be further exacerbated. Since negotiations have started about 8 years back a great deal of programs has been undertaken by the different trade partners and a lot of changes have taken place at the international level. These changes will be accompanied with

[6] ESCWA. 1998. "Challenges and opportunities of the new international trade agreements for the ESCWA member countries in selected sectors. United Nations.

new concerns about negotiations and may require adjustment of production and trade policies. In what follows we present trade and non-trade concerns with the consequent old and new concerns. We present subsequently (i) the multilateral trade negotiations and benefits, (ii) the recurrent and newer issues, and (iii) the EU and CAP reforms. Then, we discuss the most relevant issues to draw on the concerns to the region in the future.

Trade negotiations and expected benefits

Since the inception of the WTO in 1994 efforts have focused on the launching of a new comprehensive multilateral trade negotiations round. From the Seattle ministerial meeting up to the Doha declaration there has been advances on a number of trade and non trade issues. The Ministerial Conference at Cancún, Mexico sets a milestone towards achieving the Doha Development Agenda (DDA) round of trade negotiations as mandated by ministers at the 2001 Doha conference. However, giving the achievements of past negotiations, observers remain skeptical that a new comprehensive round can be completed by 2005 (Miner, 2001). The big players are expected to make additional policy reforms (e.g. trade legislation in the USA and CAP reforms in the EU) before undertaking strong concessions and commitments in the upcoming negotiations.

It is somehow disappointing that benefits from agricultural trade liberalization have not materialized as it was predicted. There are at least two reasons for the partial achievements of trade benefits. First, negotiations on agriculture alone do not consider the comparative advantage principle. As a result, the Doha declaration made provisions for broad based negotiations extending trade negotiations to further trade liberalization for industrial products and services in which nations may take advantage (Merlinda, 2002). Second, national policies and legislations are creating additional cross national boundaries transaction costs and limiting the liberalization efforts. Gerber (2000) pointed out that trade relations remain far denser within nations than between nations and that there is a lot of missing trade relative to the predictions of the standard Hecksher-Ohlin model. Accordingly, in the case where trade barriers are reduced, the absence of trade in goods as predicted by trade theory is an indication of significant transaction costs across national boundaries. “Deep” economic integration requires not only the removal of border barriers but the removal of domestic policy barriers as well (Lawrence).

Recurrent and newer issues (Table 2.2 b, 2.2 c)

The main issues already identified in the GATT agreement on agriculture (AoA) embodied market access, export competition and domestic support. However, a body of new trade and non trade concerns are emerging and attracting grower public interest. The AoA already included issues of food security, food safety and quality, environment concerns, resource conservation and rural development (Miner). Additional issues raised in the last negotiation meetings included animal welfare, biotechnology, species preservation, safeguarding the landscape, poverty reduction and preservation of rural culture (Miner).

Newer border-trade topics embodied items such as the rules of origin, standards and technical barriers, intellectual property rights, SPS standards, dispute settlement and the role of small countries (Gerber). Among the non-trade domestic policy issues are: foreign investment, competition policies, and labor and environmental standards.

Regional linkages: the EU and CAP (Table 2.2 d)

Traditional regional linkages are shaping export markets and observed trade flows. According to Diao et al. (2002), export markets for many developing countries are concentrated in a few countries in the North due to geographic proximity and historical linkages. As a result trade negotiations will be shaped by regional blocs. As such, North African and Middle Eastern countries are more interested in the EU agricultural markets and consequently in the EU agricultural reforms under the CAP agenda 2002.

Indeed, the work programme annexed to the Barcelona Declaration cites the following objectives with regard to the countries that have signed the declaration (Enzo Chioccioli, 2002):

- Integrated rural development
- Support for policies implemented by the Med countries to diversify production
- Reduction of food dependency and
- Promotion of environment friendly agriculture.

Challenges and relevance to AKST:

i- The effects of the EU enlargement

The enlargement of the EU to the Central and Eastern European countries (CEEC) is an integral part of the EU Agenda 2000. The process has started following the decisions of the European council in 1993 in Copenhagen and 1994 in Essen to be achieved by 2004. The enlargement of EU could have positive impacts as it opens new frontiers to our exports. It may however divert foreign investment to the eastern EU countries and therefore preventing the region from access to new technologies..

ii- Food safety & environmental quality Standards

With the decline in the use of traditional trade barriers such as tariffs and quotas, there is evidence that technical and regulatory barriers are increasingly used instead (Wilson, 2001). In developed countries many firms are moving toward the adoption of environmental standards. This move is relatively slow in our countries and might therefore represent an obstacle to international trade.

iii- Environment friendly agricultural practices

Current trends to protect the environment with the EU provision of direct payment to farmers complying with environmental regulations and support of agricultural methods which protect the environment, all these would mean also the spread of these agricultural techniques along the region. Among these techniques the low tillage or no tillage will be sought to replace current practices.

2.2.5 Professional and Community Organizations

Agriculture is of paramount importance in the region as a whole. However, agriculture is one of the least organized sectors in both in CWANA region, although various international organizations make significant contributions to the countries in the region on agricultural development, capacity building in different sectors of agriculture, organization of NARS, agricultural research and protection of agrobiodiversity. Since, CWANA region face a multitude of challenges to dry condition and harsh climatical conditions and the lost or decline of arable lands and agrobiodiversity. The national and international community organizations are organized themselves to overcome the agricultural problem in the region. Because of the cooperation with

various organization the agricultural community are organized both national and international basis in CWANA region.

Besides enhancing complementarities in agricultural research and exchange of technology and germplasm between international regional organization and NARS, the collaborative programs enhance the development of intra- and inter-country linkages, research coordination and management, and effective networking within each subregion. In collaboration with NARS, technology transfer and its adoption by farmers is promoted through those of collaborative programs by contributing to the development of multi-disciplinary research teams involving national scientists, extensionists and farmers. This ensures a research continuum between international organizations' research programs and those of the national agricultural research systems.

Most plant breeding, as well as conservation and characterization of plant and animal genetic resources is done by government institutions, with some assistance from regional and international agricultural research centres, such as the International Center for Agricultural Research in the Dry Areas (ICARDA), International Maize and Wheat Improvement Center (CIMMYT), International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) and International Potato Center (CIP), as will as Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD). Agricultural research and development institutions of The Arab League, namely ACSAD and the Arab Organization for Agricultural Development (AOAD), the Scientific and Technical Committee of the Organization of Islamic Conference (COMSTECH-OIC), the Commonwealth of Independent States (CIS) and the African Union's New Partnership for Africa's Development (NEPAD) initiative are the principal intergovernmental bodies for international and regional collaboration in the region.

2.2.5.1 International Organizations

The Food and Agriculture Organization of the United Nations leads international efforts to overcome hunger. Serving both developed and developing countries, FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information and helps the developing countries and countries in transition modernize and improve agriculture, forestry and fisheries practices and ensure good nutrition for all. Mosly FAO focuses on special attention on developing rural areas and also had many efford on the policies an the preparation of International Treaty for Plant Genetic Resources for Food and Agriculture through its Commission.

The missions of international organization are to achieve sustainable food security and reduce poverty in developing countries through scientific research and research-related activities in the fields of agriculture, forestry, fisheries, policy, and environment. The CGIAR centers and NARS firmly believe that agricultural research can make a significant contribution toward alleviating poverty by improving income generation and food security.

Consultative Group on International Agricultural Research (CGIAR) has 15 centers strategically located all over the world. These institutions have helped ICARDA with its main research station and offices in the region which is responsible center for the region promote strong partnerships with NARS and create effective linkages with other international and regional organizations (Table 2.2.5 a and Table 2.2.5 b) on its mandate for dry lands (www.icarda.org). CGIAR centers.

Biodiversity International (former IPGRI) with its two offices in the region serves the ultimate goal for strengthening of the capacities at national and regional level to achieve an effective conservation and sustainable use of plant genetic resources in collaboration with other CGIAR centers (CIAT, CIMMYT, CIP, ICRISAT and IRRI) have sub-regional offices in the region and carry out activities on plant genetic resources on their respective mandated crops. (www.biodiversity.org).

The International Water Management Institute (IWMI) has also research activities focusing on the sustainable use of water and land resources in agriculture and on the water needs of countries in the region to eradicate poverty through more effective management of their water and land resources through its regional office in Pakistan and subregional office in Uzbekistan for Central Asia Various achievements recorded from the IWMI projects conducted in the region (www.iwmi.org). IWMI also associated with various program such as CGIAR Challenge Program for water and Food (CPWF) and focused attention to basin scale like Nile basin and Karkheh River Basin in Iran (www.waterandfood.org).

With collaboration of the countries in the region, in cooperation with regional and international agricultural research and development institutions, the following achievements are reported in the various regional forums, meetings and reports (www.icarda.org):

1. Strengthening and integration of the NARS through:

Appropriate policies, well defined objectives, clearly defined priorities, qualified research scientists, sufficient and sustained funding, coordination among all NARS's components (research institutions, universities, private sector, non-governmental organizations, farmer associations), effective monitoring and evaluation mechanism, strong linkages between research, extension and farmers, active involvement of farmers in technology development and adoption.

2. Strengthening sub-regional and regional collaborations through:

Promotion of the exchange of scientific information and experiences, transfer of knowledge and technologies within and out side the region, establishment of Networks on CGIAR non-mandated commodities and subject matters, implementation of cooperative research projects based on regional priorities and needs, strengthening cross linkages between national, regional and international centers/organizations assist in the mobilization of financial, institutional and other forms of support to NARSs.

2.2.5.2 Regional organization/Networks:

The networks combine a thorough knowledge of the agricultural conditions of farmers in network member countries, with an understanding of the genetic potential of the crop species in question, and use a "farmers-to-farmers" basis for the development of conservation and utilisation activities. That involves the collection from farmers of locally adapted germplasm, its improvement and its return to the same farmers, or farmers in similar biotopes. The work of several of these networks is also guided by an economic intelligence function (an analysis of market factors), which helps farmers to improve quality and suit their production to market requirements.

Regional networks are mostly organized as both associations and community networks. Most known organizations and network are given below (Table 2.2.5 b). Addition to those of networks

the crop related networks also exist in the region. Global and regional crop-related networks were established, between 1992 and 1995, in close collaboration with FAO Regional Offices and relevant scientific organizations. The innovative aspect of the networks is that they promote a coordinated approach to identifying, evaluating and conserving the genetic variability of selected crop species, with the aim of improving cultivars and their adaptation to farmers' needs (http://www.fao.org/ag/agP/AGPS/cnet.htm).

In country basis, each sub sector of agriculture is well or only by namely organized. Agriculture research usually is the duty of governmental organizations almost in every country. Although national or international private seed companies conduct research in mainly the seed business, this works only cover some profitable crops and a few areas especially in recent years. However, it should not be forgotten the role of Agricultural universities and faculties on agriculture which supplying technological knowledge and educating researchers and extension specialists in the sector. National Agricultural Research Systems is organized differently in each country in CWANA region. Some of them set up regional basis and independent from centralized system which is generally responsible of all problems and cultivated crops of the region or some central institutes include activities in all areas of country which is responsible for one crop or a group of crop such as field crops, horticulture etc.. or is responsible for a specialized areas such plant protection, etc.

Since there are differences in the countries organization and NARS system and their research and follow up capacity and facilities are differs from country to country and effects the contribution to networks.

AARINENA and the Research Forum for Central Asia and the Caucasus co-sponsored by FAO**,** ISNAR and ICARDA are now the major regional agricultural research and development networks in CWANA. They play an important role for the region within the Global Forum for Agricultural Research.

The Central Asia and Trans-Caucasus Network on Plant Genetic Resources (CA-TCN/PGR, established in 1996), The West Asia and North Africa Network on Plant Genetic Resources (WANANET, established in 1992) are two active networks in the region for the collection conservation and sustainable utilization of unique agrobiodiversity of the region. The other regional network for rangeland seed information was established in the region, with two sub-regional nodes: the Mashreq countries (Iraq, Jordan and Syria) and the Maghreb countries (Algeria, Morocco and Tunisia).

The WANA Seed Network is one of the strong network established to support the development of a strong seed sector in member countries is to enhance cooperation, exchange of information and create a forum for consultation to share existing experiences, expertise and resources for seed program development in the region. The Network acts as a catalyst for harmonization through policy, regulatory, technical and institutional support to promote regional seed trade. It also aims to improve contacts with the various international organizations with interests in seeds and to promote their activities within the region (www.icarda.org). The WANA Seed Network has 19 member countries, namely - Algeria, Cyprus, Djibouti, Egypt, Ethiopia, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Pakistan, Oman, Saudi Arabia, Sudan, Syria, Tunisia, Turkey, and Yemen. This network links to several regional or international organizations dealing with

agricultural and/or seed sector development such as the International Seed Testing association (ISTA), the International Seed Federation (ISF), the International Union for the Protection of New Varieties of Plants (UPOV) in addition to development agencies such as FAO, GTZ and the Arab Organization for Agricultural Development (AOAD) (www.icarda.org).

The benefits of collaborating on genetic resources conservation and use have brought many countries together in partnership over the years. Bioversity (former IPGRI) has worked to develop networks that link the plant genetic resources activities of national programmes, research institutes and others in the region. The Central Asia and Trans-Caucasus Network on Plant Genetic Resources (CA-TCN/PGR, established in 1996), The West Asia and North Africa Network on Plant Genetic Resources (WANANET, established in 1992) are two active networks in the region for the collection conservation and sustainable utilization of unique agrobiodiversity of the region.

The crop and regional networks are also function related to agrobiodiversity protection. The Central Asia and Trans-Caucasus Network on Plant Genetic Resources (CA-TCN/PGR, established in 1996), The West Asia and North Africa Network on Plant Genetic Resources (WANANET, established in 1992) are two active networks in the region for the collection conservation and sustainable utilization of unique agrobiodiversity of the region. The other regional network for rangeland seed information was established in the region, with two sub-regional nodes: the Mashreq countries (Iraq, Jordan and Syria) and the Maghreb countries (Algeria, Morocco and Tunisia). Turkey is also member of European Cooperative Program for Plant Genetic resources (EC/PGR) (www.bioversity.org).

Case Study: Turkiye

Turkey is one of the leader countries and has the largest arable land and agricultural population in the region. Although agricultural education and research was started in 80 years ago, agricultural communities were set up in last 50 years. However, although farmer chambers were established firstly in 1881, they activated mainly after 1960s. Similarly, Agricultural credit cooperatives were set up firstly in 1930s, but they mainly started to act effectively in 1950s. However, Turkey is finished all organized process of agriculture legally in recent years. Some important laws such as agricultural grower association's law, insurance law, etc. already passed from Turkish parliament. However, it will take time to initiate exactly on the process.

Agriculture organizations are divided by sub sectors and these associations are given below in Agriculture sector. However some of them are serving only as one association which covers all country such as TUBID, TURKTED, etc… both some of them are serving in each county of different part of Turkiye and they have top central organization in Ankara such as Turkish Farmer Associations, Agricultural Credit Cooperatives, etc..

Farmer Community in Turkiye hasn't reached the expected level yet at present. The biggest and the most widespread farmer organization in Turkiye is the Turkish Agricultural Chambers Union (TZOB) and it has got a representative office in all the provinces and big counties. The organization especially deals with the maintenance of the cheaper agricultural inputs, crop support programs and subventions.

The Extension services are serving under the Ministry of Agriculture and Rural Affairs (MARA) in each province and each county in these provinces. Additionally, some agricultural cooperatives

which focus on one crop or crop group are serving in Turkiye. In addition to TZOB, there are some farmer unions given in Table 2.2.5 c.

Agricultural producer organizations in Turkey can be classified in 3 broad categories, namely cooperatives, producer unions and agricultural chambers. General information regarding the Agricultural Producer Organizations by main types is presented in Table 2.2.5 d.

There are over 700 Agricultural Chambers with approximately 4 million producer members. Their main roles are; to provide vocational services in order to carry out the development of agricultural sector in accordance with sectoral targets and objectives, to provide the common needs of farmers, to facilitate the vocational activities and to represent the farmers. These organizations are established;

- Specialized in certain products or product groups, and
- On the basis of provinces or districts.

As the legal framework for these organizations are recent, the number of unions and the number of their members are rather low, but showing a strong tendency to increase. Besides, applicant agricultural cooperatives, which fulfill the requirements for a producer union, can be registered as Agricultural Producer Unions.

There is also a Milk Producer Central Union having 7 member Milk Producer Associations.

Agricultural Credit Cooperatives are organized with a central association, 16 associations and have approximately 1.5 million members. Agricultural Cooperatives are composed of Agricultural Development Cooperatives, Irrigation Cooperatives, Fisheries Cooperatives and Sugar Beet Cooperatives. The Agricultural Development Cooperatives have activities mainly related to production and marketing including crops, livestock and husbandry. These are commonly multi-purpose organizations and generally are not specialized in a certain product or product group. Therefore, regarding their activities no accurate figures can be provided on the main agricultural sectors or on product groups.

Agricultural Sales Cooperatives and Associations (ASCAs) are generally specialized in crop products processing and sales. The Agricultural Sales Cooperatives purchases the products of their members. The unions take all the necessary measures for these products to be utilized in best circumstances. Besides, these agencies are operating on the issues of storage, standardization, first processing (processing at unions), transporting, packaging, export and sale in domestic market of the finished and semi finished products, provision of all the requirements that are in the character of the input about agricultural production activities, supporting of shareholders with credits, implementation of the insurance services for the producers.

The cooperatives can construct storage houses in order to store their products more efficiently and to get them to ready for the whole or retail sales. They can also construct their packaging facilities with the establishments having the right of the first processing and they can acquire the economic enterprises regarding the other production phases other than these. The cooperatives are to operate in line with the principles and bases identified by the union on the construction of these facilities and enterprises and their settlements as well.

In addition to these, there are some small local farmer unions and cooperatives. Government, during the recent years started to enhance the farmers', becoming organized and put forward

some legal regulations because of this. On the other hand, some special subject group or profession associations also are established too (Table 2.2.5 e).

2.2.6 Agricultural risk management policies, including drought risk

Agriculture is generally regarded as one of the most risky activities because of the price inelastic nature of demand and short run supply and its exposure to natural shocks[7]. In the CWANA region agricultural risks have an additional dimension related both to extremely variable climate conditions and to recent economic changes (liberalization), which have a profound effect on farms' operations. Worldwide, both economic and ecological changes (degradation of natural resources, rarefaction of water resources, pollution, climate change) have prompted additional attention to the subject of risk. Also, interest in strategies and tools for managing market risk has increased in recent years.

These strategies, some of which are based on widespread government intervention, allow the risks faced by farmers to be reduced. In the context of agricultural policy reform in CWANA region, particularly in North Africa and the Near East, new instruments, including insurance programmes, are put in place in order to allow farmers to effectively manage agricultural risks. This section first examines the diverse types of risks affecting agricultural activity in CWANA region. It then analyses the diverse types of risk management strategies deployed at farm level in order to reduce household income variation. It finally focuses on the development of agricultural risk management policies in the region.

2.2.6.1 Main risks affecting agricultural activity in CWANA

The diverse types of risks affecting agricultural activity in the CWANA region are (a) production risks, related to whether conditions, including drought, and to pests and diseases, (b) ecological risks resulting from the management of natural resources, such as water, and (c) market risks related mainly to output and input price variability, but also to the requirements of particular markets, such as quality and safety requirements of export markets, (d) institutional risks linked to state intervention.

In the CWANA region, agricultural production risks are mainly related to whether conditions. In fact, although including a great diversity of climatic conditions and natural environment, the CWANA region is generally characterized by very low and highly variable annual rainfall and a high degree of aridity. In the largest part of the CWANA region, especially in North Africa and the Near East, drought is a structurally recurrent phenomenon, resulting both from physical determinants and socio demographic factors. Increased cultivation of marginal and fragile arid lands, soil erosion and runoff exacerbate the region's vulnerability to drought and often lead to irreversible damage of farmland, i.e. desertification.

In recent years most countries of the region experienced severe drought episodes and consequently growing water shortages. In North Africa, in the Near and Middle East as well as in countries such as Afghanistan and Pakistan, recent reports of the Intergovernmental Panel on Climate Change (IPCC) confirm some global warming in the region and indicate that the water

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scarcity, which constitutes already a major constraint, may worsen substantially as a result of future changes in climatic patterns[8].

As a consequence of continued drought conditions between 1999 and 2001, most countries of the region (Algeria, Morocco, Tunisia, Turkey, Jordan, Iran, Gulf countries, etc.) have seen an important decline of their agricultural output, especially cereal production and livestock.

Drought has also adversely affected the livelihoods of large fractions of the rural population, especially that of dry-land farmers and of nomadic livestock owners (in Iran in particular). FAO report on the state of food and agriculture (FAO, 2002) indicates that the incidence of poverty in the region went up significantly towards the end of the decade as a consequence of the drought period, with an increase of the proportion of the population living on below $2 per day from 25 percent to 30 percent.

The unpredictable and variable climatic conditions prevailing in the region, as well as the different farming practices used, contribute also to aggravate the risk of disease and pest epidemics across CWANA. Pests, including Sunn pest, Hessian fly, and cyst and root lesion nematodes significantly damage cereal production. For this reason, the development of disease- and pest-resistant wheat varieties has been a key strategic component of breeding programs to improve food security across CWANA.

Agricultural production in CWANA is also increasingly threatened by the development of exotic pests such Peach Fruitfly (*Bactrocera zonata),* Red Palm Weevil *(Rhynchophorus ferrugineus)*, Bayoud Disease of Palm (*Fusarium oxysporum fsp. albedinis*) among others, indicating a lack of adequate Phytosanitary controls in the region.

Animal diseases also represent a major threat for livestock production in CWANA. In addition to screwworm infestation, at least three animal diseases have major economic impacts in the region, especially in North Africa, the Middle East and the Arab Peninsula: Foot-and-mouth disease, rinderpest in the Middle East, including Egypt and the Sudan; and brucellosis, endemic in the whole region.[9] These animal diseases are very seriously affecting the livestock production potential in the region and their elimination would require the implementation of well-focused pest and disease control operations, which are still lacking in most countries of the region.

In the CWANA region agricultural risks are also related to the management of natural resources, such as water. The region's irrigation systems are under considerable environmental strain, with almost all countries experiencing problems with salinity and waterlogging. A major concern is the overexploitation of groundwater, particularly in the Persian Gulf region (FAO, 2002). The current water crisis prevailing in the region calls seriously into question the sustainability of irrigation systems in most countries.

Drought and water scarcity prevailing in the region are also placing substantial strains on the environment, causing significant damage to the region's biological diversity, including both animal and plant species. As FAO report points out “wildlife has been severely affected as a result of the shortage of drinking water, lack of feed, dried wetlands and degradation of wildlife habitats. (…) in the Hamoun wetlands of Iran, which are of international importance, aquatic life

[8] ibid
[9] IFAD. Livestock and Rangeland related Technical Assistance Grant.

has disappeared. Herbivores are among the first animal species to be affected by a lack of feed. Dryness of wetlands and natural lakes has also occurred in Morocco, as well as other countries of the region, causing similar and probably irreversible environmental damage. In Jordan, the continued drought during 1999 and 2000 caused visible damage to the natural and artificial forests…" (FAO, 2002)

Risks affecting agricultural activity in CWANA are increasingly resulting from rapid changes in the organization of inputs and output markets. Although a large fraction of the farming population in CWANA still practices subsistence agriculture where farm household's production is barely sufficient for own consumption and where market risks are clearly not important, the increasing integration of farm producers of the region in national and international markets submit the latter to growing risks resulting from price instability. Markets risks faced by farm producers in CWANA are related to a diversity and combination of factors, including poorly organized national marketing circuits, important increase of input prices and production costs, state intervention in pricing of basic food products, difficult access to export markets due to growing competition for specific products (fruit and vegetables in particular) and increasingly severe safety and quality requirements, etc.

2.2.6.2 Risks management at household level (aimed at reducing farm household income variation)

In view of the extremely variable climate conditions prevailing in the region and of the dramatic changes which have affected agricultural policies in relationship to processes of economic liberalization, farm producers of the region appear to be particularly vulnerable both to climate and economic risks[10]. In this highly risky environment, farm households develop a number of strategies aimed at mitigating risks and reducing family income variation. Two types of strategies are usually distinguished: ex-ante risk management strategies and ex-post coping strategies (Dercon, 2000). The former attempt to affect ex-ante the riskiness of the production and income process. They involve crop management, technological choice, diversification of income sources (spreading risks among activities), market strategies. Risk coping strategies deal with the consequences (ex-post) of production and income risk. They involve self-insurance, through precautionary savings, informal insurance mechanisms, such as kin-based risk-sharing and informal credit. Risk-coping strategies may also involve attempting to earn extra income to compensate losses, selling livestock, and making use of government aids.

In CWANA, drought is by far the major risk faced by farm households. Recent drought episodes have seriously affected dry-land farmers and herders, resulting in severe loss of income through the loss of harvests and partial loss of flocks. Sales of animals and off-farm activities are among the most common strategies adopted by households to cope with drought events. Loss of harvests pushes also farmers to rely increasingly on purchased animal feed to avoid further decapitalization of livestock. Harvest losses make it also necessary for farm households to recourse more importantly to short-term bank credit or informal credit in order to meet farm

[10] Risk can be defined as the product of hazard and vulnerability.

operational production costs of the following year, which results for them in increased indebtedness.

Income fall consecutive to drought lead also small farmers to give out their lands to share-croppers, which is a way to cope with the lack of resources and at the same time to secure an access to part of the expected farm production. Small farmers rely also importantly on state aids such as seeds and animal feed distribution to reduce the hardship caused by drought.

In period of hardship, family networks are also mobilized by farm households. They allow transfers of money from family members working in urban areas or abroad. These coping strategies however are not available for all farm households. The same holds for off-farm work opportunities, which have tended to decrease in most countries of the region as a consequence of processes of economic restructuring.

Among ex-ante risk management strategies available to farmers in the CWNA region, diversification of farm production play a very important role in farmers' attempt to reduce climate and economic shocks. In fact, most farmers, namely in the Maghreb countries, combine livestock activities (mainly small ruminants) with cereal crops and olive trees. In this production system, livestock allows for a better management of the farm treasury (through the sales of animals for the financing of farm inputs and household expenses).

In addition to combining livestock and crop cultivation as a way to minimize risks, farmers in semi-arid areas usually diversify animal production. Multiple species herds represent a way to spread risks, to make a better use of available resources and to reduce farm expenses through the integration of low-cost productive activities.

Income diversification through off-farm activities (wage labour, small trade, etc) is also a major risk management strategy used by farmers of the region. This is particularly the case of small and medium size farmers in the Maghreb countries and the Middle-East, where pluri-activiy rates among farmers are very high (almost 45% of Tunisian farmers have an off-farm activity). However, in the Maghreb countries, off-farm activities, which not only represent a major risk management strategy, but also have constituted an important mechanism for funding and developing agricultural activities, have become rather "scarce, in the new national and international context due to emigration controls, decrease of national demand in non skilled labour, and high unemployment…" (Alary and al., 2005).

Ex-ante risk management strategies used by some groups of farmers in CWANA include also crop management and the use of improved farming techniques, including the use of improved crop varieties (drought resistant varieties), fertilization and pest management, which enables the increase of production yields or contribute to minimize the risk of production failure. However improved varieties tend to be more vulnerable to moisture stress and pests and to do better in assured rainfed or irrigated environments. The use of new technologies generates also environmental risks, such as pollution, and carry some long-term risks in terms of soil depletion and genetic uniformity (Ramaswami, 2003). This type of risks are increasingly affecting farming activities in highly intensive production areas of the region, but farmers' awareness and management strategies are still lacking

In several areas of the region, ways of minimizing risks at farm level include the development of irrigated farming, which contributes to stabilize yields and allows for the development of more

intensive and more profitable production systems. This is expressed in the important development of surface and underground irrigation facilities, which in several countries of the CWANA region leads to an overexploitation of available water resources and contributes to increasing the risk of soil degradation.

In fact shift from dry-land farming to irrigated farming, which represents a way to minimize risks related to climate conditions, can generate new types of risks for farmers, among which environmental problems, as well as risks related to the necessity to rely increasingly on the credit system, to the use of new techniques or to the necessity to integrate into collective water management systems, and finally to new forms of integration into the agricultural market (insufficiently organized marketing circuits, price instability, etc.)

In view of the fact that markets for horticulture products are liberalized in most countries of the CWANA region and that they remain poorly organized, farmers, especially small and medium size ones, are usually very vulnerable to market related risks. These risks can also be aggravated by state interventions geared towards maintaining low food consumptions prices (namely through the import of fruits and vegetables).

In several irrigated farming areas of the CWANA region, in Morocco and Tunisia, a large numbers of farmers have ceased to practice irrigation because of the difficulty (Gana, El Amrani, 2006) to sell their products at profitable prices and have thus returned to dry-land farming. Some of them have shifted the use of water from horticultural products to cereal products and forage. Cereal crop cultivation benefits in fact from more stable producer prices, as these are most of the time state controlled. With this respect, the high variability of market prices, for products such as fruits and vegetables, which is also due to the weakness of farmers' organizations, appear to be a major hindrance to the development of high value cropping systems in the region. This explains the fact that risk management strategies favoured by a large number of farmers consist in maintaining cereal crop cultivation, even if they have the possibility to diversify or to develop alternative production systems.

We should mention however that a growing proportion of farmers in intensive irrigated farming areas (Morocco, Tunisia, Egypt) have found in forward contracting a way to reduce market related risks.

Among livestock producers, risk management strategies vary considerably according to the size of the farm operation. Ex-ante risk management strategies can be based on the integration of cropping and livestock systems, through the cultivation of forage crops. These strategies are mostly available for medium and large size farmers in favoured climatic areas. In dry areas herders are often constrained to resort to the market for concentrated and forage supply, where prices are very unstable, and are thus very vulnerable to market shocks.

Finally, ex-ante risk management strategies at farm level include crop insurance schemes, which are mostly available for farmers who are integrated in the bank credit systems (*to be developed).*

2.2.6.3. Agricultural risk management policies in CWANA

Despite the strategies put in place by farm household to mitigate risks, vulnerability remains high and is reflected in fluctuations in production and consumption and poverty. The State has thus to intervene in this highly risky environment. Governmental intervention can take different forms:

price support programmes, credit policy, natural resources management policy, promotion of technical change, development of insurance schemes, safety net programmes, etc.

In the CWANA region, recent drought episodes have pushed most countries to implement a range of measures and policies to limit the social and economic damage from drought. The policy applied for example in North Africa (Morocco), the Near East (Jordan) and West Asia (Iran) consists of establishing a national drought programme to be monitored by an intergovernmental committee (National Drought Task Force), headed usually by the Ministry of Agriculture. This political decision-making body proposes a package of emergency measures to be implemented and funds are made available to ease the adverse impacts of the drought and to assist affected rural populations. Emergency measures include emergency purchase and distribution of concentrate feed to livestock owners, seeds distribution, veterinary prophylaxis measures, water development and well-sinking for people and livestock, special access to credit, debt relief or agricultural tax relaxation and creation of job opportunities [11].

However, while these measures have helped to mitigate losses of animals from drought, they have been financially costly, and where they have involved untargeted distribution of subsidized supplementary feed to livestock, they have tended to benefit the larger flock owners most. FAO report stresses out: *"Moreover, they have created dependencies on feed supplements and have encouraged the maintenance of larger numbers of animals on the rangelands for longer periods each year, thus accelerating resource degradation. Consequently, the contribution of the natural grazings to total feed supply has fallen dramatically in nearly all M&M countries, while concentrate feed use has escalated*". (FAO, 2002)

In general, drought management and mitigation interventions in the region consist mostly of short-term drought relief operations. Drought early warning systems are virtually nonexistent and national-level integrated drought monitoring are not operational in the region. In general, there is limited coordination of information from sources, such as water supply or irrigation authorities, agricultural extension services, meteorological departments, about the extent and impact of drought (DePaw). And yet this coordination of information is essential for the establishment of drought monitoring systems[12]. Hence, there is an urgent need to establish national plans to manage drought in a more comprehensive and consistent way and to move from reactive drought crises management to pro-active drought management policies, where drought would be treated both as an integral component of the production function, and as a structural feature of the climate (to be elaborated).

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[11] "For the 2000 national drought relief programme in Morocco, the government earmarked around $650 million for drought relief and mitigation activities for the period April 2000 to July 2001. This important core fund accounted for one-third of the country's entire annual investment budget. The fund was disbursed to the various components as follows: 9.4 percent for drinking water, 19.4 percent for livestock feeding and sanitation, 60.5 percent to create jobs in rural areas, 4.5 percent to stabilize the market prices of cereal grains, 3.8 percent to limit forest degradation, 1.8 percent to cover agricultural credit forgiveness and the remaining 0.5 percent for communication and public awareness"(FA0, 2002)

[12] DePaw reports that the government of Morocco has established an entity for drought monitoring, the « Observatoire pour le Suivi de la Sécheresse », which is permanent coordinating body with a legal status and madate, and with a small multidisciplinary core staff, drawn from different ministries.

Besides drought management, agricultural risk management policies in CWANA include a wide range of programmes and measures: programmes aiming at improving crop management and animal production techniques, crop and animal protection programmes, development of irrigation facilities and water management programmes, price support programmes, (in particular guaranteed purchase prices for grains), input subsidy programmes, which have tended to decrease substantially in recent years, development of credit and insurance systems, safety nets programs.

These measures and development programmes are unequally implemented in the region and substantial progress is needed in risk management policies:

In the area of animal protection, risk management measures differ between North Africa, the Middle East, and Central Asia, due to different epidemiological situations. In Central Asia, the diagnostic capacities of epidemiological situations remain limited. The cattle population is the main target of preventive vaccination and is used more as a tool for preventing the economic loss due to the disease than as a means to prevent the spread of the infection. Turkey and Iran, also vaccinate small ruminants in specific areas to prevent introduction from neighbouring countries.

In North Africa, the management is more focused on emergency preparedness and limitation of the diffusion of the disease when it is diagnosed. Effective control measures based on quarantine and mass vaccination are used. Vaccinate campaigns target the cattle population in Algeria and Morocco, both cattle and sheep in Tunisia.

Still, animal diseases are very seriously affecting the livestock production potential in the region and their elimination would require the implementation of well-focused pest and disease control operations, which are lacking in several countries of the region. [13]

Another important policy area aimed at reducing agricultural market risks is food safety and quality. In several countries of the region, initiatives have been taken to reform and improve food control systems: development of a national strategy for food control (Morocco, Tunisia), implementation, development of a food legislation complying with international requirements (Cyprus, Egypt, Jordan, Lebanon, Morocco, Oman, Pakistan, Sudan and United Arab Emirates), review and update food standards and regulations (Islamic Republic of Iran, Sudan and Syria). A number of countries have harmonized their food standards with Codex, and have introduced quality assurance systems (Tunisia).

Despite the efforts made by several countries to improve food control systems and to harmonize national food regulations with international standards, often with the support of FAO, further progress needs to be made to increase the efficiency of food safety systems, first in order to meet national public health requirements (for locally produced and imported products), and second in order to meet the food quality and safety requirements of export markets.

[13] A regional animal disease information and surveillance network system (RADISCON) is being promoted by FAO and IFAD in the Region. RADISCON is a mechanism to enhance the quality of national and regional surveillance system and the exchange of information between the neighbouring countries.

What is thus at stake for most countries of the CWANA region is the design and implementation of a comprehensive and pro-active risk policy, which would include and coordinate the following elements:

- Establishment of drought early warning systems
- Development of crop insurance schemes (only available in a few countries)
- Improvement of public investment in public works, in water management, in agricultural research and extension
- Implementation of policies that protect the environment and discourage cultivation of marginal land
- Reinforcement of marketing systems and promotion of farmers' organizations.
- The development of new and improved food safety systems (complying with food safety standards in export markets

2.2.6.4. Drought risk management in CWANA

Drought is a recurrent phenomenon across CWANA Countries. It is one of the most complex and least understood natural disasters. The beginning and end are difficult to forecast. Droughts unfold in a non dramatic manner and yet their consequences are devastating. They have a severe effect on the populations concerned and weigh heavily on all economic activities; particularly in rainfed and irrigated agriculture. The phenomenon has a negative influence on aquatic and land ecosystems as well as on the quantity and quality of underground and surface water (salinization).

Helped by regional and international organizations, are putting into place various strategies to combat droughts. They may be divided into two groups:

- Major works focused on improving countries hydraulic equipment to collect and store water. Rural water and soil water conservation development programs, range improvement schemes.
- The organization of institutional structures focused on fighting drought. The objective of these structures is to integrate the risks of "drought" into economic planning and to give rural zones the means to resist drought. They must have decision making tools to initiate emergency programs as soon as a drought is detected.

Hydraulic equipment and the fight against drought

During the 1970s and 80s, significant efforts were made in the entire region under study to construct large dams (see § 2.1.4). Preference currently is given to small and medium scale hydraulic works (Albergel & Rejeb, 1997). In Tunisia, for example, out of a potential 2,100 million cubic meters/year of surface water resources that technically could be collected by dams, 1,425 million are so (Selmi & Nasri, 1997).

These works allowed an agricultural revolution in some countries of CWANA region. The three years drought (1993-1995) was overcome in Tunisia without rationing water to agriculture, towns, tourism or industry because the hydraulic infrastructure was well dimensioned for the country needs. On the contrary, Afghanistan is facing important food crisis each year when inadequate rainfall happens in winter or during the months of April and May. FAO assesses that 6.5 million people are seasonally or chronically food insecure in this country because the lake of adequate hydraulic infrastructures. In 1999-2000, Afghanistan has been hit by a serious drought as a

consequence of low rainfall and snow melt over the winter of 1999/2000. Central and South-Eastern Afghanistan have been the worst affected, with the drought reaching crisis proportions in specific localities where the population has resorted to eating wild grasses and roots and where deaths have been reported (Mardsen, 2000). Six years after, in 2006, as a consequence of strong deficit in rain during spring, the Islamic Republic of Afghanistan and the United Nations are requesting assistance to the value of US$ 76,391,754 to face the existing humanitarian needs and to limit further negative effects of a continuing drought (UN, CAP 2006).

The Achilles heel to a policy based on reservoirs for managing drought risks is the high evaporation rate in these regions and, in particular, the quantity of sediments that fill the dams each year. It is estimated that in Morocco, 9 billion cubic meters evaporates every year, or 33% of the 30 billion cubic meters of rainfall measured. Global experience evaluates a dam's annual volumetric loss rate due to silt to range between 1 and 10% (Karouachov, 1977). In Tunisia, large dams have an average volumetric loss of 25 million cubic meters per year, or approximately 2%. For small dams, the volume lost is 5% (Boufaroua et al, 2000). By 2020, numerous countries in CWANA region must manage a post-dam period. This post-dam period is already a problem in Algeria.

To reduce the silting up of dams and the loss of agricultural land, countries have launched water and soil conservation policies.

Today, water storage in aquifers seems to be the most appropriate solution to combat dry intervals. It protects stocks collected during excess years from evaporation. The reservoirs do not run the risk of shrinking in size. The only risk is pollution by solutions that are not stopped while traversing the porous environment during the infiltration phase. Numerous countries have converted some dams to refill ground water resources. The El Aouareb dam on the Merguelill in Tunisia now is managed essentially to release water in order to refill the water table in the Kairouan valley downstream. This experiment, which interests all of the countries in the region, is monitored within the framework of the research network, 'Wadi Hydrology', of the International Hydrological Program (IHP, UNESCO).

The karstic systems of limestone rocks also show potential for storing water. The Figeh source, which supplies some potable water to Damas, has a flow of 20 to 30 cubic meters per second in winter and only 3 cubic meters per second in summer. The plan is to stock the winter surplus (when demand is only 15 cubic meters per second) in the subsoil (source ACSAD). A technical study of this topic is now underway and more scientific research is proposed in the framework of the European Union's INCO-MED project.

<u>Institutional reinforcements</u>

From past experience, emergency programs to be implemented in case of drought should revolve around the following points:

- the provision of potable water to cities and to the countryside and the supply of water to livestock;
- the safeguard of livestock based on knowledge of the forage deficit;
- financial support for farmers most affected by the drought and the provision of seeds with the following campaign in mind;
- increased employment in the countryside. One of the major social risks of drought is

rural exodus due to the fall in agricultural revenues and the drop in seasonal employment on farms. The extent of agricultural exodus (abandonment of agricultural activity by families who remain on their farms) with recourse to off-farm activities is an important phenomenon that has been noted in the Maghreb today, particularly in Tunisia. It has replaced the massive rural exodus (abandonment of land) during the 1970s (Aït Amara, 1990; Guillermou, 1999).

To plan and implement these programs, governments put in place structures to forecast and/or identify droughts. To make decisions, they must have access to diverse, reliable forms of data that are sufficiently processed to be interpreted by decision making bodies.

Such information is of two types: forecasts and observations. Forecasts deal with climatic trends, precipitation and evaporation, water resources that are available and collectible, grazing ranges and harvests. Observations are made at the first sign of the phenomenon and deal with the state of the crisis in each region and on the efficiency of the measures implemented; they must be made during the entire drought period for lessons to be learned for the next ones.

In a FAO study on planning anti-drought strategies in Morocco, M. Bernardi (1996) recommends a four level structure where the roles of each entity are well defined:

- a base level including the information providers who regularly monitor key indicators and forecasts (Agro-meteorological Committee on Drought Monitoring);
- a second level at which the impact of the drought on different sectors in the socio-economic life of the country is determined (Drought Impact Evaluation Committee);
- a third level at which authorities propose measures based on the information received (Drought Monitoring Cell);
- a top level of the Prime Minister's Cabinet who, in coordination with the Planning, Finance, and Agricultural Ministers, authorize emergency actions and propose to the government medium and long term intervention plans in order to mitigate the effects of the drought.

The strategy program depends on the first level, the level where tools remain the least effective and to which AKST could contribute greatly:

- Long term forecasting. Reliable information on the quality of the seasons to come would facilitate the preparation and execution of the best policies to combat drought, and the investments needed to mitigate its effects should be foreseen in advance by mobilizing international support.

Long term forecasting always is difficult and remains at a continental and regional scale. Although the greenhouse effect has been noted and the global rise in temperatures is undeniable, there is today no certitude concerning precipitation. On the northern shores of the Mediterranean, numerous programs were started to research the consequences of global warming on water flows and on their new distribution between different compartments of the water cycle (European environmental research program).

- Medium term forecasting. Medium term forecasting is the one for which there are the greatest expected benefits. These benefits refer to the improvement of tools such as rapid alert systems, the rationalization of planning for strategic cereal reserves and the improvement of exchanges of foodstuffs between countries in the region. For the first time, this gives governments the possibility to integrate climatic variability into economic management processes (Bernardi, 1996).

This forecasting becomes particularly reliable on hydraulic infrastructure thanks to meteorological, hydrological networks, and to different observatories of agricultural production and ranges. At this scale, WMO, UNESCO, and OSS programs encourage the sharing of information and of forecasting: Med Hycos program, AMHY program, and the environmental observatories of the ROSELT program.

- Short term forecasting. Forecasting during the season underway is of fundamental importance to the improvement of forecast models for the filling of dams, the level of underground water tables, and crop yields. Better performing models, with high resolution at both the spatial and temporal scale, could furnish more reliable information during a season. This information, integrated with others such as the zonage and use of lands, is at the base of an early alert system.Progress in satellite imagery and in geographic information systems has contributed greatly to the development of these models.

2.2.6.5. Environmental Policies and Regulations

Environmental problems in the CWANA region have several dimensions: desertification, deforestation, rarefaction of water resources, pollution, and development of disease and pests epidemics. They result from human activities, technical change and climate change. Global warming could bring about drastic changes in the location of the world's agro-ecological zones and destabilize weather patterns, leading to an increase in the incidence of severe disasters (droughts etc.).The environmental problems of intensive and high input agriculture are recognized globally. In the region main AKST related environmental problems are linked to farm mechanization, resulting in soil erosion, to the irrational use of chemical inputs and pesticides resulting especially in water pollution, to the development of irrigated farming resulting in overexploitation of ground water and salinization.

The increased awareness of environmental sustainability challenges has led to the development of environmental regulations and policies, which however are unequally implemented according the countries. In several countries, measures are taken to diversify agricultural practices and to improve the efficiency of resource use. Crop diversity will supply useful traits, and diversity of species can provide alternative crops that offer options for agricultural diversification.

Crop diversity provides the raw material for breeding new varieties of crops that can adapt to climate change. It can also provide the basis for new, more flexible production systems that are better adapt to stresses like drought or salinity and can reduce the potential for soil erosion. Crop improvement solutions to the challenges posed by pests and diseases can also help reduce the use of chemicals. A more environmentally friendly agriculture requires the use of varieties and species that can grow with reduced fertilizers, pesticides and other agrochemicals. This suggests a shift in emphasis in breeding programs from yield alone and may require ***a re-thinking of crop breeding strategies***. Among many things, it will require that farmers and breeders have access to a wider range of crop diversity--including traditional varieties--as sources of useful genes and genotypes for new crop varieties.

Organic farming is generally more environmentally friendly than conventional agriculture but may require a well planned policies and regulations to meet the requirements of organic farming, such as organic farming information, standards, certification and labelling, purchasing fertilizers, pesticides and animal health care products etc. The application of organic farming exists in some

CWANA countries, like Egypt, Tunisia, Morocco, Palestine and Lebanon (http://www.earthfuture.com/economy/sekemegypt.asp), Turkey (Aksoy, 1999; Kenanoğlu and Karahan, 2002).

2.3 HISTORY OF PUBLIC AND PRIVATE SECTOR INVESTMENT IN AKST

2.3.1 Investments in Agricultural Research and Development

The investment and institutional environments of agricultural research and development (R&D) are undergoing rapid changes. Growth in public spending on agricultural R&D in some countries has slowed, for others it has stalled, and for some it has actually declined. In addition to the changes in public research, private sector investment in agricultural research has grown in few CWANA countries, Jordan and Sudan.

Despite these rapid changes, there is a shortage of information and policy analysis to inform and guide the institutional and policy changes that are underway in many countries in CWANA region. Research is particularly lacking on public policies that can improve the funding, performance, and impact of public and private agricultural science and technology institutions, including their productivity, environment, and poverty consequences.

Investments in agricultural R&D is predominantly undertaken by public agencies in all CWANA countries. A part from Jordan and Sudan, the role of private sector investments does not worth mentioning, if not available at all. In Jordan, only 6 percent of agricultural R&D is done by private sector, mainly in high-value crops and fruit trees. Whereas, in Sudan, private investments account for 8 percent, mainly in sugarcane production and processing.

Among public agencies, the majority of agricultural R&D investments is conducted by research institutions. The rest of public investments is undertaken by higher-education institutions (Table 2.3.1 a). In Syria, for example, nearly 83 percent of public investment is done by research institutions, and the remaining (17 percent) is invested by the agencies of higher education. In Morocco, on the other hand, the contribution of higher education investment is as high as 36 percent, with the major research investment (64 percent) is conducted by research institutions. In poorer countries (Ethiopia, Eritrea and Mauritania), the public agricultural R&D expenditures is predominantly undertaken by the research institutions. The contribution of higher education to total public research investments is minimal in these countries.

Similar pattern of research staff allocation is evident between public agencies and private enterprises and between research institutions and higher education. The majority of researchers are allocated in public research institutions (Table 2.3 a).

2.3.2 History of Public Agricultural Research

Detailed historical information on agricultural R&D for all CWANA countries is not readily available. The information in Table 2.3 b for selected countries indicates that agricultural research in Tunisia, for example, began over a century ago. Formal agricultural R&D began later in other countries.

2.3.3 Human Resources in Public Agricultural R&D

During the last three decades the number of agricultural research staff in many CWANA countries grew steadily, for up to more than 2.0 percent. Likewise, the quality of research staff has improved considerably over the last years.

In Jordan, nearly 61 percent of the 245 fte researchers had undertaken postgraduate-level training, and more than one-third held a doctorate degree. This was slightly lower than the corresponding shares in other CWANA countries such as Morocco and Tunisia, where share of

postgraduates were over 90 percent. In contrast, only 25 percent of the agricultural research in Syria held MSc and PhD degrees (AST1, 2006).

Despite a rise in the number of women pursuing scientific careers worldwide, female researchers still tend to be underrepresented in senior scientific positions. In 2003, nearly 13 percent of fte researchers in Jordan were female. This is low compared with corresponding ratios in other countries, such as Morocco (18 percent), Syria (23 percent), and Tunisia (28 percent). In terms of qualifications, women represented 5 percent of researchers with doctorate degree, 17 percent of those trained to the MSc level, and 19 percent of researchers with BSc degree. In Syria, 23 percent of all the fte researchers employed in the public institutions in 2003 were female, including 5 percent of all researchers holding doctorate degree, 36 percent of those holding MSc degree, and 26 percent of those with BSc degree (Table 2.3 c).

The quality of agricultural staff in Ethiopia (measured as the share of PhD and MSc holders) was relatively low compared with other African countries. In 2000, slightly more than half of the 728 fte researchers had postgraduate-level training. While less than 10 percent held PhD degree. The female researchers share also low compared with regional averages. On average, 7 percent of total research staff were female, with female researchers holding BSc and MSc degrees dominate (14 and 5 percent of total research staff, respectively). The average share of female researchers in Ethiopia ranked second-lowest for the selected countries, following Eritrea at 4 percent.

In Sudan, 79 percent of the 591 fte researchers had postgraduate-level training and one-third held doctorate degree. In 2000, nearly 28 percent of the total fte researchers were female, including 17 percent of all researchers holding doctorate degrees and 26 percent of all researchers trained on the MSc degree.

In 2002, approximately 91 percent of the 362 fte researchers in Tunisia were trained to the postgraduate level and 70 percent held PhD degrees. By comparison, 34 percent of agricultural researchers in Morocco held PhD degrees in 2002. Tunisia's particularly high PhD share partly results from the fact that the minimum qualification required for researchers in Tunisia's higher-education institutions is an MSc (AST1, 2006). On average, 28 percent of all agricultural researchers were female. This is considerably higher than the 2002 shares for Morocco at 18 percent. Both the overall share of female researchers and the share of those holding doctorate degrees are expected to rise further in the near future given that over 50 percent of the currently enrolled students of agriculture are female and many are currently finishing PhD degrees (AST1, 2006).

2.3.4 Research Intensity in Public Agricultural R&D

Total agricultural R&D spending as a percentage of agricultural output (Ag GDP) is a commonly used indicator (defined as research intensity) for comparing research investments across countries (Table 2.3 d). Jordan, for example, invested $2.83 for every $100 of agricultural output in 2003, which was a substantial increase over the 1996 ratio of $1.61 (AST1, 2006). The 2003 ration was also considerably higher than the average ratio for CWANA (0.66 percent) and for the developed world as a whole (2.36 percent). It is worth noting that the high ratio of research intensity in Jordan does not reflect high levels of R&D investment in agriculture, rather indicates agriculture's small share of the country's GDP.

Syria invested $0.53 on agricultural research for every $100 of agricultural output in 2003. This ratio for Syria was similar to the reported 2000 average research intensity for the developing world but lower than the average ratio for CWANA region (0.66). in 2000, Sudan invested $0.17 for every $100 of AG GDP. Sudan's research intensity declined overtime, considerably lowering its ranking among other countries in the region. The 2000 intensity ratio was less than half of the 1981 and 1995 levels, even though the1995 level of 0.33 percent was already very low compared with averages for Africa and the developing world at the time (0.84 and 0.62 percent, respectively) (AST1, 2003).

In 2002, Tunisia invested $1.04 for every $100 of agricultural GDP. This was an increase over the 1996 intensity ration of 0.78 and was also slightly higher than the corresponding 2002 ratio for Morocco of 0.95 (AST1, 2006). Tunisia's and Moroccan 2002 intensity ratio were higher than the 2000 ratios of CWANA region and the developing world as a whole at 0.66 and 0.53 percent, respectively.

2.3.5 Returns to investments

Investments in agricultural R&D have contributed greatly to the wellbeing of farmers, processors and consumers through the development and implementation of new knowledge and technologies. However, there remain more than 800 million undernourished people, mostly in developing countries including CWANA region, who will need significant increases in local production to improve their food security (CGIAR, 2005). For CWANA, as well as other developing countries, increases in agricultural production and technologies that improve disease resistance and drought tolerance and sustain the use of natural resources are needed most to minimize the widening food security gap.

The benefits of agricultural R&D investments greatly outweight the costs. To sustain research contribution to poverty alleviation and food insecurity reduction, governments must invest more in agricultural R&D.

Achievement of impact goes far beyond delivery of research outputs by research organizations. It involves all players along the continuum between research and development, including research organizations, local communities, extension systems, development agencies and policy makers.

Previous studies provided overwhelming evidence that investments in agricultural R&D have delivered real benefits to poor farmers and consumers through new crop, livestock fish, forest and farming technologies that improve both productivity and farmers' income as well as helping to protect the environment, thereby contributing to poverty reduction (Evenson and Gollin 2003). The Science Council of the CGIAR systems commissioned an independent study to compare the benefits generated from its research against the total cost of operating the whole CGIAR system up to 2001. The analysis found that the most conservative assessment yielded a benefit-cost ratio of 1.9:1, meaning that the CGIAR has generated an indisputable return of nearly two dollars for every dollar invested (CGIAR, 2005 and Raitzer, 2003). The most generous scenario yielded a benefit-cost ratio of 17.2:1 (CGIAR, 2005). This means that the total investment in the CGIAR from 1960 to 2001 of US$ 7 billion will generate US$ 123 billion of benefits by 2011 (all calculated in 1990 US$). Yet even this highly favorable result probably understates the total return on investment because it does not include the followings (CGIAR, 2003):

- Benefits from the CGIAR's many research areas that are inadequately documented and/or inherently difficult to value such as impacts on policy and natural resource management.
- The multiplier effect, by which every dollar of farm income contributes an additional US$ 0.5-1 to the local non-farm economy through higher demand for other products and services.
- Land savings and their invaluable contribution on protecting biodiversity and watersheds, gained from the intensified cropping of existing farmland.

While the CGIAR system has demonstrated great international impact through scientific achievements and its pivotal role in the Green Revolution, it accounts for only a small fraction of the global agricultural R&D expenditures. In 2002, the CGIAR accounted for 1.5% of the $23 billion global public-sector investment in agricultural R&D and just 0.9% of all public and private agricultural R&D spending (CGIAR, 2005).

In line with food production trends in other developing countries, food production increases in CWANA during the last four decades is attributed to many factors. These include crop genetic improvements and other research contributions, expansion in fertilizers use and pesticides, expansion in irrigation with improved water use efficiency, mechanization, better farmers education, improvements in transportation and marketing infrastructures, and improved policy reforms.

In assessing the effect of crop variety improvement on productivity, Evenson and Gollin (2003) indicated that:

1. For all crops combined, the rate of improved varieties production has been increasing in each decade over the last 40 years.
2. Technological advances have occurred in all crops, on all continents, and in all agroecological zones, although these advances have been uneven.
3. The progress achieved in different areas is related to the effort expended on research, as well as to the pre-existing "stock" of research done on similar crops and growing environments.

The internal rates of return (IRR) to research investment suggest that public expenditures in agricultural R&D are achieving high dividends. Impact studies of international and national investments in barely germplasm improvement, for example, in selected CWANA countries indicate that IRR was up to 51% for Morocco. Iraq and Tunisia have attained an IRR of 38% for their research investment, while Egypt and Jordan had similar IRR of 32% and 31%, respectively. Algeria, Ethiopia and Syria had estimated IRR lower than 30% (Aw-Hassan and Shideed, 2003).

Adoption of improved varieties of barely is growing in several CWANA countries. High adoption levels were reported in 1997 for Egypt (50%), Jordan (50%) and Tunisia (40%). Relatively low adoption levels were reported in Morocco (19%), Iraq (14%) and Ethiopia (11%). Algeria and Syria, two large producers, had the lowest adoption levels of 5% or less of the total barley area (Aw-Hassan and Shideed, 2003).

Similar adoption patterns of improved lentil varieties are reported for some CWANA countries. The national research program of Pakistan reported that about 32% of lentil area in the targeted region of that country is currently planted with improved lentil varieties. Similarly, about 25% of lentil area in Iraq and Syria is planted with

2.4. ECONOMIC AND MARKET EVOLUTION

2.4.1 Inputs markets (agribusiness)

There is a very uneven evolution trend in the use of modern agricultural inputs in different Cwana sub-regions. The countries situated in Arabian Peninsula, Nile Valley and Red Sea and North Africa seem to practice an extensive agriculture while South and West Asian countries, Pakistan, Syria and particularly Turkey, seem to have opted for an intensive agriculture since the 1960s. Data obtained from FAO time series show that the total number of agricultural tractors was twenty times folded between 1961 and 2002 in South and West Asia while it was three folded in Northern African and Nile Valley and Red Sea countries (Figures AI-1, AI-2 and AI-3).

It is important to note the considerable investments realized in Saudi Arabia that gave a dynamic development trend for the Arabian Peninsula sub-region. These efforts appear to be particularly outstanding in investing in irrigation : the share of irrigated land in the total cropland increased from around 30% at the beginning of 1960s to more than 50% in the 2000, while the evolution of irrigated land in the other Cwana sub-regions was much lower (Figure AI-6). This ratio in the Central Asian countries was rather high before the liberalization of these economies and remained at the same level after their passage to market economy, *i.e.* around 70% of the total cropland.

It is evidence that a highly intensified agricultural practice brings through a number of problems difficult to resolve. In the Arabian Peninsula, investments in irrigation facilities are highly expensive while in Central Asian former USSR countries, excessive irrigation and input use resulted in environmental catastrophes. On the other hand, in most of the Mediterranean countries (Turkey, Egypt, Morocco) governments could no longer subsidize capital intensive agricultural systems after the second half of the 1990s.

The use of fertilizers grew also though its level stayed somewhat inferior to the use of agricultural machines and tools, and State investments for the settlement of agricultural irrigation infrastructure. For example, in the 1960s and the 1970s, the Turkish State invested as economic agent in the construction and functioning of huge fertilizer plants (Figures AI-4, AI-5). In Tunisia, Morocco, Egypt, Iran, Syrie and Irak, governments invested also in the production of fertilizers while these investments stayed at lower levels than those realized in Turkey.

Important investments were realized in the pest and disease management by the introduction of insecticides, pesticides and herbicides (Figures AI-7, AI-8, AI-9). Profiting from important government subsidies, the production and marketing of these modern inputs stay under the hands of large multinational firms that created local subsidiaries in developing countries. Turkey, Morocco and Egypt are the countries that host the affiliates of these multinationals while other Cwana countries are importing these chemical inputs. The important fall in the government subsidies to agriculture, since the 1980s in Turkey and Egypt and since the 1990s in Morocco had a negative effect in the overall use of these products. Another reason is the change in international rules that banned the use of pesticides in fresh produce for general food safety and environmental friendly concerns. North African countries, Egypt and Turkey are constrained to limit their internal use of these inputs mostly for their export-oriented agricultural products, while their use in Syria started to increase since the second half of the 1990s.

It is necessary to note that the distribution of the use of these products is very uneven amid the

farmers. Small landholders, in all Cwana sub-regions continue to practice a traditional agriculture while the capital intensive agriculture is practiced by only a small proportion of wealthy landholders. However, there is no statistical data to show concretely this evidence and real field research lacks drastically in this wise.

The extension of the use of certified seeds as well as the development of the variety protection in Cwana sub-regions are of governmental concerns and are included in international grant programs since the beginning of the 2000s. Most of the countries, like Afghanistan, Algeria, Syria and Iran intensified State initiatives to create seed trade associations in order to better organize the relationships between breeders, producers and farmers. While Afghanistan is profiting from USAID financial grant that helped this country to establish 20 village-based enterprises in 5 target provinces in order to produce and distribute certified seeds to farmers, Syria received a grant from the Japanese government that helped the Syrian General Organization for Seed Multiplication to found a culture laboratory. Turkey outstands as one of the countries of the Cwana region that started seed improvement programs in the 1980s. In fact the Turkish seed industry is in remarkable progress since these last 25 years. There are near to 150 private seed companies that deal with hybrids, vegetables and forage crops. Foreign investments originating mainly from the Netherlands, Israël and the United States of America count for approximately one quarter of these private initiatives. A new law that was enacted in 2005 gathers dominants players of this sector under one roof aiming a better coordination of the chain.

Since the liberalisation policies put in place, State control is loosening in the modern agricultural inputs market and marketing channels are controlled more and more by NGOs (national associations or international organisations) or private enterprises. State continues to undertake important infrastructural investments in irrigation systems but the agricultural chemicals are now marketed mainly by private sector players. State subsidies are also reduced by large proportions and have a significant impact on the use of these modern inputs mostly by small landholders. It is evidence that the lesser use of agricultural chemicals is in line with the new international measures to reduce or even to diminish the pesticides residues or nitrate effects on water. However, lack of an integrated agriculture has significant negative effects on the agricultural yields in these developing countries.

2.4.2 Per capita income growth and its distribution

The countries of the CWANA region vary significantly in terms of per capita income, living standards and economic performance. Regarding the 5 year averages of the 2000s, per capita income (measured in terms of annual gross national income (GNI) per capita) ranges from USD 230-500 for Somalia, the Sudan, Tajikistan, Kyrgyz Republic, Uzbekistan, Mauritania, Afghanistan, to about USD 3,000-4,700 Turkey and Lebanon. Most of the North African, South and West Asian countries as well as Egypt are in the middle of this range, with an annual GNP per capita of USD 1 100-2 500. Oil rich Arabian Peninsula countries have GNIs per capita that range between USD 8,000 and 24,000 (Table AII-1). While, these oil-rich Arab countries are classified high income countries according to the World Bank classification, the great majority of the countries of the Cwana region are considered as lower middle income countries.

Over the studied period (1962-2005), GNI growth rates in the CWANA region have varied considerably from country to country. Countries with the poorest growth rates include Iran Islamic

Republic (0.1%) and Jordan (1.0%); those with a high growth rate include Lebanon (8.1%), Saudi Arabia (6.9%) and Egypt (5.27%). The remaining countries in the region have experienced moderate GNP growth rates ranging from 2.8% (Djibouti) to 4.6% (Turkey). Most significant increases were realized after the mid-1990s, attributed to the post-war construction for Lebanon; a profound structural economic change in Turkey, Tunisia, Morocco and Algeria and good weather conditions and a general increase in production in Syria and Egypt. On the other hand, social outbursts and political conflicts in the Middle East had important negative effects on the growth rates in West Bank and Gaza, in Iraq and Jordan.

Another global trend to pin-out is the general deterioration of the relative distance between the world average GNI per capita and the GNIs per capita of the Cwana sub-regions, a gap that widens since the mid-1980s (Figure 2.4 a). The three sub-regions that showed the most homogenous GNI per capita data over the studied period, namely South and West Asia, North Africa and Nile Valley and Red Sea are presented in relation to the world average in the below graphic. A ratio of the medians of each sub-region to the world average is calculated on the basis of the five year averages ranging from 1962 to 2005. According to the results of this simple calculation, South and West Asia had a good progress during the period from the mid-1960s to the beginning of the 1980s, as this sub-region's average GNI per capita counted for 71% of the world average at the beginning of the 1980s but worsened drastically from that date on. In the 2001-2005 period, the median value of the GNIs per capita of the South and West Asia counted only for 32% of the world average. In the same manner, North Africa and Nile Valley and Red Sea sub-regions also saw their GNIs per capita drastically distanced in relation to the world averages. A sign that shows that, except Sub-Africa, all the other regions of the world did better than the Cwana region for the last twenty years and that the general economic situation of this latter is worsening due to demographic increase accompanied by political conflicts and a lack of good State regulation concerning the regional markets.

Income distribution and poverty

Although average economic growth rates have been favorable, the high population growth rate (2.3%) during this period has resulted in only a small net improvement. Moreover, there is now evidence of persistent inequalities (in both income and non-income dimensions), which seriously limit prospects for pro-poor growth. The lack of relevant data on income distribution based on time series limit considerably any research on the evolution of income distribution in this part of the world. Consequently, only a snapshot of the situation for the last decade can be given. In this respect, the gap between the shares of the 10% of the population that has the highest income and the 20% of the population that has the lowest income slices is tremendous. The highest inequality appears to be in Iran Islamic Republic where the highest 10% has 33.7% of the total national income while the lowest 20% has only 5.1% of this total. Tunisia, Turkmenistan, Turkey have similar income distribution patterns. Oppositely, in Uzbekistan, Kazakhstan, Tajikistan and Algeria this gap seems to be less profound. According to the same data, Norway, Finland and Japan had less important gaps for the same period (22-23% of share for the highest 10% against 10-11% of share for the lowest 20%).

Poverty is an important problem in most of the countries of the Cwana region. Linked to the incapacity of the urban economy to offer salaried work to a great majority of the active population

(15-65 years of age), these countries face severe poverty problems. However, poverty statistics are not available for all the countries of CWANA region and headcount indices have been estimated for only few countries. The poverty line and survey year varies form country to country, so comparison between the countries should be treated with caution.

Half of the national populations in Mauritania (North Africa), Armenia, Azerbaijan and Kyrgyz Republic (Central Asia and Caucasus) were under the national poverty line in the 1990s (Table 2.4 a). In Pakistan, Turkey and Uzbekistan the share of the population under poverty line is a little less than 30%, while in Algeria, Morocco, Jordan and Egypt, it is between 12% and 19%. Tunisia outstands as the country with least poor, as the share of its national population under poverty line is only 8%. In all of the countries that delivered data on poverty headcount ratio, except Armenia and Azerbaijan, poverty is more spread in rural than in urban areas. Tertiary sector together with informal activities offer more opportunities to urban populations to be better off than rural populations. The fact that most of the rural areas are getting more and more isolated from cash-generating economic activities has a negative impact on the rural poverty. Another factor that must be pointed out is the reduced demand for labour in the Gulf states that has exacerbated the rising unemployment situation in the region and has had a dramatic impact on remittances from migrant workers, especially in countries such as Egypt and Yemen that supplied much of the Arab casual labour market[14]. Unfortunately data are not available for all of the Cwana region countries to assess the real gravity of the actual situation.

2.4.3 Product markets

The agricultural production design is, as for the agricultural inputs markets, very unevenly distributed among the countries of the Cwana sub-regions. While West Asian and North African countries have rather important comparative advantages thanks to their natural endowments, countries situated in the Nile Valley and Red Sea and in the Arabian Peninsula have natural constraints that they have to to overcome in other to satisfy the food needs of their national populations; constraints that drive them toward food imports since the middle 1950s. Almost all of the Cwana region countries have lacking marketing infrastructure with regard to their agricultural produce and witness important post-harvest losses because of the lack of storing and conditioning facilities.

[14] *IFAD Strategy for Rural Poverty Reduction in Near East and North Africa* http://www.ifad.org/operations/regional/2002/pn/pn.htm

2.4.3.1. Animal products

The last decade of the 20th century brought along important structural changes in the composition of the product markets as many countries of West and South Asia as well as some countries of North Africa invested in livestock raising and developed their milk processing industries. In Pakistan, Turkey, Egypt, Tunisia and Morocco, these heavy public investments resulted in a net increase in the total milk production between 1961 and 2005 (Figure AIII-8). In alll of the Cwana sub-regions, the milk production per capita had considerable increases (Table 2.4 b).The real takeoff of this sector can be situated at the beginning of the 1980s with a sharp increase from the mid-1980s to our days for Nile Valley and Red Sea countries. Accordingly, there is an increase in the number and total production capacities of milk processing industries in these countries creating an attraction pool for foreign investments.

The total meat production did not show the same increase rates as for total milk production between 1961 and 2005. The South and West Asian countries saw their total meat production increase from around 110 000 metric tons (1961-1966 average) near to 6 000 000 metric tons (2001-2005) during these 40 years (Figure AIII-7). But the high population increase in this region somewhat swaps away this positive trend and the yearly meat production per capita stays at relatively low levels mostly when compared with the figures of developed Western countries. In Northern African countries and in Arabian peninsula, yearly meat production per capita increased considerably between 1961 and 2005 while in Central Asian and Caucasus countries, a net fall from 34 kg/per capita/year in the 1986-1990 period to 27 kg/per capita/year in the 2001-2005 period (Table 3). In this general overview, poultry sector showed the most important increase with the extension of intensive production technologies during these last two decades.

2.4.3.2. Grains

In all the Cwana sub-regions, grains are the essential resource for human nutrition, with wheat consumption being the most important in the Mediterranean regions and rice in Pakistan. Concerning the overall increase, the West and South Asian countries had an tremendous rise in cereals production and saw the total production volume rising from some 28 million tons in the period of 1961-1965 to near to 90 millions tons in the period of 2001-2005, the most important development being realized at the beginning of the 1970s (Figure AIII-3). The grains production in the other sub-regions showed important increases also, the most spectacular being maybe the trend observed in Arabian Peninsula, namely in Saudi Arabia after the mid-1980s resulting from important investments in intensification of the country's agriculture. Like in animal products, the grains production showed a very fluctuating trend in Central Asia and Caucasus sub-region. The economic liberalization had a destabilising effect at the beginning of the 1990s but there seems to be a good recovery since the beginning of the 2000s. As it can be observed in Table 4, because of high demographic pressure, South and West Asian countries could only have a stabilized per capita production volumes concerning the four decades studied, while Nile Valley and Red Sea and North African countries saw the per capita production fall quite sharply necessitating important grain imports. Compared to world averages, it is evident that the grains production in the Cwana region is lacking behind. This gap will probably widen in the coming future.

2.4.3.3 Oilcrops

Important public investments in agricultural sector in Turkey, Pakistan in the South and West Asia; in Egypt and Somalia in Nile Valley and Red Sea; in Morocco and Tunisia in North Africa yielded to important volume increases in the oilcrops production of the Cwana region. The production increased from around 700 thousand tons in the 1961-1965 period to more than 2,3 million tons in the 2001-2005 period in the South and West Asia sub-region, accounting for 56% of the total production of Cwana region in the 2000s (Figure AIII-4). Nile Valley and Red Sea and North Africa sub-regions also had important increases regarding their overall oilcrops production. As an industrial crop, oilseeds have important impact on regional economies.

2.4.3.4 Fruits and vegetables

North Africa, South and West Asia and Nile Valley and Red Sea countries have very rich fruit and vegetable species. The important demand for these products in international markets pushes most of the countries to invest heavily in their horticultural sector in order to increase the productivity. During the 1960s and 1970s South and West Asia and Nile Valley and Red Sea sub-regions showed steady growth trends (Figure AIII-1). But the real takeoff for these sub-regions was during the 1980s with a sharp increase between the 1980 and the mid-1990s. While the production in Nile Valley and Red Sea continues to climb, the production in South and West Asia has a stable and even a slightly descending trend while the North African countries witness a very fluctuating horticultural production. The same growth trends can be observed in the overall fruits production, the real takeoff being situated in the beginning of the 1980s (Figure AIII-2). Countries of the Arabian Peninsula follow up this trend with regard to fruits production, while their horticultural production is really reluctant. It must be reminded that fresh fruits and vegetables are becoming important export-oriented products bringing along considerable gains for the exporting countries.

2.4.3.5 Pulses

West Asian countries are reputed for their pulses since a long time. Most of the pulses are also originating from Mesopotamian region. The share of South and West Asia in the average production of pulses of Cwana region was 73% in the 2000s, Turkey, Pakistan and Iran standing out as the most important producers of the region. Egypt and Sudan in Nile Valley and Red Sea sub-region and Morocco in North African sub-region are also important producers. International demand for these crops also has an positive effect on the volume increases as well as on the productivity improvement.

2.4.3.6. Sugar beet

Sugar beet is one of the industrial crops that are highly supported by government measures, in the Cwana region as in the other parts of the world. Subsidies that continued all along the decades till the 1990s had positive effect on both volume and productivity increases. Facilities offered to producers for the storage and transportation of their crops had significant results on the production and marketing of the sugar beet in West Asian and North African countries (Figure AIII-4). There is a fall in the production volumes since the mid-1990s because of the agricultural policy changes in these countries. Most of the sugar refining units of these countries were public enterprises that went private since the beginning of the 1990s. On the other hand, Tunisia, for example, gave up its sugar industry judging it more expensive to produce its proper sugar than to import from international markets. Most of the sugar beet farming units converted their production to livestock raising and abandoned the beet production. In Turkey, government continues to subsidize the beet production, but the changes in transportation patterns and the switch from rail transportation to trucks diminished the willingness of most of the farmers that switched to the production of other crops. Turkey is, despite these policy changes, stands out as the largest producer of the Cwana region, followed by Iran, Morocco, Egypt and Syria. The production in Cwana region increases while the overall world production of sugar beet is in net decrease since the beginning of the 2000s.

2.4.4 Agriculture market shares of CWANA in the global and regional markets

The comparative advantages and natural endowments existing in some countries form the basis of the comparative competitiveness of these countries in international markets. So South and West Asia countries outstand as important exporters in most of the agricultural products, while Nile Valley and Red Sea and North Africa countries have important shares in international markets as net importers of agricultural products.

2.4.4.1 Place of Cwana region in international trade of cereals

South and West Asia countries are leading players in grains exports. There has been a tremendous increase in the grain exports of the region that climbed from less than 100 thousand tons in 1961-1965 period to more than 5 million tons in 2001-2004 period. Following the same trend for grains production, grain exports have a considerable increase between the mid-1980s and mid-1990s (Figure AIV-1). Kazakhstan is the most important exporter of the region followed by Pakistan and Turkey. Cwana region's share in total exports is only 4% despite the important role played by these three countries. Northern America has a share of 37% of the total grains exports for the 2001-2004 period, while the share of the Western Europe is around one fifth of the world total. These two blocs, together, realize the half of the world grain exports. However the nature of the export-oriented grains differs from one country to another: while Kazakhstan and Turkey export largely durum wheat, Pakistan exports rice.

Despite these significant cereal exporters, the Cwana region outstands as a net cereals importing region. Aside Central Asia and Caucasus sub-regions, all Cwana sub-regions have negative trade balances and the gap between the exports and imports of the Cwana region has widened by an annual average rate of 5.1% between 1961 and 2004. With a deficit of near to 43 million tons of cereals in 2001-2004 period, Cwana region is just behind the Asia region. North Africa and Nile Valley and Red Sea sub-regions are the most demanding regions for cereal

imports (Table 2.4 e). However, the most important increase in cereals imports is observed in the demand of North African countries (Figure AIV-2). This dependence on the international markets for food supply of their local population is a great economic constraint for the North African and Nile Valley and Red Sea countries and result in important public budget deficits. Poor natural endowments regarding grains production coupled with poor rural livelihood and increasing rural-urban migration create considerable social and economic disequilibria in the region.

The processing industry is developing all over the world. Developing countries improved the technological and productivity level of their food processing industries and wheat flour milling is one of these primary industries that flourished quite well in the Cwana region between the 1960s and 2000s. As a consequence of this development, the share of Cwana region in wheat flour exports increased at a considerable pace to occupy near to 1/5th of the total wheat flour exports in the world in the 2000s (Table 2.4 f). More than half of the Cwana region exports (56%) are generated by South and West Asia sub-region. In regard to annual average growth rates in the different regions worldwide, Cwana region outstands as the region with the most important growth pace (8,2% per year) resulting from the important increase rates observed in Central Asia and Caucasius and South and West Asia sub-regions (Table 2.4 f). The Northern Africa sub-region increased its total exports volumes since the 1996-2000 period while the exports of wheat flour in the Nile Valley and Red Sea sub-region witnessed an important fall during the 2000s. Meantime, the market shares of developed regions like Northern America or Western Europe witnessed a tremendous decrease since the beginning of the 1990s as a consequence of the development of milling industry in developing regions of the world. This U-turn trend will probably continue in the near future, the food processing industries of the industrialized regions specializing in high-value products while the developing world will invest more in primary processing for its domestic market and for exports.

2.4.4.2 Place of Cwana region in international trade of oilcrops

The trade balance of oilcrops can be calculated simply by substracting the exports from the imports for the given 5 year periods and for given countries. It is evidence that most of the Cwana sub-regions that were net exporters of oilseeds in the 1960s became dependent of the international markets for their domestic supply. The downward trend started during the mid-1980s to pull the region's trade balance toward the deficit side from the beginning of the 1990s (Table 2.4 g). The abandon of the public policies that were encouraging the oilseed production in some of these countries, mostly in Turkey, had a negative effect on the agricultural production while well-installed oil processing industries started to import their main raw material from international markets. In this way, a deliberately chosen strategy was designed in Turkey agreed both by public authorities and oil processing enterprises that saw an advantage in the low world prices. On the other side, because of this deliberate U-turn in public choices in most of the countries of the Cwana region, the entire region became dependent on the international commodity markets in this sector. Other developing regions followed more or less the same trend, while North America, Latin America and the Caribbean and Oceania saw their share increasing tremendously. Western Europe, already dependant on international oilseed markets for its domestic supply, witnessed its deficit being deepened. The most significant deficit is in the trade balance of Asia. This region that had an exceeding oilseed trade balance of more than 1.5

million tons in the beginning of 1960s, exhibited a deficit of 7.7 million tons of oilseed in the 2001-2004 period, mostly because of the changing sourcing strategies of the multinational enterprises. This international division of world commodity markets may be an important constraint for the Cwana region, if the countries can not develop wealth creating activities to replace the products that are abandoned during these four decades (Table 2.4 h).

2.4.4.3 Place of Cwana region in international trade of processed food

Direct result of urbanization process as well as the increase in urban purchasing power can be observed on the increase of the demand for processed food. Economic employment of female population increases, family structures change moving toward nuclear families where parents and children form the nucleus so that the possibility of meal preparation by other female members of the household than the mother diminishes while the remoteness of the living place from working places including schools, push urban inhabitants to consume ready-to-eat meals. In parallel the share of the away-from-home eating increases in total meals consumed by the households. In the countries of Cwana sub-regions a rather hybrid socio-cultural structure can be observed. There are extended family structure including grand parents or young brothers or sisters of one of the parents and the development of traditional type of rapid eating places also presents an alternative development in consumption patterns. Accordingly industrial processing enterprises focusing on rather generic products like fresh dairy products or cheese, biscuits and pasta products, beer and soft drinks develop at a rapid pace. On the other side, export-oriented industries based on traditional agricultural products also develop the overall industrial structure of these developing countries. In this panorama, exports increase as a result of the gain of international competitiveness among the national food processing enterprises but processed food imports also increase as a result of the increasing domestic demand for more sophisticated, high-value food products.

In the Cwana region, the total processed food exports were two-folded between 1961 and 2004, the highest increase being realized by Turkey in South and West Asia sub-region. However, as the other regions developed their processed food exports at a higher pace than the Cwana region, the share of Cwana region in the total processed food exports worldwide fell from 14.3% in the 1961-1965 period to 2.7% in the period of 2001-2004 (Table 2.4 i). The main winners of this development are Asia, thanks to China's industrialization in the food sector which starts to challenge the Western European food processing industry. Latin America and the Caribbean region also stays out as a promising challenger.

ith regard to the evolution of processed food imports, the share of Cwana region increased from 5.7% of the total world imports in the 1961-1965 period to 6.6% in the 2001-2004 period. Just behind the South and West Asia, Arabian Peninsula outstands as one of the most important importers of the Cwana region. North Africa and Nile Valley and Red Sea also increased drastically their imports in the processed food sector.

2.4.4.4. Place of Cwana region in international trade of fresh fruits and vegetables

Most of the countries of Cwana region have comparative advantages in fresh fruits and vegetables production. Increasing demand from developed countries for these fresh produce have positive spill-over effects on the organization and development of export-oriented sector in this region. Some of the countries like Morocco and Egypt have a long-term export tradition and

during the last three decades have gained important organization skills in this wise. Other countries like Turkey, Iran, Syria and Pakistan are newcomers since the beginning of the 1980s but increase their export volumes at a growing pace. However, as other regions of the world also gained important market shares in this sector, the share of Cwana region in total world exports of fresh fruits and vegetables fell from 12.2% to 8.9% between 1961 and 2004 (Table 2.4 j), and its annual average growth rate stayed slightly lower than the annual average growth rate worldwide (respectively, 2.6% per year and 3.4% per year). The winners are Asia region thanks to high growth pace of China and also India and Latin America and Caraibes. Because of the high value of this sector, developed regions like Northern America and Western Europe stay in the world competition and increase their volume exports with annual growth rates situated between 3% and 4%.

Even if the their share in total Cwana region exports is not yet very significant, fresh fruit and vegetables exports from the Central Asia and Caucasus (7.1% per year) and Arabian Peninsula (9.5% per year) sub-regions grew at a higher pace than in other Cwana sub-regions. Total export volumes of South and West Asia ande Nile Valley and Red Sea sub-regions had a constant increase while those of Northern Africa had a downward trend during this four decades and a half (Figure AIV-3). Among the traditional exporting countries, Turkey increased its exports volumes by 16 times and holds 2.3% of the total fresh fruits and vegetables volume exports worldwide as for the 2000-2004 period.

2.4.4.5 Place of Cwana region in world imports of meat

The important demographic pressure in the totality of the Cwana region had negative effects on the international trade balance of the region and the meat imports increased with an annual growth rate of 8.2% for the entire region between 1961 and 2004, the most important increase being observed in the Arabian Peninsula (Table 2.4 k). Despite important increases in total meat production within the different countries of the region, the total dependence ratio of most of the Cwana countries increased as a result of this high demographic pressure. As a result, Cwana appears as the most important meat importer in the world just behind Asia and before Latin America and the Caribbean. The annual average increase of the total volume imports of the region is two times more than the world annual average increase during the studied period (8.2% and 4.3% respectively). Important increases in the production of poultry meat are not sufficient enough to fill this gap that widens year after year.

In absolute figures, meat imports of the Arabian Peninsula were ten folded between 1961 and 2004 while the volume meat imports of the other Cwana sub-regions were multiplied by 10 to 20 times. Lebanon, Jordan and Iran in South and West Asia; Algeria and Morocco in North Africa, Kazakhstan in Central Asia, Egypt and Yemen in Nile Valley and Red Sea standout as the most significant meat importers. Accordingly, all of the regions in the world, developing as well as industrialized countries increased their meat imports during these four decades, even if the annual average increase rates in industrialized regions were less important than in the developing regions of the world (Table 2.4 g).

2.4.4.6 Place of Cwana region in world imports of milk

These results show that the general nutritional status of the countries of the CWANA region are better off, as there seems to be a significant progress in raising the per capita food consumption

in terms of kcal/person/day, which is the key variable used for measuring and evaluating the evolution of the world food situation all over the world including countries of the CWANA region and countries in transition, the levels of average national food consumption per person in the CWANA countries have increased quite satisfactorily since the 1960s and will likely continue to increase from 3006 kcal in 1997/99 to 3090 kcal in 2015 and close to 3170 kcal by 2030 Figure 2.4 c assess the evolution of the average daily food intakes in different Cwana sub-regions and their distances from world daily food intake averages in 1961-1965, 1981-1985 and 2001-2003.

2.4.4.7 Place of Cwana region in world imports of feeding stuff

While the meat and milk imports of the Cwana sub-regions increase at significant pace, government subsidies and other measures to encourage the development of the livestock production in most of the countries of these regions continue. As a result, feed imports increased considerably in volume and in value as most of these countries. While the milk husbandry and poultry sectors become dependant on feed imports, the extensive transhumant animal raising still continues to prevail in most of these countries (Yemen, Egypt, Morocco, Algeria, Iran, as well as Central Asian and Caucasus and West Asia countries) as the most important livestock raising system. As a consequence of these important increases for feeding stuff in Cwana region, the share of the region in total world imports increased from 0.9% in the 1961-1965 period to 7.5% in the 2001-2004 period, the takeoff period being situated in the mid-1970s (Table 13). Despite this significant growth pace, the Cwana region is far behind the Western Europe and Asia concerning its share in total world imports. While Western Europe had a 52% share, Asia had one fifth of the total animal feed imports during the 2001-2004 period. In the light of the growing need of livestock production for animal feed, the upward trend of world imports and most particularly imports of Cwana region seems to continue during the years to come.

2.4.5 Changing lifestyles and consumer preferences and demands

Urbanization process is, by the far, the drive for the changes in lifestyles. A number of economic, social, cultural and spatial factors push, all together, the urban families to live, to move and to consume differently. Urban households are mostly structured as nuclear families, comprising couples with children or sometimes as vertically/laterally extended families. In large megalopolises of developing countries single households also start to form around one tenth of the total urban population. Living and working places are more and more distanced and the time spent in transportation becomes an important constraint in daily planning of urban people. Also, the share of economically active females in total economically active urban populations is growing considerably. Higher purchasing powers and increased instruction levels push urban people to go out for spare their leisure time and finally the time spent for cooking and food preparation becomes a considerable constraint for urban consumer. In parallel to these changes, urban area have better physical and social infrastructure, and offer commercial malls that gather a great number of specialized shops as well as large retailers in one single place. These changes drive significantly large number of urban consumers towards a standardized, industrialized and globalized consumption patterns even if the consumer habits and preferences continue to be largely modelled by local tastes and traditions.

Despite these changes enhanced by urbanization process and concerning the “elite” reference groups in urban areas, purchasing power is still the main determining variable of consumption

patterns in these developing countries. Food consumption expenditures account for more than 40% of the total expenditures of households in most of the countries of the CWANA region, and go beyond 60% of total household spending in rural areas (Table AV-2). In comparison with the relative share of food consumption in total household spending in developed countries which is around 15%, these high ratios show the vulnerability of consumption patterns in Cwana sub-regions and the importance that the food consumption has in economic transitions toward market economy. If the households can not afford a satisfactory level of disposable income, they will rapidly be exposed to undernourishment because of the monetization of the food consumption patterns.

In parallel to this evolution, a highly skewed income distribution, a lacking infrastructure in rural areas as well as in poor urban squatter districts yield to an unequal access to education and health facilities and also to healthy food. Most of the countries of the Cwana region has "Human Development Index (HDI)[15]" numbers lacking drastically behind developed countries' index numbers. The oil-rich countries of Arabian Peninsula have HDIs higher than the HDIs of other countries of the Cwana region. Among the countries of this sub-region, Oman showed the most dynamic evolution by nearly doubling its HDI between 1975 and 2004. The countries of the Central Asia and Caucasus had HDIs stagnating or falling since the 1990s that show how difficult it is for these countries to realize their passage to free market economies. Uzbekistan and Tajikistan seem to be the countries that are worst off in this sub-region. In South and West Asia, except Pakistan that has an HDI well below the average of the Cwana region (0.539), all of the countries have HDIs around 0.71 and 0.77 according to 2004 UNDP estimations. The trends covering the period from 1975 to 2004 are positive showing a dynamic evolution for most of the countries of South and West Asia. In North Africa sub-region, Mauritania and Morocco are the most lacking countries with HDIs (0.486 and 0.64 respectively) far below the world average while in Nile Valley and Red Sea sub-regions, all of the countries show difficulties to follow up the world average. These high disparities in the standards of living, coupled with poor rural livelihood conditions bring through high risks concerning the food security of the populations of the Cwana region, mostly in countries with difficult living conditions like Djibouti, Yemen, Sudan, Mauritania or Pakistan.

In 1969-70, food production within some countries of CWANA region was almost adequate to meet demand; the self-sufficiency ratio (SSR) for all cereals was nearly 90%. However, the food gap continued to widen over the last three decades, due to failure of the expanding agricultural production (growing at 2.9% annually) to keep pace with the rapid growth in demand, so SSRs declined (Table AV-2). According to FAO estimates this trend is expected to continue (Alexandros, 1995). However, it must also be mentioned that the undernourishment in total Cwana region population is rather under control since the end of the 1960s (Table 2.4 n). In Arabian Peninsula, in North Africa, and in the Near East and Middle East countries, less than 10% of the national populations are declared undernourished. Exceptions are Occupied

[15]HDI combines a long and healthy life measured by life expectancy at birth, knowledge as measured by adult literacy rate and a decent standard of living as measured by GDP per capita in purchasing power parity. http://hdr.undp.org/hdr2006/pdfs/report/Techinical_notes.pdf

Territories of Palestine and Pakistan. In Nile Valley and Red Sea sub-region, Egypt stands out as the country with least share of its national population undernourished while in Djibouti and Sudan, a quarter and in Yemen more than one third of the national populations are undernourished. Difficult economic conditions in Central Asian countries have also had negative effects on the food security of their total population since the beginning of the 1990s. Mostly in Armenia, Uzbekistan and Tajikistan, respectively one quarter and half of the total national population are estimated to be undernourished according to the preliminary FAO data. On the contrary, Kyrgyzstan and Azerbaijan seem to achieve to better off their global livelihood since the beginning of the 1990s.

These results show that the general nutritional status of the countries of the CWANA region are better off, as there seems to be a significant progress in raising the per capita food consumption in terms of kcal/person/day, which is the key variable used for measuring and evaluating the evolution of the world food situation all over the world including countries of the CWANA region and countries in transition, the levels of average national food consumption per person in the CWANA countries have increased quite satisfactorily since the 1960s and will likely continue to increase from 3006 kcal in 1997/99 to 3090 kcal in 2015 and close to 3170 kcal by 2030 Figure 2.4 c assess the evolution of the average daily food intakes in different Cwana sub-regions and their distances from world daily food intake averages in 1961-1965, 1981-1985 and 2001-2003. The composition in the per capita daily food intake changed drastically in the oil-rich Arabian Peninsula countries. The increase in the consumption of meat and eggs (particularly poultry meat); milk and milk products, fats, oils and nuts was spectacular. North African countries, thanks to the increases in cereals imports, increased drastically their consumption of cereals but also starchy roots (mostly potatoes), sugar and other sweeteners, milk and milk products. All Cwana sub-regions, but most particularly South and West Asian countries still are great consumers of fruits and vegetables even if the differences between the world average and the average of this sub-region seems to be narrowed. While the average consumption worldwide of fruits et vegetables increases, the apparent consumption of fruits and vegetables in the countries of Cwana sub-regions decrease compared to their high levels in the 1960s. The average daily food intake in all of the Cwana sub-regions continues to be dominated by vegetable origin as the consumption of animal products and most particularly meat and eggs, fish and seafood lack drastically behind the world averages. Compared to the consumption levels observed in developed Western countries, this gap widens even more. The relatively high consumption levels of pulses that contain sufficient proteins in their energy composition, fill somewhat the gap widened by this weak consumption of animal products.

Nonetheless, the general daily energy intake in the Cwana sub-region had a positive progress through the 1960s to 2000s and the daily food intakes are, today at the same leves of world averages and even at higher levels, despite high demographic growth rates in most of the countries of the Cwana region. Of course it must be remembered that these global positive figures do not reflect the uneven distribution amid the different socio-economic classes and in poor rural areas.

2.4.6 Credit markets

NO INFORMATION ON CREDIT MARKETS

2.4.7 Local markets and marketing channels

In our days, subsistence agriculture persists while the farmers feel more and more the need to market their produce. So the market accessibility is becoming a key factor of rural development and the lacking links between the rural and urban areas outstand as the most important constraint to the improvement of the rural livelihood. On the other hand, a great majority of the farmers of the Cwana region are small landholders and have highly limited means to invest in new technologies and to improve their yields. The break in the rural-urban continuum increases the remoteness of these small landholders from urban consumption centers and from markets. The last two decades from the mid-1980s on are marked by governments' willingness to improve the conditioning facilities for agricultural produce and the market accessibility for small landholders. In the North African countries, namely in Tunisia and in Morocco, milk collect centers have an important role in the considerable increase of the share of marketed milk in the country. In Turkey, successive governments oriented public credits via agricultural cooperatives to the installation of greenhouses in horticultural regions of the country and to the improvement of conditioning facilities of fresh produce. However, despite these encouragement measures, quasi-totality of agricultural and livestock production are marketed through long marketing channels where middlemen keep an important part of the value created in supply chains, landholders having less than 30% of the final market price, in most of the cases. Traditional marketing channels comprise, between the farmer and the final consumer, a number of marketing agents: the village tradesman, commissioner, wholesaler, industrial processor, retailer for the domestic market and the village tradesman, commissioner, wholesaler, exporter, in the case of export-oriented products. Most of the wholesalers/exporters as well as industrial processors do not want to take the risk of getting directly in touch with farmers and prefer to hire the services of these middlemen who ensure the continuity in the product flows as well as the scales demanded by wholesalers/exporters and processors. In fact, neither the industrials nor the wholesalers/exporters desire to deal with a great number of small holders in order to collect the large volumes that they need. Middlemen endorse this service and deal with a large number of small farmers in order to gather the necessary volumes demanded by the downstream players. On the other hand, they procure the cash money that the small farmers need badly, as the formal credit system is not working well in the Cwana region countries.

These long marketing channels are absolutely harmful for the quality of agricultural and food products and for the food safety within the supply chains linking farmers to consumers. The poor quality of agricultural produce and lacking volumes create important bottlenecks for the industrial processors as well as for exporters. On the other hand, the important number of middlemen in these long channels increases the price that the final consumer pays for its food while the farmers do not get better off.

An important change is brought through with the penetration of large retailers originating from developed Western countries into the domestic markets of developing countries (Reardon and Berdegué, 2002). Countries of Cwana region are no exception to this new trend. These large retailers bring to these new host countries their logistic services and the spill-over effects within the domestic markets are rapid and spectacular. High volumes and standardized products demanded by these large retailers transform rapidly the structure and functioning of the supply

chains and an important consolidation process can then be observed amid the domestic wholesalers and retailers. The number of the suppliers diminishes while the small family owned traditional grocery shops disappear rapidly. *Agrifood market institutions are being affected alos, with a rapid rise in private standards and a gradual rise in the use of contracts* (FAO, 2005).

2.4.8 Labor market

In relation with rural-urban migration flows and urbanization process that prevailed in the countries of the Cwana region since the beginning of the 1970s, the structure of their labor markets has changed considerably. The prominent points of this change is the significant fall of the share of the economically active population in agriculture to total economically active population in all of these countries studied (Table AVI-1). In fact, even in Nile Valley and Red Sea sub-region where this share is the most important, the fall is considerable (an average of 72.6% in the 1961-1965 period and 55.9% in 1986-1990 period and 44.6% in 2001-2003 period). In Central Asia and Caucasus sub-region and in Arabian Peninsula, the share of economically active population in agriculture in total economically active population is 24% and 9% respectively. In North Africa sub-region where the rural-urban migration as well as cross-border migration flows are important, the share of agriculture in total economically active population fell drastically to less than 30%. In South and West Asia sub-region this share is very uneven from one country to another : while in Afghastan two thirds and in Pakistan and Turkey, nearly half of the total economically active population is still occupied in agriculture (an average of 66.3%, 46.1% and 44.8% in 2001-2003 period), in Lebanon, this share is only of 3.2% for the same period.

Another prominent point to mention is the increasing participation of female population in economic activities in this region of the world (Table AVI-2). The average of Cwana region for the share of economically active female population in total economically active population is around 33% for the 2001-2003 period while the world average for the same period is around 41%. However, there are important differences from one sub-region to another and from one country to another. In Central Asia and Caucasus sub-region as well as in Egypt, in Mauritania and Somalia, this ratio is above the world average (46.9%, 45.7%, 47.6% and 43.4% respectively) while in Turkey it is around 38%. In other countries of the Cwana region, the share of female population is between one quarter and one third of total economically active population at national level. These two trends have considerable impact on the overall labor supply growth. In fact, labor supply continues to grow at high rates in these countries, reflecting high population growth rates and additional inflows from rural-urban migration and increasing female participation rates (Tzannatos, Z., 2000). However, urban formal sector is not sufficiently developed to absorb this labor supply excess because of the slow growth rate of the industrial sector. The tertiary sector has a hypertrophied growth in nearly all of these countries. Informal sector activities are the most significant sources of income for the recently urbanized populations (Tzannatos, Z., 2000). This important shift from high-paying formal jobs to low-paying informal jobs reduces considerably the income level of recently urbanized households. A vicious circle is in place then, less educated people being employed only in informal sector that diminishes the household's income and giving less chance for the children belonging to these households to get well educated and aspiring high-paying formal jobs.

These negative trends are accentuated by the chances that occurred on macro-economic level of most of these countries: in some Arab countries relying to oil-exports, the decline in oil prices during the 1980s affected negatively the investments in these countries. On the other hand, in most of these countries (Algeria, Morocco, Egypt, Turkey and Central Asian countries) the retirement of the public sector from economic activities as an employer had also negative effects on their labor market. Last but not least, after the Iran-Iraq and Gulf wars, countries with significant out-migration (Egypt, Jordan, Turkey) faced falling demand for their citizens abroad. In parallel, the remittances and social compensations from workers abroad (in Western Europe and oil-rich Arab States) had a declining trend for Algeria, Mauritana, Sudan and stagnant trends in other countries of the region, like Turkey (Table AVI-3). They have negative impact on the purchasing power of number of urban and/or rural households of the Cwana region. Most of the countries of the Cwana region, are not ready yet to absorb the increasing labor supply and huge infrastructural investments are needed to boost the non-agricultural sectors' demand for labor. The qualification of this labor is another huge problem that the solutions can not be found in the near future byt necessite, on the contrary, long-term investments.

2.4.9 Conclusion

Different development levels of the Cwana countries must be mentioned once more. There is a great need to realize field studies based on local surveys in order to analyze and to assess the real marketing conditions in the different regions of these countries. A global view is highly reducing as it does not take into account the important divergences that exist between these countries as well as between the different regions of a same country. The problems that exist in Turkish agricultural sector can not be considered similar to the problems that exist in Algeria, in Sudan or in Djibouti. Nnor the improvements reached in the agricultural sector of Pakistan can be compared to the improvements observed in Saudi Arabia.

This global assessment can give us some hints that the countries of the Cwana region are losing their comparative advantages in most of the agricultural sectors since the second half of the twentieth century and the sectors that are developing recently in these countries, like livestock raising or fresh fruits and vegetables create a certain dependence of these countries for their upstream sourcing (modern input sector). Any country can not continue in a complete autarchy and all of these countries need each other for sourcing in sectors in which they do not have comparative advantages. Nonetheless, this development must be in the sense to create value and wealth for the developing countries of the Cwana region as well and emphasizes ithe extreme need to develop their own knowledge and technology basis in order to challenge the world leaders.

2.5 TECHNOLOGY TRANSFER AND ADOPTION

2.5.2 Traditional Knowledge in CWANA

2.5.2.1 Traditional Knowledge (TK)

Traditional knowledge (TK) is a cumulative body of knowledge, know-how, practices and representations maintained and developed by peoples with extended histories of interaction with the natural environment (International Council for Science, 2002). Traditional knowledge developed from experience gained and adapted to the local culture and environment. It is mainly of a practical nature and provides the basis that enable communities to sustain their local-level decision-making about many fundamental aspects of day-to-day life.

Warren and Rajasekaran (1993) described TK as the adaptive and decision making skills of local people learned and transmitted through family members over generations; strategies and techniques developed by local people to cope with socio-cultural and environmental changes; time tested natural resource management practices that are accumulated by farmers due to traditional experimentation and innovation. TK related to agriculture includes the range of information on which farmers, consciously or unconsciously, base their decision-making process related to their production systems (Brokensha et al., 1980; Warren et al., 1989; 1991).

TK is dynamic, resulting from the continuous process of experimentation, innovation, and adaptation. It is difficult to determine the historical depth of traditional practices when documentation on the past is lacking or insufficient. For example, since the birth of agriculture 10000 years ago, farmers, fishers, pastoralists and forest dwellers have been managing genetic diversity by selecting plants and animals to meet environmental conditions and food needs in the Near East, North Africa and Central Asia. Farmers transfer this knowledge from one generation to the next.

Traditional knowledge consists of practical (instrumental) and normative knowledge concerning the ecological, socio-economic and cultural environment. Traditional knowledge originates from people and is transmitted to people by recognizable and experienced actors. It is systemic (inter-sectorial and holistic), experimental (empirical and practical), handed down from generation to generation and culturally enhanced. Such a kind of knowledge supports diversity and enhances and reproduces local resources.

Traditional and local knowledge are part of a complex system, therefore they cannot be reduced to a mere list of technical solutions and restricted to a series of different applications according to the results to be attained. Their efficacy depends on the interaction between several factors. These should be carefully considered in order to understand the historical successes achieved by the use of traditional knowledge and to use its internal logic to find modern solutions.

Each traditional practice is not an expedient to solve a specific problem, but always a studied and often a multifunctional method involved in an integrated approach (society, culture and economy) closely linked to a concept of the world based on the careful management of local resource.

Many experts and scientists doubt about the basis of TK and so not give enough relevance to TK in development planning (Howes and Chambers, 1980). Therefore several development projects are designed without taking into consideration the effectiveness of TK and traditional agricultural practices.

Ethnographic studies in CWANA on the traditional farming systems indicate that the local farmers have detailed practical knowledge of their local environment. Most practices are not arbitrary, even if some farmers may not be able to explain them. In traditional systems that have established sustainability the experience of generations of farmers in the local environment shapes a wide range of practices that contribute to crop productivity and protection in different ways. It is important to examine the range of practices in traditional systems, because these are the key to sustainability and the system is often designed to prevent or minimize pest and disease problems through a number of indirect methods.

TK represents accumulated various experiences of interactions between a group of people who are well informed about their own situations and their physical and biological environments, and the production systems. They are also aware of the possible impact of a change in one factor on the other parts of the production system. The quality and quantity of TK vary among locality members, including farmers, agriculture workers, women, in the rural, pastoralists, shepherds, animal growers and so on who are the protectors of TK. It is also depending on age, gender, social status, intellectual capability and professional occupation (Warren and Rajasekaran, 1993)

Traditional knowledge is usually specific to locality. A good example of this is the relevance of an agricultural calendar used by the local peoples of the region. Local farmers set the time for their plantings not by written schedules but by local observations of star risings and settings, the position of the sun's shadow and observable changes in the seasonal round, such as bird migration, appearance of certain insects or plants, etc). What is ultimately important is how the farmer is able to define a planting time that would provide a productive crop given the constraints of rain and floods and the menace of pests and diseases. In Yemen, for example, farmers use local shadow scheme or local star calendars which are based on observations of stars in a given locality for defining the planting time. Those observations rarely are applied outside of a specific context or local region (Serjeant, 1974; Varisco, 1985; Varisco, 1993).

The work undertaken in recent years relating to TK has a substantial component concerned with recognizing, validating and maintaining TK. A number of initiatives have been developed which strengthen traditional knowledge systems. The ways in which TK can be kept in context and not completely protected using the more extractive approaches of traditional ethno-botanists. In fact, there has been a rapid increase of international fora considering different aspects of the protection of traditional technologies and knowledge. There is a growing trend towards the recognition/ creation of rights of control in local farming communities over genetic resources with which they are associated and related knowledge.

In an effort to both conserve and promote a better understanding of indigenous knowledge systems UNESCO launched the Local and Indigenous Knowledge Systems (LINKS) project in 2002. Since its inception LINKS has supported a number of field-based documentation efforts. However, despite broadened interest and support, the issue of local and indigenous knowledge continues to be plagued by misconceptions and false stereotypes. “In addition to empowering local and indigenous communities in biodiversity governance, through their recognition as knowledge-holders, the LINKS project also seeks to maintain the vitality of local knowledge within communities. The key to achieving these objectives are efforts to strengthen ties between elders and youth in order to reinforce the transmission of indigenous knowledge and know-how

from one generation to another. (UNESCO, 2005). The International Treaty on Plant genetic Resources for Food and Agriculture (www.fao.org), which already has been ratified by several countries in the region, recognizes the enormous contribution that farmers and their communities have made and continue to make to the conservation and development of plant genetic resources. This is the basis for Farmers' Rights, which include the protection of TK, and the right to participate equitably in benefit sharing and in national decision-making about plant genetic resources. Farmers possess invaluable local knowledge, including choosing the right varieties or breed to be suited with a particular agricultural ecosystem. The contribution of farmers is increasingly recognized along with their right to receive some of the benefits, including monetary benefits through the Farmers' Rights.

As a consequence, TK has not been captured and stored in a systematic way, with the implicit danger that it may become extinct. TK about cultivated and wild species is rapidly being lost. Genetic information coded in wild species or forms and traditional or native crop varieties could be embossed out as intensive mono-cultural production favors the adoption of newer, high-yielding crops. The collective knowledge of biodiversity and its use and management maintains in cultural diversity; conversely, conserving biodiversity often helps strengthen cultural integrity and values (Global Biodiversity Strategy: Policy-Makers' Guide (World Resources Institute, The World Conservation Union, and the United Nations Environment Program, 1992).

Also in CWANA there has been an exponential growth in the number of publications on the relevance of TK in several areas. This also recognizes that helping the local people to use their own knowledge of indigenous foods and agriculture provides better prospects for long-term sustainability than imposing solutions from outside. Yet to date there has been little documented information about the foods that are utilized by the some poorer of African part of the region, and particularly how these foods are preserved in a hostile environment for later use. For example in Sudan (Dirar, 1993) various foods are considered in terms of their role in the struggle for survival and in the social fabric of rural Sudan, as well as from the perspectives of nutrition and food microbiology. Information was gathered from elderly rural women who traditionally hand down such knowledge from generation to generation. With increased urbanization and dislocation of family structures, there is a danger that such knowledge might otherwise be lost forever.

2.5.2.2 Plants

North Africa has one of the oldest and richest traditions associated with the use of medicinal plants. Medicinal plants are important for the people of the region, especially in rural areas, as in many places, they are the only source of medicine available. Even in many urban areas, the prices of modern medicines are increasing, and people are turning back to traditional plant remedies.

The demand for medicinal plants is currently increasing in both developed and developing countries, because of their accessibility and affordable costs and the growing recognition that natural products have fewer side effects. Therefore a number of important plant species have become scarce in areas where they were previously abundant and some species may become threatened with extinction, if their collection and use is not regulated.

The theme of medicinal plants was a good entry point for biodiversity conservation and was relevant to most countries in North Africa.

The forms of uses vary and depend on local knowledge, which is based on traditional techniques linked to local identity.

Local communities, such as the Bedouins in Egypt, possess invaluable knowledge of nature. This traditional knowledge is being gathered, documented and fed into a regional compendium on medicinal plants. Most Egyptians rely on modern medicines, though herbalists and their shops are still thriving. The Bedouin communities, with a much stronger traditional culture, have a real interest in medicinal plants. There is a big demand for medicinal plants in Egypt, but most of this is for export to the USA and Europe. Of the 2000 species of plants in Egypt, 1000 occur within 30 km of the Mediterranean coast. A large number of Egypt's plants have become rare or extinct due to habitat destruction, overgrazing, and over harvesting.

The Center and Garden for Conservation of Threatened Plants was built near El Hammam, to conserve medicinal plants currently under threat in North Africa, as well as serve as an education and awareness centre for the entire region. Trials to cultivate the plants under different conditions and propagate them are undertaken in the Garden and transplants and propagules were exchanged with the nurseries of the Bedouin communities, so that they could cultivate the plants in micro-nurseries. Four micro-nurseries, established with the Bedouin communities on their lands, along with around twenty smaller ones, focus on the sustainable use of medicinal plants.

The cultivation of these plants is a new concept for the Bedouins, and has slowly caught on, due to both a diminishing availability of plants from the wild, and the realization that a market can be found for both medicinal and culinary uses. These nurseries have been a decisive factor in significantly reducing the uncontrolled gathering of endangered plant species (http://iucn.org/places/medoffice/nabp/index.html).

Case Study 1: Food Barley: Importance, Uses and Local Knowledge. 2005. Stefania Grando and Helena Gomez Macpherson (Eds.) Pages: x + 156pp. ISBN: 92-9127-173-0.

This study highlights experiences in food barley production in over 14 countries, including a review of food barley-based farming systems, bottlenecks in production, research efforts in improvement, major cultivated varieties, quality characteristics desired by consumers, and constraints to production and research needs. Local crop development is based on farmers' knowledge of local crop varieties, farmers' skills in adapting those varieties to their environmental and socio-economic conditions, and the contributions of local seed systems. The papers presented in the book focus on the description of varietal characteristics that are important to farmers; the ways in which farmers observe, select and experiment with crop varieties; and the techniques they employ for storing and distributing seed.

Barley grain is used as feed, malt, and food. Our ancestors depended on barley as a staple food more than we do now. Barley played an important role in the origin and development of the Neolithic culture. Early barley remnants from Mesopotamia and Egypt are much more abundant than those of wheat, and the earliest literature suggests that barley was more important than wheat for human food. The Sumerians had a god for barley but none for wheat. In the Near East and Mediterranean, the shift to wheat as human food came in classical times, and by the first

century A.D. barley was already mostly fed to animals. In northern Europe barley remained the main food cereal until the 16th century.

Nowadays barley is an important staple food in several developing countries; generally it is the most viable option in places characterized by harsh living conditions and home to some of the poorest farmers in the world.

Barley is still a major staple food in several regions of the world: in some areas of North Africa and Near East, in the highlands of Central Asia, in the Horn of Africa, in the Andean countries and in the Baltic States. Food barley is generally found in regions where other cereals grow poorly due to altitude, low rainfall, or soil salinity. It remains the most viable option in dry areas (< 300 mm of rainfall) and in production systems where alternatives for food crops are very limited or absent, such as in the highlands and the mountains.

Food barley consumption has decreased considerably in the last 40 years with the increase of urban population and, often, the introduction of national policies supporting wheat consumption. This is the case of Morocco where food barley consumption has decreased from 87 kg/person/y in 1961 to 57 in 1999. In the case of Algeria, Libya and Tunisia, food barley consumption in 1961 was 27, 35 and 15 kg/person/y, respectively.

Food barley use is associated with local knowledge on preparation, health and nutritious attributes. Food barley is used either for bread making (usually mixed with bread wheat) or for specific recipes. Its cultivars have particular characteristics appreciated by consumers that make them irreplaceable by feed or malting barley. Local knowledge and unique genetic material are under risk of being lost for future generations.

Archaeobotanical and archaeozoological analysis in archaeological sites, in addition to ethnobotanical and subsistence base studies in contemporary rural societies, have indicated that probably most of all the earlier ways of obtaining food and materials continued (Anderson and Ertug-Yaras, 1998). In some part of the CWANA region, especially through the Fertile Crescent (Turkey, Syria, Iraq, Lebonan, Palestine, Jordan) many material recorded as utilized for different purposes. In Anatolia, for instance, about ten to twelve thousand years after domestication was successfully accomplished, wild plant gathering is still an active tradition in several parts of the country (Ertug, 1998; 1999; 2000a; 2000b; 2000c; 2000d).

Case studies 2 and 3 from Anatolia: Various aspects of wild plant gathering in agricultural societies: Ertug, F, 2006. etno@fusunertug.net.

Two case studies, conducted in Aksaray in Central Anatolia and Muğla in South-western Anatolia, indicate that people have adopted various ways of using their environment for food, medicine, fuel, fodder, building materials, and many other purposes.

In a single village and its surroundings in Aksaray 300 locally used and named plants have been recorded. The villagers consider over one hundred plant species edible, and the others are used for medicine, fuel, fodder, building material, dye, gum, glue, so on. In the Bodrum peninsula in the Muğla area, about 360 useful plants have been recorded during a two years study. 140 of these wild plants were for food, about 100 were medicinal, and others were used for various purposes, such as making baskets, brooms and mats.

It is almost impossible to find two identical patterns of managing faunal and floral resources, and some variations are apparent even within the same unit of study. Different wild plants are gathered in the two regions, and even within the villages in both regions. In both regions, however, although they now have access to fresh vegetables all year round, the wild plants available in winter and spring continued to be gathered to supplement the villagers' diets, during the periods when, historically, fresh vegetables were scarce. This continuity of gathering may well be explained by the nutritional needs of people as well as their search for 'traditional tastes'. While several plant uses, such as for mat plaiting and fuel collecting, are decreasing, gathering wild edibles is still more or less consistent in these rural areas.

Case study 4. Inventory of traditional knowledge to combat desertification (http://www.mappeonline.com/unesco/atlas/index.htm)

UNESCO launched a global programme (The Traditional Knowledge World Bank) for an inventory assigned to IPOGEA, Research Centre on Traditional and Local Knowledge. The project gathers and protects historical knowledge and promotes and certifies innovative practices based on modern re-proposal of tradition.

'The Water Atlas. Traditional Knowledge to Combat Desertification' by Pietro Lauretano has been produced by IPOGEA.

Traditional knowledge and techniques were identified by carrying out surveys and studies on field as well as by collecting photographs and current or in progress projects documents. An iconographic system has been elaborated to show and easily identify the techniques and their use. Each technique matches its related icon.

Each single technique is linked to information about photographs, charts and drawings, accomplished and in progress projects, bibliographical documents and analysis of exact references and geographic and chronological dissemination maps. All this information is divided (in clusters of competence and) in several categories including Agriculture, Water management, Soil and environment protection, Breeding, Hunting, and Harvesting.

A specific case study was carried out in Wadi Mzab in Algeria, where traditional techniques were classified according to the Natural context, the Rural settlement, and the Urban settlement.

2.5.2.3 Water management

Large-scale water management techniques have been developed by the ancient empires that grew up on the alluvial sediments of silt, loess and sand along the Afro-Asian river basins in the five sub regions of CWANA. Great civilisations known as hydraulic societies prospered not only near rivers as Nile, Euphrates or Tiger but also in the arid areas and in the oases by developing important hydraulic infrastructures for elevating the water from rivers as the norias in the Oronte River, for stoking and transporting water or for rain harvesting. An important knowledge as regards water management and irrigation was transmitted in generations.

The validity of traditional knowledge on water management techniques and the use of practices derived from it have been studied and asserted since the eighties on various levels. Research on traditional water techniques has continued for more than twenty years aiming at tackling the problem of overcoming a top-down approach to the transfer of water management technologies and at achieving a participatory relationship able to foster sustainability (Brokensha et al, 1980).

Many international bodies such as the International Labour Organisation (ILO) (Bhalla, 1977), the Organisation for Economic Co-operation and Development (OECD), the Food and Agriculture Organization (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP) and the World Bank have declared its validity in research and documents. The interest of the United Nations' conventions is clearly highlighted in the report entitled Building Linkage between Environmental Conventions and Initiatives.

2.5.2. 4 Water harvesting

Water harvesting, defined as the redirection and productive use of rainfall, can be traced back through human history almost as far as the origins of agriculture. This ancient practice sustained populations when conditions would have otherwise totally prevented agricultural activities, and many peoples in the world have continued to rely on water harvesting. Harvested water is used for drinking (although this is less common now, since even rain water is of less safe quality), irrigation, livestock drinking water and groundwater recharge.

Various forms of water harvesting have been used traditionally throughout the centuries. Some of the very earliest agriculture, in the Middle East, was based on techniques such as diversion of "wadi" flow (spate flow from normally dry watercourses) onto agricultural fields. Reviewing archaeological evidence, Prinz (1994) notes indications of water-harvesting structures in Jordan, believed to have been constructed over 9000 years ago, and in southern Mesopotamia from 4,500 BC (Bruins et al., 1986). A sequence of reviews and manuals produced over the last 20 years provide a good inventory of water harvesting techniques, old and new, and also essential information for their implementation (Frasier, 1974; UNEP, 1983; Pacey and Cullis, 1986; Reij et al., 1988; Critchley and Siegert, 1991; FAO, 1994; Prinz, 1994). From these and other sources, one may note situations where farmers' innovations, ancient and modern, have stimulated research, and others where research has been started to solve perceived problems at the farm level.

At the beginning of the Nineties, a great number of studies about traditional water harvesting infrastructures were published (Prinz, 1996; Prinz and Wolfer, 1999). These techniques which deeply mark the landscapes of the arid and semi areas arid are regarded as forming part of the world inheritance. In North Africa, Saharan Tourism helped a lot to their promotion. In South Tunisia for example, several water harvesting given up in the Sixties are rehabilitated today towards a production of fresh fruit and vegetables to be supplied for use by hotels and eco tourism enterprises.

In other poorer region, the productivity of land and water in rain-fed areas is greatly enhanced through water harvesting. Marginal lands with annual rainfall of less than 300 mm can be cultivated if controlled but limited additional water is made available (Oweis et al., 1999, Rodriguez et al., 1996, Rodriguez, 1996). In many instances, such an incremental water supply can be provided through appropriate water harvesting techniques.

A new interest to evaluate traditional water management techniques came up nowadays as they seem to be a sustainable factor for development of arid areas and can ease future water scarcity in many arid and semi-arid regions of world. (Prinz et al., 1999).

The modernisation and the diffusion of these old technologies have to be sought for increasing agricultural productivity and providing sustained economic base. As the appropriate choice of technique depends on the amount of rainfall and its distribution, land topography, soil type and soil depth and local socio-economic factors, these systems tend to be very site specific. The water harvesting methods applied strongly depend on local conditions and include such widely differing practices as bunding, pitting, microcatchments water harvesting, flood water and ground water harvesting (Prinz, 1996, Critchley and Siegert, 1991).

The rain water harvesting areas are not very well mapped, and very few statistics are available at countries or regional level. Several experiences are quoted in the specialized literature but very few information is given about their importance in term of concerned areas, beneficiary people and economical return. For the CWANA statistics (AQUASTAT FAO data base) are available only in Republic Islamic of Iran (40 000 ha), Egypt (133 000 ha), Lebanon (500 ha) and Tunisia (898 000 ha).

A selected sample of national experiences is summarized here to illustrate the range of experiences and potentialities.

Work in Tunisia may be divided broadly into two types: the description and rehabilitation of indigenous systems, and the large-scale technical development program of the 'Departement de la Conservation des Eaux et du Sol'. This latter program is one of the few in the CWANA region which attempts to integrate soil and water conservation activities with hydrological priorities (Selmi, 1994). As well as the construction of bunds and terraces for conservation, it includes the building of small dams on watercourses high in the catchment areas of major rivers. Purposes include flood control, the recharge of shallow groundwater used for irrigation, and the reduction of siltation of major dams supplying domestic and industrial needs. Among the spin-offs is the availability to hill farmers of water 'harvested' by the small dams for use in supplemental irrigation. One acknowledged weakness of this whole program, however, is its primary focus on engineering works, in the undoubtedly good cause of conserving soil and water supply but tending to neglect the socio-economic problems and different utilization options of land users.

Indigenous systems in Tunisia have recently been described in two monographs, Ennabli (1993) and Alaya et al. (1993). The first provides detailed descriptions of nearly thirty traditional systems for capturing and utilizing water in the dry areas of Tunisia. The wide range of water interception, concentration, conveyance and storage techniques reported (many still under utilization) illustrate the wealth of ingenuity in human adaptation to dry environments. The second publication focuses on ‘tabias’, the earthen bunds widely and variously used in Tunisia to intercept and redirect runoff water to crops and trees. Though primarily an implementation manual, this book is also richly descriptive of traditional practices.

The ‘meskat’ system, which utilizes ‘tabias’ to support olive plantations, covers about 300,000 ha in central Tunisia (Prinz, 1994). Essentially it comprises catchments of about 500 sq meters surrounded by ‘tabia’ and spillways to control runoff flow into bunded plots of trees. Undoubtedly this is a successful system, still well maintained; but Reij et al. (1988) comment that it suffers heavily from increasing land pressure resulting in a decrease of the catchment areas leading to lower efficiency.

The 'jessour' system is based upon the cultivation of sediments built up behind large 'tabia' (often stone-reinforced and with stone spillways) constructed in cascade down narrow mountain valleys in southern Tunisia. Akrimi at al., (1993), from the Institut des Regions Arides (IRA) near Medinine, reported a multidisciplinary study involving 'jessour' cultivators in the Matmata mountains. Maintenance of the 'tabia' and spillway structures is a major problem in some areas, due partly to a degree of out-migration, and it is Tunisian Government policy to assist 'jessour' rehabilitation. However, proposals for further research by the same IRA team note the launching of major development schemes for soil conservation and rainwater harvesting but comment that participation of the local population has been weak due to the failure of the schemes to take account of local traditions and existing production systems.

There have also been development schemes in Jordan, earth dams to divert runoff for pasture improvement and bund building for soil and moisture conservation on steep land. Research was started by the University of Jordan, in 1987, to explore the development potential and particularly the water-harvesting potential of a 70 km^2 catchment under low rainfall (100-250 mm per annum) east of Amman (Taimeh, 1988). Irrigation from wadi flows trapped by earthen dams and micro-plots supporting fruit trees are two techniques that have shown promise, socio-economic as well as technical Currently, data collected in this catchment are being used to develop a coupled prediction-optimization model for water harvesting, storage and utilization in similar dry areas of Jordan and elsewhere (Sarraf and Taimeh, 1994).

Other ongoing regional activities include a relatively large development project (with included research component) in a steppe area in southern Syria, for the integrated management of soil, water and vegetation resources (Rashed, 1993). The project uses water supplied by various harvesting techniques in conjunction with a limited groundwater supply to enhance production, particularly of forage crops and bushes.

In Yemen, a major research focus is the conservation of the ancient terrace system, parts of which have fallen into disrepair following socioeconomic changes. The issue here is not simply the conservation of soil and water by the terraces, but the control of water from the highest, and often degraded, pasture lands (and including water harvesting for human consumption) down to the protection of the intensively utilized banks of the main wadis and the flood irrigation systems downstream. A new multidisciplinary project, with a participatory approach, addresses the socioeconomic, institutional and policy issues that are involved (Muhred, 1994)

The rainfed coastal areas of Egypt have received considerable research and development attention over recent decades. Initially, the main aim was to facilitate the sedentarization of the Bedouin population, and projects were undertaken to rehabilitate degraded rangeland and increase runoff utilization, through wadi terracing (similar to Tunisian 'jessours') and the enhancement of indigenous runoff farming systems (Perrier, 1986). More recently, the coastal areas have come to be seen as another small but potentially productive national agricultural resource, and emphasis has shifted towards more intensive development. However, the natural resource issues- water quantity and quality, population growth, and environmental deterioration (Abdel-Kader et al., 1994) - remain the same.

In Pakistan, in highland Balochistan there is an indigenous 'khuskaba' system, by which bunds are used to guide runoff water and promote infiltration. Rodriguez et al. (1995) found 1:1

treatments (catchment:production area ratio) in valley floor situations increased seven-year wheat yields over control values, higher ratios having a risk of waterlogging in wetter years. It was also noted that farmers practising the indigenous khuskaba system adjust the size of the catchment area according to the soil moisture at planting and rainfall expectations for the season.

There are also several water storage practices that have passed down from generation to generation. The individual cistern is one of the more ancient and always used and sometimes modernized.

Cisterns did not concern only people without access to adequate and safe water or villages lacking a local water source, not connected to a water supply network. Harvested rainwater stored in cisterns during the short rainy months appears as an adequate sustainable mean to supply water isolated habitations. Cisterns can be a multi – use water resource: besides water for drinking and cooking, households can make use of the extra water for irrigation (productive home gardens) or for their livestock.

Early, in the eighties, studies have been done on traditional cisterns and on the conditions to multiply them and to modernize their and their management (Bourges et al., 1979; Fujirama, 1982). Many projects for building cisterns have been contracted in the five sub regions of CWANA.

The region is also very rich in traditional knowledge related to irrigation, such as ‘Kharez’ in Pakistan and Afghanistan, ‘Qanat’ in Iran, ‘Foggarras’ in Tunisia and Algeria, and ‘Khettaras’ in Morocco. The survival of these ancient irrigation systems is a testimony of brilliant engineering local knowledge. Presumed to be of Persian origin and introduced to the Maghreb during the Arab conquest, they were partly responsible for the ksours’ former wealth along the long range trans-Saharian trade routes of the past.

A ‘kharez’ (‘qanat’) is an unlined tunnel in the hillside, bringing water by free flow from underground aquifers to be used for surface irrigation. Dug by local craftsmen from shafts at close intervals, they are small in size but may be many kilometres in length. In Afghanistan, it is estimated that 6 470 ‘kharez’ still supply water to 167 750 ha (data of the last inventory conducted in 1967). ‘Kharez’ are often used for domestic water supply.

In Baluchistan, Pakistan's poorest and least-developed province, the karez is the only water-harvesting mechanism available to the poor, who constitute the majority of the population. In some areas, the karez is a vital link between the communities and the dams built by the government.

In North Africa,the simplicity and ingenuity of these man-made underground systems allow the capture and the distribution of groundwater over thousands of kilometres. The system works through a complex network of underground channels and storage chambers set 10 to 15 metres deep, so as to avoid loss evaporation. Hundreds of conduits (seguias) carry water, bringing it eventually to the surface, leading it to the gardens thanks to a very slight slope at a flow between three and 12 litres per second.

Water distribution occurs by a string of combs (kasria) of different sizes into the allotments. The kasria is the plate measuring some 25 cm wide and 150 cm long with differently sized holes

along its length. Inserted vertically into the underground stream, its size determines the holes which correspond to the needs of individual families.

2.5.2.5 Intellectual Property Rights (from Correa, 2001)

Several proposals have been made, within and outside the IPRs system, to “protect” TK. Such proposals often fail to set out clearly the rationale for its protection. Any system of protection, however, is an instrument for achieving certain objectives. Therefore, a fundamental question, before considering how TK may be protected, is to define why it should be.

Some understand the concept of protection in the context of IPRs, where protection essentially means to exclude the unauthorized use by third parties. Others regard protection as a tool to preserve traditional knowledge from uses that may erode it or negatively affect the life or culture of the communities that have developed and applied it. Overall the main arguments for granting protection to TK include:

- equity considerations,
- conservation concerns,
- the preservation of traditional practices and culture,
- the prevention of appropriation by unauthorized parties of components of TK, and
- promotion of its use and its importance in development.

2.6 AKST AND ITS IMPACT ON AGRICULTURAL PRODUCTION AND DEVELOPMENT GOALS

2.6.1 Impact on agricultural production and development goals

Increased agricultural productivity in 20th century has greatly contributed to poverty and hunger alleviation and enhanced economic growth. That was mainly attributed to increased investments in agricultural research and development (R&D).

Globally, nearly $ 731 billion (or 1.7 percent of the world's GDP) was invested in all the sciences in 2000; including research conducted by public and private institutions (Pardey et al, 2006). Of the developing countries, real research expenditures between 1995 and 2000 increased the most in the Asia-Pacific (11.9 percent) and Middle East and North Africa (11.5 percent) regions. The overall average of annual growth rate in research spending for developing countries was 8.6 percent over the 1995-2000 period. The lowest annual growth rates were 1.9 percent for the "other developing countries" (which includes several former Soviet States) and 3 percent for Sub-Saharan Africa. China and India achieved the highest annual growth rates in research expenditures of 19.7 percent and 12.2 percent respectively.

Similarly, trends of public spending in agricultural R&D reveal that investments increased by 51 percent worldwide over the last two decades, from $ 15.2 billion in 1981 to $ 23 billion in 2000 (Pardey, et al., 2006). During the 1990s, developing countries as a group undertook more of the world's public agricultural research than the developed countries. The Asia-Pacific region has accounted for larger share of the developing-country total since 1981, accounting for 32.7 of global total agricultural research spending in 2000. China and India alone accounted for 39.1 percent of the developing world's agricultural R&D expenditure in 2000, a large increase from their combined share of 22.9 percent in 1981.

Five developing countries (China, India, Brazil, Thailand and South Africa) accounted for 53.3 percent of the developing world's public investments in agricultural research in 2000, up from their 40 percent share in 1981. Meanwhile, only 6.3 percent of global investment in agricultural R&D was conducted in 80 countries (mainly low income and home to 625 million people).

Research intensities (that is, agricultural R&D spending expressed as a percentage of agricultural gross domestic product, Ag. GDP) provide relative measures of R&D investments. Developed countries as a group spent 2.36 percent of Ag. GDP in 2000 on public agricultural R&D, a noticeable increase over the 1.41 percent of Ag. GDP in 1981. Developing countries, on the contrary, have not experienced a measurable growth in the intensity of agricultural research since 1981. These countries spent only 0.53 percent of their Ag. GDP on public agricultural R&D in 2000. These figures indicate that the scientific or knowledge intensity of agricultural production grew at a much faster rate in rich relative to poor countries, suggesting increased intensity gap over the past three decades (Pardey, et al., 2006).

Asia-Pacific region has experienced the lowest research intensity of <0.5 percent since 1981. The West Asia and North Africa region is the second lowest region in terms of research intensity (Figure 2.6 a). Although most of Sub-Saharan countries had lower 2000 intensity ratios than in 1981, the research intensity in this region is still higher than those of Asia-Pacific and WANA regions.

Per capita agricultural R&D spending in another research intensity ratio, revealing that rich countries spent $ 692 per agricultural worker in 2000. Whereas, poor countries spent just $ 10 per agricultural worker in 2000.

Historically, agricultural innovations in the form of improved crop varieties, livestock breeds, and farm management practices were typically the result of farmer experimentation (adapting and developing earlier ideas, then passing on inventions to younger generations). Publicly funded research is relatively new, it began in the early to mid 1700s as part of the efforts of the agrarian societies that formed throughout the United Kingdom and Europe at that time. Consequently, the publicly funded and operated agricultural experiment stations developed around the mid 1800s (Pardey, et al., 2006). Both public and private agricultural R&D continued to evolve from the trial-and-error efforts of many individuals to large scale input supply firms investing in their own private R &D facilities.

In agriculture, it is difficult, however, for individuals to fully appropriate the returns from their research investments, and it is widely held that some government action is needed to ensure adequate investment in R&D to fully capture the public good dimension of the agricultural research. Private investments are evident in agricultural R&D. About 36 percent of global spending on agricultural R&D in 2000 was invested by private firms and the remaining 64 percent by public agencies. Most of the private R&D (about 93 percent) was invested in rich countries. The contribution of the private investment to agricultural R&D is still limited in developing countries (6.3 percent) compared to its sizeable contribution in developed countries (54 percent of the agricultural R&D is private). In developing countries, the agricultural R&D is predominantly public and there are large disparities in the private contribution among regions of the developing countries. In the Asia-Pacific region, nearly 8 percent of the agricultural R&D investments is private compared with 3.5 percent in the Middle East and North Africa region. In Sub-Saharan Africa, the private investment in agricultural R&D is the lowest (1.7 percent) among developing countries (Table 2.6 a from Pardey, et al., 2006).

This pattern of private contribution to agricultural R&D investments has important implications to intensity of agricultural research in developed and developing countries. In 2000, developing countries as a group had an agricultural R&D intensity ratio of 0.56 percent compared with 5.16 percent for developed countries. This results in a developed versus developing country intensity ratio of 9.2:1 compared with a 4.5:1 ratio if only public research investment were considered (Pardey, et al., 2006).

Previous information on agricultural R&D expenditures suggests the following conclusions:

- There has been a slow down of support for publicly funded agricultural research among developed countries. This is partially attributed to a shifting emphasis from publicly to privately funded agricultural R&D, and to shift in government spending priorities. For developing countries, including CWANA region, majority of agricultural R&D investment is undertaken by public sector. The contribution of private funding is, and will continue so, limited. Thus future expansion in agricultural R&D investments needs to be funded by the public sector.
- There is clear reorientation of agricultural R&D in developed countries away from productivity-enhancing in food staples toward concerns over the environmental effects of agriculture, as well as the food quality, medical, energy and industrial applications of agricultural

commodities. Such research reorientation has important implications on linkages between developed and developing countries in terms of the productivity-enhancing effects on staples, which are still a priority research for developing countries. This is particularly true in line with current trends in research expenditure of international agricultural research centers toward environmental sustainability and policy at the expense of productivity-enhancing research.

- Although limited, the majority of private agricultural R&D in developing countries is often oriented to crop-improvement research of export crops, such as cotton, corn, and sugarcane. This implies that private R&D contribution is expected to stay minimal in productivity-enhancing research of staple crops. Publicly funded agricultural R&D will continue as the main source of productivity-enhancing research in developing countries of CWANA region. Yet, spillovers of agricultural science and technology within and among countries have been a key feature of agricultural development.

2.6.2 Options and Insights of Making more Effective Use of Agricultural Science and Technology

To enhance the effectiveness of public investments in agricultural science and technology in CWANA region, the following insights are recommended:

- Enhance technology strategies and priority setting. CWANA countries are invited to develop their strategies and research priority settings in line with their comparative advantages, resource endowments, and contribution to the developmental goals of poverty alleviation, food security enhancement, and natural resources sustainability. Regional research priorities for CWANA region were already developed by ICARDA in 2002 with full participation and active involvement of all stakeholders using a bottom–up approach for stetting research priorities (Belaid, Solh and Mazid, 2003) New efforts in the orientation of national research priorities in CWANA countries need to capitalize on the new research focus of international agricultural research centers (represented by the CGIAR Centers) which is directed toward the Agricultural development in developing countries. The CGIAR's five priority areas for research are:

1. Sustaining biodiversity for current and future generations
2. Producing more food at lower cost through genetic improvements
3. Creating wealth among the rural poor through high-value commodities and products
4. Combining poverty alleviation with sustainable management of water, land and forest resources
5. Improving policies and facilitating institutional innovation to support sustainable reduction of poverty and hunger

- Define options and opportunities for optimizing the contribution of agricultural R&D and determine the best application of resources to meet research priorities.
- Develop and maintain appropriate agricultural science and technology data bases. These include quantitative and qualitative information on changing research and funding environment as well as institutional changes at national, regional, and global levels.

- Understand the evolution and identify complementary roles of different research partners, including NARS, advanced research institutions, and CGIAR Centers. ICARDA in its research and development continuum clearly draws the roles of different partners in the whole research and development chain. This also includes monitoring changes in the research environments at all levels for implications on strategies and priorities of different organizations.
- Carry out ex-ante and ex-post research evaluation for accountability and resource allocation purposes. This should lead to the development of appropriate processes and mechanisms for allocating research resources to maximize impact.
- Improving incentives for technology generation, access and use. Investments in agricultural R&D can make a significant contribution to feeding poor people. The potential impact can be greatly enhanced if successful partnerships are further developed.

2.6.3 DYNAMIC INFLUENCING THE ROLE OF WOMEN IN AGRICULTURE

In the last decades a number of factors have influenced the contribution of women to agriculture in the CWANA region in both qualitative and quantitative terms.

2.6.3.1 Land and Agrarian reforms

According to first resolution of the United Nations Sub-commission on the Prevention of Discrimination and the Protection of Minorities "[…] continued discrimination faced by women in all matters [related] to land and property is the single most critical factor in the perpetuation of gender inequality and poverty." Law and social norms in many countries of the CWANA restrict women's ability to buy or inherit land, particularly agricultural land and resources, affecting women's participation in agriculture.

In Iraq the land and agrarian reforms assigned plots to men and women alike and the law guaranteed gender-equal inheritance rights. The state recognised and supported women's roles as landowners and farmers. Customary law, however, often prevailed over state law and ownership of land continues to be predominantly excusive to men. In Syria, on the contrary, the land reform assigned the plots to the male head of the households only, and these were also the addresses of the agrarian reforms that centralised the agricultural production system. Women became 'helpers' rather than farmers in their own right. Their access to agricultural basics was limited and they arguably lost independent access to food production and their control over the produce revenues.

Lacking control of and entitlement to production means and sources often implies restricted access to loans and social security, limited autonomy and decision making power, and eventually curtailed ability to achieve food security. Women's limited access to markets also impacts on their control of revenues and decision making power. As shown in a study on Jordan, women working on land they own, rent or sharecrop, rather than on household land, are much more likely to engage in marketing activities, control the income earned on the land and allocate household expenditures. Agriculture, however, is mainly a male activity, in Jordan, and land is predominantly owned by men. The percentage of women farming their own land is very low,

approximately 1% of Jordanian population and 11% of the female agricultural labour force (Flynn, Oldham 1999: 56).

2.6.3.2 Migration

Many countries in CWANA region have been characterised by male rural-to-urban migration and by out-migration mainly to the Gulf States. As a consequence, the number of female headed-households has increased substantially along the years. This has often been paralleled by agricultural intensification trends that in Jordan as in Syria, Lebanon, Gaza (Esim, Kuttab 2002) and Egypt (Taylor 1984: 3-10) caused an increasing demand for women's labour in agriculture (World Bank 2005: 6). Women work more and more as unpaid family labourers, their agricultural duties added to their domestic ones. In some countries female farmers have started also working off-farm in agriculture since revenues from migrated relatives are often not sufficient for survival and plots are too small to sustain the family. These processes led to a growing feminization of agriculture with increasing rates of women working in the unpaid and informal systems. The latter are characterized by gender-based wage differentials, precariousness, lack of social services that contribute to women's vulnerability. The increase in household workload involves also children who contribute their share to the expense of school attendance, free time and health.

These changes in the management of rural households have not been followed by adjustments to legal rights (such as property ownership, assets entitlements or labour rights) or to the agrarian systems (such as distribution of agricultural basics, market arrangements, technology introduction and generally agricultural development plans) that in the majority of cases assume farmers to be male thus favouring their needs, preferences, and rights. This negatively affects women's agricultural work and arguably, agricultural productivity.

Migration also influences intra-household dynamics. Women can gain independence because of men' absence. They participate in decision making at least by managing small budgets, their mobility is increased as they sometimes go to the market to sell their products even if they still rely on male relatives for major decisions such as the sale of an animal (cow, veal…..) (CNEA, 1996). In other cases women can lose independence if some relatives manage the household during the absence of the migrant. In the case of Syria women seem to perform most of the agricultural work without having control of management or decision-making processes that are still in the hands of male relatives (Abdelali-Martini et al 2003). A study on Egypt in the 1980s reported that women gained more control of their own life if their husband migrated, only in independent households. In extended families, their autonomy was reduced by the increased control of the mother in law (Taylor 1984).

2.6.3.3 Conflict

Women's rights to property, land access and entitlements to agricultural basics are not effectively protected either by legal structures or social norms. In conflict and post-conflict situations, when the number of female headed-households increases, these rights are even more difficult to

demand and women's means for a sustainable livelihood are undermined. They very often resort to working in the informal sector despite the latter's constraints with regard to assets, markets, services, regulatory frameworks and its larger gender-based wage differential (Esim, Kuttab 2002).

According to a study on the Palestinian conflict women face the repercussions of the occupation, the gender-based discrimination to property rights and the obstacles due to traditional, patriarchal practices (ibid.). Agriculture is the second most important sector for women's employment and feminisation of agriculture is a growing phenomenon. Apart from problems in claiming their rights to land and resources, women have to deal with an old agricultural system and techniques since not much investment was ever made in agriculture because of the continuous occupation. Moreover, in 2001, women's agricultural activities were shrinking due to land confiscation, and decrease in donor support for agriculture. "In this context informal employment has become a survival mechanism especially for households maintained by women" (ibid.: 3).

In Iraq women headed-households are numerous in the rural areas and they are more and more becoming a vulnerable group because of the ongoing violence. Women farmers are particularly vulnerable because they have limited control of production resources such as land and technology, and reduced access to support services. (UN, WB 2003)

2.6.3.4 Mechanisation and technology introduction

Mechanisation and labour-saving technology have radically changed agricultural production and also work organisation in the rural areas. These have been beneficial to women in some cases and detrimental in others. Home-based technology, such as piped water and electricity, have helped reduce female domestic drudgery by reducing fuel and water collection work. Agricultural machinery, on the contrary, is usually designed for male users thus strengthening the gender division of labour. Big handles and heavy levers can impede women's access to machines. Social biases that associate machinery use to men further limit women's use of technological improvements (Brandth 2006: 17–27). This is confirmed by a research on Lebanese agriculture according to which the low involvement of women in technology is due to practical difficulties in access and cultural restrictions on use. Also, women's crops and livestock are usually disregarded as research priorities (ESCWA 2001).

In the 1960s, when agricultural production started being mechanised in Egypt, men's work began to change radically while women's work remained in the labour intensive sector of cultivation (Saunders, Mehenna 1986). The introduction of new agricultural technology in the Syrian countryside brought many migrated farmers back to the fields with the prospect of an increase in production. Men took over the use of the machinery for land preparation or harvesting while women and children were assigned other tedious, manual jobs such as weeding and thinning. In some cases the new machines have freed women from performing time-consuming jobs, but

these were the source of extra incomes women earned when working seasonally off-farm (FAO 1995).

2.6.3.5 Globalisation trends

Many countries of the CWANA, such as Egypt, Jordan, Turkey and Syria, are moving towards structural adjustment policies that reduce agricultural subsidies, increase the role of the private sector and free market, decrease government expenditures, increase efficiency. Evidence shows that liberalisation measures have mainly disfavoured small-scale farmers, unskilled and informal workers. Women constitute a large part of these categories and are increasingly suffering from job insecurity. The increase of precarious work has affected mainly women who are the first to be discriminated against in employment patterns. At the same time, the potential benefits connected to a globalization of the labour force do not benefit women whose working choices are restricted, for social reasons, to the internal labour market and eventually to limited rewarding conditions.

Policies of market liberalisation suffer from gender-biases and market dynamics have marginalised petty trading and women who are mostly concentrated in it. Gender-discriminations in state and market institutions, add to intra-household inequalities which reduce women's control of the revenues of their work (Baden 1998). Social policies to counteract the marginalisation of disadvantaged sectors have not been put in place. On the contrary, the retreat of the state in providing social security has greatly affected women who have been in charge of making up for the lacking support. As a matter of fact, the weakening of the public health system has been compensated by household-based health-care for the old and sick performed by women and girls mainly. This duty is time-consuming and risky for the health because of exposure to illnesses.

Migration trends have continued intensifying the load of female labour in the rural areas. Environmental degradation is adding pressure by affecting the ecosystem many depend on for their livelihoods (Sindzingre 2004).