Abstracts

Eighth International Conference on Development of Drylands

Human and Nature – Working Together for Sustainable Development in Dry Lands

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Abstracts of Oral Presentations

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Mohan C. Saxena

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Table of Content

Plenary Session Presentations

1. Future challenges to the sustainable use of natural resources in the dry areas

Prof Dr. Adel El- Beltagy,
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The dry areas of the world are particularly prone to desertification. An estimated 80 million people are affected annually. The deterioration of vegetative cover, wind and water erosion, salinization, and the degradation of soil fertility and structure are all manifestations of desertification. Nearly 50% of the arid regions globally, including one-quarter of the irrigated land, one-half of the rainfed cropland and three-quarters of the rangeland, are estimated to be degraded. Unless this trend is checked, the food security of the people in the dry areas will continue to be under threat.

In attempting to develop options for the development of drylands there is an urgent need to improve the livelihoods of the poor, while at the same time protect natural resources of land, water and biodiversity. Experience has shown that simple recipe solutions that tend to be sectoral do not function efficiently and that there is a need for customizable toolkits and options that can be tailored by communities to meet their priorities. Such toolkits and methods are knowledge intensive, requiring greater attention to knowledge management and exchange including new institutional arrangements and greater attention to informal and community social structures.

Through consultations at a broad level, ICARDA has developed an integrated multisectoral approach that distilled the main question: 'how can poverty in desertification-prone areas be reduced and the poor achieve stable, secure livelihoods without undermining the ecosystem goods and services that they vitally depend on?'

Under a new consortium called the 'Desertification, Drought, Poverty and Agriculture' a set of six inter-related research themes were proposed: Understanding and coping with land degradation and drought risk; Managing and restoring ecosystem functions; Policy and institutional options; Harnessing genetic resources; Diversifying systems and livelihoods; and Knowledge and technology sharing.

Examples of how ICARDA is contributing to these themes are presented.

2. The future dimensions of drylands in the implementation of the UNCCD

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Implementation of the UNCCD will focus on activities to meet the needs of people living in dry lands while enhancing measures to combat desertification. While the Convention will focus on seven areas, there are four that are of a particular interest to the International Conference on Dry LandsDevelopment: 1. Measures for the rehabilitation of degraded land;

2. Drought and desertification monitoring and assessment;
3. Access and use of appropriate technology, knowledge and know-how; and 4. Linkages and synergies with other environmental conventions and national development strategies.
The paper deals with these four areas histrically and provides perspective for future.

3. Sustainable development for fragile ecosystems

Prof Dr. Adli Bishaye, Friends of Environment and Development Association (FEDA) Board Chairman, Emeritus Professor AUC, Cairo, Egypt

The mission of Friends of Environment and Development Association (FEDA) is to implement strategies for sustainable development in Egypt, as put forward by a special UNDP Task Force coordinated by the author. The Bruntland definition of sustainable development was adopted and its framework was based on a dynamic balance between (a) resource management, (b) environmental protection, and (c) human and economic development. To achieve this balance, we require appropriate management, necessary financial resources, and R& D with emphasis on optimization between the ecological and economic dimensions of development. Public participation (social & political), adequate infrastructure and efficient support services are also of utmost importance in implementing strategies for sustainable development. It was realized by FEDA's Board that it would be more realistic and effective to limit its implementation activities to fragile ecosystems, namely coastal, desert and historic areas. Since 1993 we have been working in Rosetta (coastal area), Wadi Natroun (desert area) and Gamalia district (historic part of Cairo). These three fragile ecosystems, though different in location, climate and natural resources, are well known for their cultural heritage. Both Gamalia and Rosetta have some of the most important Islamic monuments, while Wadi Natroun is known for its famous Coptic Christian monasteries. FEDA's sustainable development objective is to implement projects leading to upgrading of these fragile ecosystems with the goal of improving the quality of life of its residents and encouraging tourism. For this to be achieved we need to deal with both human and environmental aspects.

The paper reviews some of the steps taken towards achieving sustainable development in these fragile ecosystems through (a) upgrading physical conditions and improving infrastructure of demonstration areas, (b) developing democratic community structure through information management, monitoring and public awareness as well as capacity building and initiation of local organizations, and (c) improving living conditions of the inhabitants with respect to social, educational, cultural, health, environment and economic support through training and technological upgrading.

4. Progress in aeolian desertification in China

Prof Dr. Wang Tao, Director General, Key Laboratory of Desert and Desertification, Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Academy of Sciences, Lanzhou, 730000, China China

Aeolian desertification is land degradation characterized by wind erosion mainly resulting from the excessive human activities in arid, semiarid and part of sub-humid regions in North

China. The research on aeolian desertification has been underway for more than 5 decades leading to the establishment and development of China's desert science. Researches in this field have made a great contribution to the national economic reconstruction and the protection of the environment. This paper focuses on the major progress in the aeolian desertification research in China during last 50 years, including fundamental studies, monitoring and assessment, vegetation succession, landscape ecology, plant physiology, impact on ecosystem, efficient use of water and land resources and sustainable development in desertified regions, the process of aeolian desertification and its control models and techniques including different studied periods, deserts formation and evolution, origin of sand materials to the deserts, the history of evolution of sand deserts and aeolian land, landscape of the main sand deserts, sandy lands and aeolian desertified land. We suggest that the key fields of desertification research of China in the future should be the blown sand physics, process of sand storm, ecology of desert environment and desertified region restoration, water and land resource utilization and sustainable development of agriculture in desertified regions, and desertification reversion and control.

5. The role of traditional hydrotechnology in dryland development: Karez, Qanat and Foggara

Prof Dr. Iwao Kobori, United Nations University, Tokyo, Japan

Karez (Kan-er-jing) in Xinjiang, China is a well known traditional underground irrigation system, which is still used in Turpan basin. However, introduction of pumping well and open canal system in the area has serious impact on this traditional system. Similar phenomena are occuring in Iran (Qanat) and North Africa (Foggara). Recently, international organizations such as UNU, UNCCD, UNESCO, EC (European Commission) have paid attention to rehabilitation and sustainable development of these traditional systems. The author has been working on this subject in the past 50 years around the world, and would like to discuss key issues on this subject.

6. The use of spatial data for integrated agricultural planning and management

Prof Dr. Ayman Abou Hadid, Director, Arid Lands Agricultural Research and Services Center (ALARC), Ain Shams University and Supervisor, Division of Agricultural Applications and Marine Sciences, National Authority for Remote Sensing and Space Sciences (NARSS), Cairo, Egypt

The agricultural production depends on the utilization of natural resources for intensive cropping systems. Plant production actually is a function of several climatic and edaphic factors. The use of climatic data for the estimation of water requirements is a major tool to rationalize water consumption. Estimating evapotranspiration from the climatic data is a well established technique. The problem is the need to have surface agro-meteorological equipment on the location, which is expensive especially in remote areas where new land reclamation projects take place.

The aim of this work was to establish a polynomial fitting for the air temperature based on hourly climatic measurements as a first step. The second step was to have a correlation

between air temperature and canopy temperature for different agricultural conditions. Having these two algorithms allows the researcher to use the NOAA satellite images to calculate canopy temperature and transform it to air temperature, then using the air temperature parameter to calculate evapotranspiration.

Climatic factors affect the crop water requirements, time of cultivation, length of crop stand in the field, tolerance to pests and diseases, economic viability of agricultural production, and finally the total yield and product quality. The starting point of any agricultural development is to understand the prevailing climate. Early planting is one of the options for summer-cultivated crops in order to get the maximum economical yield. Early prediction for diseases and insects is important to help the farmers avoid heavy spray of pesticides and take necessary actions to avoid diseases. The use of climatic data could help in providing tools for proper pest management through the possibility of forecasting the incidence of pests and diseases, and hence reduce the risk in plant production and help to minimize the amounts of chemicals used to control pests.

Agricultural decision support system with mathematical and logical models is linked with a Geographical Information System (GIS) to provide tools for planning the land utilization and resource management options. The advantage of using spatial data for the calculation of evapotranspiration is the wide coverage of large areas especially in new land reclamation projects where it is difficult to establish surface stations. The results showed a high potential for using this approach to estimate irrigation requirements at low cost and for wide areas of land.

7. *Jatropha curcas* L., an excellent source of renewable energy in the dry areas

Prof Dr. Mohan C. Saxena, Senior Advisor to DG, International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 5466, Aleppo, Syria. (E-mail: m.saxena@cgiar.org)

Increasing industrialization in the developing world is leading to spiraling increase in the demand of fossil fuel. Because of finite nature of fossil fuel reserves, the demand can not be met on sustained basis. In addition, the green-house gas emissions from fossil fuel are taking a heavy toll of the environment and contributing to global warming. Developing a reliable source of renewable energy is therefore attracting a major global attention. Several crop and tree species are good source of products that can be processed to produce bio-fuel on a sustained basis.

In the arid and semi-arid regions, particularly on the degraded lands and lands affected by moving sands, *Jatropha curcas* L. has proved to be a promising oil-bearing tree.

The seeds of this Euphorbiaceae tree contain more than 30 % oil, which can be used for making bio-diesel. The seed cake produced after oil expulsion is rich in nitrogen (> 5 %), phosphorus (>2.5% P_2O_5) and potassium (1% K_2O) and can be converted into valuable organic manure for improving physical and chemical properties of the soil. The plant propagates freely from seeds as well as from cuttings and can start producing fruits in two to three years after establishment. It is well adapted to the harsh environments of desert margins, and can withstand drought once it is established through supplemental irrigation in the dry areas.

Preliminary studies have shown that it could prove a very promising species for rehabilitating degraded areas and protecting the land from wind erosion when introduced in dry areas within the framework of watershed management. A well established plantation of *J. curcas* could produce on good soil on an average about 5 tons seed/ha/year giving 1500

kg/ha oil and 2500 kg/ha seed cake. However, under marginal conditions a yield of 1.5 tons seed/ha can be expected. The crop is being promoted as a valuable source of bio-fuel produced on degraded drylands in several developing countries.
The government of India has a very ambitious plan for promoting *J.curcas* production on degraded lands and the private sector and the non-governmental organizations are providing technical support to farmers to harness full benefit from this valuable plant.

8. Living with desert: 'CWANA-Plus' partnership

Prof Dr. Hans Van Ginkel, Rector, United Nations University, Tokyo, Japan

The CWANA-Plus (CWANA+) Partnership is a joint initiative by United Nations University (UNU) and the International Center for Agricultural Research in the Dry Areas (ICARDA). The intent is to foster South–South cooperation on sharing experts and facilities, training scientists, and promoting the best practices among centres of excellence in sustainable dryland development across the vast CWANA (Central and West Asia and North Africa) region plus neighbouring dry areas in Western China, South Asia, and sub-Saharan Africa. The strategy used is to capitalise on the existing networks of ICARDA and UNU to link relevant centres of excellence in research and capacity building; identify the research gaps, and select partners to reach out in these areas. The anticipated key outcomes of the CWANA+ network are: (1) An extensive regional network for information exchange and sharing of successful experiences in sustainable management of drylands; (2) Development of collaborative activities amongst partners in the network, through the identification of research gap and available financial resources; and (3) Enhanced capacity building and academic cooperation within the network and with the rest of the world. Three examples of the ongoing activities will be used to illustrate the operation of the CWANA+ Partnership.

9. Agricultural water consumption management in Iran considering aridity and drought incidences

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The Islamic Republic of Iran is located in one of the most arid regions of the world. About 64.7% (105 million ha) of country's total area has an arid to semi-arid climate. The average annual precipitation is 252 mm, which is one-third of the world's average precipitation. This low amount falls with high temporal and spatial variability. Beside aridity, drought is also a potential threat to agricultural productivity in Iran. Therefore, food and agricultural production in Iran is highly dependent on proper use of water in agriculture. Analysis of past meteorological data indicated that average rainfall during 1995-2000 was less than the

average of the last thirty years. The agricultural sector in Iran is one of the most important economic sectors of the country, and water scarcity is the most limiting factor for agricultural expansion and higher production. Due to limitation in water resources and low possibility to increase new water resources, the needed increase in agricultural production can be obtained only by the use of technical and scientific methods to increase agricultural water productivity (WP). The overall agricultural water productivity, which is defined as the amount of crop production per unit amount of water applied for irrigated crops or per millimeter of precipitation for dry land farming crops, presently is about 0.8 (kg/m^3). This is very low and needs to be increased to about 1.6-2.0 kg/m^3 by year 2020 to meet the projected demand of food and other agricultural products. Use of crop varieties with higher drought resistance and changing the cropping pattern to get better use of environment as well as improvement of farm-management practices are key to increase WP in Iran. Overall, we need to adapt our agriculture with aridity and drought and WP concept would have a key role in our decision making process.

10. Development of dryland China from historical view: a case of development of the natural oasis and its desertification over the last 2000 years in Minqin basin

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Most natural oases in the western China's dryland have been changed to irrigated farmland over the 2000 years when Han Chinese brought advanced agriculture techniques into dryland China. Consequently, dryland has been overused and consequently desertified. The Minqin Oasis in arid China is a very good example. The oasis desertification over the last 2000 years is very typical in the arid China. Minqin Oasis is located along the ancient silk-road in the east part of Hexi Corridor and low reaches of the Shiyang River. It was a pastoral land before Han Chinese immigrated into the area. By the time of the West Han Empire, Minqin Oasis became Chinese territory after series wars and agriculture was introduced. As a result, the pastoral area changed into agricultural farmland gradually. With the acceleration of exploitation under increasing population pressure, land degradation has gradually taken place. The productive land that was once suitable for plant and fish culture became a scene of desert sea with "no irrigation, no farm".

This study focuses on understanding the oasis desertification process over the last 2000 years, using multi-methods such as historical document, archaeology, remote sensing and geographic information system. The result shows that the human activities in Minqin Basin can be dated back to the Shajing Culture, a Neolithic culture at around 2600 years ago. Since the area became part of the territory of Han Dynasty at BC 210, the natural oases gradually changed into farmland. In Han Dynasty, the area of farmland reached up to about 14,800 ha, and during the Wei-Jin Dynasties it reached to 27,830ha. Thereafter, farmland area deceased during the period of 800 years from the South-North Dynasty to Yuan Dynasty, when grassland people invaded the area. The second intensified development of Minqin oasis began in Ming Dynasty when central government of the Ming Dynasty encouraged poor farmers in east China to develop the oasis. The area of farmland in the oasis reached 26,579ha followed by another intensive development period in Qing Dynasty with the total

farmland area of 75,847ha, the highest during the history. It is found that a intensive development period of the dryland during history was always followed by a strong desertification period afterward. When a new dynasty established, a wave of developments of *natural oasis* into farmland oasis began, and the developed farmland in the oasis was subject to desertification in the late dynasty leading to abandoning of village and towns by the inhabitants that relied on farmland.

11. Desertification and its control in India

Dr. Prakash Narayan,
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Land degradation (including desertification in drylands) is estimated to affect at least one-third of the 328 mha geographical area in India. Drylands, constituting about 223 mha in arid, semi-arid and dry subhumid regions, are more prone to degradation on account of climatic constraints, fragility of natural resources, and high pressures of humans and animals, as well as industrialization. Arid areas (49.5 mha) are the worst affected, especially in the western part of Rajasthan state that includes the Thar Desert (20.87 m ha), as well as in arid Gujarat (6.22 m ha). Recurrent drought, high wind, poor sandy soils and very high human and livestock demand for food, fodder and fuel wood are causing over-exploitation of fragile resources, resulting in wind and water erosion, water logging, salinity-alkalinity and vegetation degradation. Dumping of mine and industrial wastes is also now contributing to desertification.

Traditional practices of water storage and conservation and mixed farming that integrates perennial trees and grasses with crop cultivation and livestock rearing, which proved as best practices for sustainability and resource conservation, are now disappearing. As a consequence, about 92% area in arid Rajasthan is now affected by desertification (30% slightly, 41% moderately and 21% severely). About 76% area is affected by wind erosion of different intensities, and 13% by water erosion. Another 4% area is affected by water logging and salinity/alkalinity. In the neighbouring arid Gujarat about 93% area is affected by desertification. Water erosion is the major problem (39%), affecting agriculture, especially in the dominantly hilly and undulating terrain of Kachchh and Saurashtra with shallow soils that are highly fragile due to slope and periodic earth movements. The other major problem is salinity (47%), which is inherent in the large barren salt marshes like the Great Rann of Kachchh but is also present in the narrow coastal plains.

About 174 m ha area in rainfed semi-arid and dry sub-humid regions are mostly affected by water erosion that is getting accelerated due to declining tree cover, land use changes with expansion of cropland and intensive mono-cropping, while the irrigated areas of these regions are being affected by water logging and salinity. Besides, the Indo-Gangetic plains of Punjab and Haryana states, with dominance of rice-wheat cultivation, are showing signs of depletion of groundwater, organic carbon, and deficiencies in essential plant nutrients.

To combat the adverse impact of these processes on finite land and water resources, India embarked upon a national policy to bring 33% of the country's land area under forest, as well as to implement desert and drought-prone area development programmes, which include sand dune stabilization, wind erosion control, soil and water conservation in

peninsular India and river valley projects, watershed development, agro-forestry, social forestry and joint forest management, salinity control, etc., through state land development departments, forest departments, R&D institutions, NGOs, and people's participation.

The Central Arid Zone Research Institute is contributing to these efforts through research interventions. Its technology on sand dune stabilization through vegetative means has been used by the State to stabilize about 300,000 ha area of menacing sand dunes, especially on government-controlled land. Promising technologies for shelterbelts, border row plantation, plantation of tree belts across the wind and alternating with crop/grass rows that utilize remunerative native/exotic trees, shrubs and grasses for food, fuel, fodder, fruits, minor forest products like gum and resins, have also been developed for the farmers who are the major users of sand dunes in the region. Shelterbelts of a three-row wind break of *Acacia tortilis*, *Cassia siamea* and *Prosopis juliflora* as the side rows and *Albizzia lebbek* as the central row has proved promising. A number of diversified farming systems have been evolved for low-rainfall areas, which include agro-forestry, agri-horticulture and agri-silvi-pasture, to sustain livelihood during crop failure and to maintain livestock during drought. Improved practices for pasture and rangeland management, especially through silvi-horti-pastoral systems and rotational grazing, and rehabilitation of mine spoils through vegetative means have been developed and are being propagated by R&D institutions as well as state departments.

For water erosion control on arable lands, contour cultivation, bunding, graded bunding and bench terracing are adopted in conjunction with minimum tillage, cover crops, inter-cropping, strip cropping, contour vegetative barriers, etc. For non-arable lands check dams, gully plugging, stabilization of gully heads and vegetative measures are advocated. These measures and appropriate land uses are integrated on catchment basis with due regard to capability of the land. Rain water conservation, its harvesting and efficient utilization are in-built in watershed management programmes. Combating desertification through land care while enhancing agricultural productivity is the underlying principle for sustainable land management in the drylands of India.

12. Scientific bases of increasing efficiency of rainfed lands of Kyrgyzstan

Prof Dr. Acad. Djamin Akimaliev,
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The rainfed areas make 40 % of all arable land i.e. about 0.5 million hectares. The main factor limiting stability in yields is the precipitation. On the basis of the amount of precipitation received the rainfed lands can be divided as low (250 mm per year), medium (300-350 mm) and well-supplied (450 mm) areas.

The basis of increasing the land use efficiency of rainfed areas should be the adoption of cereal-fallow rotation, in which the fallow area would account for 20 percent of the cropping intensity. Keeping the field fallow increases moisture conservation in the ground as also the accumulation of nitrate nitrogen. For enhancing the beneficial effect of fallow control of weeds is essential. The productivity of winter wheat grown after fallow is increased to 0.5-1.0 ton per hectare depending on sufficiency of rainfall in the year.

Appropriate conservation tillage is important in rainfed agriculture. The application of flat-cut tillage leading to deep friable soil allows increase in the productive reserve of moisture by 25-40 mm. The most favorable water conservation occurs when tillage with deep

flat-cut cultivator is applied to the land during the fallow phase, shallow-sized treatment under winter wheat phase and thorough ploughing under the phase of spring barley that is the last crop of the rotation.

The productivity of crops in cereal-fallow rotation depends, in the first place, on the quantity of precipitation, and secondly by the place of the crop in the rotation. In wet years the maximum yield of winter wheat (about 5 tons per hectare) is obtained after fallow treated by flat-cut – deep cultivator. Winter wheat and spring barley are the best cereals for realizing full yield potential in a of cereal-fallow rotation system.

In Kyrgyz Agriculture Research Institute a large emphasis is placed on developing drought-tolerant cereal varieties for rainfed areas. The bread wheat varieties 'Erythrospermum 760', 'Adyr' and 'Kayrak' belong to this group. This varieties are rather early maturing and capable to form ear before the setting in of drought. On an experimental field of Institute the productivity of grain for the last two years was 3-6 tons per hectare depending on the amount of precipitation. These varieties contain about 15% protein and about 29% gluten in the grain.

The main variety of spring barley cultivated in rainfed areas is 'Naryn 27,' which is characterized by high productivity, drought tolerance and 15-16% protein content in the gains. It has vigorous early growth in the vegetative period and its heading occurs 8-12 days earlier than other varieties, thus permitting it to escape severe drought. The potential productivity of 'Naryn 27' in rainfed conditions is 3 tons per hectare. The Institute has also developed new varieties of spring barley for use in a rainfed system: 'Taalay', 'Bestam' and 'Kylym'. These are early maturing, drought tolerant, having a protein content of 14-15% and a grain productivity potential of 4 tons per hectare.

Research has shown the possibility of replacing fallow by other crops - safflower, peas, chickpea, chickling (*Lathyrus sativus*) and vetches (*Vicia* spp.) - to increase the intensity and diversity of cropping and enhancing land-use efficiency of rainfed agriculture. Use of legumes not only increases rotational efficiency but also promotes enrichment of soil with available nitrogen.

13. Sustainable development in semi-arid communal rangelands

Prof Dr. R. Gareth Wyn Jones and Dr. Einir. M. Young,
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Communities living in arid and semi-arid communally-managed rangelands, historically often nomadic or partially nomadic, have for millenia been an important element of human society, providing basic subsistence to individuals and families while impacting on major ecosystems. Now threatened by many inter-contected social, economic and environmental forces, they appear anachronistic in a comsumerist, technology-driven, but environmentally concerned world even though they remain a common feature of many disadvantaged semi-arid and mountainous areas in Asia, Africa, and parts of South America.

This paper addresses some of the problems experienced by such communities and their environments and suggests possible, albeit partial, solutions in the light of work conducted by an international team of researchers in Namaqualand, South Africa, the Matsheng communities of the Kgalagadi, Botswana and the Maloti Highlands of Lesotho as part of a

EU funded project 'MAPOSDA'[1]. The paper also makes comparisons with the ICARDA funded Khanasser[2] project in Syria and other similar integrated projects in marginal areas including those in marginal areas in developed countries, be they in private or communal ownership.

Broadly we suggest that the 'agricultural route' from poverty becomes *more* problematical in such marginal areas whether they are communally or privately-managed, while the importance of other escape routes increases e.g. migration, remittances, pluri-activity, positive environmental management combined sometimes with tourism and non-agricultural, non-land use based enterprises. There can be no expectation that more than a small minority will earn an adequate return from their ranges. However the ranges remain culturally and socially highly important and a crucial 'fall-back' and emergency reserve for many community members, even if they are based for most of their time in urban centers.

It is imperative that government policy (a) recognizes and encourages the multitude of pathways from rural poverty, (b) as rule of thumb, acknowledges that the more disadvantaged the area the more important the non-agricultural route out of poverty, (c) ensures that the diverse pathways from poverty recommended do not undermine either the social importance or the environmental integrity of the rangelands and their native wild flora and fauna.

[1] INCO Project No ICA4-CT-2001-10050 (For details of the project and participants visit www.maposda.net)
[2] http://www.icarda.org/Publications/AnnualReport/2003/Project4-2.htm

Concurrent Session Presentations

Theme 1: Soil and water conservation and degradation

1. Comparison of regional flood frequency analyses methods

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The probability and value of unexpected events in hydrology is of importance for designing projects. In regions lacking data, it is necessary to apply indirect methods to estimate the discharge of river flow. Regional analysis of flood is one such technique. One of the methods for regional flood analysis in arid and semi arid regions is Hybrid technique, which was applied on data of southern Alborz watersheds to estimate the peak flow. The results of this method were compared with Index flood and multivariate regression methods.

The data of 43 and 19 relevant hydrometric stations were chosen for Hybrid method, Index Flood and Multivariate regression methods using the best fitted regional distribution of the data, log Normal III, the instantaneous discharges for different return periods were estimated. In addition, the most important and independent variables of the basin including: area, annual average rainfall, mean elevation, slope and Miller coefficient were selected. The homogeneity test using cluster analysis determined two homogeneous regions as well as the whole area of the watershed. To evaluate the accuracy and applicability of the obtained models, the results obtained from four neighboring and control watershed were compared which showed that accuracy of the proposed models for homogeneous regions in all return periods was high Also, in all return periods, multivariate regression method had higher accuracy among all methods where as in return periods of 10, 25 and 50 years, Hybrid method showed accurate results than Index Flood method.

2. Water management using drainage water and its impact on irrigated rice in the Delta region of Egypt.

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This study aims to analyze the effects of reusing drainage water (DW) in rice irrigation system in the northern Nile Delta, Egypt. Amount of applied water, quality of water, water use efficiency, and grain yield were measured. Six treatments of irrigation with fresh water

(FW) only (I), irrigation with FW mixed with DW at 1:1 ratio (I_1D_1), irrigation with FW mixed with DW at 1: 2 ratio (I_1D_2), irrigation with FW mixed with DW at 2:1 ratio (I_2D_1), irrigation with FW mixed with DW at 1:3 ratio (I_1D_3, and irrigation with DW only (D), were set up. Electrical conductivity (EC) of FW and DW were 0.35 and 2.86 dS m^{-1}, while the values of sodium adsorption ratio (SAR) were 2.81 and 3.94, respectively. In all irrigation treatments three rice varieties (Sakha 102, Giza 178 and Sakha 101) were grown. The interactions between irrigation treatments and rice varieties were not significant in terms of amount of applied water. As to the irrigation efficiency, I_2D_1 showed water saving (3550 m^3 ha^{-1}) while grain yield from the different irrigation treatments were in the following order: I (9476 kg ha^{-1}) > I_2D_1 (8929 kg ha^{-1}) > I_1D_1 (8918 kg ha^{-1}) > I_1D_2 (8730 kg ha^{-1}) > I_1D_3 (7992 kg ha^{-1}) > D (7619 kg ha^{-1}) averaged over the three rice varieties. Thus, an increase in the amount of DW led to a decrease in rice grain yield. Besides, field water use efficiency also decreased in all treatments with DW as compared to FW. Highest crop water use efficiency of 1.182 kg m^{-3} was obtained in treatment I, whereas lowest value of 0.949 kg m^{-3} was obtained in treatment D. The levels of soil $EC_{1:5}$ decreased after irrigation season under all irrigation treatments except the treatment D.

3. Rainfall time series in semi-arid environment of Mauritania

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Mauritania extends in western Africa from the western part of the Sahara Desert to the coastal area facing the Atlantic Ocean. It has arid and semi-arid climate. Management of water resources has been the most important issue in Mauritania because of the arid environment. Agricultural activity in oasis areas depends only on limited rainfall during the rainy season from June to September. In addition to apparent difference between the rainy and dry season, there is a big annual fluctuation of the rainfall over time. Oasis areas on the edge of the Sahara are suffering from the water scarcity, salinity and desertification. Therefore, the sedentary people live in a difficult situation because the source of drinking water and irrigation is mainly the shallow water table in wadi basins. Sometimes, sudden storm brings large amount of water in short period. On the other hand, a year, or even several years, may pass without any rain in some locations. As the rainfall is crucial for any development activity in arid zones, a quantitative evaluation of rainfall pattern is essential for the water resources management. In this study, daily rainfall data at three stations in the arid region of Mauritania (Atar, Chinguetti, and Akjoujt) were used for the analysis. Rainfall time series from 1931 to 1999 of three stations were analyzed. Frequencies corresponding to periodical fluctuations of the rainfall time series were obtained by the power spectrum analysis. Then, the Fourier series was applied for reconstruction of the original time series. Rainfall time series of the stations follow the same tendency with the rainy period in 1950's and the dry one in 1970's. The Fourier series showed the trend of fluctuations of those time series.

4. Desertification controlled by fluvial, aeolian and playa interactions: evolution in the distal part of a terminal fan and a case study from an arid land in Central Iran

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The implementation of the convention for combating desertification can not be achieved without a multidisciplinary method of study, among which, understanding the geology as well as geography of the area receives enough attention. This study stresses the importance of desertification and its relationship to fluvial, aeolian and playa interaction. It represents a case study from distal part of the Abarkoh terminal fan (total fan size >940 km^2) in the Gavkhoni-Sirjan depression in Central Iran, which is a sensitive area to desert fluvial system and its interaction with adjacent aeolian and playa environments. The late Quaternary evolution of this area represents the relative dominance of wind vs. water transport and deposition as a function of fluctuation in the discharge of ephemeral fluvial systems and changes in water table/playa lake level. The combination of climatic change, human impact and to a lesser extent syndepostional tectonics resulted in a fall in water table/playa lake level and associated recent periods of extensive erosion and dune shifts. Recent deflation of the dune fields either exposed the playa-fringe, lacustrine travertine-marl deposits with exhumed plant roots or eroded part of the vegetated sand dunes. The occurrence of the significant erosion and reworking of the sand dune fields was partly controlled by the termination of the fluvial system in the playa periphery, where sand dunes damped and controlled the fluvial pathways. Periodic flash floods bypassed the alluvial fan and deposited fluvial muds in the inter-dune areas, where they are interbedded with wind-blown sands and granules. The interaction between fluvial, aeolian and playa environments is distinctive by fluctuation in water table/playa level and associated aeolian landscape, which reshaped by the major ephemeral streams that flooded the inter-dune deposits. Salt-encrusted sand flats covered the major areas of the playa, whereas the sand dunes shifted and stabilized toward the northwest, where the ephemeral streams drain into the playa fringe.

5. Floodwater effect on infiltration rate of a floodwater spreading system in Moosian

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Uneven rainfall distribution in time and space as well as the low amount of rainfall has made the farmers to overuse the ground water in order to manage more reliable farming in the southwestern plain of Ilam province in Iran. In this scenario, ground water recharge has an important role in the farming security. One way to increase ground water quality and quantity is a floodwater recharging system. However in practice, like many other natural resource projects, this system has some real difficulties. Among the main difficulties is clogging

phenomenon, which occurs through sedimentation by fine particles over the surface of water spreading systems.

In this study a floodwater-spreading system was selected to measure and monitor the variation of the infiltration and clogging phenomenon. The vertical variation as well as flow direction variation of the infiltration was studied. The study showed that the sedimentation siginficantly decreased the surface infiltration of the desilting basin when compared with the data obtained from the control points. The control points were selected of the intact area where the soil and geomorphic surface were similar to the selected sites. Removal of the top 10 cm of the natural surface beneath the sediment showed that the infiltration rates were significantly increased. Therefore, in order to decrease the adverse effects of sedimentation the infiltration rate in the desilting basin, the recent sediment of the basin should be removed and the top 10cm of the natural surface below the removed sediment should be plowed.

6. Determination the limits of precipitation variation in different points of watershed, by using distance of point to rain gage in arid and semiarid regions

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Precipitation is a very variable parameter in spatial dimension and for a specific point the observations are not accessible. A spatial model to find appropriate estimations for such points is necessary. The objective of this research was to develop a linear model to estimate precipitation at a specific point by using statistical data of another point with a defined distance. In this research, monthly data of 30 years for 350 rain gages with determined geographical longitude and latitude was used.

7. Study on relationship between precipitation parameters and erosivity factor in Khuzestan province, Iran

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The goal of this study was to investigate the relationship between rainfall parameters and USLE R-factor. To gain R-factor, at first, shower kinetic energy must be calculated and then its erosivity computed by using maximum 30 minutes rainfall intensity. Therefore 3 meteorological stations in Khuzestan province and one station each in Kohgiloyeh and BoyerAhmad and Boushehr provinces were selected and the records of their hyetographs of 13 years were analyzed. For any hyetograph, monthly, seasonal and annual rainfall erosivity was computed and corresponding rainfall parameters were extracted. Temporal and spatial variation of rainfall erosivity was studied and relationships between R-factor and rainfall characteristics were investigated using regression analysis. Results showed that February to March were the months with highest risk of erosion. Among the seasons, winter hadthe most erosivity risk. Spatial analysis of rainfall erosivity showed that Dezful and Ramhormuz had

the maximum erosivity factor. Mean annual erosivity factor of Khuzestan province was computed. Regression analysis showed strong relationship between rainfall amount (mm) and maximum 30 minutes rainfall intensity (cm/h) with R-factor. A model that computes R-factor by means of rainfall amount was developed.

8. Assessment of agro-environmental degradation in hyperarid zone-Sudan

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The study area is located in the Northern State, between latitudes 18 30' to 18 45'N, and longitudes 30 30' to 30 40'. This area lies on the eastern bank of the River Nile, known as Wad El Khowi basin. The climate is continental hyper arid characterized by low rainfall, high evaporation, very low humidity with severe north-easterly winds causing serious wind erosion. The soils were formed in old Nile alluvial deposits derived from basaltic igneous rock of the Ethiopian high plateau. The area is bare land devoid of any vegetation cover. The most serious natural problems facing the region are wind erosion, bank erosion, catastrophic Nile floods, soil salinization and sodification. These natural degradational processes were investigated through visual interpretation of remotely sense data, including multi-date aerial photographs, landsat TM, MSS and Radar images, coupled with field observations. Soil sample were collected and analysed to map and assess the salinity and sodicity hazards.
The main objectives of this study were to specify the causes, and assess the degradation processes and their impacts on the soci-economical activities. The results revealed that the agro-environmental degradation led to shortage of food, reduced income and induced migration of young men internally and externally. Sand encroachment and bank erosion reduced the extent of arable lands, while salinity and sodicity reduced the yield of food and cash crops. Thus, they have adverse impact on agricultural development, which is the main economic activity.

9. Paleoenvironmental determination of a loess-paleosol sequence by using Fusarium species and different forms of iron in NE Iran

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For paleoenvironmental identification of buried paleosols in loess sequences in Naharkhoran valley, Gorgan (Shahrak Resalat and Shahrak Talar), different forms of iron and changes in calcium carbonate concentration were studied Also, for the first time Fusarium species was used. Different physico-chemical and microbiological analyses were performed on soil samples collected from this sequence. The results indicated that the loess-paleosol sequence in the regions under study showed wide evidence for pedogenic processes. The changes in color, calcium carbonate content and particle size distribution indicated that the soils had

experienced several pedogenic periods. Amounts of amorphous Fe oxides (Feo) decreased with increase in pedogenic Fe oxides (Fed) and the ratio of Feo/Fed decreased with increase of pedogenic Fe. With decreasing of pedogenic Fe, the redness ratio decreased and the calcium carbonate concentration increased. The decrease in crystalline Fe oxides is attributed to the weathering and decompositition, indicating soil development. In soils of *Shahrak* Resalat, *Fusàrium solani* and *F. oxysproum* were obtained from profiles 1 and 2 in all area and *F. graminearum* from profile 3 which is specific in cold area. The evidence indicated that in the past soils were under cold environment. In soils of Shahrak Talar *F. solani* was obtained from profile 1 and species *F. culmorum* from profile 4 that is specific in cold area. The evidence indicated that in past soils under study were dominated by cold environment. The abundance of macrofossil shells of Gastropoda (*Cathaica pulveratrix, Catinella arenaria*) in Shahrak Talar is an indicators for periodic dry-cold and warm-humid climate in this sequence. Thus in this soils, loess-paleosol horizons are indication of glacial and interglacial periods. On the basis of Nettleton classification system Shahrak Resalat soils are classified as Paleoinceptisols, Paleoaddendosols, and Paleovertisols and in Shahrak Talar Paleoinceptisols, Paleoaddendosols, Paleovertisols, and Paleoaridisols.

10. Wind erosion and performance of the wind erosion prediction system (WEPS) on the dryland of the Columbia Plateau in the United States

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Wind erosion is a severe problem on most dryland agricultural fields all over the world, which could degrade soil productivity and air quality. Blowing dust has the potential to impair the health of the general public as well as reduce visibility. Soils that are dominated by fine particles in the low precipitation region of the Columbia Plateau in the United States, are particularly susceptible to wind erosion. An intense high wind event on 28 October 2003 with winds in excess of 15m/s resulted in a loss of more than 1200 kg/ha topsoil and a loss of 220 kg/ha of PM10 (particulates less than 10 micrometers) from a 9-ha fallow field site.
The Wind Erosion Prediction System (WEPS) is a process-based model that simulates creep, saltation and suspension during high wind events. WEPS can predict soil loss and dust emission from agricultural fields, evaluate impacts of viable farming practices and changes in land management on wind erosion, and provide assistance to develop best management practices for wind erosion control. However, few attempts have been made to validate the model. Soil loss, dust emissions, soil properties, surface characteristics and weather were examined at a dryland fallow field site on the Columbia Plateau for validating the model in 2003. Results suggest that WEPS over-estimated total soil loss during major dust storms, but under-predicted soil loss during minor storms. Indices of model evaluation were over 0.8, suggesting good performance of the model in estimating total soil loss. WEPS under-predicted the loss of PM10 for all events. Indices of model evaluation were generally less than 0.8, suggesting relatively poor performance of WEPS in estimating PM10 loss. Sensitivity analysis on WEPS indicates that near-surface soil water content, crop residue

cover, wind speed and soil wilting-point water content are the four most influential parameters affecting wind erosion.

11. The combined impacts of soil cultivation and crop residue on C and N kinetics in a semi-arid soil

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Soil C and N mineralization plays the primary role in supplying nutrients essential to plant growth, especially in drylands. Soil cultivation and crop residue may affect C and N turnover, and hence nutrient availability in semi-arid soils. This study was conducted to evaluate the combined impacts of soil cultivation and crop residue on C and N turnover in a calcareous soil in Central Iran. Soil samples were collected from 0-15 cm depth in cultivated and uncultivated plots and analyzed for major soil attributes. Wheat (*Triticum aestivum* L.) and alfalfa (*Medicago Sativa* L.) residues were collected and analyzed for the chemical composition. Carbon and N mineralization rates were measured using laboratory incubations for 60 days. Results show that in this calcareous soil, cultivation decreases soil organic carbon and total N contents, while C/N ratio, bulk density, pH, and P and K contents remain unaffected. Cultivation resulted in a significant increase in soil C and N mineralization, and therefore high losses of soil organic matter. Data on crop residues indicates that wheat residue has a lower quality than alfalfa residue, and therefore decomposes more slowly. It may be concluded that soil cultivation and residue quality have a striking influence on C and N cycling and nutrient contents.

12. Micromorphological investigation on a loess-paleosol sequence in Gorgan, northeast of Iran

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Micromorphological properties of a loess-paleosol sequence in Nahar-khoran area, south of Gorgan city in Iran, were studied in order to assess the paleoenvironmental conditions of the area. Seventeen soil successions were observed across Nahar-khoran loess sequence and their morphological properties were described. The disturbed soil samples for physico-chemical analysis and the undisturbed samples for the preparation of thin sections were also collected. The results of the field observations and laboratory experiments such as soil color, soil structure, clay content and CEC, showed that all paleosols were more evolved than the loess layers and implying the presence of more favorable climatic conditions. The micromorphological observations revealed many evidences on the occurrence of pedogenic processes. The existence of hypocoatings and nodules of Fe and Mn oxides indicate that the studied sequence had periodic fluctuations of redox conditions. Occurrence of different types of b-fabric, angular blocky microstructure and clay coating in voids were an evidence of the presence of shrinking and swelling processes resulting from dry and wet conditions. Another

characteristic of this succession is evidence of biological activity such as faunal excrements, root residues in channels and granular microstructure. The presence of gastropoda shells that inhabited in dry-cool conditions and located in loess layers, points to the prevalence of dry-cool climatic conditions during loess accumulation. Biogenic calcite of cytomorphic and needle-shaped types in paleosols are other indicators for favorable climatic conditions. The presence of carbonate calcium pedofeatures sush as nodules, infillings, coating and hypocoating are the representative of the leaching processes with dry periods and carbonate removal from upper horizons to depths. Clay coating and hypocoating, present only in paleosols, provide evidence for the presence adequate rainfall and moist climatic conditions. The presence of compound pedofeaturs such as clay and carbonate and Fe and Mn oxides as juxtaposed and superimposed coatings or hypocoatings in paleosols, show that these soils are polygenetic and have experienced several evolution cycles because of the change in climatic conditions. As conclusion, Nahar-khoran loess-paleosol sequence is an indicator for periodic dry-cool and moist-warm conditions. The loess layers are representatives of the dry-cool climate, whereas the paleosols are indicators of the moist-warm conditions. Formation of the studied loess and paleosols has probably taken place in glacial and interglacial cycles with different climatic conditions respectively.

13. Characteristics and classification of degraded wind deposited gypsiferous saline-alkali soils in eastern part of Isfahan, Iran

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The degraded wind-deposited gypsiferous saline-alkali soils in east of Isfahan, Iran are described and classified. These soils are developed on the old terraces of the Zayanderud river consisting of old river alluvium covered by eolian deposits. The source of gypsum and soluble salts is said to be evaporitic basins, present in the area. Gypsum and soluble salts coming from these sources are mostly transported by wind.

In the northern part of the area where eolian deposition is active, eolian hummocks are 10 to 30 cm high and 1 to 2 meters apart. The thickness of the layers formed by eolian deposits is around 20 cm. In the southern part where eolian deposition is not active and belongs to the past, the thickness of the deposits on the soil surface reaches to 80 cm. The deposits are loamy in texture, contain 8 to 30 percent gypsum and are very severely saline and alkali. The old river alluvial soils underneath the wind deposits is clayey, massive, dense and show redoximorphic features. Ggypsum and soluble salts are also present, but their amount is much less than those of the eolian deposits.

Concerning the criteria for the gypsiferous soil classification, it is worthwhile to note that in spite of the presence of high amounts of gypsum in the studied soils, there is no secondary gypsum observed in the soils. Because of this, according to the Soil Taxonomy, the requirement for a gypsic horizon to have at least one percent secondary visible gypsum is not fulfilled and therefore the soils are classified as "Typic Haplosalids" at subgroup level. Presence of gypsum and sodium which are two factors affecting physico-chemical properties of the soils is not expressed in this name. Classification of the soils based on the World Reference Base (WRB) for Soil Resources is more approipriate, as the soil is classified as

"Hypersalic Gypsic Solonchack (Aridic-Sodic)", hence the presence of gypsum and sodium is also expressed.
The wind deposits not only restrict the plant growth in the area due to gypsification and salinization of the soils, but also fill the local reservoirs of the sewage refinery. Mulches and windbreaks are suggested to be used for prevention of eolian deposition.

14. Research on the adaptability and ecological effect of the plantation tree species in leanness limestone mountainous areas of Jiang Xi province

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According to natural-economic condition of limestone mountain in JiangXi province, more than forty conifer and broadleaf species are introduced by matching species with the site. After investigating the new forest and the 14-year old seedlings for such characters as the tree trunk diameter, height, root distribution and the soil characters, the results showed that *Toona sinensis, Alnus crenastogyne, Liquidambar formosana, Platycladus orientalis, Cornus macrophylla, Eucommia ulmoides, Cyclocarya paliurus, Firmiana simplex, Sapium sebiferum, Choerospondias axillaries, Sapindus mukorosii, Koelreuteria paniculata, Sophora japonica, Amorpha fruticosa, Evodia trtaecarpa, Ailanthus altissima, Gardenia jasminoides, Phyllostachys nigra* var. *henonis, Txachycarpus fortu* are all choicest trees suitable for growing in limestone mountain, both as pure forest and as mixed forest with *Toona sinensis* and Liquidambar formosanat. They can significantly improve the physical and chemical characteristics of the soil in mountain limestone. The species *Eucommia ulmoides, Yclocarya paliurus, Gardenia jasminoides, Alnus crenastogyne, Evodia trtaecarpa, Cornus macrophylla, Phyllostachys nigra* var. *henonis* have special economic usage and have good ecological and economic benefit. So, they are recommended for developing the fragile ecological conditions in the limestone mountain areas.

15. Identification of indicators of salinization processes in Luohui irrigation scheme, China: Part of research to prevent salinization

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Like in other arid and semi arid areas, salinization is a main problem in Luohui irrigation scheme, which is spread over 52,000 ha. In order to identify the indicators of salinization processes in the study area, electrical conductivity of groundwater (EC_w), pore water salinity of surface soil (EC_p), moisture content of surface soil (MC), groundwater depth, elevation and geographic coordinates were measured at about 80 wells in the field. Soil samples (from

0 to 10 cm depth) were collected for laboratory analysis. Salinity of soil saturation extract (EC_e) and soil separates were measured. All results were interrelated and analyzed. Accordingly, the identified indicators for salinization process are: 1) higher EC_w (up to 21.1 dSm^{-1}) with in shallow depth (0 to 3 m); 2) relatively higher correlation coefficients between EC_w and EC_e and EC_p for the shallow depth (0 to 3 m); 3) dominance of loam textured soils (63%); and 4) higher evaporation (1689 mm/annum) as compared to the rainfall (514 mm/annum) leading to salinization processes due to capillary water rise, 5) agreements between EC_w and EC_e for some irrigation wells indicating salinization process due to use of saline irrigation water; 6) the agreements between local information and measured higher EC_p and MC at specific spots nearby the wells indicating salinization process due to dumping and compacting of dug soil during well sinking,; and 7) an increasing trend of EC_w along the downstream direction and higher EC_w in poorly drained areas indicating that salinization process due to variation in topography and drainage status. To prevent further salinization, lowering the groundwater table, controlling dumping saline soil, and managing the use of saline irrigation water are recommended.

16. Water vapor movement in salinized soils

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Water vapor movement is one of the most important factors determining the simultaneous transfer of water, heat, and solute in soil. Although it has been researched for a long time in case of normal soils, it has scarcely been studied in salinized soils. Water vapor movement, especially the latent heat transfer, was investigated theoretically according to the measurements of thermal conductivity of salinized sand and clay. Soil thermal conductivity was measured by the improved heat-probe method under several levels of water content, sodium chloride concentration of soil solution, and temperature. The data were analyzed on the assumptions that the effects of temperature and sodium chloride concentration on soil thermal conductivity are caused by latent heat transfer, and that the water vapor movement is described by Philip and de Vries model (liquid island model). The phenomenological coefficient containing tortuosity factor in Philip and de Vries model was calculated by the extended method of Hiraiwa and Kasubuchi. As a result of this analysis, the phenomenological coefficient showed a constant value under the fixed water content condition, but it decreased with sodium chloride concentration. Although the coefficient should be more than 1, it never exceeded that value even at its maximum (which was in the case of clay). These results suggested that the Philip and de Vries model has to be modified or another term has to be inserted in the modelto deal with the effect of solutes like sodium chloride. Further research is required on the tortuosity factor, which is one of the most important parameters to describe the gas and liquid movements in soil.

17. Desertification assessment, monitoring, and modeling - A presentation of DeSurvey background and operation

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The desertification concept was discussed at the beginning of the 20th century by European and American scientists in terms of increased sand movements, desiccation, desert and Sahara encroachment and man made deserts. At that time, one school favored the idea of a postglacial long term climate change (desiccation) as a major driving force causing desertification. Others stressed the importance of human impact expressed in terms of bad management of the natural resources including over cutting, overgrazing, over cultivation and misuse of water.
The word "desertification" was introduced in international literure by the French scientist Aubreville in 1949. Desertification meant the spreading (expansion) of deserts or desert-like (non productive or very low productive) conditions from existing deserts into non-desert areas close to the desert margins. Aubreville stated that real deserts were being born, under our very eyes, in the 700-1500 mm annual rainfall areas in Africa. Since then, different concepts of desertification have developed and been discussed over and over again by scientists, politicians and the international aid and development society. Important international events were UNCOD in Nairobi 1977, UNCED in Rio de Janeiro 1992 followed up by the UNCCD adopted in 1994 and entering into force in 1996.
Today, there is little doubt among scientists that desertification is a function of a combined impact of climate variability, climate change, human impact and varying land system degradation vulnerability. This is exemplified through a discussion of a few African, Chinese and European desertification monitoring case studies followed by a presentation of a recent EU integrated assessment, monitoring and modeling initiative, DeSurvey (2005-2010). The initiative is targeting desertification affected areas in Europe, Africa, China and South America. It probably constitutes the largest ever international research project to exclusively focus on desertification surveillance and assessment. The integrated project considers all the factors influencing desertification i.e. climate, socio-economic pressure and landscape vulnerability for desertification.

18. Field observation of runoff characteristic within a gully in an ocher plateau

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Although, the average annual precipitation in an ocher plateau is about 400mm, comparatively strong rain events in the rainy season (July to September) can generate outflow to a river. But, within a gully at the upstream region of the river basin, there is usually no

water. The duration of runoff is less than 1 hour. Because of this difficult in collecting the observations the runoff data are hardly obtained. Therefore, in this study to investigate the runoff characteristics in the ocher plateau, we installed a small examination valley and carried out the field observation of the rainfall intensity and river discharge within the gully at the upstream region of Yellow River basin. From the filed observation it was found that the runoff data could be obtained if the rain intensity was about 10mm for 5 minutes for a short time. When the rain intensity was lower (2mm or less) a longer time was needed for its occurrence to be able to record runoff. The mechanism of rain-water outflow and the runoff characteristic in the ocher plateau became clear to some extent by using this procedure.

19. The image of the desert in Chinese literature: The legend of Wang Chao-chan

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The time is 33 B.C., and the place is China. The Western Han emperor, in order to secure a treaty with the Huns, sent one of his many wives, a beauty named Wang Chao-chun (also known as Ming Fei), to the Hun leader, Hu Han-yeh (r. 49-33 B.C.). She is known to late generations as a great beauty who was a tragic victim of the times. Her legend is popular not only in China, but also in Japan. In 1983, the author was able to do visit and conduct research in the Dunhuang caves, where the variations in the narrative cave paintings could be observed, and an enormous amount of material could be collected. I Especially fortunate was the opportunity to be able to work in Cave No. 17. Later, searching for more information, the author traveled to examine the Dunhuang documents in the Pelliot Collection of the National Library of France (Paris) and the Stein Collection of the British Library (London) for research. Based upon this intensive study, the author wrote a doctoral dissertation titled *The Narrative Cave Painting of Dunhuang: Research Related to the "Legend of Ming Fei.* A portion of that work would be used as one example to introduce the concept of "the image of the desert" in Chinese literature.

20. Interrelations of soil and vegetation in Hoz-e-Soltan region of Qom province, Iran

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The objective of this study was to find the effect of soil variables on the distribution of vegetation types in Hoz-e-Soltan region. Study area was located in the saline region of Qom province. After delimitation the study area and determining plant types, sampling of soil and vegetation were done. Vegetation cover percentage and density were estimated. Soil was sampled at 0-20 and 20-60 cm depths. Soil factors including texture, electrical conductivity (EC), acidity (pH), lime, soluble ions such as Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, CO_3^{2-}, and HCO_3^{-} were determined. In order to find the relationship between soil factors and vegetation

properties, and also to determine the most effective factors on the distribution of plant types, multivariate procedures, i.e., principal component analysis (PCA) and canonical correspondence analysis (CCA) were used. Results showed that there was a specific relationship between soil variables and plant types. The most effective factors on the separation of different communities were soil salinity and texture.

21. Study on the groundwater and its chemical characteristics in Badain Jaran desert region

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Surface (including lake water) *vs.* ground-water chemistry in Badain Jaran desert, assessed through field sampling of surface water and groundwater, allowed geographical zones and chemical types to be differentiated. The chemical properties of phreatic water show that the recharge from atmospheric precipitation is noticeable. The temporary runoff can only recharge the groundwater in the marginal areas of the desert. While bedrock fissure water in the mountain areas plays an important role in recharging groundwater in the piedmont alluvial-diluvial layers, although the contribution to the groundwater in the interior of the desert is very limited. Artesian water recharges shallow groundwater through the scuttles; this is particularly obvious in the interdune land. Water quality apparently varies from the top of sand mountains to interdune land lakes. The salinity increases from 1-1.5g/L to 1.5-2g/L, or even over 10g/L. The ionic composition of water changes from HCO_3^--SO_4^{2-}-Cl^--Na^+ to Cl^--SO_4^{2-}-HCO_3^--Na^+ type. That soluble Cl^--Na^+ accumulate at the topsoil layer and insoluble bicarbonates accumulate in deep layer, it is a vertical zoning feature. Strongly salinized zone is formed at 3-6 m depth, slightly salinized zone at 10-12 m and very weakly salinized zone at 15m. The salinity of shallow (0.5-10 m deep) and deep water well (20-80m) is 1.74 g/L and 1.39 g/L, total hardness of shallow and deep water well is 32.9 German degree, and the water chemical type of shallow and deep water well is Cl^--SO_4^{2-}-HCO_3^-, HCO_3^--SO_4^{2-}-Cl^- type respectively in the Bayinnuer area. The existence of low salinity water or even freshwater beneath the upper high-salinity water is significant value for the development and utilization of arid water resources.

22. Desertification and its control in Erdos region

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Ordos is one of the most seriously desertified regions in China. About 86% of its total land is desertified. There is about 42,000 km^2 area affected by wind-erosion and about 47,000 km^2 affected by water erosion. Of this, 15000 km^2 of active and semi-fixed sand land and 25,000 km^2 of water erosion region need to be controlled urgently. The land desertification in this region is because of the dry climatic factors, but also the human activities such as over-

reclamation, over-grazing and abusively herb-digging are contributing to desertification. During the last 30 years efforts to control the desertification have shown promise. The desertified area has decreased from 86% in the 1980s to 56% at present, and the vegetation cover rate is also as high as 67%. The control measures including controlled grazing, exclusion and forestation have been proposed.

23. Chloride as a tracer and climatic change during the last 2000 years recorded from unsaturated zone of Badain Jaran desert

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The history of groundwater recharge and climatic change during the last 2000 years has been estimated and reconstructed using environmental chloride from unsaturated zone profiles in the southeast Badain Jaran desert, NW China. The long-term recharge was estimated to be 0.96-1.36 mm yr^{-1} from three boreholes with depth of 7.4-22.5 m based on the chloride mass balance approach, which showed that no effective modern recharge is taking place, but that the lakes are supported by regional groundwater flow, the age of the water being late Pleistocene as inferred from the isotopic compositions. The unsaturated profiles well preserved the climatic change events of 10-20 years duration and the climate can be subdivided into 3 wet periods and several dry periods. Before 1300 AD it was relatively dry but distinct wet periods may be recognised between 1340-1450, 1500-1610 and 1710-1820 AD. At ca. 1500-1550 AD, which is an important datum, the climate witnessed a violent change from drought to wet. The considerable decrease in recharge rate indicated that it was an important turning event of the local climate from wet to dry at the beginning of 1800s, and then the climate deteriorated severely during the last 200 yrs. The unsaturated zone records shows, compared with the ice core records, that a large-scale climate difference took place between mountain regions and the desert during the 20th century.

24. Vegetation cover change during 1981 to 2001 in Northwest China

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A long time series (21 years) of Advanced Very High Resolution Radiometer (AVHRR) data with 8x8 km^2 spatial resolution were used to monitor multi-year vegetation cover changes in Northwest China. Linear regression is used to simulate and characterize the change trends. The yearly maximum normalized difference vegetation index (NDVI) in Northwest China elicited explicit inter-annual changes during the period from 1981 to 2001. Before 1993, these changes were relatively small. After 1993, there was a distinctly observable decrease. From 1981 to 2001, the vegetation cover in Northwest China showed a generalized

degradation. However, also some local areas of improved vegetation status (greening) coul be observed mainly in the Xinjiang Province, middle of Gansu, north of Ningxia, and north of Shanxi. Strongly degraded regions were mainly localized in the south of Northwest China. The driving forces for the changes in NDVI are discussed. Precipitation has a strong influence on the vegetation cover in the study area especially in the lower altitude regions.

25. Regionalization of land surface heat fluxes and evaporation over heterogeneous landscape of arid area by using satellite data and field observations

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Arid areas with an inhomogeneous landscape are characterized by extreme gradients in land surface properties such as wetness, roughness and temperature which have a significant but local impact on the atmospheric boundary layer (ABL). Observation of the actual extent over these areas is essential to understand the mechanisms through which inhomogeneous land surfaces may have a significant impact on the structure and dynamics of the overlying ABL. Progress in this research area requires spatial measurements of variables such as surface hemispherical reflectance, radiometric surface temperature, Normalized Difference Vegetation Index (NDVI), Modified Soil Adjusted Vegetation Index (MSAVI), vegetation coverage, leaf area index (LAI), local aerodynamic roughness length, etc. Imaging radiometric board satellites can provide useful estimates of most of these variables. Using these variables we can derive the distribution of land surface heat fluxes over inhomogeneous landscape.

Parameterization methods to derive the regional land surface variables (land surface reflectance and surface temperature), vegetation variables (NDVI, MSAVI, vegetation coverage and leaf area index LAI) and land surface heat fluxes (net radiation flux, soil heat flux, sensible heat flux and latent heat flux) over inhomogeneous landscape by using Landsat TM data, Landsat ETM and field observations has been proposed in this study. The method was applied to the areas of HEIFE (Heihe Basin Field Experiment in northwestern of China) and Dunhuang area. Five scenes of Landsat TM data and Landsat ETM data used in this study are June 3, 2000, August 22, 2000 and January 29, 2001 in Dunhuang area and July 9, 1991 and August 21, 1995 in HEIFE area. The regional distributions of land surface variables, vegetation variables and heat fluxes over inhomogeneous landscape in arid and semi-arid areas are obtained in this study.

26. Investigation on soil erosion using geomorphology and EPM model, a case study of Talegan watershed in Iran

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Finding a suitable model for evaluation of erosion and sedimentation processes is an important area of research in soil conservation. In this study done in "Taleghan" watershed in Tehran province, Iran, two empirical models, "EPM" (Erosion Potential Model) and "Geomorphology", were used These are quantitative and qualitative, respectively. In "Geomorphology" Model several factors such as erosion faces, lithology, slope, vegetation cover and soil type are studied to determine the erosion condition. "EPM", which was developed in 1988 for some part of Yugoslavia, uses four factors, land use, susceptibility of soils and geological formation, current erosion condition and shape.
In this research, using GIS (Arcviwe, Idrisi, and Ilwis), erosion faces map, geology map and slope map were crossed and homogenous unit map was produced. Erosion condition using "Geomorphology" model was determined in each unit and using GIS, erosion condition maps were produced. For evaluating erosion condition with "EPM", coefficient of each factor was determined, and erosion intensity coefficient (Z) was calculated for entire watershed and homogenous units. Amount of erosion and sediment were calculated and erosion condition map was produced. Finally the results of two models were compared with amount of observed sediment in main river "Taleghan rud", in Gilank hydrometery station. The results show that "Geomorphology" Model was better than "EPM". Hence the prediction of "Geomorphology" model gave about 16% underestimation than the observed amount of sediment and the prediction by "EPM" gave an overestimation by about 27%. In this research, GIS soft wares and Excel software were used.

27. Effects of *Formica cunicularia* (Hymenoptera: Formicidae) on revegetated desert ecosystem in the Tengger Desert, Northern China

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Formica cunicularia (FC) is a dominant mound-building ant species in arid and semi-arid regions in China. It significantly modifies soil parameters. In our study we investigated the soil modified by FC in different re-vegetation years and landforms, and several soil parameters sampled in ant nests and adjacent (control) plots in Shapotou artificial re-vegetation area in China. The results showed re-vegetation years, landforms and their interactions significantly affected anthill density, anthill coverage and soil turnover ($p<0.01$). The longer the dunes were stabilized, the stronger were the FC nest; the activities of FC are

different on various topographies, more nests in hollow and windward slopes but less in dune tops and leeward slopes. We found increased concentrations of organic matter, and total and available N, P and K in the nests. We recorded changes in soil physical properties and soil seed bank. Bulk density of ant nests was lower in 10-20cm depth and higher in 0-10 depth than adjacent soil. Compared to adjacent soil, ant nests had the higher soil electric conductivity and water content. We also found that seedling density and diversity in anthill were higher than those in adjacent soil.

28. Using underground water in desert region

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The potentials of underground water in the desert region in Uzbekistan require further studies to ensure its possible exploration. Within the framework of UNCCD, practical help was provided for the rural population who live in an area with the heaviest impacts of desertification and drought. It also improved the health condition of 20-45% of the population. The Project territory (Bukhara province) is located in the Kizilkum Desert. Zeravshan river in this territory acts as a collector of underground water with a mineral content of more than 2 g/l. The lack of sufficient water for washing off the soil prevents a lot of arable lands to be used for agriculture and considerably reduces the productivity of crops or natural rangeland yields. The rural population living in the territory uses underground water for drinking and economic-household needs. Besides, a lot of hand-operated pumps were established in the territory for pumping out underground water from top layers up to 6 m in depth. The quality of used water is not homogenous (mineral content > 2 g/l). In most cases pumps are not equipped with filters and such water is muddy or frequently contains silt/sand. The use of such underground waters for food preparation usually has bad consequences for health unless it is boiled. In order to improve water supply in the region within the framework of our Project, drilling wells up to depths of 10-20 meters was done along with installation of deep filters and special electro-pumps. The fresh underground water in this area is dated to the ancient times of Zeravshan riverbed. The depth of the resources varies from 60 up to 150 meters. Increasing mineral content is observed as one moves away from the ancient riverbank. In order to supply water from borehole to a population of "Iransha" town, one of the most remote settlements, it was decided to drill a chink at the depth of 150 meters on the distance of 20 meters from the river. The water rises from a depth of 80 meters. The borehole started to operate in November 2002. Results of the medical examination in Iransha Village settlement (814 persons were surveyed).showed that human health improved considerably. Because of the use of fresh water

29. The Indian Ocean SST and its relationship to wetness and dryness in southern Iran

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The relationships between the Indian Ocean sea surface temperature (SST) and rainfall variability in southern parts of Iran were studied. It was found that during autumn, the SST over western parts of the ocean affects autuml variability of rainfall. However, the tropical Bengal Gulf SSTs revealed a strong association with winter-time dryness and wetness over the studied regions. It was concluded that although Indian Ocean is not a source region for rainfall in Iran, the fluctuations of seasonal SST over this ocean play an important role on the trajectory of rain-bearing air masses.

30. Detection of soil evaporation and plant transpiration by three-temperatures model (3T model)

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Soil evaporation (*E*) and plant transpiration (*T*) are two main components of water consumption in ecosystem. Estimation of *E*, *T*, and evapotranspiration (*ET*) is highly required for water-saving agricultural and sustainable use of water resource. To accurately estimate *E*, *T*, and *ET*, there are three challenges. There is however a difficulty to separate *ET* into its two components, *E* and *T*. The second challenge is the heterogeneity of the land cover because most of the available methods are applicable only to flat and uniform area, which is rarely the case in the natural ecosystem or in farmland. The third challenge is that most of the conventional models for *ET* estimation arebased on the measurements at points. Scale up of *ET* model to a heterogenous area or to a regional level is difficult. Based on energy balance theories, a model to use surface temperature to detect of *E* and *T* is proposed. Because three temperatures are the key components for the proposed model, it is referred as "three temperatures (3T) model". The major advantages of 3T model are that: (1) the quantitative information on *E* and *T* can be obtained with considerably fewer measurements and can be remotely measured; (2) *E* and *T* can be separately estimated and can be applied under heterogeneous conditions; and (3) aerodynamic resistance, surface resistance, and empirical parameters are not included. Therefore, there is no fetch requirement.

31. Opportunites for producing more food with less water in dry areas

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Water scarcity is a serious threat to food production and sustainable livelihoods for the poor in the dry areas. Water sources are limited and water allocated to agriculture is decreasing, while the demand for food is increasing due to the rapid population growth. The most feasible option to ensure food security is to increase water productivity.
Water productivity in rainfed agriculture in the dry areas is very low. Even in irrigated areas, water productivity could be improved by changing cropping patterns and introducing precision agriculture. This paper examines the potential for improved water productivity in rainfed and irrigated agriculture as well as in the marginal drylands, with examples of on-farm water management, germplasm improvement and agronomic practices within an integrated natural resource management framework. In the dry areas, the strategy should be to maximize return per unit of water instead of unit of land. Given the increasing water scarcity, policies and institutions should be adjusted to support a culture of efficient water allocation and use in agriculture

32. Integration of land degradation management plan and land use planning in Gorgan semi-arid plain, southeast Caspian Sea region

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Land-use planning is a comprehensive master plan for every sustainable development action plans and can integrate desirably all land use and natural hazards management alternatives (plans, strategies and Scenarios) via Multi-Attribute Decision Method such as AHP under data and decision uncertainty. In this paper, at the first step, land degradation potential hazard was mapped at 1:250000 scale in the context of 19 physiographic units according to the synergetic effects of five key factors and numerical valuation of five dominant processes including salinization, ponding of water and water-logging, water erosion, and vegetation deterioration, using a numerical subjective model. At the second step, with respect to the nature of land degradation mechanism in the Gorgan coastal plain, four hazard management plans consisting of (1) Drainage and surface flow water collection, (2) Shrub plantation and green belt creation, (3) Soil physico-chemical improvement, and (4) Protection and preservation were proposed according to the goal of land management organizations and two important criteria of cost and efficiency of development plans. As the final step, the implementation priority of the management plan alternatives was determined in each of the hazard class zones focusing on hazard intensity (hot spots), cost and developmental efficiency of plans through subjective judgment and pair-wise comparison by AHP. According to obtained results, land degradation hazard classes I, II, III, and IV are spread with a spatially ordered pattern from mountain in south to desert coastal plain in north along a sharp geo-ecological gradient of the study area.

33. Chloride dynamics as signature indicator of salinity in dryland regolith after deforestation

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In dryland environment, the soils that are inherently saline deep in the profile may be at risk of becoming saline in the crop root-zone after deforestation for cropping, pasture, and/or grazing. We conducted a study in a near semi-arid catchment to investigate the link between the hazard and risk using the changes in chloride distributions in profiles, as signature indicator, under forest and deforested lands used for grazing and/or cropping. Soil cores were taken from 6 sites, across the catchment, representing different land-use systems and soil types that are approximately 30-40 years after deforestation and from the nearby undisturbed forest to 6-m depth as control. The cores were segmented at 50-cm depth increment and sub-samples from each depth increment was analysed for chloride, pH, EC, and selected cations. At all 6 six sites, the chloride distribution changed after deforestation and the subsequent land-use for grazing or cropping indicating forest clearing has changed the geohyrdology in the landscape. In 5 out of the 6 sites, the chloride moved down the profile after forest clearing. This implies increased deep drainage, but it is not known whether the drainage was laterally discharging salt or reaching the deep aquifer. The potential for the drainage water reaching deep aquifers and creating rise in water table and consequently surface salinity risk over-time is the major concern to the growers, community, policy makers, and the government. The total salt load across the sites in the 6-m profiles ranged from 20 to 300 t ha^{-1}. Though the chloride distribution in the profiles changed after deforestation, the total load in the 6-m depth remained unchanged or decreased or increased compared with the corresponding forest profiles depending on their location in the landscape, the site, and cropping vs. grazing.

34. The relationship between climate change condition and the forms of chemical compounds of nutrient elements in dry steppe soils of Mongolia

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This paper discusses specific peculiarity of soils distributed in dry steppe, goby zones of the country, and their influence on chemistry of nutrient elements of soils in dry climate conditions. Also discussed is total and available content of nutrient elements and their reserves in soils. The forms of chemical compounds of some nutrient elements in soils are also discussed in relation to the changes in dry and wet climate conditions of the country of Mongolia. The present soil cover situation in these zones is also presented and the negative impacts of both climatic change and anthropogenic activity on soil cover is discussed.

35. Climatic variability and changes in arid and semiarid regions of Iran in relation to drought and water scarcity

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Climatic variability and changes as the main cause of drought and water scarcity were investigated in arid and semiarid regions of Iran using 89 climatological stations with 41 years data records. In this research, monthly precipitation data were investigated from homogeneity and randomness point of view. Homogeneous monthly precipitation data were checked for icriability and changes using nonparametric statistics test including Mann-Kendal, Mann-Whitney and Spearman's ρ tests. In order to evaluate climatic variability in study area, annual, seasonal and 12 individual monthly precipitation time series from 1960 to 2000 were investigated for detecting any possible trend in precipitation amount. The results showed that there is no evidence of climate change in the study area. Although many stations showed decreasing trend of precipitation, but this was not statistically significant. Stations with significant positive and negative trends were assigned and mapped in order to assess geographical tendencies. Moreover, Cramer-von Mises statistics test was also applied to determine spatial pattern and geographical tendencies of trend signs across the study area. The results indicated that central and southeast corner of Iran were facing climate change in the form of negative precipitation trend. Considering the global warming and increasing temperature, the adverse effects of negative precipitation trend in conjunction with significant positive trends in temperature is very crucial and leads to many ecological and economical problems in the study area. For this reason, monthly temperature time series is also checked for climate variability signals. The results revealed that the temperature increased in most of the studied stations. Although the temperature increase in main cities can be related to the industrialization and growth of cities, increasing temperature in rural areas may be linked to climate change and global warming. It is obvious that the frequently occurring droughts in this region can be attributed to increase in temperature and decrease or uncertainty in precipitation.

36. Important factors affecting suspended sediment yield in arid and semi-arid areas of Central Iran

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Almost half of Iran is characterized by arid and semi-arid climate and this fact needs to be taken into account in developing better management practices directed to sustainable development. To estimate the rate of soil erosion and sediment yield in the central Iran, the Esfahan and Sirjan watershed, which is 20% of the total area of the country, was considered.

Fourteen sub-watersheds having 11 years of continuous recording were selected and categorized into two homogenous groups using clustering technique. The important factors affecting the generation of mean daily suspended sediment load were then recognized out of 49 physiographic, hydrologic, land use, geologic and climatic characteristics with the help of factor analysis technique. The 20 years peak discharge, rangeland percentile and ruggedness number were found to be the most important factors controlling the yield of suspended sediment in the study watershed.

37. Evaluation of organic-based emulsions for stabilization of dryland soils in the southwestern United States

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Under the U.S. Navy's Environmental Pollution Abatement Ashore Program, and in conjunction with the Naval Facilities Engineering Service Center and Encapco Technologies LLC, the Desert Research Institute (DRI) is testing organic-based emulsions for treating arid-zone soils of the southwest United States. The emulsion was developed to stabilize and chemically bind soil particles and contaminants.

At the Nevada Test Site, the emulsion is being tested for effectiveness in preventing wind resuspension of soils contaminated with $^{238+239}$Pu. The Pu is often associated with respirable size soil particles (PM_{10} or less) and poses an inhalation risk. DRI's Portable in-situ wind erosion laboratory (PI-SWERL) induces wind shear at the soil surface to simulate stresses caused by winds. The PI-SWERL allows a rapid means of measuring wind erosion index based on PM_{10} resuspension. In addition, a saltation flux sensor array was established to measure when sand-grain saltation begins, considered to be a precursor to PM_{10} dust generation. Effectiveness of the emulsion over time is also being tested at 3, 20, 40, and 60 weeks after emulsion application to assess variability in performance over a year of seasonal changes in temperature, wind, and precipitation.

At Yuma Proving Ground, Arizona, the emulsion is being evaluated for its effectiveness to chemically bind and prevent the transport of Depleted Uranium (DU) from ordnance testing; and to determine whether significant changes to hydrologic processes, such as infiltration and surface runoff potential, occurred after field application. Soil crusting after application could potentially lead to reduced soil infiltration and increased runoff, potentially leading to soil erosion. To test for these scenarios, rainfall simulation and infiltration experiments are being conducted. Field experiments were conducted before treatment and three weeks after treatment. Additional tests will be done 14, 23, and 50 weeks post-application to evaluate the influence on soil hydrologic properties over time.

38. Impact of draught animal and mechanization on the soil structural state, yield and erosion

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The impact of draught animal and mechanization on the soil structural state and erosion and yield was studied in a field experiment. Two sets of tillage operations were chosen: first consisted of tillage by reversible monoshare plough followed by tine cultivator and harrow pulled by two wheel tractor practiced up and down the slope (treatment I11) and across the slope (treatment I12); the second consisted of tillage by swing plow of excavation share followed by tine cultivator and harrow pulled by draught animal practiced up and down the slope (treatment I21) and across the side slope (treatment I22). All tillage treatments were followed by manual sowing of faba bean. The site had 300 to 400 mm of average annual rainfall. The field had silt-sandy soil with 11% slope and was under cereal – faba bean rotation during 1996-1997. Soil structural state was characterized by soil penetration resistance, dry bulk density, water content, and erosion. The result showed that soil penetration resistance was affected by soil tillage treatments. Tillage practiced across the slope created lower penetration resistance than soil tillage practiced up and down the slope. Below 15 cm depth, penetration resistance was nearly the same as initial state. Soil tillage using animal draught and mechanical power across the side slope was less compact than soil with tillage up and down the slope. Soil tillage across the side slope using animal draught and mechanization improved water content in the soil surface layer and in the deep profile. Soil tillage practices up and down the slope, was more erosive than soil tillage performed across the slope. The highest values were obtained after treatments I11 (100%) practiced up to down the slope. The lowest values were obtained after treatment I22 (47%). Effect of these treatments on faba bean yield showed that treatments I12 and I22 gave higher faba bean yield than treatments I11 and I21. It shows that across the slope soil tillage improved faba bean yield from 1 to 1.5 Q/ha.

39. The role of sustainable agricultural management in the prevention of land degradation in Iran

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Nearly 33 million hectares in Iran are covered by deserts and 120 million hectares are facing desertification. Unfortunately, mismanagement, improper irrigation systems, first and second degree salinization and human factors all have been causing desertification. Over-exploitation of land and water resources has resulted in yield decline, loss of soil fertility and water pollution. Of 16 million hectares of lands under cultivation in Iran 6 million hectares are irrigated and the rest are under dry farming. As a result of inappropriate agricultural land use,

the lands are left and infertile ones are cultivated. This research, reviewing agricultural management status in some case studies, intends to show that in all cases in which agriculture has been based on sustainable development principles, it has resulted not only in reclamation of land but also increased the yield.

40. Combating desertification via an integrated approach

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Desertification is now viewed as more of a development problem rather than merely an environmental problem. Hence contemporary approaches to combat desertification focus on ensuring that rural populations inhabiting dry lands have a sustainable livelihood that depends on a resilient natural resource base. Often agriculture is not the mainstay of the livelihoods of dryland populations and therefore there is a need for careful analysis of livelihood strategies and a better targeting of interventions aimed at improving agricultural productivity and income generation. To achieve this aim a multi-level framework of analysis has been developed that is linked to an Integrated Natural Resource Management approach. The outputs of such an approach are technological, institutional and policy options that feed into a process of development which is in turn firmly grounded in the contextual realities of the conditions facing the rural poor in dry lands.

We will describe the approach and illustrate it with examples of both institutional and technological options that are applicable to a dry land community situated in the Khanasser valley in Syria. The valley is a typical Mediterranean dryland rainfed region receiving approx. 220 mm rainfall annually mainly during the winter months. Challenges include land degradation from wind and water erosion, declining soil fertility lack of water for irrigation, financial constraints to meet customary expenses and adoption of new technologies, lack of information and knowledge on appropriate technical knowledge and unclear land property rights and policies that discourage investments.

A multi-faceted cross-disciplinary approach has been taken in the valley to introduce new land use options and to broaden the interactions between local communities, researchers and local and national government. We believe such an approach can have widespread applicability to the world's dry lands.

41. Agricultural drought with special reference to soil water availability and water requirement of dryland crops in Marasthwada, India

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In recent years the main emphasis of national efforts has been towards stabilization and augmentation of agricultural production on dry land farming areas because 70% of Indian agriculture is devoted to dry farming. Therefore, for developing dry land farming system on firm scientific basis, it is necessary to build up adequate scientific knowledge on rainfall-

climatology. In most cases the climate is the major factor determining the productivity of drylands. Besides weather, understanding of water retention and release characteristics of the soil is also extremely important in food grain production since the plants meet almost all the water requirements from the moisture stored in the soil. In spite of the uncertainty scarcity of rainfall, dryland crop production can be significantly increased by the adoption of improved agronomic practices which include both non-monetary inputs,and monetary inputs. The objectives of this paper is therefore to characterize agricultural drought using an approach that deals with soil, climate and crop and seasonal change in the soil moisture content, to asses the suitability of the crops for a particular place. The study indicates that there is no stress period during the growing season in eastern part, while the probabilities show a moderate stress in reproductive and maturity stage for long duration crops in western zone. In this paper, we try to describe a practical method for characterizing agricultural drought.

42. Two new simulation models for plant breeders and agronomists- theory and applications

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Agricultural research in arid or semi-arid region requires a substantial investment in land, labor and other resources. Simulation models assist scientists in making more efficient use of these resources by providing insight into potential plant responses as well as water use for various years and locations. Adopting a certain simulation model depends on the ease to adjust (re-calibrate) and to use it, as well as on the availability of the inputs needed to run the model. However, there are wide ranges of simulation models used by plant breeders and agronomists as well as decision makers in all over the world simulating the growth, developments and water used by plants.

This paper describes two simulation models, which may be of interest to agronomists and plant breeders dealing with the problems of crop water use in dry areas. The first simulation model requires low input daily weather data and few soil and plant parameters and is written in simple BASIC language and is used to simulate crop growth and development as well as transpiration by the crop and evaporation from the soil. Also, it is mainly designed to accommodate different genotypes of the same species that have different plant development characters. The simulation output will be daily leaf number, leaf area, plant development and growth of straw as well as grain, together with the water used by soil and plant. This model depends heavily on the radiation use efficiency of the study crop. The second simulation model is SIMWASER, which simulates daily soil water balance and plant growth for any space of time from one vegetation period up to many decades thus being able to predict long term water use efficiency of different cropping patterns for a given site. However, this model requires large input of daily weather and soil data and less for plant data and is written in FORTRAN language. This model is specialized in the water movement within the soil profile, and also to the air (soil evaporation) or to the plant (transpiration).

Both models were used in simulating plant growth and development and water consumption of barley and wheat at two locations in Northern Syria Results show close relation between

simulated and measured data, but more field measurement data for further calibration are needed.

43. Application of random cascade model to heterogeneous transportation in dune sand

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While sand dunes in arid and semiarid areas are considered to be barren lands for the agricultural activity, a suitable way of irrigation often makes sand dunes high yielding farm land. As long as the water demand of plants is satisfied, most of sand dunes show high agricultural productivity. On the other hand, salinization of field is sometimes caused in arid environment. On the stage of irrigation planning in sand dunes, we have to evaluate water and solute transportation in dune sand. However the heterogeneity of sandy type soil for mass transportation hampers planning of efficient irrigation. Sandy type soils were supposed to be homogeneous compared with clayey type soils. Some researchers have shown heterogeneous characteristics of sandy type soil in the mass transportation especially in the unsaturated condition. While doing irrigation planning, the heterogeneous effect of sandy type soil needs to be taken in consideration.
In this study, a dye tracer method was used to visualize preferential flow patterns in dune sand. The random cascade model was used to evaluate heterogeneous dye staining patterns. Dye tracer solution was poured onto various surface areas in Tottori Sand Dune, Japan. Result of the experiments showed that dye staining patterns in the larger scales were more heterogeneous than that in the smaller scales. Heterogeneity in the horizontal direction was much more significant than that in the vertical direction. Two approaches were used to identify the parameters of the random cascade model. The random cascade model described well the heterogeneous dye staining patterns in sand. Simulation results based on the log-normal distribution showed good agreement with the data of the depth of deepest dye penetration. The random cascade model is a good way to evaluate the heterogeneous effect of soil.

44. Effects of rainfall characteristics on infiltration and redistribution patterns in an arid shrub desert

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Rainfall, as the sole source of water replenishment in the semi-arid sand dune area, plays an important role in sustaining the desert ecosystem. Infiltration at several locations was measured simultaneously during rainfall. The redistribution of infiltrated moisture through percolation, root extraction and evapotranspiration pathways was investigated in the growing

season for 45 days on re-vegetated sand dunes in the Tengger Desert, China. Time domain reflectometry probes were inserted horizontally at 12 different depths below the ground surface in the *Caragana korshinskii* dwarf-shrub community to record volumetric soil moisture at hourly intervals. Seven rainfall events occurred during the experimental period. Rainfalls were sporadic with widely different intensities. Infiltration rates varied greatly with individual rainfall quantity and antecedent soil moisture, with drier soil profile facilitating infiltration. The relationship between infiltration rate and rainfall intensity was linear, with infiltration rate at ten times the magnitude of rainfall intensity. At rainfall intensity <0.46 mm h^{-1}, *no* soil moisture was gained. Root withdrawal of soil water and evapotranspiration (reaching 69-90% of precipitation) restricted the wetting front penetration. The concentration of roots at about 140 cm depth imposed a diurnal moisture cycle there, with moisture depletion in daytime and replenishment at night by internal transfer from adjacent layers.

45. Comparison of small-scale environment for three type biological crusts on longitudinal dune surface in Gurbantunggut Desert, China

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Gurbantunggut Desert, the largest fixed and semi-fixed desert in China, is covered by well-developed biological crusts. The distribution of biological crust has selective characteristics on different positions of longitudinal dune surface. The species composition, thickness and intensity of pressure vary a lot according to different type of biological crusts. The selective distribution of biological crusts and their eco-environmental conditions on longitudinal dune surface were studied in 2002. The result showed that the moss crust was mainly distributed in the interdune area, where sand surface was stable and the dominant grain size were fine and very fine sands. The soil moisture in interdune could reach 5% during early spring and ephemeral plants grew well in this area. Lichen crust was mainly distributed from lower to middle parts of the slopes where the dominant grain size is fine sands and the soil moisture was about 4% in spring and ephemeral plants also grew well in this area. The algae crust was mainly distributed at the top of dune to upper part of slopes, where the sand surface is active and the soil moisture content was the lowest, which indicated that those species are adapted to the formidable conditions.

46. Sand stabilization and microhabitat effect of shrub belts on the top of the Mogao Grottoes

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A blown sand control system is needed to protect the top of the Mogao Grottoes. In particular, a shrub shelter belt is an essential component of such a control system. Observational results show that the airflow field nearby shrub shelter belt is redistributed, and the near-surface sand stream is dramatically changed. The effective prevention range is 20-30 times of the height of shrub shelter belt, while wind velocity decreases from 68.1 to 40.7%, and sand transport rates at 2m behind every shrub shelter belt are 1/38 and 1/138 as much as the sand transport rates at 30m in front of the shrub shelter belt. Furthermore, the depth of sand accumulation in the shrub shelter belt reaches 0.7m. The fine and very fine sand on surface (0-20cm) layer increases by 20.6 and 5.5% respectively, and the organic content increases greatly in the area of vegetation roots development. Moreover, the shrub shelter belt also has an effect on micro-climate. The daily average temperature in dunes at 0.5, 1.0 and 1.5m heights is 0.5, 0.9 and 0.2°C higher than in the shrub shelter belt, respectively. The relative humidity of the shrub shelter belt also increases at these heights by 0.4, 0.3 and 0.1% than in the shifting sand. The variation of day and night temperature on the surface (0-20cm) layer is sinusoidal in distribution.

47. Wind erodibility of soil after fall tillage in a dryland wheat-fallow cropping system

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Traditional agronomic practices in the conventional wheat-fallow rotation employed in the Columbia Plateau in central Washington State include multiple passes with tillage implements during the fallow cycle, both to create a dust mulch layer to retard soil moisture losses and to manage weed populations. High winds and low rainfall during the early fall season create conditions optimal for wind erosion of soil. This combination of tillage-intensive fallow practices and dry, windy conditions leave the soil highly vulnerable to wind erosion. The objective of this study is to quantify PM10 emissions from a silt loam soil in a low rainfall area of the Columbia Plateau during a simulated wind event following various postharvest tillage operations. Our goal is to provide quantitative information regarding the potential to reduce PM10 emissions from fallow fields through the adoption of less intensive tillage practices that can offer crop yields equal to or greater than those obtained from traditional agronomic practices. Experimental plots were established in winter wheat stubble on silt loam soil in an area of the Columbia Plateau with 244 mm mean annual precipitation. Treatments included postharvest tillage with either an undercutter implement having overlapping 80-cm wide V-blades or a sweep implement with overlapping 36-cm

wide V-sweeps on 30-cm spacings and a control treatment without any postharvest tillage. *Tillage* was performed at a depth of 13 cm. A portable wind tunnel designed and built by the USDA-ARS was used to generate air flow over a known surface area in field plots. DustTrak™ aerosol monitor portable laser-photometers were used to measure PM10 emissions at 20, 40, 60, and 80 cm heights within the working section of the wind tunnel. Relevant soil physical properties were measured following postharvest tillage including the quantity of standing and flattened surface residues, stubble height, aggregate size distribution and stability, surface roughness, and soil water content.

48. Integrated techniques for sustainable development: a boon for ground water recharge in hard rock terrain

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Continuous declining trend in ground water all over the world has bounded the scientific communities to adopt suitable advanced techniques for ground water recharge. Any conventional and non conventional technique alone can not provide the whole information to the planner because of its own limitation but combining the various techniques certainly gives information helpful to propose suitable sites for water conservation structure. The detail hydro-geological study, including geological, geomorphological, slope, lineaments, soil type, runoff and water quality data, generate sets of information in the initial stage. Further integrated Remote Sensing, GIS, GPS and GPR data play a vital role in presenting the spatial and tabular surface and subsurface information. Rock fracture, its nature and depth, porosity and permeability play a vital role in recharging ground water. The multi-electrode resistivity imaging is one of the best techniques, where the multi-electrode arrays led to an important imaging showing the layers representing the low, medium and high resistivity which is helpful to locate clay permeable sand, gravel layers and also the bedrock. The imaging represents the changes in the rock type and water bearing zone. In Basaltic terrain it is helpful to distinguish the different type of flows also. Radon test is also one of the best recognition tests, where the higher anomalies give an idea about the fracture pattern, soil porosity and permeability of the ground surface. It gives the idea about the nature and distribution of the aquifer. Integration of all those techniques fulfills the gap of information and the final data is very helpful for the planner for the development and management of surface and ground water in dry land area.

49. Profile distribution and density of soil organic and inorganic carbon in chestnut soil

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Chestnut soils are typical steppe soils in arid and semiarid zones. Soil organic and inorganic carbon (SOC and SIC) profile distribution and densities have been estimated in chestnut soils. The estimate was derived from 58 profiles sampled in Wulanchabu County and Xinlin River Basin in Inner Mongol. Organic carbon is intensively accumulated in the topsoil, and inorganic carbon tends to concentrate in deep soils. Profile distribution of soil inorganic carbon is mainly of two types: low-high-(low)-(high) and high-low-(high)-(low), the latter may be induced by soil erosion and carbonate redistribution. The mean SOC density for 1 m depth column was 8.71 kg m^{-2}, and that of SIC was 7.11 kg m^{-1}. The mean SOC and SIC density for 1m depth column for different land use was: land withdrawn from farming >farmland>grassland. This could be useful for further evaluation of global soil carbon storage.

50. Late quaternary palaeoclimate in the deserts of northwestern China

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Drylands occupy a large part of northwestern China owing to arid and extremely arid climate associated with uplifting of the Tibetan Plateau and the continent-ocean distributions. Under the influence of the Tibetan Plateau's gradual uplifting during the Cenozoic Era, the dry climate zone in China has undergone distinct changes: being shifted from subtropics to the temperate interior of the northwestern China, and accompanied by an increase in aridity. Even though, various indicators, including those from from gemorphological, sedimentological, lacustrine and palynological records, suggest that the climate in the extensive deserts of northwestern China has experienced clear variations in terms of not only temperature but also humidity. Here we would like to present a comparative investigation of the landscapes in the sense of climatic geomorphology, that is carried out in western Inner Mongolia and in southern Xinjiang. Our chronology is based on luminescence and radiocarbon datings. Field investigations show that the Badain Jaran Desert, located in western Inner Mongolia, differs considerably from the Taklamakan Desert of southern Xinjiang with regard to morphology and late Quaternary climatic histories. Periods of more humid environment are recognized from records covering the last glaciation and Holocene in both deserts. But the events of higher precipitation are thought to be more frequent in the Badain Jaran than in the Taklamakan.

51. Effect of saline water management on rice production and soil improvements in salt accumulated rice field

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Possibilities of using poor quality water for the rice growing in salt accumulated fields were examined in two experimental fields of the Agricultural Research Station, El-Sirw, Damietta Province, Egypt in 2003 and 2004 seasons. Rice cultivar 'Giza178' was used in this study. Water quality treatments were: applying mixed water (MW) with salinity level of 1.4 – 1.62 dS m^{-1} throughout each season (T 1), applying drainage water (DW) with EC of 4.69 - 5.2 dS m^{-1} throughout each season (T 2), applying MW up to the panicle initiation (PI) and then DW up to the end of each season (T 3), and applying DW up to PI then MW up to the end of each season (T 4). Water-management treatments were: water-saturated condition (0 cm water depth), 3 and 6 cm water depth with a watering interval of four days. The observed parameters were: Na^+, Ca^{+2}, K^+ contents in rice leaves, leaf area index , dry matter production per m^2, grain yield, soil EC, soluble cations Ca^{+2}, K^+ and Na^{+2} at the end of each season. All the parameters studied were significantly affected by both water management and water quality treatments. The soil chemical condition and rice productivity were better under the treatment of 6 cm water depth at four-day intervals. The treatment (T 1), with 6 cm water depth, gave the best results from the viewpoint of rice production and soil traits. Treatment T 3 scored the second rank, followed by the treatment T 4. Treatment T 2 stood at the last rank. The water-management treatment of 6 cm water depth reduced Na^+ and salinity level of saline paddy soil with the treatments T1 and T3

52. Terracing, an effective solution to the problem of soil erosion and food deficiency in the hilly area of loess plateau

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Severe soil erosion and absolute poverty have been the most significant problems threatening sustainable development of the Loess Plateau. These two factors of environmental degradation and socio-economic issue are always interlinked and usually reinforce each other. The situation in the hilly area, a majority of the Loess Plateau, has been even more unfavorable. Poor water and nutrients retention on the sloping land usually do not allow reliable harvests, and famine has been a common occurrence in drought years. Furthermore, concentrated rainstorms hitting on the erodible loessal soil often cause massive topsoil lose, which results in not only local environment degradation and more fragmentized landscape, but also in sending heavy load of sediment to distributaries of the Yellow River.

In order to protect land recourse and obtain securer harvest, farmers here have developed an effective terracing system, which remarkably alleviated soil erosion, food deficiency and poverty. The case of Zhuang-Lang County, Gansu province, PRC well demonstrates the success of this system. Zhuang-Lang county is located in the hinterland of the Loess Plateau. Recognizing traditional agricultural practices on its widely distributed slope land could not produce enough food for its people, the county authority launched a terrace-construction movement since 1960s. for nearly four decades, Zhuang-Lang people have reshaped almost all of their sloped land into high standard terraces, which greatly reduced soil erosion and also built up a much secure base for agricultural production. This paper documents the unique achievements of terrace building at such a large scale, and also analyses its costs, benefits and functions in ecological, economic and social context. A future prospect and some of the underlying implication of terrace building will be briefly discussed at the end of the article

53. Formulating provincial integrated ecosystem management strategies and action plans for land degradation control in the drylands of western China

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The People's Republic of China - Global Environment Facility (PRC-GEF) partnership on land degradation in dryland ecosystems, is based on the belief that the inter-linked problems of land degradation and rural poverty in the drylands of western China can be addressed through the adoption of an integrated ecosystem management (IEM) approach. Land degradation is a multi-dimensional problem that cannot be effectively tackled with a piecemeal approach, in which individual technical agencies follow their own narrow sectoral strategies, each focusing on part, but not the whole, of the wider problem. Tackling land degradation in the drylands of western PRC therefore requires that each province/autonomous region should develop its own IEM strategic planning framework as the basis for the development and implementation of a comprehensive, multi-sectoral, and inter-agency action plan for restoring, sustaining and enhancing the productive capacity, protective functions and bio-diversity of its natural ecosystem resources.

The Capacity Building to Combat Land Degradation Project implemented by the Government with GEF and ADB financial support under the auspices of the PRC-GEF partnership, is currently assisting the six most degraded dryland provinces/autonomous regions in Western China (Inner Mongolia, Gansu, Ningxia, Qinghai, Sha'anxi, and Xinjiang) to formulate their own provincial IEM strategies and action plans for land degradation control. These are intended to be comprehensive and multi-sectoral broad strategic planning framework documents that will be used to: (i) mainstream integrated ecosystem management (IEM) concepts and principles into the 11th and subsequent five year plans; (ii) promote inter-agency cooperation and collaboration; and (iii) guide cost effective targeting of investment resources.

The provincial IEM strategy and action plan formulation process involves a variety of interrelated activities that can be broken down into 10 key steps: Step 1 Preparatory planning/capacity building; Step 2 Preliminary investigation/secondary data collection; Step

3 Provincial eco-system characterisation; Step 4 Land degradation assessment; Step 5 Assessment of the policy, legislative and institutional environment; Step 6 Determination of the constraints and opportunities; Step 7 Formulation of draft strategy and action plan; Step 8 Review and finalisation of the strategy and action plan; Step 9 Operationalisation of the strategy and action plan; and Step 10 Monitoring and evaluation. Multi-sectoral and inter-disciplinary task forces have been mobilised in each of the six provinces\autonomous regions and are currently working through these steps with the intention of submitting their strategy and action plan to the appropriate central and provincial government for final approval by the end of 2006.

54. Land desertification and eco-economic sustainable development in irrigated areas of the downstream of the Yellow river

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There are more than ten large drainage channels in the irrigated areas of the downstream of the Yellow River. Since restoration of Yellow River irrigation in 1956, with the development of Yellow River irrigated areas and large amount of Yellow River sedimentation drained to the farmland, and together with rainfall erosion, the phenomena of land desertification become very serious, which directly affects local agricultural production. With the development of agriculture and industry production, therefore, it is very important to deal with land desertification for land improvement within the irrigated areas of the downstream Yellow River and for development of agriculture and industry production. Therefore, starting with balance analysis between water resources and sedimentation of the Yellow River irrigated areas, mathematical models were built for computation of Yellow River irrigation sediment recession and rainfall soil erosion. Based on the recent data of Yellow River flow and sediment, the silting up in channels and land desertification were calculated. This information will be useful for the development of agriculture and industry in the plain region downstream of the Yellow River.

56. Global overview of desertification: Perspective from the Millennium Ecosystem Assessment

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Desertification is driven by an imbalance between human demand and the supply of benefits by natural systems. It is understood that population growth, inappropriate policies, and some aspects of globalization lead to unsustainable stresses on drylands. A new global evaluation report on desertification developed by the Millennium Ecosystem Assessment (MA) has determined that growing desertification in drylands – which occupy over 40 percent of the world's land area and are home to over two billion people – threatens the homes and livelihoods of millions of poor. Environmental impacts of desertification are further exacerbated by political marginalization of the dryland poor and the slow growth of health

and education infrastructures. This is manifested in poor wellbeing indicators. For example, infant mortality in drylands in developing countries averages about 54 children per 1,000 live births, 10 times higher than that in industrial countries. Income per capita and statistics for nutrient-deficient populations also show similar disparities.
The MA report also highlights the global nature of the desertification challenge. The impacts on the global environment – increasing dust storms, floods and global warming – are well known and documented. There are also alarming impacts of desertification on societies and economies, notably those related to human migration and economic refugees. The MA report points to a variety of integrated policy options to reverse the decline of drylands while optimizing economic output. These include integrated land use management policies that prevent overgrazing, over-exploitation and unsustainable irrigation practices. Stresses on degraded and at-risk lands can also be reduced by creating new and sustainable livelihood options for dryland populations. These alternative livelihoods – like solar-energy production, ecotourism and saline aquaculture – take advantage of the unique dryland attributes. Inclusion of these approaches in the mainstream national strategies for poverty reduction and combating desertification is essential to success in combating desertification.

57. Study on the rainwater outflow of small basin in Loess Plateau

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Desertification becomes a problem around Loess Plateau and urgently measures have to be taken. The tree planting measure is examined for preventing desert encroachment in Loess Plateau.To to this end, it is important to have adequate quantity of water resources. Therefore, in this paper, in order to clarify the relation of the rain and the outflow characteristic, we observed the water level in gully and the rainfall intensity in the chosen small basin. By consideration of the result, to some extent, the mechanism of the runoff characteristic was clarified. In addition, we have developed the numerical computation model that may reproduce the outflow characteristic of the examined basin. The model has been validated by numerical comparison with the observed result.

Theme 2: Dust-storm process

1. *Vorticity influence upon dust storm generation in Inner Mongolia and northern China*

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The relation of dust strom in Mongolia and in northern China with vorticity was investigated from March 19 through 31, 2001, using three-dimensional nonhydrostatic model-MM5. Outside area of the maximum negative geopotential height tendency ($\partial\Phi/\partial t$) at the 500 mb level, the area of maximum negative vorticity which induces the strong upward motion of air coincides the area of the duststorm generation in the inner Mongolia of the northern China under relative humidity less than 30 % and wind speed over 8 m/s. The transportation of dust arisen from the source region always follows the negative vorticty area in the downwind side. The region of dust storm generation is the area of maximum negative vorticity and it is the same region of the unstable atmospheric layer (negative PV layer) near the ground surface in the vertical distribution of PV, which is a function of heat and frictional terms with respect to time.

Dust particles during the day are uplifted to about 700 mb level (about 3 km), where potential temperature gradient with pressure ($\partial\theta/\partial p$) is zero, but its uplift motion is confined to 700 mb level, where stable upper atmosphere influenced by the stratosphere exists. Convective boundary layer (CBL; negative PV value) exists in less or more than 1 km and initially dust particle floats from the ground surface to the mixed layer (ML) of about 1.5 km above the CBL and it remains inside the ML. Westerly wind drives the particles to the downwind side. At night, a shallow stable boundary layer near the surface (inversion layer; big positive PV) is developed and the particles inside the stable layer merge to the ground surface and move downwind side. The dust particles in the ML still move downwind side and their dry deposition from the top of stable layer into the surface occurs

2. High concentrations of PM10, PM2.5 associated with atmospheric boundary layer in Seoul city during yellow sand event

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Hourly concentrations of TSP, PM10, and PM2.5 near the ground surface during the period of dust storm event from March 20 to March 25, 2001 gave important information on concentrations of coarse and fine particles between dust storm periods in the Seoul district of

Korea. In general, the concentrations of TSP and PM2.5 during dust storm period were twice as high as in non-dust storm period. Maximum concentrations of TSP and PM2.5 with values of 1388 $\mu g/m^3$ and 142 $\mu g/m^3$ were also found at 17 o'clock with a ratio of 9.77 and at 18 o'clock, with a ratio of 10.04. For this period, relative humidity was low around 50% with a minimum of 41%, but those values measured by Korean meteorological Administration in the south-western part of Seoul city were slightly different from the measured data at Sejong University.

In order to investigate the effect of the dust transported from China on the concentrations of TSP and PM10 at Seoul city, back trajectories of air masses at ever 6 hour were given for dust storm period from March 20 to 25, including its beginning stage of March 19. Air masses in the lower atmosphere near 500m ~ 1500m (atmospheric boundary layer) are also transported from Baotou in the inner Mongolia toward Seoul city, showing different pattern for the two levels. After back trajectories in the middle and lower levels passed near southern border of Mongolia and Baotou through Zengzhou and Xuzhou and finally reached Seoul city, the TSP concentration at Seoul city was partially influenced by the dust storm.

The back trajectory can give us major direction of air masses and do not present the various directions of different air masses. Through March 20 to 25 in the main stage of dust storm event in Korean side, air masses in the 3km and 5km height levels blew off from Ximiao, Ningxia and Lang Shan, blew through the inner Mongolia, the southern part of Mongolia and passed through the northern part of China, reaching the Seoul district. The dust from the ground surface in the source region was transported through Beijing area into Seoul district under the prevailing westerly wind. The transported aerosol caused high concentrations of pollutants of TSP, PM10 and PM2.5 of the city.

In this research, the sudden high concentrations of TSP and PM10 were found for few hours, especially at 15 to 18, March 22, 2001. One of important goal is to find out why such a sharp concentration of the TSP took a place. For instance, between 0000 UTC (0900 LST) and 0300 UTC (1200 LST), on March 22, there was a passage of cold front through Korean peninsula. Before the passage of cold front, the convective boundary layer near Seoul was not shallow, but during the passage of the front, it became remarkably shallow, resulting in the compression of boundary layer and the increase of the TSP concentration. Normally, small size particle easily floats up to the convective boundary layer, because its settling velocity is too small, but in the case of dust storm, a great amount of the coarse dusts of large size was observed in the study area. Thus, the dusts also moves down to the ground surface, even inside the convective boundary layer.

3. Assessing wind erosion vertical dust fluxes: direct measures vs. models

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In the framework of the Sino-Italian cooperation project "WinDust", aiming at studying sand and dust storms (DDS) in Northern China, a brand-new technology has been developed to measure vertical net fluxes of dust (PM_{10}) by wind erosion. The system (named **CoDY**) is

based on the *Eddy Covariance* methodology, already widely used and assessed in the framework of GHG, VOCs and aerosols flux measurements. The first prototype of the system has been used to monitor wind erosion in 6 sites selected in two focus area of Northern China: the Alashan prefecture and the surroundings of Beijing; the campaign lasted two months (May-June 2005). The focus of the monitoring in Alashan was to assess relative importance of emissions from several soil types thought to be major sources of dust. Effects of vegetation cover (density and species) have been investigated as well. Moreover, wind erosion from agricultural sites and from abandoned rubble pits in the Beijing area has been monitored.

In order to provide direct validation to the measures, the Lu & Shao dust emission model (WEAM), was applied on the same sites, in the same climatic and environmental conditions; to do this, an extensive campaign for data collection have been carried out, in order to carefully set model's parameters - as site-specific particle size distributions and soil roughness. The obtained results show an overall agreement between measured and modeled dust fluxes. However, a deep and thorough comparison highlights that some wind erosion dynamics, as the effects of wind direction with respect to roughness geometry, that have been modeled in WEAM, need to be taken into account in order to enhance model's accuracy and reliability. Direct measures also gave some insight on the functional relation between friction velocity and dust fluxes in different conditions; it can also help improving theoretical wind erosion modeling.

4. Dust storm process and its interactions with climate

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Investigations of dust storm along with dust properties are relevant to the global climate change studies due to the role of dust in a number of important processes. Desert dust could affect climate through direct effect by absorbing and reflecting solar radiation and indirectly by modifying cloud properties. Both effects could contribute to the variation of the earth's radiation budget, and the degree of these effects is determined by chemical and physical properties of dust particles. On the other hand, desert dust is a source of plant nutrients, in particular micronutrient iron that is a limiting element for the growth of phytoplankton in the surface waters of several large open ocean regions. Recent iron fertilization experiments in the ocean provide strong evidence on the important role of iron in regulating phytoplankton growth. Therefore the input of aeolian iron to the ocean may regulate the ocean carbon cycles and then global climate. This presentation will focus on discussions of the above two aspects. Results from both in situ measurements and atmospheric modeling will be discussed on dust properties and dust-ocean biosphere interactions focusing on the North Pacific.

5. Dust sandstorm dynamics analysis in northern China by means of atmospheric, emission, dispersion modeling (to be presented by Guarnieri, Francesca)

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The application of Numerical Prediction Models to strong weather phenomena such as dust sandstorm (DSS) is considered of prime importance in the evaluation of control/mitigation measures.

In the framework of the Windust Project, a three-dimensional comprehensive atmospheric, emission, dispersion large-scale model was developed for the northern Asia domain in order to provide a regional characterization of DSS dynamics acting on the area covering Alashan to Beijing. This comprehensive system was based on three different modules: 1) atmospheric model - Regional Atmospheric Modeling System (RAMS parallel version 4.3), 2) dust emission model, named DUSTEM (version 1.0), and 3) dispersion model - Comprehensive Air quality Model with extensions (CAMx version 4.11s). Using the Reanalysis-2 dataset as atmospheric forcing for RAMS, a three-nested grid approach with different horizontal resolution (i.e. 50 km, 10 km and 2.5 km) was adopted. The proposed regional characterization was based on numerical modeling simulations for two relevant DSS events (20-22 March 2002 and 28-30 March 2004). These simulations were aimed at inferring large-scale meteorological factors responsible for DSS events affecting the Beijing area and analyzing the DSS dynamics. By running different emission scenarios, the contribution of the Alashan area to the DSS affecting Beijing was estimated. The effects of mitigations measures in terms of dust/sand emission reduction were evaluated by running future intervention scenarios. Full system implementation and validation, based on both meteorological and dust concentration data, is presented. The project is funded within the Sino-Italian cooperation on the environment sector of the Italian Ministry of the Environment ad Territory.

6. Statistical law of particles ejected from the surface in steady state saltation

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Collision between the saltating particles and the sand surface is understood to be critical in the momentum transformations necessary for repeated saltation, which could be described by the lift-off velocity distribution of saltating particles at steady state. By means of the experimental studies on saltation via the high-speed photography or stroboscope, the velocity distribution function is suggested to fit to the experimental data obtained under certain conditions. Since 1990, with the development of computer, some mathematical or theoretical models simulating the particle-surface collision process are constructed to calculate the lift-

off state of saltating particles. The most familiar velocity distribution functions are normal distribution, log-normal distribution, gamma distribution, exponential distribution and Weibull distribution. Obviously, they are completely different from each other, and comparisons are never made among them. The application of statistical analysis could provide both a theoretical basis and enough evidence for recognition of statistical law. On the basis of the experimental data for the movement of saltating particles obtained respectively by White and Schulz, Mitha et al. and Dong et al., the statistical inference methods, such as run test for randomness, Kolmogorov-Smirnov test for goodness-of-fit, and analysis of variance, were adopted to make an inference of the most probable form of lift-off velocity distribution functions for saltating particles in steady state and suggest the relations among the lift-off velocity, particle size as well as wind velocity. Results, the main contributions of this study are: (1) the distribution function of vertical lift-off velocities conforms better to Weibull distribution than to the normal, log-normal, gamma and exponential ones; (2) the distribution function of horizontal lift-off velocities is best described by log-normal distribution in forward direction and Weibull distribution in backward direction, respectively; and (3) the distribution function of lift-off velocities is ependent on particle size and wind velocity.

7. Dynamics of wind erosion in the Xilin River Basin, Inner Mongolia

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Due to overgrazing in the past decades erosion by wind plays an increasing role in Inner Mongolian landscape processes. Wind erosion is a sorting process that selectively removes the finer, most fertile and chemically active portions of the soil. While coarser particles (> 100 μm) move in creep or saltation modes and deposit near to the erosion area, fine dust particles travel in suspension great distances and affect huge areas in East Asia by periodical dust storms.

An interdisciplinary group of international scientists started 2004 to investigate matter fluxes in Inner Mongolian grassland as influenced by stocking rate. The objectives of a sub-project in the Chinese-German co-operation is to quantify material transport by wind within the Xilin River basin and to model the spatial and temporal variability depending on a change of grazing management. The Xilin River basin in their natural condition can be regarded as a deposit area for aeolian dust. Investigations in ungrazed and overgrazed experimental fields are to assess the amount of material in- and output and lead to conclusions about matter fluxes in parts of the Inner Mongolian grassland.The quantification is accomplished by a laser dust analyzer (fine dust between 0.3 and 20μm diameter) as well as by sediment- and bottle traps, situated to measure the horizontal and vertical dust transport. To assess the soil deposition in the past, the inventory of the radio nuclides ^{137}Cesium and ^{210}Lead is measured on various sites. The inventory of ^{7}Be is applied to analyze short erosion processes because of its short half-life period (53 days).

8. The climatic characteristics of sandstorm in the Hexi corridor

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The climatic characteristics of spatial distribution and temporal variation of sandstorm in the Hexi Corridor were analyzed on the basis of observation data from weather station and the NCEP/NCAR reanalysis climate data during 50 years and the climatic circulation scenarios that lead to make sandstorm in north China were analyzed. The results are as follows: The spatial distribution of the sandstorm in the Hexi Corridor is formed with surface arid unstable transition zone. It means that, in same atmospheric condition, the ground surface states determine the spatial distribution of the sandstorm. The temporal variations of the sandstorm in the Hexi Corridor are related to the strength of wind, and it is same in daily variation, annual variation, inter-annual variation and decade variation. That is, on the given ground surface, the atmospheric state determines the temporal variation of the sandstorm. The temporal-spatial expansion analysis for the sand storm shows that the sand storm number has clearly shown a rising trend from the end of last century to the beginning of this century.

9. Linkages between sand transport, surface roughness, and dust generation-new approach to difficult problem

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Recent studies have shown the critical role of impacting sand grains in the mobilization of silt and clay size particles and therefore dust emissions. Field studies in Australia and the SW USA have demonstrated the close relations between the horizontal flux of sand size particles and the vertical flux of fine particles (dust). Where there is an unlimited supply of saltating particles, the horizontal mass transport rate is directly related to shear velocity, so that dust emissions scale to the third or fourth power of wind shear velocity. Where there is a limited supply of particles able to abrade soil clods or playa crusts, dust emissions are limited by the supply of particles rather than the wind shear velocity and the vertical flux of dust is almost independent of wind shear velocity. In turn, sand transport rates are significantly influenced by surface roughness elements, especially vegetation cover, which absorbs some of the wind energy and also protects the exposed surface. Recent field and laboratory experiments that increase our understanding the partitioning of wind shear stress between the soil surface and the vegetation cover provide new insights into the design of managed vegetation for control of wind erosion and dust emissions.

10. Integration of the advanced remote sensing technologies to investigate the dust and sand storm source areas

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Advanced Remote Sensing technologies have an important role in the development of effective strategies to reduce and combat the Dust and Sand Storms (DSSs) phenomena that frequently affect the North East China. An integration of the available remote sensed data allowed the development of an extensive multi-source and multi-temporal analysis to identify the base line environmental conditions in the area of interest and to detect the potential dust sources at regional and local scale in North China. The dust sources characterization was carried out by means of the Spectral Mixture Analysis (SMA) for the Beijing and Alashan (Inner Mongolia) study areas using Landsat ETM+ imagery. The objective of the SMA is to map the spatial extents of spectrally distinct rock and soil substrates that may be dust sources. The differentiation of the substrate is based on the selection of the most suitable end members to represent the spectral mixing space in the selected areas. The investigation of the soil-vegetation system and its changes was conducted producing and analyzing the time series of the Normalized Difference Vegetation Index (NDVI). The NDVI "profile", obtained by the low resolution AVHRR and MODIS images, is an important statistical indicator to evaluate the land cover evolution during the seasonal, annual, and decadal changes over the area from Alashan to Beijing. The construction of a complete dataset for the investigated areas included the study of the topographic response (DEM elaboration) to acquire detailed and recent landscape morphology from SRTM data, describing the elevation features of the considered surface. The integration of different remote sensing technologies, supported by the GIS capabilities for the environmental inventory, allowed to asses the present physiographic conditions in the Northern China and to analyze the causes of the man-induced land cover changes. The project is funded within the Sino-Italian cooperation on the environment sector of the Italian Ministry of the Environment ad Territory.

11. A study on threshold wind velocity of particles on slope

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Bagnold's typical equation expressing relationship between the threshold wind velocity and particle diameter for the initiation of sand particles on the flat bed has been widely accepted in sand saltation research. However, slope is also an important factor in controlling the entrainment process of sands by wind. Because the dune is the most basic aeolian landform in deserts, and the slope has a great influence on particle saltation in the dune windward slope and leeward slope. According to the forced status of the particle in slope and based on the rolling model, this paper establishes a threshold wind velocity formula of the initiation of

sand particle. By means of Ansys software, this paper simulates the distribution of wind speed when a stable wind is blowing over a dune slope, and quantitatively analyses the effects of both slope gradient and particle position on the initiation of sand particles. The results show that the slope angle and particle position have obvious effects on the initiation of sand particles.

12. Research and programs that lessen likelihood of dust bowl reoccurrence

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Wind erosion is a serious problem in many parts of the world especially in arid and semiarid regions. It physically removes from the field the most fertile portion of soil. Soil from damaged land enters suspension and becomes part of the atmospheric dust load. Dust obscures visibility and pollutes the air, causes automobile accidents, fouls machinery, and imperial animal and human health. Aeolian sediments also pollute water bodies and cause associated problems. Following the disastrous "Dust Bowl" in the United States, the U.S. Department of Agriculture started an intensive research program on wind erosion in cooperation with Kansas State University. Their stated mission is to increase understanding of wind erosion processes, develop reliable predictive tools, develop control practices, and transfer technology for sustaining agriculture, protecting the environment and conserving natural resources. The predictive tools of the Wind Erosion Equation and Wind Erosion Prediction System have been used to help identify highly erodible lands and planning of conservation practices on those lands. Programs and practices that have been effective for reducing wind erosion include: Shelterbelt Project, Conservation Reserve Program, Environmental Quality Incentives Program, Conservation Security Program, National Grasslands, and No-till on the Plains. Research, implemented conservation programs, and improved farming practices have greatly lessoned the likelihood and severity of a "Dust Bowl" reoccurrence.

13. Dust and sandstorms in NE Asia: a transboundary environmental problem

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Dust and sandstorm (DSS) is the generic term for a serious environmental phenomenon in Northeast Asia. DSS involves strong winds that blow a large quantity of dust and fine sand particles away from the ground and carry them over a long distance with severe environmental impacts along the way, and often with serious impacts in the countries downwind of the DSS source. Both the Korean Peninsular and Japan are the recipients of this dust that can, under some circumstances, carry as far as North America. The major sources of DSS in the region are believed to be the desert and semi-desert areas of the People's Republic of China and Mongolia.

DSS can be thought of as non-point source (NPS) pollution. Unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. In environmental management literature, NPS pollution often refers to those problems caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants,

finally depositing them into lakes, rivers, wetlands, and so on. DSS represents a NPS pollution problem. Because our knowledge about the sources and movement paths of sandy dust is incomplete, it is difficult to pinpoint the exact point source of the dust. Dust storms sweep across northern China and the Korean peninsula each spring, thanks to seasonal wind patterns. Since DSS has no regard for national boundaries, it is typically viewed as transboundary pollution. When DSS particles are finally deposited in their destinations, their environmental impacts are felt in areas far removed from their sources.

The various forms of dust and sand storms are discussed and the forces that favor the onset of DSS are outlined. DSS are the result of the interaction of climate, geography soil type and human actions. Climate and weather patterns play a major role. Southern Mongolia and northern PRC, the source of most dust and sand, have a continental climate and are located far from the influence of oceans. In PRC this is coupled with the influence of a fringing chain of high mountains such as the Tian Shan and the Kunlun in Xinjiang and the Tibetan plateau and the Qilian mountains further east. These cause a rain shadow effect that leads to desert conditions on their leeward side. Similar influences are observed in western and southern Mongolia.Prevention and control of DSS will be a long and difficult task and one that requires cooperation between several countries in the region. The present article reviews some of the measures and outlines a strategy to combat DSS in northeast Asia.

14. Experimental dust production: saltation bombardment efficiency on erodible soil surfaces

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A model of saltation bombardment efficiency is constructed using dimensional analysis and experiments. General relations are derived that provide a rationale for scaling laboratory measurements of bombardment craters and their ejecta. Specific expressions are presented for 12 kinds of hard and loose soil surfaces in arid and semiarid areas in northwest China. In the hard soil regime, saltation bombardment is dominated by the soil compressive strength and its efficiency is directly related to the kinetic energy of the saltation particles and inversely proportional to the compressive strength of the soil surfaces. While in loose soil regime, the bombardment is mainly dominated by the gravity. These results indicate that the saltation bombardment is a key mechanism for the dust emission from soil surfaces in the arid and semiarid areas in northwest China.

15. An integrated approach to combat dust sand storms in Northern China

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Dust sandstorms (DSS) events are frequently experienced in the arid and semi-arid areas of China. The Chinese Government and the Beijing Municipal Administration are strongly concerned for the recent increase of DSS frequency and extension of the affected areas. In order to understand DSS's causes and effects and evaluate proper countermeasures, a dedicated project, named 'WinDust' was developed jointly with the Beijing Environmental Protection Bureau (EPB). The project lays in the framework of the Sino-Italian Cooperation Program for the Environmental Protection (SICP), launched in 2000 by the Italian Ministry of Environment and Territory (IMET).

Within the WinDust project an integrated approach was developed in the study area, extending from the Alashan prefecture (Inner Mongolia) to Beijing, to propose and test methodologies of intervention aiming at preventing and mitigating DSS impacts. Advanced Remote Sensing (RS) and Geographical Information System (GIS) techniques were implemented to characterize the potential DSS originating source areas and to describe the evolution of the land cover in the last twenty years. A fully coupled atmospheric/emission/dispersion model was set up to understand a) the DSS dynamics b) the large-scale meteorological factors responsible for DSS affecting Beijing area, and c) the contribution of the Alashan area to the DSS affecting Beijing. Direct measurements of emission dust fluxes were conducted in sensible areas by means of an Eddy Covariance-based technology, setting the basis for a dedicated emission inventory. Such emission measurements allowed to select and tune the most effective dust emission model. Demonstration activities (energy and water saving in agriculture, low-tillage techniques, micro-propagation-based plant production, rubble pits restoration) were undertaken in order to identify the most suitable and cost-effective mitigation and control measures, both in the Alashan area and in the degradated areas surrounding Beijing. Such activities provided several results that were assessed to set up an integrated management approach to DSS mitigation and control.

The WinDust project results showed the effectiveness of advanced RS methodologies and monitoring/modeling techniques in assessing the trend of many environmental variables, such as those controlling DSS phenomena.

16. Circulation dynamical structure in course of dust storm occurrence over the north china

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The fields of geopotential height, vorticity, divergence and wind speed as the circulation dynamical structure in course of the dust storm occurrence over north China in spring are analyzed based on the NCEP-NCAR data. The results show that there are some similar circulation dynamics features in strong stage of the dust storms. There is a deep low-pressure system over Mongolia and a high-pressure system developing over Ural, and a strong pressure gradient between both. It is the source driving dust. The low-pressure system is supported by positive center of vorticity, the minus vorticity area around it and strong gradient zone between both. There is a vertical structure with convergence at low-level and divergence at high-level in the center of system. This is favorable for strong winds to occur near ground and air stream to rise, which raise dust into the dust storm. The strong wind region is according to the strong vorticity gradient zone. The vorticity transfer made by the strong wind shear strengthens the low-pressure system and then enhances the wind speed farther.

17. Quantitative prediction of Asian dust storms using an Integrated dust storm prediction system

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Wind erosion is a serious environmental problem in arid and semi-arid regions of China and in many other parts of the world. Recently, the dust storm occurred frequently in spring in China, which has attracted wide attention. This study presents an integrated dust storm numerical modeling system, which is based on wind-erosion scheme(Shao, 2001), a dust-transportation model and mesoscale model (MM5) with a geographic information database. This system could predict the dust emission rate from surface and dust concentration in the atmosphere of individual dust storm event, that is, a quantitative prediction of sand storm process is possible. We have implemented the system for examining the dust storms over the Asian continent in April 2005. The dominant dust particles found ranged in the size from 0 to 22μm. The predictions were compared with synoptic records from the meteorological network and the satellite image. The predicted spatial patterns and temporal evolutions of dust events and the predicted near-surface dust concentrations were found to agree well with the observations. The validation confirms the capacity of the modeling system in quantitative forecasting of dust events in real time. On the basis of the predictions, dust activities in

northeast Asia are examined using quantities such as dust emission, deposition, and load. During an individual dust episode, dust sources and intensities vary in space and time, but on average the Gobi Desert, the Hexi Corridor and the Taklamakan Desert are identified to be the main source regions. The Gobi Desert is the strongest dust source.

18. Ground-surface conditions for sand-dust event occurrences and soil conservation of Aibi Lake region in Xinjiang, China

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The Aibi Lake region is one with highly frequent sand-dust events in the western Junggar Basin. During the springtime sand-dust event occurrences, the landforms, soils, vegetations, and the activities of human to exploit land were investigated, and data on soils and vegetations were taken. The physical-chemical properties of these soil samples were analyzed, and the characteristic indices of vegetations were calculated. The vegetation cover, community diversity, ecologic dominanance, topsoil moisture, soil organic matter, soil texture, soil salt content and pH were chosen as the ground-surface parameters. Comparing with other regions with low frequency and strength of sand-dust events, in the Aibi Lake region, where the gray-brown desert soil and gray desert soil are widely distributed and agricultural reclamation are intensive, the passive factors of impacting its ground-surface stability are mainly the high pH values and organic matter contents of soils, and the ecologic dominant degrees of vegetations. Good erosion-resistance of the ground surface occurs from the high vegetation cover, plant community diversity and coarser soil texture.

By biological, physical and chemical approaches, the ground-surface conditions can evolve towards restraining sand-dust events to occur and preventing soil erosion. By planting grass and trees and returning cultivated land to grassland and woodland, vegetation cover can be raised. This would also increase the diversity of plant community. By selecting alkali-salinity-tolerant plants and irrigation methods, the aims of harnessing salinization and alkalization and reducing pH of soil can be achieved. By mixing sand into heavy clay soil, the soil will be ameliorated decreasing the source of sand-dust events.

Whether ground-surface conditions are prone to sand-dust event occurrences is closely related to some characteristic parameters of the landscape pattern. For example, the larger the separation or fragmentation of bare land-cultivated in spring season and desert landscape with low vegetation cover, the higher the aerodynamic roughness. Accordingly, the strength of topsoil being eroded and the amount of sand-dust being transported will be reduced. So, according to a certain spatial pattern, by returning land-cultivated to grassland and woodland and rationally building shelter belt around the farmland, soil loss or erosion can efficiently be prevented.

Theme 3: Range management

1. Assessing some *Atriplex lentiformis* effects on soil characteristics and vegetation cover in planted land: A case study from Dashly- Broun region of Golestan province

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Range improvement through planting non-native and adapted species requires studies on several different aspects. Ecological positive or negative effects in new species must carefully be examined before allowing their plantation in vast areas. The aim of this study was to determine the ecological effect of *Atriplex lentiformis* species on soil characteristics and vegetation cover in Dashly-Broun region in Golestan province. The study was based on comparison of vegetation cover and soil characteristics under bushes and between bushes of planted areas with adjacent nonplanted sites. The soil characteristics studied were texture, Nitrogen, Phosphorous and Potassium content, pH, electrical conductivity and organic matter content in three mentioned areas and at four depths of soil profile (0-5, 5-15, 15-30 & 30-60 cm). The study showed that the *Atriplex* plantation increased Nitrogen, Phosphorous, Potassium and organic matter contents of soil especially in depths of less than 15 cm and electrical conductivity was increased in depth of less than 5cm. Canopy cover percentage and species composition in planted areas were better than in the control area. It can be concluded that *Atriplex* did not have any negative effect on vegetation in Dashly-Broun region.

2. Comparison of different range utilization methods and their effect on range condition: A case study from Damghan rangelands

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Rangelands are primarily used for livestock production in Iran. The utilization systems of rangelands are categorized in nomadic, village, public and private sector. The goal of this project was to compare the different utilization systems and introduce the best utilization system with the least range deterioration, and social and economic problems. To achieve this goal, 31 range sites with different utilization systems were investigated. The results indicated

that the contribution of range users in scientific range management viz: range carrying capacity, grazing commencement and termination, range improvement practices etc. in each utilization system, has a direct effect on range condition. The lower the number of range users in a private section, better the range condition. Range sites following a scientific range management had a much better range condition. In general the range condition in sites with only one range user was in a better condition in all range utilization categories compared to public utilization (more than one range user in the same site).

3. Physical land evaluation for extensive grazing using GIS, in a watershed of Khorasan province, north-eastern of Iran

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Overgrazing is the most important agent causing accelerated soil erosion and land degradation in semi-arid and arid zones of Iran. Appropriate land use planning in these area based on land suitability evaluation provides a suitable base for conserving the land and controlling desertification. Land evaluation identifies possible alternatives in land use that may more effectively meet national or local needs. In terms of extensive grazing land, evaluation should identify alternatives for land use planning that promote the balance and integration of land, livestock and people for the sustained benefit of all. Extensive grazing refers to the land utilization type in which animal feed on artificial pastures. The watershed under study is located 60 km away from Sabzevar city in northeastern Iran covering an area of about 25 km^2. The annual precipitation is about 250mm and average temperature is about 12° C. This study evaluated physical potential of the given watershed for grazing by sheep and goats, and assessing the limiting factors for such use. Land qualities evaluated included accessibility to animals, soil erodibility, moisture availability, flooding hazard, salinity and alkalinity, and drinking water availability for animals. The requirement of grazing land utilization type (LUT) was defined in terms of rated land characteristics. Then matching the requirements of LUT with the land qualities of each pixel of DEM (prepared in 100×100m by GIS software) resulted in a rating for every land characteristics. Some characteristics such as slope, aspect, and distance to drinking water for animal were calculated directly by GIS. Land index for every pixel was calculated. Finally, qualitative and physical land suitability classes were determined based on land indices and classified for grazing management. As a result, with analysis of spatial modeling it was possible to assess the land suitability with accuracy. Overall results showed that the studied area was only marginally suitable and non-suitable. The most limitating factors included moisture availability for plant growth, slope, rock fragment and rock out and distance to drinking water. During the late winter, spring and early summer, when the seasonal rivers supply drinking water, the limitation of is decreased and some management units become moderately suitabile for given LUT. In conclusion, overgrazing in the watershed must be controlled and managed in the season and in suitable land units to conserve soil and natural vegetation for sustainable land use in future.

4. Application of remote sensing in mapping potential for rangelands in the desert of India

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The Thar desert of India lies in the north-western part of the country and is a hot desert. It covers an area of 210,016 sq km, which is about 64.1 per cent of the area of the Rajasthan State. Thar Desert comprises of twelve districts of Rajasthan namely, Barmer, Bikaner, Churu, Ganganagar, Hanumangarh, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali and Sikar. The desert supports 17,509,490 persons. Typical characteristics of the Thar are large diurnal variation of temperature and high maximum temperature during summer season causing great evapotranspiration; scanty and xerophytic vegetation and practically no agriculture making it necessary for inhabitants to depend upon the animal resources resulting in sparse and nomadic population; and long and frequently occurring droughts and famines.

Extensive efforts have been made towards desertification control, ecological rejuvenation and restoration of the Thar desert in order to reclaim the productivity. Natural rates of desert regeneration have been very slow due to severe biotic pressure (overgrazing, and extraction of fodder and fuel wood). Introduction of fast growing exotic species of trees and grasses have proved highly successful. The wastelands in Thar desert have a big potential for development into a rangeland by growing nutritive fodder species well adapted to the arid desert environment. Remote sensing technology is a reliable tool in the wastelands identification, mapping, monitoring and management to develop it as rangeland. Integration of GIS has provided remote sensing a significant powerful platform in the mapping and management of rangelands. In the present study an attempt was made to map wasteland of Jhunjhunu district of the Rajasthan State using remote sensing and GIS and find a potential for the prospective development of rangeland. About 264.16 ha area was been observed. Necessary measures should be taken to utilize the rangeland for drought proofing and supporting livestock.

5. Landscape function analysis(LFA) : A new method for rangeland eosystem function assessment

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Land degradation and desertification are two most important problems in of the current century that decrease the soil quality and productivity. Ecosystem function has mainly related to soil surface condition. LFA (Land Function Analysis) is a new method developed by Australian scientists for analysis of the landscape function. This method is based on three main soil attributes: stability, nutrient cycle and infiltration. In this method, we score the soil qualitative characters and compare them to maximum scores. In a case study, we selected two rangeland sites in northern part of Iran (Golestan province) to test LFA method. Chahar Bagh site was grassland located in Alborz Mountain and Inche site was a halophyte shrubland in

Gorgan plain. The results showed that the landscape function was higher in score at mountainous than lowland site. It may be because of higher precipitation, more dense vegetation and lower soil salinity in Chahar Bagh site. This method is a quick and easy way for rangelands ecosystem function analysis and is recommended for arid and semi-arid rangelands.

6. A number of ecological propositions and their implications for rangeland management in drylands

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Rangeland ecosystems shift across dynamic thresholds between different ecological states in response to natural or human-induced factors. The different ecological states are the result of interactions among climate, soils, grazing history, and management practices. The notion of a single 'pristine' final state is only conceptual in nature, and because of this, dynamic thresholds and the effects of various processes on ecosystem structure and function must be incorporated into decision-making. Rangeland managers should have a working knowledge of the key ecological processes in each state, and the processes that drive a system across a dynamic threshold from one state to another. To do this they need indicators for critical decision-making points. It is essential to identify the thresholds of an ecological transition state and ecological indicators of these states. The criteria of these ecological indicators are that they should be measurable, sensitive to stress on the system, have a known response to disturbance and easy to measure. The state and transition approach may offer an appropriate framework as an aid for decision making and can be used to highlight 'management windows' where opportunities can be seized and hazards avoided. Five propositions are set out and their implications for the management of semi-arid and arid rangelands are discussed.

7. Investigation of range condition and range condition trend at protected and unprotected rangeland in semiarid region: A case study: from Buein Zahra, Qazvin province, Iran

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In this study, range condition trends at two similar sites (protected and unprotected) were investigated. Protected area for 38 years (from 1964 to 2002) was a park, without livestock grazing and planted with two range species (*Haloxylon aphyllum* and *Calligonum comosum*) was managed to stabilize soil and sand hills. Unprotected area beside the first area for the same this time was grazed mainly by two local livestock (sheep & camel). Range condition at

both area was assessed by four factor methods after estimating the vegetation cover and making inventory of plants.

Also, range condition trend was determined by balance method. Results showed that in the protected area plants diversity and plant cover increased and wind effect on soil and sand hill decreased but in unprotected area, in addition to decrease in plant cover and plant diversity, the wind and water erosion of soil increased due to shortage of plant cover and sand dune formation increased.

8. Daily transpiration rates of *Festuca ovina* and *Agropyron intermedium* rangeland species

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Proper study of the components of the hydrological cycle is necessary for sound utilization of rangelands located in the arid and semiarid regions. Transpiration is one of the water cycle components, which has not been paid enough attention yet. The comparison of the different kinds of rangelands species in terms of transpiration rates provides a good management conditions achieving optimal forage production using a defined input precipitation. The present study is a preliminary comparison of transpiration between two important Iranian rangeland species, *Festuca ovina* and *Agropyron intermedium*. The plants of these species were grown in plastic pots with surface area of 50 cm^2 and amount of daily evapotranspiration from was measured using weighing technique for a period of 36 days under natural conditions. The amount of average daily transpiration of *Festuca ovina* and *Agropyron intermedium* was found to be 5.10 and 5.03 ml, respectively. The statistical analysis showed no significant difference between the two studied rangeland species at the 95% significance level.

9. Rangeland degradation related to social and ecological characteristics of 50 communities in the Syrian steppe

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In many dry areas in Central and West Asia and North Africa (CWANA), increasing population pressure is causing changes in land use that are degrading the region's natural resource base and threatening the livelihood of the inhabitants. Encroachment of cultivation and overgrazing are rangeland problems that the International Center for Agricultural Research in Dry Areas (ICARDA) and its partners are addressing in several countries. A survey was conducted in the Syrian Steppe (Badia) to provide information needed to implement proper grazing management. Fifty communities including 359 households were randomly selected and surveyed in the spring of 2005 and the relationships between rangeland degradation, current management and community characteristics were determined. Rangeland degradation was assessed for each of the communities. An index of degradation was determined by evaluating eight erosion and degradation indicators, scoring each on a scale of 1-5 (where 1 represented the least degradation and 5 the most), and then averaging the scores. The indicators included root exposure, soil compaction, gullies and presence of invasive plants. Utilization was high with over 70% of the forage consumed on 87% of the sites. The amount of forage produced by different types of rangeland varied with over 80% of the sites producing less than 300 kg/ha. Results showed that the rangeland of some communities was more severely degraded than others. An analysis is conducted in order to identify which community characteristics could explain some of those differences. While controlling for environmental conditions we are evaluating human pressure, grazing exit options (through reciprocal grazing arrangements with other steppe communities), surrounding infrastructures, and distance to the cropping zone to determine the impact these factors have on the relative degradation of the communities rangeland.

10. Effective environmental factors in distribution of vegetation types in Voshnaveh of Qom Province (Iran)

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The aim of this research was to investigate the relationship between environment characteristics specially soil factors and vegetation cover to determine the most important factors affecting quantitative change in vegetation in different vegetation types. The studied area is located in Voshnaveh Rangeland in Qom province. After examining rangeland we selected 6 indicator vegetation types. Method of sampling was random- systematic and vegetation measurement parameters were canopy cover percentage and diversity of plant

species. Soils were sampled at 0-30 and 30-60 cm depths to determine texture, EC, pH, content of lime, organic matter, nitrogen, phosphorus and potassium, and gravel percentage. To determine the most effective variable on the separation of vegetation types PCA was performed for 22 factors in 6 sites. Result showed 4 ecological groups between vegetation types. Each plant species had specific relation with environmental variables because of habitat condition, plant ecological needs and tolerance range.

11. Role of Salsola in grazing cycle of livestock from ranges of dry regions

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Salsola sp. known as shoor or shooreh in most parts of the country, is an annual or perennial plant from Chenopodiaceae family.In desert regions , especially in northern margins of Iranian central desert. *Salsola* sp. is found up to an altitudes of 1000 m above mean sea level. The plants are resistant to drought condition and tolerate moderate salinity in the soil. In the Semnan and Yazd region 14 species of this genus were collected and evaluated. Among these six were annual and seven perennial.

The most impotant species of *Salsola* in this region, based on their role in supplying forage and in providing green cover in the range, were *S. arbuscoliformis*, *S. rigida* cf *oriantalis* and *S. arbuscula*. Although some annual species like *S. kali* have shown special utility for forage production under harsh condition in many parts of the world, this study was carried out to determine *Salsola* characteristics in Iran. In rangelands of arid regions, especially in winter grazing ranges of Semnan and Yazd province, *Salaola* sp. is an important component of green cover. Animal herders, especially nomads believe that *Salsola* plays a key role in providing salt for domestic animals in addition to its essential role as a forage in grazing cycle from ranges. Usually in ranges with *Salsola* plants, a part of grazing time, usually at the end of the day, will be devoted to these range plants. Domestic animal would thus have no need for putting salt stones in the area . This part of grazing is useful for livestock nutrition and helps the shepherd to lead the herd towards watering places . Protein and dry matter production of some *Salsola* sp. is considerable and is comparable with *Medicago sativa.*

Theme 4: Forage and livestock production

1. Pasture and forage legume improvement for food security in the dry areas of Central and West Asia

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There are large feed deficits in more than 80% of the countries in the dry areas of Central and West Asia and North Africa (CWANA), indicating that poor livestock keepers cannot take advantage of the growing market for livestock products to improve their livelihoods. Improvement and integration of pasture and forage legumes into crop-livestock systems can improve crops and livestock and make the system more sustainable. The International Center for Agricultural Research in the Dry Areas (ICARDA) has been working on development of improved pasture and forage legume cultivars in collaboration with national research and development institutions in CWANA. The paper summarizes results of ICARDA's work on development of *Lathyrus* and *Vicia* species for high hay, straw and seed production and better quality to improve the nutritional well-being of resource-poor farmers in the drought-prone areas of CWANA.

2. Some aspects of forage quality assessment

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Efficiency of animal production is closely correlated with the nutrient value of the forage available. Feed quality has been defined as the amount of nutrient material that an animal can obtain from a feed in the shortest possible time. Among several factors, crude protein (CP), digestible dry matter (DDM) and metabolisable energy (ME) have been considered more appropriate attributes for evaluation of range forage quality. The objective of this paper is to provide some information on different aspects of forage quality assessment. Effects of climate, soil, and phenological stage on forage quality of five grass species were investigated and ratio and forage quality of plant parts in different phenological stages were measured. In addition, effects of location on forage quality was also investigated. Analysis showed that environmental conditions affected the forage quality greatly. Effect of climate was more serious than the effect of soil characteristics. Phenological stages caused more variation in forage quality than climate and species. Nutritive values differed significantly ($P<0.05$) both within and among plant part and phenological stages for each species with leaves having the highest nutritive value. Based on correlation between factors, measurements of crude protein and acid detergent fiber are more important than other characterstics. Forage quality of the same species at the same time varied between sites.

3. Study on milk production potential of Pakistani camel (*Camelus dromedarius*) kept under dry land conditions

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The study was undertaken to assess the dairy character of camels raised under dry land conditions, belonging to the Barani Livestock Production Research Institute (BLPRI) Kherimrat, District Attock (Punjab-Pakistan). Milk production of five freshly calved she camels were recorded monthly from 7th day post-calving till the completion of six months lactation. The browsing/grazing for these animals in the mountainous rangeland comprised Pholai (*Acacia modesta*), Kandair (*Alhaji camelorum*) and Kao (*Olea ferruginea*) trees and some local grasses. Common salt and water were provided *ad-libitum*. Experimental animals produced 2100.6±163.32 litres milk in a period of 180 days, that is a daily production of 11.6 ± 0.90 litres. Camels showed their peak milk yield in the second month of lactation (13.36 litres/day), which ranged from 10.35 to 13.36 litres in the study period. The results of the study revealed that camel possess an appreciable dairy potential even under the range or dry land conditions. This characteristics can be further exploited under good feeding and management conditions coupled with careful selection and breeding. Being a member of food producing family, camels can significantly contribute for the food security and nutrition of the people living in arid/semi arid areas of the country.

4. Feed legume strategies for improved crop-livestock production in the dry areas of Central and West Asia and North Africa

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Millions of poor farmers in the dry areas of Central and West Asia and North Africa (CWANA) rely on livestock for their livelihoods. Current estimates indicate that both human and livestock populations are likely to continue to increase rapidly over the next five decades. As a result of this, as well as climatic changes, mixed crop-livestock and peri-urban meat and milk production systems are expected to dominate farming systems in the region. The changes in production system, together with improved market demand for livestock products, due to economic reforms and urbanization, present significant opportunities for improving the livelihoods of the poor people who depend on livestock production. The paper summarizes feed legume-based strategies to improve crop and livestock outputs in the smallholder crop-livestock systems in CWANA.

5. Forage potential of leguminous and non-leguminous fodder shrubs in the dry areas of West Asia

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Several shrubs in the dry areas have potential as stock-feed and for re-vegetation of degraded rangelands, but quantitative data on their fodder yield and quality are scanty. Edible fodder (leaves plus twigs with less than 10 cm diameter) production and concentrations of crude protein, neutral detergent fibre, acid detergent fibre and digestible organic matter in the edible fodder of 29 non-legume and 9 legume shrub species were evaluated in northern Syria. *Atriplex halimus-halimus*, *A. nummularia*, *A. canescens*, *A. halimus*, *C. istria*, *M. arborea* and *C. mollis* were among the species with high potential for production of quality fodder.

6. Investigation on effects of phenological stages and species on forage quality of rangeland grazing by Fashandy breed sheep, a case study from Taleghan region of Iran

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Variation in forage quality in different phenological stages was investigated. Five species were selected; samples were collected from Taleghan area in two phenological stages. Nitrogen and ADF were measured by chemical analysis of plant samples. Crude protein, ADF, dry matter digestibility and metabolizable energy were assessed. According to the results, forage quality of species significantly differed at different phenological stages. Forage quality was higher in vegetative stage and was lower at maturity stage. Forage quality of species was significantly different ($P< 0.01$). Among species, highest forage quality was of *Lotus goeblia* and lowest of *Cynodon dactylon*.

7. Adaptable system of arid fodder production

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On the basis of long-term investigation it was possible to work out the system of arid fodder production which is adapted to conditions of desert and semi-desert. This system also allows insuring guaranteed fodder resources for karakul sheep during risky seasons. The system itself consists of different methods: rational utilization of vegetation cover of native rangelands, range improvement, creation of permanent pastures of different seasonal utilization and plantations of *Haloxilon aphyllum*. The yield of biomass may vary from 0.15 to 0.35 t/ha depending on season. All these methods allowed increasing a fodder production

by 2-3 fold. The range productivity in deserts is determined not only by individual adaptive potential of plants, but also by interactions among different organisms, populations, species richness, which is an important part of artificial agrophytocenoses. Different vital forms such as shrubs, semishrubs and herbs form the desert agrophytocenoses. It is also necessary to take into account the vegetation period and palatability of range plants during different seasons. In addition to *Haloxilon aphyllum,* different species such as *Salsola richtery, Kochia prostrata, Eurotia ceratoids, Aelenia subaphylla, Salsola orientalis, Poa bulbosa,* and *Agropiron desertorum* are widely used for creation of permanent pastures. Adaptable system of arid fodder production stipulates the widespread utilization of biological potential of plants on a given ecological environment and leads to sustainable development.

8. Evaluation of triticale lines as a new crop for cold dryland areas in Iran

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Triticale is a crop with high production potential, high lysine content, cold tolerance and extensive adaptability in non-productive soils. So it can be considered as a new crop or a direct substitute for barley in animal feed rations in cold dryland areas. Low growth duration in spring sowing and low winter survival in winter sowing are the major problems of barley production in highlands. Breeders in dryland research institute in Maragheh, Iran started studying to find a potential triticale line. In 2001, several selected lines from SPII, Karaj nurseries were evaluated in dryland conditions. Observations showed that triticale compared to wheat ('Azar-2') could be one week earlier in heading but mostly late in maturity with less productivity. Since 2002, 320 hexaploid triticale lines received from CIMMYT were evaluated in several observation nurseries and advanced yield trials. The results showed extensive variation in morpho-physiological characteristics and the best lines were selected for additional studies. Finally, two promising line were found. The line 578-82 was same as wheat (Azar-2) in maturity but earlier in heading with 8% more grain yield. Line 77-ITSN82 was 6 and 3 days earlier, in heading and maturity, respectively, with 10% more grain yield.

Theme 5: Biodiversity and Ethnobotany

1. Agrobiodiversity conservation and the livelihoods of local communities in the dry areas of West Asia

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West Asia encompasses the mega-center of diversity of species of global importance (wheat, barley, lentil, and many forage legume and fruit tree species), whose conservation will contribute to sustaining agriculture and food security worldwide. The landraces and wild relatives of these species form the basis of the traditional farming systems and contribute significantly to the livelihoods of local communities in the drylands and mountainous ecosystems in the countries in North Africa and West Asia. The GEF-funded project on conservation and sustainable use of dryland agrobiodiversity has developed a holistic approach to promote the conservation of the landraces and wild relatives of the species originating from Jordan, Lebanon, the Palestinian Authority and Syria. The socio-economic and farming systems surveys showed that agriculture contributes to approximately 50% of the household income and that the landraces of barley, wheat, lentil, chickpea, olive, fig, are still widely used and contribute along with livestock to the livelihoods of local communities in the target areas. The technological, institutional and policy options are developed and tested within the project, which can contribute to the improvement of the livelihoods of local communities while conserving and sustaining the natural resource base and local agrobiodiversity. This contribution will present the relationship between local agrobiodiversity and the livelihoods of local communities and the examples of technologies, add-value and alternative sources of income to improve and diversify the incomes of the main custodians of agrobiodiversity.

3. The effect of soil factors and water-logging on canopy cover in some index plant species in arid and semiarid Aghqalla-Gomishan region

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This study aimed at determining the effect of soil and waterlogging on plant types in Aghqalla – Gomishan region, which is characterized by arid and semiarid climate. Classification of index plants was done in terms of soil characteristics (chemical and physical properties) and waterlogging. Correlations were determined between canopy cover percentage and soil characteristics. After delimitation of the study area, sampling of soil and

vegetation was done. Soil and vegetation characteristics were surveyed in different areas. Relationship between canopy cover percentage and soil characteristics and waterlogging was studied by simple regression and multiple regression. Soil properties were texture, acidity, electrical conductivity, sodium absorption ratio, organic matter, lime percentage, nitrogen percentage and potassium content.. Significant correlation between soil and plant were observed in 6 range plants. Soil characteristics can separate different plant type, although they are not fully correlated. More over, the result showed that the vegetation distribution pattern was mainly related to such soil characteristics as salinity, texture and amount of waterlogging. Generally, each plant species depending on the habitat conditions, ecological needs and tolerance show a significant relation with some soil properties.

4. Biodiversity and conservational strategies of *Ziziphus* species, a multi-uses plant in dry lands of Iran

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Present research work is a part of a national project ongoing in Iran. Taxonomy and diversity of *Ziziphus* species was studied for contributing to the Flora of Iran. *Ziziphus* is a genus of Rhamnaceae family, which has 58 genera and nearly 900 species. Represented in Iran by three species, two varieties and one hybrid viz. *Ziziphus spina_christi*, *Z. nummularia*, *Z. jujuba*, cross between *Z. spina_christi* and *Z. nummularia*. Species *Z. spina_christi* and *Z. nummularia* are native of the area from Illam province in the west to Sistan_Balochestan in the east (the Saharo-Sindian area). *Z. jujuba* is native to Golestan Province, in the northern area of Iran (Hyrcanian region). These species are commonly used by the people for industrial purpose, food, fodder, and for ornamental and medicinal purposes. In Iran, *Ziziphus* tree is considered as a sacred plant and most of the people try to protect it in their holy places, graveyards and even in their houses. At some places some very old plants are found with good growth and huge canopy but in agricultural fields this tree species is being extensively cut by farmers for their domestic uses. As a result these species are becoming rare day by day. Although a good diversity of this plant was seen in Bushkan (Bushehr Province), along the road from Dehloran to Shush (Khuzistan Province) and Kalaleh (Golestan Province), but a lot of efforts are needed for the conservation of this multipurpose plant species. Special attention is needed for *Z. jujuba*, which is becoming a rare plant in Iran as in most of its habitats it has been completely demolished. Possible conservational strategies to protect this multipurpose tree species with the active participation of local people are discussed.

5. Plant diversity, environmental adaptations and balanced management of central Asian deserts

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The Central Asian desert vegetation has a unique composition apparently as an evolutionary result of their extremely harsh and dynamic environments and, in recent times, from strongly human driven pressures. These combined pressures have resulted in very difficult biological growth environments. The Chenopodiaceae family dominates with their quite diverse flora, specifically by perennials. Surprisingly essentially absent in Central Asian deserts is a large worldwide group of desert plants, called Crassulacean acid metabolism (CAM) plants. Only one small genus Orostachys has been found with CAM. Also this is the northern most edge of growth for C4-photosynthesis plants that dominate the desert flora. Several new aspects of desert photosynthesis, symbiosis and reproduction have been detected recently, which give clues about the unusual biology needed by plants to successfully grow and be productive in Central Asia. Some of these are presented on seed production, photosynthesis and soil nutrient uptake mechanisms. By combining our accumulated knowledge of biodiversity, biochemistry, physiology, and environmental adaptations, recommendations are presented for more effectively and sustainably managing the deserts of Central Asia; even in the presence of strong anthropogenic pressures. We propose that fostering such sustainable efforts will enhance public health, society well being, and economic growth across all of Central Asia.

6. Ethnobotanical studies on medicinal plants of Ziarat region in Golestan province in Iran

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Medicinal plants are a main group of economical plants. More than 7500 plant species of this group are found in Iran. Golestan Provinces is one of the main regions in plant diversity. In this research, medicine plant distribution in Ziarat region has been investigated. Ziarat is located in 6 km southwest of Gorgan City (latitude and longitude of 36° 47' to 36° 43' and 54° 25' to 54° 29' respectively). The altitude ranges from 650 to 2250 m above the mean sea level. The average annual rainfall in this area is 574.5 mm.

There is a need for the study on the medicinal plant species distribution in different regions and also for introducing the existing species in new areas. Our study showed that 107 species belonging to 93 Genra of 42 families were present After determination of species we interviewed local people to find out the traditional medicinal uses. *Asteraceae* with 21 species, *Lamiaceae* with 12 species and *Fabaceae* with 10 species constituted the bulk of the

collected species. In this research customary usage of traditional medicinal species of this region was studied that could be a basis for phytochemical, pharmacological and economic research for this region. Most of these pharmaceutical plants belong to *Geophyte* orders (36-4%).

7. Bryophytes in Qilian Mt. and adjacent areas

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Based on comprehensive collection and identification of specimens, site and sample investigation, a complete checklist of bryophytes in Mt. Qilian and adjacent areas was provided, including 520 specific and sub-specific epithets of mosses and hepatics in 187 genera belonging to 56 families. Among of them, 315 species in 115 genera of 34 families, 335 species in 91 genera of 3 families, and 70 species in 20 genera of 4 families are new to Mt. Qilian, Gansu, and Qinghai province, respectively. The dominant geographic element is 303 species of Pan-Arctic, accounting for 92.66% of the total species. The phyto-geographical compositions of the bryoflora of Mt. Qilian consist of 180 species of north temperate (55.05% of the total), 45 species of China-Himalaya (13.76% of the total), 21 species of east Asia (6.42% of the total), 14 species of Asia-Europe (4.28% of the total), 13 species endemic to China (3.98% of the total), 11 species of east Asia-North America (3.35% of the total), 9 species of Asia temperate (2.75% of the total), five species of China-Japan (1.52% of the total), five species of northern hemisphere (1.52% of the total), four species of old tropic (1.26% of the total) and 20cosmopolitan species (6.12% of the total).

The comparisons of floristics of bryophytes between Mt. Qilian and other three mountains show that the bryophyte floristics of Mt. Qilian is closest to Mt. Guancen, Shanxi's, with the highest genus co-efficient of 65.22%. The bryophyte floristics of Mt. Qilian shares with Mt. Bogeda, Xinjiang shows a genus co-efficient of 50.56%. The bryophyte floristics of Mt. Qilian and Mt. Changbai, Jilin is distant, with genus co-efficient of only 38.51%. The connections of bryophyte floristics between the four mountains are mainly by the Pan-Arctic elements.

8. Land use and biodiversity conservation in the agro-pastoral interlocked land in Inner Mangolia: A case study of Horqin Sandy Land

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The agro-pastoral interlocked area in northern China covers about $8.0*10^5 km^2$ in the areas with annual precipitation range of 350 to 450mm. Horqin Sandy Land is in the northeast part of this area and once was covered by *Ulmus* spp. scattered grassland and the dominant land use was nomadic pasturing. However, since late 1700s, there was a dramatic land use change

characterized by invasion of cultivation in grassland for cropping, beginning from the southern edge of this area and then moving northwestwards along rivers, around lakes and in lower land of relatively abundant water. Expansion of cropland over this area has caused severe land degradation and habitat fragmentation, and has brought severe threat to the biodiversity in a harsh climate of larger inter-seasonal and inter-annual variation of precipitation and strong wind.

Monitoring in Horqin Sandy Land revealed that desertified land area increased from $4.23*10^4 km^2$ in 1959 to $6.1*10^4 km^2$ in 1987 and then decreased to $5.1*10^4 km^2$ in 2000, while the grassland area reduced by more than $1.5*10^4 km^2$ from middle of 1960s to 2000. There are 15 species of animals and birds and 11 plants classified in this area as the endangered species while many species have been pushed northwards to the border between China and Mongolia, in which the climate is more adverse. Considering the danger to these species and biodiversity conservation, the Chinese government, researchers and the public at large have made great efforts to protect these endangered species through issuing related laws and regulations, setting up nature reserves and increasing investment in research. But, with a rapid population increase and reduced availability of cropland per capita and fast urbanization, the agro-pastoral area in northern China will be inevitably used to meet the land shortage in the future. Therefore, it is foreseeable that land use change will be intensified and life in this area will be face great challenges. Based on these concerns, some models aimed at biodiversity conservation are introduced.

Theme 6: Stress physiology

1. Effects of defoliation and water stress on the growth of determinate and indeterminate soybean cultivars

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This study aimed at determining the responses of determinate (Enrei) and indeterminate ('Tousan 69') soybean cultivars to the combined stresses of defoliation and drought. Controlled irrigation rates and simulated insect defoliation were used on soybean grown in the greenhouse. Defoliation significantly increased soil water contents to the extent that defoliated plants had higher leaf water potentials than non-defoliated plants under drought.

The average seed yield of irrigated 'Enrei' (197 g m^{-2}) exceeded that of non-irrigated plants by 19%, while defoliation reduced seed yield by 50%. Also, the average seed yield of irrigated 'Tousan 69' (284.8 g m^{-2}) exceeded that of non-irrigated plants by 39% and defoliation reduced yield by 14%. The difference in the yields of the two cultivars in nresponse to irrigation and defoliation indicated that the determinate cultivar, 'Enrei' had higher drought-tolerance than the indeterminate cultivar, 'Tousan 69'. However, 'Tousan 69' was more tolerant of defoliation than 'Enrei.' For the cultivar 'Enrei', defoliation caused a significant yield reduction with or without irrigation.

Drought did not significantly affect the yield of defoliated 'Enrei', indicating that water apply is not of prime importance for defoliated determinate soybeans cultivars. On the other hand, defoliation did not affect the yield of 'Tousan 69' under the irrigated treatment, because of compensation for defoliation effect via delayed leaf senescence and new leaf area expansion, which enhanced the light interception capacity of defoliated plant canopies. However, under drought condition, expansion in the area of new leaves after defoliation was markedly restricted and defoliation caused a significant yield reduction. This study indicated that water management is very important for increasing defoliation tolerance of indeterminate soybean cultivars.

2. Water deficit stress effect at vegatative growth and reproductive improvement stages of soybean (*Glycine max* L. Merr.) genotypes

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Drought is known to influence soybean yield. The extent of soybean diversity for hardiness is debatable. The objective of this study was to evaluate the effect of water deficit on phenological, morphological and agronomic characteristics of new lines and cultivars of

soybean. Twenty genotypes belonging to group III maturity were tested in three experiments. In the first experiment genotypes were irrigated as normal condition (60 mm evaporation from pan, Class A). In the second and the third experiments, plants were irrigated after 180mm evaporation , at vegetative growth stage to maturity, and reproductive development stage, respectively. Combined analysis of variance showed that water deficit stress declined node and branch number in main stem, significantly. There were significant differences in yield and its components. They decreased in drought conditions. Water deficit stress before flowering to maturity had more harmful effects on genotypes. Seed and pod number decreased in drought condition but the reduction was more intensive when stress occurred sooner. There was significant correlation between yield and pod number in each irrigation treatments. Water deficit declined seed oil content. There were negative correlation between seed oil and protein content. Water deficit at vegetative and reproductive stages caused high decrease in harvest index. Genotypes such as 'Vacova' and 'Adepta' produced the highest yield in drought conditions. They had more pods and seed weight, but their heights and node number were not the highest. Water deficit had less effect on harvest index of 'Adepta'. However drought decreased yield but some genotypes tolerated drought, better. Drought had less effect on their yield components and/or morphological characteristics.

3. Leaf water potential and photosynthesis in water stressed seedlings of *Robinia pseudoacacia* and *Quercus liaotungensis*

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Reforestation with *Robinia pseudoacacia* has been widely performed in the Chinese loess plateau for the purpose of soil and water conservation. However, much evidence suggests that this species does not grow well in many parts of the region. By contrast, natural forests of *Quercus liaotungensis* show signs of having high adaptability and making stable ecosystems. Measurements of photosynthesis using current year seedlings revealed that *R. pseudoacacia* exhibited higher assimilation and transpiration rates and lower water use efficiency than *Q. liaotungensis*. Severe water stress induced by withholding water resulted in permanent wilting of most of the pot-cultured seedlings within 14 and 24 days for *R. pseudoacacia* and *Q. liaotungensis*, respectively. The predawn and midday leaf water potentials in both species did not show marked changes until the soil volumetric water content decreased to about 0.05. Then the leaf water potentials exhibited a steady decline for a short period, before they vastly decreased to the stage of permanent wilting. The soil water content at which this steep decline appeared was lower for *Q. liaotungensis* than for *R. pseudoacacia*. The decreases of transpiration and carbon assimilation rates were more gradual in *Q. liaotungensis* than in *R. pseudoacacia*. Regressions of leaf water potentials to assimilation rates showed that both predawn and midday water potentials at an assimilation rate of zero were lower in *Q. liaotungensis* than in *R. pseudoacacia*. The results suggest that *Q. liaotungensis* might be more suitable for the loess plateau where the soil water is limited. *R. pseudoacacia* should be

planted in relatively water-adequate places to fit its high assimilation rate and water consumption, albeit drought tolerant to some extent.

4. Effect of genotype variability on nitrate uptake and assimilationof wheat cultivars

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The nitrate concentration in the soil at the start of the growing season is high because of mineralization of organic N during fall and the addition of N fertilizer. It may be useful to exploit this N as much as possible. Therefore, nitrate uptake, assimilation and dry matter production among a range of wheat cultivars were examined in a series of experiments utilizing a hydroponic system in Agricultural Sciences and Technology University of Khouzistan, Ahwaz. Seedlings were grown at 2 rates of nitrates (0 and 1.0 mM) and the experiments lasted for 26d. Significant genetic differences in growth and nitrate uptake were identified. The cultivars 'Atlia' and 'Uavarous' consistently produced large seedlings, which took up large quantities of nitrate from solution whereas 'Falat', 'Star' and 'Seri 11' produced small seedlings and took up small amounts of nitrate. However, apart from differences based on seedling vigor, there was evidence that group one of cultivars was more efficient physiologically in assimilating nitrate. For comparable amounts of nitrate taken up from solution, total dry matter production in this group of cultivars was consistently greater than the other cultivars examined. Results from this work established that genetic differences in nitrate uptake exist between cultivars, which in most cases were related to the size of the plant, especially the root system. However, the importance of greater nitrate uptake by the seedling and consequently of early growth, to grain yield was not clearly established because early vigor was not always beneficial for yield.

5. The effects of drought stress and harvest time on seed vigour and germination of wheat cultivar in Khuzestan province

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Seed quality changes during development and ripening period and also environmental factors affect seed quality. In order to determine the effects of drought stress, cultivars and different harvest times on seed vigour variations, germination percentage and ripening stage of wheat with maximum seed quality, the experiment was conducted in at Ramin Agricultural Education Natural Resourse Complex, Ahwaz. The experiment was arranged in a split-split plot design with 4 replications. Three levels of irrigation were the mian plots, three wheat cultivars were as subplots and the sub-subplots were seven stages of harvesting during the seed ripening period. The results indicated that only harvest times had affected germination.

The highest and the lowest germination were obtained at the sixth stage (99.8%) and the first stage (76.2%) of harvest, respectively. The effects of the cultivar and drought stress on germination were not significant. Cultivars and harvest times were significant variables affecting seedling dry weight. Durum wheat cultivars had the highest seedling dry weight. The highest seed vigour and germination was obtained at physiological maturity (maximum seed dry weight) 44 days after the anthesis. At this stage the seed moisture content was lower than 15%, which is suitable for mechanical harvesting with no damage to seed quality.

6. Genetic variatation of stem reserve utilization for grain filling in promising bread wheat genotypes for moderated cold rainfed conditions of Iran

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In the Mediterranean climate of western Iran grain filling is subjected to temperature and drought stresses. Grain filling often occurs when temperatures are increasing and moisture supply is decreasing. Foliar diseases of wheat also tend to spread and intensify towards and after flowering. Rusts and Septoria leaf blotch can result in total leaf damage at grain filling.

The final result of these stresses is kernel shriveling and grain yield reduction. Carbohydrates reserve in stem from pre-anthesis plant assimilation have been recognized as an important source of carbon for grain filling when current photosynthesis is inhibited due to drought, heat or disease stress. The genetic improvement of stem reserve storage and utilization as a mechanism for grain filling under stress was suggested and practical guidelines for selection work were provided. In this study to identify the capability of stem reserve utilization for grain filling in 16 advanced wheat genotypes with superior performance under rainfed condition than local check cultivar 'Sardari', we planted them in a RCBD with 3 replication. Plants in half meter length of one row in each plot were sprayed by Sodium Chlorate solution (0.4%). At harvest 10 random spikes from sprayed and non-sprayed plants were harvested and grain yield and 100-kernel weight were recorded. Differences between these traits for sprayed and non-sprayed plants were calculated and correlated with the grain yield of plots.

The correlation between differences in 10 spikes grain yields and 100 kernels weights and plots grain yield were negatively significant (r= -0.741** & -0.521*, respectively) indicating that the genotypes with better performance utilized the stem reserves for grain filing under artificial stressed condition created by spraying Sodium Chlorate solution. 'Sardari' ranked second for this traits. But, some of these genotypes which out-yielded 'Sardari' were poor for these traits, showing the possibility of improvement of these genotypes for stem reserve utilization for grain filling for better performance.

7. Drought tolerance indices in chick pea and their related traits

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Terminal drought stress is a major limiting factor in chickpea production in rainfed conditions of western Iran. To identify morphological and phenological characteristics of related to drought tolerance, 17 genotypes of chickpea originating from ICARDA were evaluated in rainfed (stress) and irrigated (non-stress) conditions in a RCBD design with four replications. During growth period traits such as days to emergence, days to 50% and 100% flowering and pod formation , days to maturity, plant height , number of main-branches, and sub-branches per plant, kernel weight and grain yield were recorded for each genotype in both conditions. Stress tolerance index (STI), and mean productivity (MP) were calculated for each genotypes. STI, MP and grain yield in both conditions were used as dependent variables and the other recorded traits as independent variable to obtain a multiple regression model for each dependent separately. According to this models the direct effect of 50% flowering and 50% pod formation and days to maturity (recorded in stress condition) on STI, MP, and grain yield in rainfed condition were significantly negative and the effect of number of main-branches and kernel weight were significantly positive. Under irrigated condition, direct effect of length of flowering period and kernel weight was positive on grain yield and the direct effect of days to 50% pod formation was significantly negative.

8. Effects of water stress in germination and vegetative growth stages, some pure lines of wheat under different water levels

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In order to evaluate the effects of water stress at germination and vegetative growth stages, some pure lines of wheat were studied in two separate experiments. In the germination stage experiment 40 lines of wheat were exposed to -1.6, -1.2, -0.8 and 0 MP for 7 days at 25°C. The following traits were measured: final germination percentage, length of stem and rootlet, dry weight of rootlet and stem of seedlings. Then, in order to study the accumulation of metabolites in leaves, 8 lines of wheat obtained from the first experiment were compared with two commercial lines ('Azar2' and 'Zarrin'); water stress was created by applying water at 100%, 75%, 50% and 25% of fieldl capacity.

The results showed that water stress decreased germination percentage, length and dry weight of rootlet and stem.The lines were divided into 3 groups: tolerant (lines 15 and 28), semi-tolerant (lines 19 and 17) and sensitive (line16 and most of the other lines). The lines tolerant to water stress had more length and dry weight of rootlet and stem than the sensitive lines.

Under the conditions of water stress in the second experiment a decrease was observed in plant water potential and RWC. Decrease in the amount of RWC was parallel with the

decrease in the amount of water potential so that the least decrease of RWC and water potential occurred in the treatment 25% of field capacity in 'Azar2' and the line no. 15 and the most decrease occurred in line 36 and 'Zarrin'. Accumulation of proline and soluble carbohydrates had negative and significant correlation with plant water potential and RWC. The most accumulation of proline occurred in line 16 while the most accumulation of soluble carbohydrates was in 'Azar2' and the least was in the line no 36. So, there is a relationship between the accumulation of osmo-regulator metabolites and water potential in tolerant lines.

9. Study on some physiological characters in tolerant and sensitive barley varieties under stress and non-stress conditions

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In western Iran, with its Mediterranean climate, wheat production is depressed due to decreasing rainfall and increasing soil evaporation during the grain-filling period. Pre-anthesis assimilates stored in plant parts may represent an important buffer for grain filling when current assimilates are limited due to drought. This hypothesis could be tested by chemical desiccation of the canopy after flowering as a means for inhibiting plant photosynthesis and thus revealing the capacity for grain filling by the transfer of stem reserves. Also, investigation of stomatal and nonstomatal parameters limiting photosynthesis (Pn) under water- stress condition could provide an understanding of the physiological basiss of drought resistance. To determine the potential of sustainability of grain weight using chemical desiccations and to investigate the leaf gas exchange in different advanced barley lines, a filed experiment was carried out during 2002-03 growing season at Ghamloo research station in Kurdistan province, in west Iran. A split plot design with two main plots (rainfed and irrigation), 24 sub plots (different barley genotypes), with three replications, was used. Ten days after anthesis, photosynthesis was arrested in irrigated plots by spraying the shoots with $NaClO_3$ (0.4% solution). The grain weight of all lines reduced under spraying. There was positive and strong correlation between grain weight reduction in spayed and rainfed conditions($r = 0.7^{**}$). By using this method some varieties with more stability in kernel weight under drought stress were identified. Using IRGA device, gas exchange characteristics such as internal CO_2 concentration, stomatal conductance, photosynthesis rate, transpiration, and mesophyl conductance were studied in both rainfed and irrigated plots. Water Use Efficiency was also evaluated. According to Stress Susceptibility Index(SSI), varieties were divided in three groups: tolerant, semi-tolerant and sensitive. Except water use efficiency, all parameters were reduced under rainfed condition, but this reduction was less in tolerant lines than in the sensitive ones. Under rainfed condition Pn reduction in sensitive groups was 44% while in tolerant was 28%. Also in rainfed condition there was higher significant correlation($r = 0.72$) between Pn and mesophyl conductance compared with the Pn and stomatal conductance($r = 0.57$). It was concluded that inhibition of Pn under rainfed condition was due mainly to reduced mesophyl conductance (nonstomatal factor) rather than stomatal factors.

10. Effects of different nitrogen levels on yield and yield components of wheat cultivars under rainfed and well-watered conditions

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Drought stress and nitrogen deficiency are major constraints to winter wheat production and yield stability in most rainfed regions in Iran. Drought reduces yield and consequently profitability for producers and lower end-use quality of the crops. A comparative study of the growth and yield response of cultivars to wheat to varying levels of N and soil moisture (rainfed and well-watered) was carried out in field. Two individual experiments were conducted with four replications, 16 bread wheat cultivars and two levels of nitrogen. Other macronutrients and micronutrients were supplied in non-limiting amounts, and weeds, pests and diseases were controlled as required. Responses were measured in terms of leaf area, N uptake and water relations and at the end of growing season, plant height, number of ears per unit area, number of grains per ear, 1000-grain weight, grain yield and above-ground total dry matter were determined. The results showed that drought and nitrogen deficiency reduced plant growth, phytomass and leaf area. It appeared that N supply could alleviate the adverse effect of drought stress. High N contributed to increased vegetative growth under limited water supply, which was probably associated with delay in leaf N mobilization and senescence. It was observed that leaf senescence was associated with declines in leaf N content, chlorophyll and photosynthesis. Nitrogen treatment slowed down the rate of leaf senescence .It was concluded that under rainfed wheat growing conditions similar to this experiment, using appropriate amount of N can alleviate the adverse effects of drought stress on wheat growth, development and grain yield.

11. The effects of drought stress on physiological characteristics of forage pearl millet

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The physical environment is a major factor in growth, productivity and survival of plants. Water stress is usually the main physical limitation to forage yield. It has considerable effects on forage growth, development and quality. Although, pearl millet has been known as an important subsistence cereal for dry areas of the semi-arid tropical regions, nowadays it is cultivated across a wide range of environments ranging from extremely stressful to favorable. To assess the effect of drought stress based on deficit irrigation on physiological characteristics of pearl millet at different growth stages, a field experiment was conducted on the research farm of Karaj Agriculture Faculty of Tehran University in 2002. The treatments were arranged in split-split-plot design. The irrigation intervals (weekly irrigation interval, 11-day irrigation interval and 15-day irrigation interval) were assigned to the main plots and irrigation volumes (control- 100% water requirement), moderate water stress (75% of water requirement) and severe water stress (50% of water requirement)) were assigned to the sub-plots. The crop was cut three times during growth cycle. Leaf and stem characteristics (biomass, crude protein and water-soluble carbohydrates) net photosynthesis, transpiration, stomatal conductance and internal CO_2 concentration were measured

separately. The F.A.O. Penman-Monteith equation was used for estimating crop water requirement and LCA4 Gas Analyzer was used to estimate the net photosynthesis and it's dependent parameters. The results showed that irrigation intervals had significant effects on crude protein, stomatal conductance and transpiration. On the other hand irrigation volume had significant effects on biomass, crude protein, transpiration, stomatal conductance, internal CO_2 concentration and water-soluble carbohydrates. Different cuts had significant effects on most of the traits. It can be concluded that with 75% of estimated water requirements of pearl millet, the quantity and most of the physiological traits of dry forage did not get affected as compared to control. Therefore, pearl millet can be considered as a suitable forage crop for water stressed and normal conditions of countries in the Middle East like as Iran.

12. Effect of water stress, plant density and ethephon on growth and yield of maize (*Zea mays* L.)

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Ethephon (2-choloroethyl phosphonic acid) has been widely studied under field conditions as a growth regulator to enhance yield in corn (*Zea mays* L.). However, the impact of ethephon-induced changes in vegetative growth on water use and grain yield of maize grown at various densities under drought stress conditions has not yet been studied in detail. The objective of the present study was to examine the effects of water stress, plant density and ethephon on growth, development and grain yield of corn (single cross 704) under water-deficit and well-watered conditions. The field study was conducted at the Experimental Farm of the College of Agriculture Shiraz University, Shiraz, Iran, during 2003-4 growing season. The experimental design had a split-split plot arrangement. Irrigation levels (low and high) were the main plots, the plant densities (53333 and 80000 plants /ha) in the subplots, and ethephon levels (0, 0.28, 0.56 and 0.84 kg ha-1, applied at the 6-leaf growth stage) in the sub-subplots. Treatments effects on vegetative growth were assessed by plant height, leaf area index (LAI), and dry matter yield measurements. Kernel number per unit area was measured from grain yield and kernel weight data. Results indicated that ethephon application had the potential for improving resistance to drought in corn. Increasing application rates of the ethephon were associated with a significant reduction in early season plant height and LAI . Ethephon application at intermediate level (i.e. 0.56 kg / ha) decreased grain yield at low plant density however, it enhanced the grain yield at higher plant density. It was concluded that ethephon application at intermediate rates could be beneficial for maize grain particularly at higher plant densities.

13. Photosynthetic characteristics of desert plants Haloxylon ammodendron and Calligonum mongolicum in conditions of high temperature and irradiation

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Over 20-year-old C_4 desert shrubs, *Haloxylon ammodendron* and *Calligonum mongolicum*, growing at the southern margin of the Badain Jaran desert were selected to explore their photosynthetic characteristics under three water conditions in natural conditions of high temperature and irradiation, namely arid desert environment, post-rain moist air conditions and water supply condition. The results showed that *H. ammodendron* and *C. mongolicum* exhibited the photosynthesis down regulation phenomena and photoinhibition to different degrees under intensive irradiation in the arid desert environment. However, under the post-rain moist air conditions and higher soil moisture content conditions after water supply their net photosynthetic rate (Pn) increased and showed a unimodal diurnal course, and no photoinhibition was found. As compared to the arid desert environment the mean diurnal Pn of *H. ammodendron* after rain moist air conditions increased by 3.1 μmol $CO_2 \cdot m^{-2} \cdot s^{-1}$; one and two days after water supply condition its Pn increased by 9.7 and 7 μmol $CO_2 \cdot m^{-2} \cdot s^{-1}$, respectively. When there was no significant difference ($p<0.05$) in high temperature and intensive sunlight, once water condition was improved, the light compensation points of the two species reduced, but their light saturation point increased, photosynthetic duration prolonged and efficiency for solar energy utilization increased. From the study it may be concluded that water stress causes the photoinhibition of *H. ammodendron* and *C. mongolicum*. Increasing air humidity or soil moisture content can eliminate their photoinhibition.

14. Effect of soil matric potential on waxy corn (*Zea mays* L. *sinensis* Kulesh) growth and water use in salt soil in arid areas

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The decreasing of available farmland makes saline soil a valuable alternative land resource for agriculture in North West China. In order to obtain high yields and economic benefits, it is very urgent to develop a suitable management strategy for farmers to cope with soil water moisture and salinity. A field experiment was carried out to investigate the effect of soil matric potential on waxy corn growth and water use under drip irrigation in saline soil of North West China in 2005. The experiment included five treatments, which controlled soil matric potential (SMP) at 20 cm depth immediately under emitter higher than -5.5, -10.5, -15.5, -20.5, -25.5 kPa. There were significant differences among the five treatments on waxy corn growth. The higher the target SMP value, the higher the yield of waxy corn. Plant height, stem circumference, LAI and above ground biomass all increased with increasing SMP value, but the highest waxy corn irrigation water efficiency value was achieved with

SMP of –10.5 kPa. The SMP of -10.5 kPa at 20cm depth immediately under drip emitter can be used as an indicator for corn drip irrigation scheduling on saline soil in the arid areas of North West China.

15. Sodium uptake pathways in a salt-accumulating halophyte

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Although many data indicate that high-affinity potassium transporters (HKT), inward rectifying potassium channels (AKT) and low-affinity cation transporters (LCT) mediate Na+ influx into plant cells, evidence is now accumulating that suggests non-selective cation channels (NSCCs) are the major pathway for Na+ influx into root cells. As can be inferred from the range of suggestions, the mechanism of plant Na+ uptake remains largely unknown. The data on which these hypotheses rest has largely come from experiments on glycophytes (including the model plant Arabidopsis), which accumulate little Na+ into their leaves when compared with most halophytes. We used the succulent halophyte Suaeda maritima, a member of the Chenopodiaceae (which accumulates sodium to concentrations around 500 mM in its leaves and whose roots transport Na+ at rates of around 100 nmol g-1 dry weight s-1) to examine its Na+ influx pathway, and found two distinct low-affinity Na+ uptake pathways: pathway 1 insensitive to TEA+ or Cs+, but sensitive to Ba2+ mediate Na+ uptake under mild NaCl conditions; pathway 2 sensitive to TEA+, Cs+ or Ba2+ mediate Na+ uptake under severe NaCl stresses. It looks like that Suaeda maritima is the best material for characterizing Na+ uptake and transport

16. Drought tolerance and micro-structure of stomata in woody species in loess plateau

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Differences in drought tolerance on the basis of pressure-volume (P-V) analysis using a pressure chamber (PMS1000: PMS instrument co.) and micro-structure of stomata in various woody angiosperms including native *Syringa oblata, Armeniaca sibirica, Rosa hugonis, Acer stenolobum, Caragana microphylla, Pyrus betulaefolia,* and *Quercus liaotungensis,* introduced *Robinia pseudoacaci,* and several shrub species growing in Kong-lu mountain near Yan-an city were studied. Branch samples of each species for P-V curve analysis were taken before dawn, packed in humid plastic bags to inhibit transpiration and carried into a room for further studies. Several leaf samples of each species were taken from the same tree, fixed in 70% ethanol and carried into Tottori University. Small leaf segments (2mm x 2mm)

were taken from each sample and the structures of stomata and leaf surface of them were observed using scanning electron micro scope (SEM). The density of stomata in leaves of each species was microscopically determined using SUMP method. The micro structure of them was observed using a SEM. The drought tolerance of *R. pseudoacacia* determined on the values of xylem pressure potentials at turgor loss point (ψw^{tlp}) and osmotic potentials at saturated condition (ψs^{sat}) was less than that of native species such as *S. oblata*, *A. sibirica* and *R. hugonis*. The drought tolerance of native *Q. liaotungensis* was comparatively greater than that of induced *R. pseudoacacia*. There was no direct relationship between stomatal structure and values taken in P-V analysis. However, specific characteristics in the structure of stomata were observed in several species.

17. The impact of irrigation water quality on water uptake by citrus trees

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Murcott citrus trees grown in greenhouse lysimeter filled with sandy soil were used to investigate the evapotranspiration (ET) and the effect of saline water irrigation on water depletion by the plant. The study was carried out at the Arid Land Research Center, Tottori University, Japan (35° 32' N; 134° 13' E). For the study, two lysimeters were used for three periods of experiment with duration of about 2 weeks for each. In period I and period III, plants in both treatments were irrigated with non-saline water. In period II, one was irrigated with non saline water and the other was irrigated with highly saline water (EC = 8.6 dS/m). An irrigation amount of 60 mm was applied at 70% field capacity using the perforated pipe method. After application of non-saline water, the ET values of the two treatments were similar and the average ET rate was 4.48 mm/day. However, the application of saline water increased the soil salinity around the root zone and decreased the ET rate. The average ET rate under the saline water treatment decreased to 71% of that under the non-saline water treatment. Irrigation with saline water increased the soil moisture and the deep percolation due to the decrease of ET. After application of saline water, there was difference in soil profile moisture in between the two lysimeters. The maximum difference occurred at the soil depth of 0-45 cm, where most of the roots of the trees are growing. After the leaching event, however, the differences in ET and soil moisture between the treatments become smaller. The results showed that an occasional leaching is an effective management strategy for sandy soils to control soil salinity. During the leaching period, sufficient non-saline water should be applied to control salinity levels in the root zone.

18. Estimation of evapotranspiration from maize crop combining sap flow, and weighing lysimeter data

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Modeling water consumption in field crops is a key point for better irrigation management. Knowledge of both components of evapotranspiration (soil evaporation and plant transpiration) can be useful for recommending new techniques aimed at improving water use efficiency at field crop level by reducing the amount of water lost by soil evaporation. This study was carried to assess the accuracy of transpiration measurements obtained by sap flow technique compared with the transpiration estimated by difference from weighing lysimeters and micro-lysimeters measurements under crop cover. A water consumption experiment using maize crop was carried in a greenhouse of Arid Land Research Center, Tottori University, Japan. The calculated transpiration and evapotranspiration values from two models: Penman-Monteith equation and Shuttleworth-Wallace double layer model, averaged over 30 min interval, were compared to the above-mentioned data and model performance assessed. Because these models require many parameters, and they can hardly be used at large scale by irrigation managers, a simplified model for estimating evapotranspiration is proposed. This model requires net radiation over crop canopy, air temperature and vapour pressure deficit along with leaf area index. Evapotranspiration and transpiration efficiencies are also presented for different plant canopies.

19. Adaptation of *Sophora moorcroftiana* (Benth.) Baker to Yarlung Zangbo River Valley environments in middle Tibet

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Sand-blowing and other climatic factors (e.g. air temperature and precipitation varying with altitude) control plant dynamics in Tibet Plateau, especially in its valley, which in turn respond to the environmental variations in very different ways. However, the mechanisms behind the response of vegetation in Tibet Plateau are not well understood. Thus, this study aimed to determine: (1) how plant respond to climatic factors along the gradient of altitudes in plateau area, and what the differences in plant adaptation are in altitude sequence between alpine area and plateau area; and (2) how dominant species *Sophora moorcroftiana*, adapts to sand burial in valley area. It was found that stem basal diameter tended to decrease as the altitude increased from 3039 to 3928 m a.s.l in Yarlung Zangbo River valley.; population density increased with increasing altitude; seed bank density and seed germination of *S. moorcroftiana* did not change with elevation; seed weight also did not exhibit any obvious trend with increasing elevation. Further analysis showed that plant responded to change in altitude remarkably differently. The stem basal diameter exhibited a similar trend along the vertical gradient in plateau area and in mountainside. Both in alpine and plateau area, plants had similar means to adapt to altitude in respect of growth status, but displayed differences in reproductive parameters such as seed bank density, dry weight of seed, seed germination, seedling density and sapling density. With respect to the effect of sand burial on *S.*

moorcroftiana, the results shows that sand accumulation remarkably reduced seed bank density and seedling density in the population. However, it promoted shoot sprouting and shoot growth at individual scale. In other words, sand burial stimulated *S. moorcroftiana*'s growth, which is in consistent with the conclusion that foredune species do not merely tolerate sand burial, but also respond positively to sand accumulation.

Theme 7: Renewable energy

1. An experimental study on water-making system using natural energy in Tottori Sand Dune

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Our research group belongs to the "Program of Arid Land Science", which is one of the 21st Century COE programs, and aims at utilization of natural energy in arid regions. Especially we are studying technique to produce water, which can be used for drinking, medical treatment and irrigation, from the vapor in air using the electric power generated by wind or solar power. In our previous research, a simple and small water-making system was built by eight Peltier devices to prepare the cold surfaces, where vapor was condensed into water. This system was installed in a closed chamber, in which temperature and humidity were kept constant, and the optimal operating conditions were investigated by the performance tests. Currently, we are planning to conduct the outdoor experiments with the water-making system at the Tottori Sand Dune in Tottori Prefecture of Japan. In this plan, the electric power for making water is supplied from the wind turbine and solar cells.

A meteorological observation system has already been installed on the site in order to measure temperature, humidity, wind speed, wind direction, solar radiation and rainfall. The system is collecting the meteorological data now. The water-making system that will be installed in the near future will observe atmospheric temperature, humidity, and the amount of electric power, i.e. battery residual quantity, and will operate automatically based on the operation-control conditions. The amount of water production and the meteorological data will be compared in order to investigate the efficiency and problems of the system and the possibility of practical utilization will be discussed.

2. Sustainable energy carrier production from biomass by microbes in drylands

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Biomass resources can be distinguished as byproducts with no or low value from agricultural crops or industrial processes and as crops grown solely for the purpose of energy production. Because biomass is a widely available, renewable resource, its utilization for the production of energy has great potential for reducing CO2 emissions and thereby preventing global warming.

Most common cereals produced in the drylands include wheat, corn, while rice is mainly grown in wet land. Sugar and starch crops are produced all over dryland including sugar beet, potato sweet potato and cassava. Although these crops are grown primarily for

food and feed, they also produce large amounts of lignocellulosic and starchy byproducts. The potential of using lignocellulosic biomass for energy is quite high becauseit is the most abundant renewable organic component in the drylands.

This paper would introduce several fermentation processes, starting with the most advanced process of ethanol production. This is followed by methane production, an established process for wastewater purification, which is gaining more attention because of the inherent energy production. Subsequently acetone, butanol and ethanol fermentation is discussed as this provides attractive proposition in the drylands because the potential utilization of agricultural resources for the production of chemicals or fuels instead of fossil fuels. Finally the biological production of hydrogen is introduced. The major advantage of energy from hydrogen is the lack of polluting emissions since the utilization of hydrogen, either via combustion or via fuel cells, results in pure water.

3. Windmill, the only viable option for Thar

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Thar region of Pakistan has a geographical area of about 22000 sq. km., and according to 1998 census 1.1 million people were living in it. The livestock population is 1.5 m. Average annual rainfall ranges between 200 to 350 mm. It is revealed from studies that Thar has been formed in recent geological times. Due to blowing of sand, silt, salt and shells from the sea through Runn of Kutch by southwestern wind the sand hills are formed. The soil is however fertile and if water becomes available, good productivity could be achieved. Studies have shown that there is good underground water resources in the area, however the cost of pumping water using electricity or fossil fuel is exhaurbitant. The area has very high wind velocity(up to 45 km per hr for some 3000 hrs per year), particularly during the warmer months when demand for water is highest. The average wind speed is 15 to 30 km per hour. On this wind velocity 25 feet diameter Low Speed Windmill can pump 12000 gallons water per day from a depth of 120 to 150 feet. Installing wind mills can thus be an economically feasible preposition. The author has prepared a fesibility study on the subject for seeking research investmet funds from donors.

4. Fermentative hydrogen production from sugar crops in dryland by mixed culture

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The demand of hydrogen as a new clean energy source is increasing rapidly. Therefore, low-cost technology for bio-production of hydrogen is being developed in many countries. Improving bihydrogen-producing capacity and reducing cost is the key to realize industrialization. Chinese researchers have studied biohydrogen production for over 20 years, both photosynthetic and fermentative processes. For fermentative hydrogen production,

Chinese scientists developed anaerobic process in 1990s. Isolation and identification of highly efficient biohydrogen producing anaerobic bacteria is the important foundation for fermented biohydrogen production process for anaerobic digestion of organic wastewater. The paper focus on (1) fermentative biohydrogen production system, (2) laboratory experiments and pilot scale test for continuous hydrogen production, (3) fermentative types and engineering control, (4) isolation, culture and characterization of anaerobes, (5) engineering applications of pure bacteria, (6) fundamental research on ecology, genetics and improvement of anaerobes, (7) the two-phase anaerobic process of hydrogen production and methanogenic phases; a new development, and (8) the integrated processes with bioengineering and wastewater treatments. China has built the first demonstration engineering factory producing over 1200m3 /d of hydrogen in Harbin, in the northeastern part of China. In photosynthetic hydrogen production, Chinese scientist have paid great attention to studying the fundamentals, engineering and microbiology. This paper provides a summary of ecological aspect and engineering control of fermentative hydrogen production system.

5. Potential renewable energy sources in Indian Thar desert

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The importance of renewable energy sources is discussed for dry lands in view of present energy crisis in Indian arid region. The status and potential of different renewable sources viz. solar, wind, bio-gas and bio-mass have been enumerated. Extensive work on the utilization of immense, non-pollutant and inexhaustible solar energy carried out at CAZRI, Jodhpur for various applications in is highlighted. Harnessing wind power, biogas and bio- mass energy under Indian Thar desert have also been suggested as potential source of energy. Exploring the potential of renewable energy in arid region would make desert dweller more self-dependent with respect to energy and provide livelihood in such difficult regions.

Theme 8: Indigenous/traditional knowledge and heritage

1. The role of indigenous knowledge in sustainable development of natural resources

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Once the man realizes his role in development (eliminating the destructive factors and enhancing the positive ones by his intelligence), the development will be really meaningful. The ultimate goal of the development is the well being of the people. To achieve a sustainable development, team work is a necessity, and to achieve this, it is necessary that all the individuals participate in development programs and acknowledge its importance. The concept of sustainable development in general and in natural resources has been delt with in this article. Effective factors and methods to measure the sustainable development have been discussed.

2. Traditional Syrian water management

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The hydraulic noria has been one of the most significant examples of Syrian ecological systems employed for supplying and carrying water for irrigation. It is an installation which, using the power of the river, raises water to irrigate fields which are usually at a higher level than the level of the water. The system is composed of two main parts, the wheel and the aqueduct. The wooden wheel has the base submerged in the river and turns because of the current. Water is transported through compartments or pots placed on the periphery of the rim of the wheel, and is carried into the channel on the top of the aqueduct, and is directed to irrigate fields and gardens. The Orontes valley, in West Syria, has been the ideal place for the development of numerous hydraulic norias. They were employed for irrigation until the 1960s when they were replaced by modern pumps.

This system has significant environmental advantages. It is an economical and clean technology. It allows irrigation requiring no petrol or oil, but exploiting the power of the river. The installations are also well integrated into the landscape, using materials easily available in the area.

The paper analyses this device focusing on its architectural, technological, ecological and environmental aspects. Due to its simplicity, efficiency, low operation and maintenance costs and its aesthetic qualities, this type of water-architecture deserves further attention and consideration in order to be renovated as a device which, in some cases, could be fully employed for its original purpose.

3. The role of indigenous knowledge in the livelihood activities of rural communities in Sudan

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Rural people in Sudan have inherited indigenous knowledge on many aspects of their surroundings and their daily lives and it constitutes a valuable resource for development. The indigenous knowledge covers a wide range of subjects concerned with land use and knowledge transfer. Although the potential of indigenous knowledge for development has been realized by professionals and scientists, it remained, for sometime, a neglected resource by formal institutions. Gender equity and indigenous knowledge are linked in many ways of life. Tapping the valuable knowledge of both women and men can help in the sustainability of development efforts.

Indigenous knowledge, in Sudan, has developed through time by indigenous people who use their knowledge to adapt with their surrounding environments by adopting compatible coping systems. Studies indicated that the historically acquainted indigenous knowledge is in harmony with the biodiversity conservation and livelihood support strategies and it is enabling to local communities' participation in the development plans. Indigenous knowledge integration with the scientific and applied research facilitates sustainable natural resource management. Donor funded development projects, introduced later in the past century, adopted extension systems for awareness raising and knowledge transfer among rural people. Statistical comparison between different categories of target groups based on questionnaires indicated significant differences among people with regards to knowledge source whether inherited or acquired from external sources, like extension, with insignificant differences between peoples' attitudes towards practices acquired through indigenous sources.

The objective of the present paper is to present the importance of indigenous knowledge in the lives of rural communities and explains statistically how people express their links to indigenous knowledge as compared with knowledge acquired through extension agents.

4. Sustainable water resources management in central drylands of Iran: Traditional knowledge or modern technologies, a case study from Yazd province

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Due to the geographical location and climatological condition, Iran has arid and semi-arid environment, covering about 90% of the country. In drylands quantitative and qualitative water resources limitations have been one of the main obstacles in sustainable development. Since ancient times oasis inhabitants developed an understanding for the need to adapt to the dry environment, and, in order to access the sustainable development goals, using their indigenous knowledge and experiences, have innovated traditional methods for rational water resources usage and management. In this regard the famous one is called qanat. However, in recent decades as a result of climatic changes, socio-economic transformations and increasing population growth, the modern, but in some cases incompatible, methods have replaced these

traditional systems. Multiple water demands as well as appearance of deep wells and the pumping equipment have made it possible to pump a large volume of water from aquifers, which leads to unsustainability and disturbance of ecological equilibrium in the drylands. Continuation of above-mentioned trends has led to use of newer methods such as inter-basin transfer of fresh water from hundreds of kilometers far from drylands, Zagros Mountains located in western wet part of the country, without considering its environment and socio-economical aspects.

5. Water harvesting methods in arid regions of Iran

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A considerable part of earth is covered with drylands and deserts. In these regions, water deficiency is observed more than the other parts of world. High temperature, dry weather and evapotranspiration exceeding precipitation, cause a negative water balance in these regions. Lack of fresh water is the main characteristics of deserts, and new sources of water are not easily obtained. Although many changes have occurred in application of new sciences and technologies for taking advantage of water resources, we have not succeed in solving food and nutritional security in the desert region of many countries. In order to supply the required water, inhabitant of dry lands have to collect and save water and rainfall and use in agriculture and domestic consumption. In this paper we have tried to introduce, the traditional rainfall collecting methods for providing fresh water in Iran. Also introduced are new techniques which nowadays are known as water harvesting methods.

6. Indigenous agricultural knowledge in rainfed rice-based farming systems: means to sustainable agriculture

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Farmers in developing societies have quite a sophisticated knowledge evolved and gained through their close interaction within natural and physical micro-environment and cultural adaptation, which are recognized now more eco-friendly and sustainable. Looking to the importance of the role of farmers' knowledge in sustainable agriculture, an effort has been made to conduct a study in purposively selected villages of *Gond* and *Halba* tribes of southern part of Bastar district, Chhatisgarh, India towards indigenous rice crop management under rainfed agroecosystem. A combination of methodology including participant observation, group discussions, semi-structured interview schedule and Participatory Rural Appraisal (PRA) has been used. A group of experienced scientists from different disciplines were chosen to get their perception towards scientific rationale of farmers' practices. Study indicated that tribal farmers were having experiential wisdom to conserve and select the location-specific indigenous paddy rice varieties for getting sustainable yields. A poor socio-

economic status and risk-prone biophysical condition for agriculture do not permit the tribal people to adopt energy intensive technology for local rice crop management. They have therfore developed their own innovative strategy of location specific rice cropping. Most of the conserved and adopted indigenous varieties of rice are resistant against diseases and insect pests. Both the tribes possess invaluable local knowledge towards rice crop management practices, but the practices differ. These tribal farmers have indigenous method of soil classification, fertility management, soil and water conservation through selected plants/trees/shrubs and cultural practices, creating micro-environment, seed selection and conservation, planting methods, weed control, maintaining the indigenous gene pool of location specific rice varieties, cropping systems and local techniques of insect pest management. The farmers were more confident about their local practices of managing and producing the indigenous rice which is more compatible to sociocultural and biophysical resources. Perception of agricultural scientists indicated that most of the documented local practices of indigenous rice crop management by tribal people had a rationale and they were worthy of consideration from sustainability point of view.

7. Strategies for sustainable Qanat rehabilitation

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Qanats are subterranean tunnels that tap the groundwater and lead the water artificially to human settlement and agricultural lands using gravity flow conditions. In general Qanats are only found in dry areas. Qanat systems are important for dry areas because if properly used they do not exhaust groundwater resources, even in times of drought. In Iran, Qanats are scattered throughout the landscape and some are still used to provide water to turn a wheat mill. Qanat digging is a profession that is dying out. In 1975, the last qanat was dug in Iran. There are only 40 traditional qanat diggers left in Iran. From Persia the technique was exported to neighbouring countries. Through contacts between Persians and other people like the Greek and Romans, the technique spread further east and westwards. The Byzantine and Arabs continued to use and re-use the technique. Nowadays, qanats can be found in Japan, China, Central Asia, Pakistan,North Africa, Spain and South America. In the Arab World the ancient tunnels systems can be found from Iraq until Morocco and from Syria until Oman. In its nature a qanat is truly a sustainable technique of extracting groundwater. It cannot exhaust an underground aquifer. Therefore qanats are interesting for countries with water shortages. Based on previous research experience, indicators are developed to apply on the ground and aim to contribute to policies that enhance and promote the re-use of qanats in a modern environment. The criteria are first steps towards the development of an international strategy to reverse or halt the abandonment of qanats.

Theme 9: Sustainable development of oasis; desert communities and socioeconomic studies

(a) Sustainable development of oasis and dryland environments

1. Implementation of the approaches of UN Convention to Combat Desertification (UNCCD) through local area development to combat desertification in district Tharparkar, Pakistan

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Tharparkar, one of the southern districts of Sindh province, spreads over 19,637 km^2. It is situated between 24°, 27° north latitudes, 69°, and 72° east longitudes. The landscape includes sand dunes, sand valleys, hills and Rann of Kutch. The boundaries of Tharparkar are dividing India and Pakistan in the southeast. The population of the district is about 907,000 persons, one of the most populous arid regions in the world. The region is facing resource degradation as a result of persistent droughts and overexploitation of natural resources. Rangelands and forest lands have lost productivity and ecological value because of the over exploitation by human population and over grazing by increasing numbers of livestock.

The United Nations Convention to Combat Desertification (UNCCD) addresses poverty issues in the marginal dry lands of the world. The convention advocates for local area development initiatives to enable local communities to effectively take part in measures to fight against desertification. Decentralized institutional arrangements and economic incentives are important to assist the poor in managing natural resources in the dry lands. The convention proposes measures like development of rural markets, expansion of agricultural diversity, establishment of adequate price and tax policies, promotion of drought-resistant crops, and application of integrated dryland farming systems.

The Society for Conservation and Protection of Environment (SCOPE) is a NGO, which is closely associated with UNCCD and its implementation process since 1993. SCOPE has selected Tharparkar district for local area development initiatives to combat desertification, in the context of the convention. SCOPE has developed a comprehensive local area development programme which includes: (1) Organization of local communities into formal cooperative organizations to undertake trades like livestock and handicrafts marketing; (2) Introduction of agro-pastoral farming system for growing food and fodder; (3) Assisting local farmers in conservation of water by introduction of water thrifty technologies; (4) Supporting pastoral community by livestock management activities; (5) Supporting women's' economical status by capacity building in handicrafts making; and (6) Conservation of biodiversity by involving community.

2. Twenty-five years'experience of research in dryland areas in Morocco

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Dryland agriculture in Morocco covers about 68% of arable land and contributes over *50% of* crop production. It produces major staple food crops and livestock and sustains a substantial portion of the population. The brief socio-economic characterization of dryland agriculture reveals the complexity of this agriculture and the nature of challenges it poses. It consists of mixed farming where crops and livestock are highly integrated. Diversity is the primary characteristic of these systems. Such diversity is displayed in soils, agricultural practices, cropping systems, livestock systems, etc.

Improving productivity and welfare of the people of these areas is an important goal for political, economic and humanitarian reasons. Sustainable dryland farming development is possible if farmers are provided with technologies geared towards conservation and continuous management and development of the natural resources for the maximum possible benefit of human and animal resources inhabiting the dryland area, preservation of adequate level of productivity of the ecosystem through optimum utilization of available resources and minimizing risks through planning, management and adequate production incentives for the continued satisfaction of the needs of human population.

Drought events are frequent in dryland areas, affecting all the components of the farming system of the dryland farmers. Drought management is crucial to maintenance of resources. It is now widely recognized that efforts to mitigate drought must take human, economic and political consequences into account. Dryland agricultural production could increase substantially if there is a sustained appropriate research together with favorable economic policies and a supportive policy framework. But no amounts of political will and policy reform can stop or reduce the rate of resource deterioration unless scientific and technical advances are incorporated into development.

In the early 80's, the Government of Morocco through INRA and USAID through MIAC consortium developed an applied agronomic program for dryland farming in the 200-400 mm rainfall zone of Morocco. The objective to have applied dryland agronomic research and complementary socio-economic research to produce technical basis, and applied research capability, for increasing agricultural development in the drier parts of rainfed areas. The major outputs of this program are the agro ecological characterization; development of cereal and food legume varieties resistant toabiotic and biotic stresses; development of improved cultural practices, improved techniques for crop livestock integration, adapted machinery, and alternative crops for marginal land; and rural appraisal and community approaches

3. Simulation of critical scale of oasis maintenance and development in the arid areas of north-west China

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This oasis is a special geographic landscape among vast desert in northwest China (NWC). The surface sensitive heat flux and latent heat flux at Zhangye oasis during August 1 to 11,

1991 were simulated using NCAR nonhydrostatic mesoscale model MM5 Version 3. The horizontal grid resolution is set as 1km. By comparing the simulation results with HEIFE observation, it was proved that the model could be used to simulate the surface energy and water mass exchange of arid and semiarid regions in NWC. Based on the above results, the influence of different oasis scale on the local atmospheric field near ground surface, and the critical scale of oasis maintenance in NWC are studied. The following conclusion was obtained: the local thermal circulation between the oasis and the desert/Gobi would be formed in the oasis downstream, if the oasis scale is larger than 4 km. This local thermal circulation between oasis and desert adjacent to oasis helps conserving water vapor over oasis. At the same time, it transfers abundant water vapor from the oasis into the desert close by the oasis to supply relatively plentiful water vapor for desert crops on the fringe of the oasis. So, it is advantageous for oasis extension. If the scale of oasis is smaller than 4 km, the occurrence of local thermal circulation between the oasis and the desert is unlikely. This study provided a new standpoint for oasis maintenance and development.

4. Desertification process and driving model in Minqin Oasis, Gansu Province

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The oasis degradation because of irrational use of water and land resources has been the most common type of desertification process in arid northwest China. The recent desertification process and its driving model in Minqin Oasis, situated in lower part of Shiyanghe River of Hexi Corridor, Gansu Province, were studied based on the changes of climate and hydro-ecological conditions. The recent desertification process in Minqin Oasis reflects has two leading aspects, degradations of natural and man-made vegetations around the oasis, and land salinization in the northern part of oasis by abandonment of farmlands. Desertification within the oasis mainly results from irrational use of water and land resources led by turnoff of natural river, reduction of surface water supply, over-exploitation of ground water and over-reclamation of sandy lands. The elevation of air temperature under global change could be another factor for promoting desertification. The integrated strategies for combating desertification in Minqin Oasis are put forward.

5. Developing a science of desert living – towards a new understanding for livelihood

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Semi-arid and arid lands cover approximately two-thirds of Australia. Like other desert regions of the world, sustainable use of these lands depends on the people who want to live there having the livelihoods to continue to do so. These heartlands are the focus of a 7-year

research project that has the vision of developing a sustainable future for desert people through the development of thriving desert knowledge communities and regional economies. Australia's Desert Knowledge Cooperative Research Centre (DK-CRC) is a unique organisation established to carry out interdisciplinary research that contributes to developing desert knowledge economies. It aims to understand how the environmental, social, economic and cultural drivers that are common to many desert regions of the world can be harnessed across disciplines to contribute to this vision. DK-CRC brings together local knowledge, including traditional Indigenous knowledge, with conventional science to create new opportunities from their synergy, thus seeking to speed up the development of the new community-based knowledge required to cope with increasing rates of change in today's world. At the same, DK-CRC coordinates collaboration among government policy makers, private companies and research providers such as universities to maximise the use of research in institutional and policy design and industry development.

The presentation will focus on the development of 'desert knowledge' as a commodity and of the science of desert living which underpins this, through the operations of DK-CRC.

6. Alternative futures analysis of desertification: Implications for China

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Alternative futures analyses operate at the local, landscape or regional scale, over a typical period of 20 to 50 years, designing and modeling potential changes to the landscape in a GIS. The process involves communities, managers, policy makers and scientists, and is specifically designed to address locally important issues and concerns.

Workshops are held with different interest groups to elicit attributes of the region that stakeholders most value or are most anxious to preserve, as well as their ideas on what is needed to improve resource allocation, living conditions and opportunities. This input is used to identify plausible change scenarios. Concurrently, biologic, hydrologic, geologic, socio-demographic and demographic data are integrated within the GIS to determine the current status of the landscape. Results from a series of process models specifically addressing different landscape processes (e.g., geomorphology, fire, vegetation) describe the environmental effects of the various alternative land use scenarios. These results are then evaluated by stakeholder groups, and the most viable land use or land management option is identified. The GIS products, including statistical summaries and graphics help to facilitate understanding of ecological and demographic processes and may be used at the community or government level to assist in decision-making.

China has an active National Program to Combat Desertification as part of the United Nations Convention to Combat Desertification, and has implemented moderately successful rehabilitation programs in many areas. However, problems resulting from changes in subsistence and land use are now a major concern, affecting both the local communities as well as the sustainability of the natural ecosystem. Conducting an alternative futures analysis can provide a forum for conflict resolution concerning different land use strategies, would help to develop an understanding of how natural and human systems might change and would

indicate the most viable strategies to maintain sustainability and live within the confines of desertification. A hypothetical example from the Shiyang He Watershed in the vicinity of Wuwei and Minqin is discussed.

7. An ecosystems approach for sustainable management of dryland environments

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The Millennium Ecosystem Assessment (MEA) has provided a stark warning that human activity is putting such strain on the Earth's ecosystems that they will be unable to sustain human development in future generations. Dryland ecosystems are most severely affected by degradation, which is closely linked to extreme poverty. Reversing the degradation of ecosystems while meeting increasing demands for their services will require that future decisions take into account the true value of nature—the value of ecological resources and the ecosystem services they provide. The United Nations Environment Programme is promoting change in development decision-thinking towards wiser and more sustainable use of ecosystem resources and services in the world's most vulnerable countries. Tools for valuing ecosystem resources and services of dryland nations are being developed and promoted to explicitly and systematically incorporate the value of ecosystem services in development planning. It is hoped that better valuation of dryland ecosystem services will enhance the ability of Governments and the international community to (i) identify key emerging environmental issues related to human use of dryland ecosystems, (ii) proactively target technical and capacity building support to areas in most need of assistance, and (iii) catalyze coordinated responses at national and international levels, including among MEAs. At the same time the work seeks to increase public awareness of the degree of dependence of dryland country economies on their environmental resource base and the impacts of current national and international policies on depletion trends in environmental resource stocks. A pilot project is described which aims to build capacity of five West African countries in environmental valuation, diagnosis of ecosystem degradation, and analysis of policy alternatives for sustainable ecosystem management at national, watershed and land-use system scales.

8. Innovative cross-disciplinary approach to impact assessment of climate change on agricultural production system in arid areas

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The research project ICCAP (Impact of Climate Change on Agricultural Production System in Arid Areas) is an on-going project of RIHN (Research Institute for Humanity and Nature) of Japan, to analyze the relationship between climate and agricultural system. It is being implemented mainly in Turkey as an international joint project in cooperation with the

Scientific and Technical Research Council of Turkey and the Arid Land Research Center of Tottori University, Japan.

Agricultural production is intricately related to its surrounding natural elements and phenomena, such as soils, crops, and fauna and flora as well as meteorological, hydrological, and geological conditions of the region. Any change in these conditions, which may result from global climate change, inevitably affects the dynamics of the agricultural ecosystem. However, agriculture is basically a human activity. To cope with climate and other subsequent changes in natural conditions, humans have adapted to the new environment, or taken appropriate measures accordingly. This project attempts to comprehend 'the agriculture as a system of relationship between human and nature', with a view to identifying current and future challenges, and effective countermeasures against possible climate changes. Based on a comprehensive assessment of the basic structure of agricultural production system with special reference to regional climate, land and water use, cropping pattern and irrigation system, the project attempts to predict and evaluate the impacts of future climate change and the regional adaptability. Finally, the correlations between changes in nature and human activities are to be examined in an integrated manner. In this process, regional climate change prediction with higher resolution is critical to precise impact assessment. This paper describes ICCAP's challenging aspect to develop the methodology, which is applicable not only to the case study area but also to other agricultural regions in arid and semi-arid areas.

9. Experiences of sustainable management of marginal drylands in eight countries

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This paper presents findings from an ongoing international, multi-partner project that focuses on better understanding and enhancement of sustainable management and conservation of marginal drylands in Northern Africa and Asia. It is jointly organized by UNU, UNESCO and ICARDA, and implemented at selected study sites in eight countries (China, Egypt, Iran, Jordan, Pakistan, Syria, Tunisia and Uzbekistan) with support from the Government of Belgium. The project uses a harmonised methodological approach for the study sites – which represent a diverse and broad spectrum of environmental, social and economic settings – to compare results and share knowledge. The project aims to foster the rehabilitation of degraded drylands using community-based approaches, with training and capacity building comprising key elements of the project. Project implementation over the past two years has led to a number of success stories about engagement of local communities in innovative management approaches. These include, among others, low-cost water desalination in Egypt, development of olive-based products in Jordan, and rain-water harvesting and saline-water aquaculture in Pakistan. Direct engagement of local people and communities in design, development and implementation of project activities has ensured success in the short term and sustainability in the long term.

(b)Desert communities and socioeconomic studies

1. How risk influences the adoption of new technologies by farmers in low rainfall areas of North Africa

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The risk has long been considered an important factor that reduces technological adoption. Two approaches have been developed: the first focuses on the investment decisions in an uncertain environment and the second explores the linkages between the risk induced by the technology and the risk attitude of farmers. We proposed to test these two hypotheses on the process of technology adoption by farmers in semi arid areas of North Africa where drought risk is permanent: How farmers' risk attitude influences the level of adoption of new technology and then the technology transfer? Which are the agricultural policies that favor the adoption in an uncertain environment? Why risk reducing technologies are not being adopted?

Different technologies have been considered such as the spine-less cactus in alley-cropping, the feed blocks made out of agricultural byproducts and wastes for livestock feeding and the forage crops such as vetch. These three technologies have been tested and developed in the semi-arid area of Maghreb countries with various levels of adoption. To test the influence of risk on the technology adoption process by farmers, a mathematical programming model that maximizes the utility function of farmers under a set of agronomical, economics and institutional constraints has been used. The risk attitude depends on farm assets' characteristics, the market conditions and the technology perception. The risk taking is formulated under the Target Motad approach at the individual level. We have simulated the impact of changes of risk attitudes on the levels of technology adoption in different institutional contexts

2. The role of urban and rural women in sustainable energy development in Iran

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Sustainable social development is achieved only when all the society members, male and female, actively participate in development programs. Iranian women, both urban and rural, play a significant role in their own communities. The results of this investigation show that in urban communities the women are involved with all the activities of raising the children, house keeping, food production and processing. In rural communities their duties are even more by involving in agricultural activities as well as the handicrafts production. Despite the lack of statistics, it is clear that the role of women in social development in Iran could not be ignored. So to achieve a sustainable social development for the forthcoming generations a fundamental investment for the well being of women in Iran is highly recommended.

3. The role of indigenous range-use organs in range improvement activities in arid and semiarid regions

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Within the last decades hundreds of range improvement projects have been developed in Iran solely based only on technical principles. However, the evidence shows that there have been no close co-operations among range-users and governmental organizations on range conservation, improvement and utilization. The goal of this study was to evaluate the indigenous range utilization cooperatives, their role and capability in range improvement programs, and the possibility of a scientific management to use them in range improvement projects. To achieve these goals after a preliminary study, two questionnaires (for farmer and government agents) were designed. A few old and experienced ranchers were interviewed to explain why they do not actively participate in range improvement projects provided by the government. The possibility of a combination of modern (scientific) and local techniques to improve rangelands has been assessed.

4. Social changes and rangeland-based livestock management in developing countries-lessons from Iran

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Pastoralism or livestock management based on grazing lands areas can be classified in two main categories: ranching systems and herding systems. The second category may be classified into four distinct classes too. These are sedentary, transhumant, semi-nomadic and nomadic systems. These systems are defined according to their highlighted socio-economic characteristics. Sedentary groups have no migrations in their profession. They tend their herds around their villages. In nomadic systems the children and women have a year-long contribution to migration and livestock management but they contribute only for a part of a year in semi-nomadic systems and have no direct role in herd affairs in transhumant styles. Increasing needs for training, hygiene, technology and instability in land tenure and political decisions are common important socio-cultural changes in these societies. Social changes affect life style and lead to increasing sedentarization migratory systems. Consequently the full nomadic systems are gradually reduced to semi-nomadic ones and the latter are reduced to transhumant systems too. It may be expected that sedentary and ranching styles are final outcome of linear changes but anthropological investigations on Iran's pastoralist groups indicate that transhumance are going to be more prevailing than others. It may be the resultant of social change as a driving force and nature-induced limitations as the opposite

forces. So, transhumance can be considered as a prevailing style for coming decades of traditional nomadic systems.

5. The quantitative relationship between urbanization and water resources utilization in the Hexi Corridor

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Based on the statistical data from the year 1985 to 2003, we analyzed the quantitative relationship between urbanization and total water utilization, water utilization benefits, per capital water utilization in the Hexi Corridor, including its 5 districts and 3 inland river basins. A relationship model between them was constructed. Results show that the relationship between urbanization and total water utilization in the Hexi Corridor can be simulated by a logarithmic curve. If this condition continues, rapid urbanization in the Hexi Corridor will face up higher water stress, so the development mode of water resources and urbanization should be adjusted, and the fresh water withdrawal should be decreased step by step. The relationship between urbanization and water utilization benefits can be simulated by a linear equation. Where the urbanization and industrialization level is higher, the water utilization benefits are higher. So the Hexi Corridor should accelerate the process of urbanization and industrialization to obtain higher water utilization benefits. The relationship between urbanization and per capital water utilization is complex, but it obviously relates to the total quantity of water resources. We also found that, scarce water resources obviously restricted the process of urbanization in the Hexi Corridor. And the water resources constraint intensity is biggest in the eastern part, where water resources are the scarcest. The process of urbanization is faster in the middle region than in the eastern part. However, the middle region consumed much more water resources. The western region has the highest urbanization level and water utilization benefits, but its per capital water utilization is also the highest. Therefore, the Hexi Corridor should construct an intensive water resources utilization system to lessen the water resources constraint on the process of urbanization. It is also an important task to carry out the strategy of urbanization and the great development of west China.

6. Optimizing the environment law to combat desertification; A case study 0f Gansu Province, Peoples Republic of China

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This paper reviews the framework and practice of natural resource and environmental law in the Peoples Republic of China through a case study of Gansu Province, one of the poorest provinces most adversely affected by desertification. The effectiveness of environmental law in preventing desertification is examined through a case study of Shiyang River Basin

Management in Gansu Province. It turns out that ongoing water use policy and inappropriate management has exacerbated ecosystem degradation, and further contributed to already serious desertification. Equity issue in sharing natural resources in the river basin is argued. The capacity of environmental law is analyzed by examining desertification issues in Gansu Province legal jurisdiction within the Desertification Prevention Control Law, Agriculture Law, Grassland Law, Water Law and Land Administrative Law. Specific suggestions to optimizing laws to combat desertification are proposed in respect of legal criteria for promoting natural resources and eco-system sustainability, administrative supervision over natural resource utilization, collectives' stewardship, water law enforcement and institutional coordination.

7. Livestock production strategies as related to community characteristics: the case of Syrian Badia

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In Syria, as in many countries of West Asia and North Africa, the pastoral system is facing important structural changes such as the sedentarization of part of the population, flock mobility with motorized transportation, rangeland degradation, and increased flock reliance on concentrate feeding. Degradation and concentrate feeding are often associated even if both are also influenced by the increased sheep population and public policies (barley subsidies). Also, today very little verification can be found on the relative impact of rangeland health and forage availability on the feeding strategies.

Based on survey data collected from 359 households and 50 badia communities in the spring 2004, we are proposing to analyze the pastoral production strategy of Syrian Bedouins according to the rangelands characteristics of their community. The vegetation of the steppe communities was characterized according to type of rangeland (native, previously cultivated or rehabilitated through either shrubs plantation or resting). The degradation level of the native rangeland was also assessed. In a second step, an econometric model is developed in order to estimate the feeding strategy and the mobility pattern of pastoral households. Household characteristics (i.e. household assets as family labor, private land, education level, flock size, equipment), and community characteristics (infrastructure, human and animal pressure, rangeland characteristics) are being introduced in the estimation in order to address the following questions: 1) Is there a critical level where rangeland degradation begins to affect considerably the pattern of mobility ? 2) Are the communities that used to strongly depend on cultivation before a cultivation ban in 1992 more likely to intensify there production systems?, and 3) Do rangeland rehabilitation projects have an impact on the feeding calendar? Recommendations are derived from the results and discussed.

8. Study on the threshold of urban economic development and urbanization with the restraint of water resource in arid area of Northwest China

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The threshold of urbanization in arid area of northwest China refers to the utmost proportion of nonagricultural population transformed from agricultural population to the total population, based on the speed and the scale of economic development, on the basic guarantee of environmental construction and on the economic capabilities to accommodate a certain amount of transformed nonagricultural population. This paper, taking the arid area of Hexi Corridor in Gansu province as an example, studies the thresholds of urban economic development and the corresponding thresholds of urbanization under the restraint of water resource. The results show that, if there is no transregional water transfer, the upper limit threshold of gross water requirement in Hexi Corridor should be 7.81×10^9 m^3 in the coming 30 years. There in to, the proportion of ecological water, productive water and domestic water will be adjusted to 13.2:83.5:3.3. Besides, the threshold of GDP, which corresponds to national gross water requirement, is 1.81×10^{11} yuan, and the fastest average annual growth rate can reach 6.91%. The adjusted and optimized proportion threshold of primary industries, secondary industry and tertiary industry is 18.99:47.20:33.81. With the multiple restrictions of gross water requirement threshold, economic aggregate threshold, economic increase threshold, water use structure and industry structure optimization threshold, and economic growth rate not less than 7%, agricultural water reduction by 9.12×10^8 m^3 with a speed of 0.61%, the proportion of ecological water not less than 13%, we deduce that the total population threshold should be 5.82×10^6 persons, nonagricultural population threshold should be 2.05×10^6 persons, and urbanization level threshold should be 35.14% in the following 30 years. And this is just the average level of urbanization of China in 2001. If water importation reaches 1.31×10^9 m^3, the threshold of urbanization level can reach 47.17% at the utmost. In order to validate the guarantee level of economic development for the threshold of urbanization level under the restraint of water resource, the paper introduces three economic indexes: gross domestic product per capita, added values of secondary industry and tertiary industry per nonagricultural population, and added value of primary industry per agricultural population. The results show that, gross water requirement threshold, economic aggregate threshold, economic increase threshold and urbanization level threshold differ greatly between different cities due to the varied water scarcity, water-fetching conditions, developmental character, developmental phase, economic strength and developmental prospects of each city.

9. Lay environmental perceptions and their policy implications for mitigating desertification in Minqin County, Gansu Province

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In recent years it being increasingly recognized that resolving environmental problems is better achieved by winning over and educating the local population than by imposing an 'expert' solution from above. However, little research has so far been conducted into the environmental perceptions of the general public in China. This study aimed to contribute to this important area of research by empirically exploring the lay public's environmental perceptions regarding the problem of desertification, desertification-inducing activities, and human-environment relationships in Minqin County in Gansu Province, northern China. The study adopted as its theoretical underpinnings Zube and Sell's Process Model of the Perception of, and Response to, Environmental Change (1986), Fischhoff et al's psychometric paradigm (1978), and Dunlap and Van Liere's NEP Scale (1978). The primary data was collected via a questionnaire survey (n=1,152) administered in December 2002.

The major findings of the questionnaire survey were: (1) Although many respondents were aware of the problem of desertification, they did not fully understand the various issues involved; (2) Respondents perceived the ecological risks posed by different desertification-inducing activities to be different, and most had only a weak altruistic attitude towards the environment; (3) Respondents' environmental perceptions were significantly affected by their personal attributes; and (4) There was a considerable difference in the way in which the desertification problem in Minqin County was perceived by experts and laymen respectively.

As far as the policy implications of these findings are concerned, two approaches are essential to encourage self-motivated social participation to resolve the problems of desertification in Minqin County: (1) The different perceptions of laymen and experts of the problem must be addressed at the outset in the formulation of any desertification-mitigating policies and (2) Any attempts to educate the lay public should not assume the existence of a homogenous community of like-minded people.

10. Water quality in courtyard rainwater cistern systems in rural area of Gansu Province of northwest China

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Rainwater is frequent the only available domestic water source in rural households in Gansu Province of northwest China. In recent years, courtyard rainwater-harvesting systems are being used to supply animal and domestic drinking water. However, whether the system could provide the household with adequate safe water is still an unanswered question. This study was to determine water quality in rainwater cisterns from courtyard rainwater-harvesting system. The results indicated that physicochemical qualities [pH, hardness, EC,

metals (As, Cd, Cr, Pb, Hg, Cu, Zn, Fe, Mn, Se), chloride, fluoride, prussiate, sulphate, nitrate, COD, BOD5] of the harvested rainwater, except for turbidity, were within the limits approved by the Chinese Drinking Water Standard (GB 5749-85). However, bacteriological quality did not meet the acceptable standard; microbiological analysis showed varying degrees of contamination in the different samples. Both the total bacteria and fecal coliform counts in water samples were significantly higher than the acceptable standard. This may be due to the poor maintenance of the courtyard rainwater harvesting system, suggesting that bacterial contamination is the major problem for water quality in courtyard rainwater harvesting system. Therefore, appropriate treatment measures should be adopted before harvested rainwater can be declared potable.

11. Combating desertification – technology is not enough

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Desertification, the silent disaster, affects a billion people, most of them poor. Tremendous efforts have already been made to address the problem of desertification, but little has improved at world scale. Similarly, efforts to reduce poverty do not seem to narrow the gap between the rich and the poor. Recognising decades of failures in anti-desertification actions, the UN-CCD was based on a new paradigm that brings participation to the fore. Participation has become an element of most if not all cooperation programmes to combat desertification, if only with widely differing interpretation. UNDP 1994 examined this and found definitions ranging from forced participation through various forms of "bribery" or high-input support through to effective participation. *Effective participation* builds on trust, common objectives and cost-efficiency; it requires time, patience and mutual respect between the "beneficiairies" and the external supporters.

With reference to examples from Asia (including China) and Africa, the paper points out that many programmes remain over-focused on technology while under-representing two other essential dimensions, *the microeconomic viability* and *the socio-cultural acceptability* of techniques introduced. The paper summarises relevant policy advice from UNDP and some of its key partners in the field of participatory methodology, microfinance, macro-micro linkages in poverty reduction, and environmental governance; all with focus on desertification combat and dryland management.

In conclusion, the paper calls for *three specific measures / principles* to ensure effective participation and success in desertification control programmes: (1) "Ownership" and leadership of the affected population from the diagnostic phase onwards, (2) Credible and *participatory* analysis of microeconomic potential and risks, and required macropolicy changes, and (3) Credible and *participatory* analysis of socio-cultural challenges and opportunities, including gender aspects. Success cases are described for more insight into some of the proven methodologies of effective participation, for answers to the question: How is it done?

12. Impact of dust and sand storms on the economy and the environment in Northeast Asia

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The occurrence of dust and sand-storms (DSS) has worsened in recent years in Northeast Asia. As a case study, this paper examines the impact of dust storms on China's economy and the environment. The first section establishes a context using the best information available on desertification and dust storm trends in the country. Building on the context, the second section focuses on interpreting how the trends have impacted the economy as well as the environment. Section 3 outlines an analytical framework for addressing the core issues surrounding the dust storms, including the implications for regional economy in several provinces. The final section discusses the cost effectiveness of existing programs for mitigating the adverse effects of dust storms on the economy and the environment.

13. Factors affecting adoption behavior regarding soil conservation technologies in the watershed area of Zarrin Gol, Golistan province, Iran

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This research aimed to demonstrate the factors affecting adoption of soil conservation technologies among farmers executing soil conservative procedures in watershed area of Zarrin Gol in Golestan province. The work was done through survey of 240 farmers executing the soil conservation operations in six villages of mountainous districts of Zarrin Gol using a questionnaire. The data resulted from this procedure was analysed using SPSS software under windows system. Deductive methods(factor analysis, path analysis) were used as the statistical methods. The findings of factor analysis indicated that six factors - innovation chacteristics, access to credits, size, participation in education, communication channel and organizational support accounted for 77.1% of total variance. The findings of path analysis indicated that variables such as compatibility, observability of results and number of soil conservation loans had direct effects on dependent variable. Variables such as participation in instructional courses, total lands under ownership, extension visit execution, amount of information extracted from radio about soil conservation operations and rigid access to loan of soil conservation had indirect effects on dependent variable. This research suggests the need of paying attention to complementary function of diffusion model variables, farm structure and structure-oriented models in order to explain and describe the

adoption behavior toward soil conservation technologies, and as a result ,adopting suitable extension approaches in accordance with them.

14. Perception of dryland farmers regarding economic and social aspects of sustainability

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Sustainable agriculture involves the evolution of a new type of agriculture rich in technology and information with less energy use and market purchased inputs. Sustainability is successful management of resources to meet the challenging human requirements while retaining and accelerating the quality of environment as well as conserving natural resources.

A study was conducted in the Bhiwani district of Haryana state, India in 8 villages on 200 dry land farmers to find out their perception about economic and social aspects of sustainable dry land agriculture. The study revealed that majority of the farmers perceived minimum tillage, crop diversification, soil fertilization application, integrated nutrient management, weed control, integrated pest management, maintaining plant population, drought resistant varieties, moisture and water conservation practices, agro-forestry and subsidiary occupation like livestock, poultry, horticulture, vegetable etc., as economically feasible, viable, as well as socially acceptable and sustainable for sustainable dry land agriculture. Farmers had very good perception about tillage, crop diversification, soil fertility, integrated nutrient management, weed control, integrated pest management, maintaining plant population, moisture conservation measures, agro-forestry, livestock, dairying and poultry. This may be attributed to their better financial position and social status, etc

15. Impact of improving access to off farm employment opportunities on alleviation of grassland degradation and rural poverty

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Degradation and desertification of China's rangeland is spreading, mainly in the poverty-stricken and environmentally fragile areas in the northwest. Poverty alleviation and rangeland conservation are urgently needed to promote the sustainable development of northwestern China. This study applies a linear programming bio-economic model to Inner Mongolia in China to simulate decisions made by farm households concerning on-farm and off-farm economic activities and to investigate the impact of improving access to off-farm employment opportunities on the alleviation of rangeland degradation and rural poverty. Simulation results indicate that if no restrictions are placed on farm households' grazing or reclamation activities, the act of increasing off-farm employment opportunities alone does not alleviate rangeland degradation, although it does lead to increased rural household

income. Land use regulations are needed to conserve the local rangeland environment. Under land use regulations, increased off-farm employment opportunities may increase household income and help to alleviate poverty. However, environmentally fragile areas that might benefit from increased off-farm activities may be less likely to create opportunities for *them*. When land use regulations are implemented to conserve rangeland environment, efforts should be made to increase rural-urban interaction and to create off-farm opportunities for the farmers, which would help to promote conservation of the resource base and improve household income.

16. Improving rural livelihood in Afghanistan through the promotion of sustainable production technologies for high value crops

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Rehabilitation of Afghanistan's agricultural production capacity is fundamental to any recovery of food security and the improvement of rural livelihoods. Currently, only some 6% of the irrigated area is planted with vegetable crops grown both for family consumption and sale as a cash crop. However, only a limited number of farmers who have access to secure irrigation systems (wells) are able to grow vegetable crops profitably. In areas of Afghanistan where arable land is limited and water is scarce, protected (plastic) agriculture (PA) offers an opportunity for vertical expansion and for generating returns per unit of land and of water from the production of high value crops, which would represent an attractive alternative to the cultivation of poppy. Since 2004, a project was implemented under the Rehabilitation of Agricultural Markets Program (RAMP) funded by USAID. The project established a PA Center for adaptive research and technology transfer, a workshop to manufacture green house structures, and strengthened the capacity of hundreds of farmers, extension agents, NGO personnel, etc. Results from a socio-economic assessment provide sufficient evidence that protected agriculture has the potential to contribute significantly to both the development of rural communities in the dry water-scarce areas in Afghanistan and to the Afghan economy. It can play an important role in supplying local markets with fresh produce that could not be grown otherwise, in creating employment within rural communities and productive opportunities for the disadvantaged, particularly women, returning (landless) refugees and the disabled. It also offers potential for development of a private service sector in the construction and supply of protected agriculture equipment. Ultimately, high yielding quality produce from protected agriculture could be expanded to serve the export market and generate a valuable source of foreign revenue. This would also ease pressure on natural resources of land and water in the drier areas of Afghanistan.

17. Range management options and transaction costs amongst pastoral households in West Asia and North Africa

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Recent proposals for the management of rangelands have focused on the need to account for pastoral mobility to enhance the successes of development interventions in pastoral areas. The general assumptions support that the use of existing pastoral mobility strategies would reduce transaction costs. These proposals, however, face many challenges following the transformation of many pastoral production systems and livelihood strategies. Traditional access-options based solely on institutional arrangements, collective action and reciprocity are eroding or are associated with high transaction costs that are pushing pastoral communities to rely more on markets and individual production and livelihood strategies. Therefore, the reduction of transaction costs might be true when it comes to collective management of the resources but would be different when one considers individual household transaction costs and mobility strategies. This phenomenon is obvious amongst pastoral sheep producers in the West Asia and North Africa region. Sheep producers are increasingly relying on crop residues and market feeds. Institutional arrangements continue to be an important part of their production strategy but the length of their stay outside community pastures is reduced. Moreover, herd movements are associated with high transaction costs, which limit the use of this option, especially for the small livestock owners. This paper uses the data collected from the property rights research on rangelands from Mashreq and Maghreb Project that was conducted in Jordan and Tunisia. The research was conducted from 1999 and 2000. Using econometric analyses, the study fills an important gap over the discussion of the impact of introduced range management options on transaction costs of herd mobility. The study looks at the determinants for herd mobility and evaluates transaction costs associated with mobility and distance of that mobility.

18. Evaluation of agricultural sustainability in rural village in the suburbs of Yanan City, Sanxi, China

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In China, the "Natural Forest Conservation Program (NFCP)" has been conducted to conserve forests and mitigate land degradation and desertification. The purpose of this study was to clarify the agricultural sustainability that is evaluated by comparing the actual population density and human carrying capacity (HCC) in this area. To estimate HCC at the village level in China, we investigated rural villages in the suburbs of Yan' an City, Shaanxi Province using a questionnaire submitted to village farmers, literature, and a cutting survey. We calculated HCC using data obtained from this investigation.

Results indicated that the "Grain for Green" project has progressed rapidly, and that cropland had decreased and forest increased in this area. Farmers' total income increased because they cultivated orchards, raised cash crops, employed plastic greenhouses, and worked in town when they could not engage in agricultural activities. Therefore, analyzing data now, *HCC* may be high because of the high economic productivity of land. It is expected that the rate of population accommodation (PA) would be small because there is a large non-farm income. Agricultural sustainability in the area should therefore be improved. The project may enable farmers to go back to cultivation after the subsidies are terminated. In this case study, the data suggest that the impact of the subsidy termination is not so critical for them since farmers' incomes excluding the subsidies increased. The agricultural sustainability in this area, however, would depend on the governments' policy after the termination. Additional data is now being analyzed

19. The coupling mechanism between the urbanization and eco-environment in water-resource constrained west China: A case study on Hexi corridor

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Since the start of 21st century, the tide of urbanization has swept across whole China. However, the urbanization in west China is restrained seriously by water resource and eco-environment. In the past flourish and death of a large number of ancient cities in this region were closely linked with the changes in water resource and eco-environment. Nowadays, the eco-environment status has changed a lot. For example, Ejina Oasis withered sharply, and Hongyashan reservoir in Minqin County dried up in 2004. The water table dropped seriously and a large area of narrow-leaved oleaster and desert date hursts died away. Promoting the urbanization process in West China under the restraint of water resource and eco-environment is a difficult task. This paper discusses the evolution of water resource, eco-environment and urbanization in this area, and then uses the systematic science theory to set up a dynamic coupling model of the concerted development between the urbanization and eco-environment. The results show that the changes in water resources can be described on drainage basin scale. The up-river runoff volume at mountain pass does not change much, but the water consumption in the middle reaches shows an increasing trend. So, the surface water and the groundwater replenishment in the lower reaches are reducing constantly. The evolvement of eco-environment shows a logistic course, and it follows the elastic threshold law. The whole urbanization subsystem is set up in the larger eco-environment system, and the development of urbanization will face the natural and social limits. This kind of limit to urbanization is consistent with the cask theory, namely, the concerted coupling degree of them is determined by the "short board" factor of the whole system. Under the constraint of water resources, the urbanization has an interactive negative relation with the eco-environment. Their dynamic evolutive system is a non-linear dynamic system. It represents a discontiguous and chaotic behavior, and its evolvement can be described as an inverse "U" shaped curve. The study on Hexi corridor shows that the concerted development relation

between the urbanization and eco-environment is worsening constantly, and the ecological crisis is entering its latent period.

20. Sustainable development of desert communities: from pastoral to sedentary farming systems in northwest Egypt

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Ecologically balanced pastoral systems in semi-desert region of the Northwest Coast (NWC) of Egypt evolved into sedentary, more productive FS due to development implemented in the last few decades. However, settlement of the Bedouins and changes in their social norms and living style, and random development and urbanization have increased human and livestock pressures on an inherently poor and fragile resource base, engendering resource degradation and poverty. The paper summarizes the experience of Matrouh Resource Management project (MRMP) in involving desert communities of the NWC and their socioeconomic setting to achieve its objectives of sustainable development and poverty alleviation. The paper analyzes the biophysical, socioeconomic, and policy factors that have influenced the evolution process of the systems. It describes the bases used to identify and characterize the systems evolved and major problems, specific to each. The paper highlights the positive effects of the social setting, traditions and customs of the Bedouin community in sustaining the pastoral system over the time, and how these were employed by the project for adopting participatory, community-based approaches to R&D. It briefly presents these approaches, and the technological packages developed by the project that generated substantial improvements in productivity, conserved the natural resources, and reduced poverty. The paper gives, however, a special emphasis to lessons learned from relatively recent changes in socioeconomic setting, norms and traditions of Bedouin communities and its negative impact, threatening resource sustainability and likely inflicting some social disputes within and between communities. The need for conducting socioeconomic studies to guide a balanced and equitable resource endowment and development, and respecting the property rights of resource users in NWC-Egypt (and other semi-desert areas) is also an important lesson learned from MRMP.

21. Housing design performance affected by sand deposits in Sahara desert

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The aim of the paper is to investigate the effect of aeolian sand deposits on the building environment of human settlements in the Sahara Desert. The flow of sand and dust presents a complex problem to the architects, as it demands attention not only to certain aspects of building design but also to planning the settlement as a whole. In addition, control of wind-

blown dust and sand involves many different factors affecting vital aspects of environmental design. These include such planning measures as layout and the orientation of buildings. The use of specific layout and building forms in a few existing traditional towns in desertified areas in the Sahara has at least been partially successfully in mitigating the particular problem of sand deposition.

The region of Souf in Algeria is an example of an area suffering from sand erosion and deposition. It is situated in the southeast Algeria, a vast territory consisting mainly of sand dunes (the grand oriental ergs). Its traditional housing has special design features, which help to mitigate the problem. In addition, it has an area of modern housing. To improve the standard of architectural design for use in the design of new settlements in such areas, the study and comparison of the traditional and the modern housing schemes were carried out in addition to the laboratory testes using wind tunnels in order to identify the physical features of the traditional housing which mitigate sand deposits, and assess how these features can be adapted into the new housing design to combat the problem. Results are reported

22. Detecting and monitoring impacts of ecological importance in semiarid rangelands

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The paper reviews the characteristics of arid ecosystems and impacts that have ecological significance in desertification processes. The problem of what constitutes an ecologically significant impact in dryland ecosystems has been considered, and accelerated soil erosion is regarded as a prime indicator because it determines the resilience of these systems.

He role and purpose of monitoring is discussed. In this context three potential inventory and monitoring systems (satellite imagery, aerial photography (including videography) and ground photography) are compared. On the basis of these evaluations a cost model is suggested as a guide in formulating optimal multistage frameworks for monitoring remote arid sites. The combination of decision support systems and remote sensing are tools that are being integrated into management aids for use by land administrators and land users

23. INT-79, the hidden language of rural water supply programs

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On the 29th of November 2005 a seminar "The Hidden Language" was held at Delft University of Technology, the Netherlands, in association with AMRF Society, NGO Forum for Drinking Water and Sanitation, Bangladesh Rural Advancement Centre (BRAC) and sponsored by Inter Church Organization for Development Cooperation (ICCO), the Netherlands. It reviewed conscious attempts to implement participatory and rights based approaches to development in rural water supply of Bangladesh. Such approaches entail a change in cultural codes and values in rural Bangladesh. In that, among other things, it

suggested the need to introduce 'alien' concepts i.e. cooperation across family lines, the emancipation of women and poor, and new and democratic decision-making procedures. One may doubt whether transfer of cultural norms should occur anyhow. It reflects too much like introducing the old-fashioned western idea of cultural supremacy. But in the meantime change of culture does occur and seems almost inevitable; even in Bangladesh, and for that reason it might be better done consciously, wisely and with respect for the receiving culture. In their efforts to do so, donor organisations tend to overlook the fact that transfer of codes and values occurs often implicitly and unconsciously. This enables miscommunication and deficiencies in the participatory process that should lead to the fulfilment of programme goals. Therefore, it is important to make the tension explicit between the project goals (mostly stated in terms of technical results) and the process that should lead towards these goals (participatory development, rights based approach). Hidden meanings transferred in project criteria and project implementation unconsciously have to be exposed to the open in order to make the participatory process more efficient. These 'hidden' values to be uncovered are: (1)Cooperation across the lines of family loyalties, (2) Women in public life, (3)Opposition, criticism and pluralism, Drive for fundamental change and (4)Instrumental time and planning.

These are the values at work generally in project proposals and project implementation in development aid. Though interferences in indigenous culture seem almost inevitable, transfer of technology, policy and values should take place in a respectful way. It stresses the need to seek for ways to integrate the "transplant" in the older layers of culture and institutions of the receiving society. To do so, donors do not underestimate or neglect the capabilities of society to develop itself. Additionally, a society should have the ultimate judgement on whether this process of integration truly contributes to its development.

24. Environmental law reform to control land degradation in the dryland region of Western China

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The paper will review the legislative action in the Peoples Republic of China to improve the effectiveness of its environmental law for land degradation control. Land degradation in China has accelerated over recent years for many reasons including inappropriate land use practices and ineffective laws and land use policies. In the past, many land use initiatives have not been well supported by legislation or its implementation, resulting in many severe environmental impacts in the dryland agricultural area of China. Severe effects of land degradation, which is the overall reduction in the capability of land to produce benefits from a particular use under a specific form of management, include loss of productive capacity of agricultural land, damage to roads and other infrastructure, and loss of watershed protection functions. Dust storms from wind erosion in western China are of global significance. The current framework of environmental law varies substantially in its capability to recognize

different land degradation issues and to implement effective control programs. Many detailed studies and strategies have been undertaken in the past ten years, including the revision of some environmental laws, in an attempt to reverse the severe land degradation. Due to the scale of the problem, the Government of China requested the Asian Development Bank in 2000 to take a lead role in facilitating the Peoples Republic of China Global Environment Facility Partnership Program on land degradation in dryland ecosystems. The aim of the Program is to strengthen China's enabling environment and build institutional capacity to adopt an integrated approach to control land degradation. Whilst significantly benefiting China, information and experiences from the Legal Component of the PRC-GEF Partnership Program will be invaluable to other regions of the world and will make a significant contribution to the international environmental law for land degradation and desertification control in general.

25. Dust storms in Northeast Asia - an economic analysis

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Falling under the category of nonpoint source, transboundary atmospheric problems, dust and sand storm (DSS) has tremendous environmental impacts across the Northeast Asian region. Growing in frequency and intensity in recent years, DSS causes huge economic losses and raises serious public health concerns in the sandy dust source areas in Mongolia and the People's Republic of China (PRC), along the dust transport routes, and in the affected downwind locations in the PRC, Korean peninsula and Japan. DSS events are the outcome of interactions between geological and climatic processes and anthropogenic activities. Human-induced factors, which have caused the widespread land degradation in the vast grasslands of Mongolia and China, have contributed much to the worsening of DSS events. While over-cultivation, overgrazing, overstocking, reckless harvesting of medicinal plants and irrational use of water resources constitute the principal human causes of land degradation, the underlying causes are poverty, unsustainable land use practices, and poor policies and institutional barriers.

This paper provides an economic analysis of the DSS problem, with a focus on economic costs and values at risk associated with the DSS events. Following an overview of the recent trends in the occurrence of DSS events and their damaging effects on the environment, economy and society in the Northeast Asian countries, section 2 presents estimates of the direct and indirect costs of DSS events. Section 3 outlines a DSS prevention and control model, which aims at reducing economic losses and restoring damaged ecosystems. The final section evaluates several options for developing a regional program to mitigate the damages of DSS events in Northeast Asia.

26. Community participation in watershed development and management in Madhya Pradesh, India

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Watershed development activities in India have been on a low because of the needs, constraints, and practices of local people. Participatory watershed management—in which communities help to delineate their problems, set priorities, define technologies through policies - has significant implications in watershed development. Sustainability of watershed management requires not only better technologies and policies for resource use, but also better organizational mechanisms and processes through which user or user agencies can come together to make decisions.

The study area was Dudhi micro watershed of Raisen district, Madhya Pradesh India, which is a region of central India with a population of several million people. Currently the area is exposed to severe water shortage and inadequate water quality. It has been designated by the Indian Government under the Drought Prone Area Programme (DPAP), for ground water development and water resources management strategies in order to alleviate hydrological / agricultural drought and increase land productivity. The ground water occurs under unconfined conditions in the study area. At some places semi-confined conditions also exist in the basaltic lava flows.

This paper attempts to share the authors' perceptions regarding the meaning and an importance of community participation in watershed development. Watershed development activity has been carried out in terms of cost effective soil and water conservation structures under Deccan trap environment through Participatory Rural Appraisal exercise with detailed hydro geological studies.

27. Impact of dust and sand storms on the economy and the environment in Northeast Asia

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It is argued that ecological environment in the lower reaches of the inland river basin would always be destroyed with social and economic development of the middle reaches and upper reaches in the arid regions of northwest China. In this paper, taking the Heihe river basin as a case study, we analyzed some critical ecological and economic problems of the inland river basin, such as desertification, water resource shortage, shrinking of oasis, economic development imbalance, poor household income, etc. The system integration theory was applied to put forward a sustainable development pattern of the Heihe river basin. The pattern is divided into three levels: (1) agriculture integrated with pasture livestock; (2) farm production integrated with food industry; (3) the ecological economic system of Heihe river basin integrated with other systems outside of the basin. At the same time, the detailed

approaches and methods of each system coupling level are demonstrated in this paper. The result shows that the energy output of the integrated system could be improved 6-60 times compared with the summation of the individual systems before integration. The root cause of the improved energy output from the integrated system is mainly the improvement *in the* resource use efficiency in each sub-system.

Theme 10: Application of new technologies and technology transfer; and crop improvement for dry areas

1. Economic evaluation of drip (tape) irrigation method in wheat compared to surface irrigation in water-limited areas

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Various aspects of drip (tape) irrigation method were evaluated on wheat. Economic evaluation and water productivity of this method were also compared with the traditional method of irrigation (surface irrigation) in water limited area of Kermanshah, Iran. Lateral length and lateral space of tape, and limited irrigation based on water requirement of irrigated wheat in the area were tested in a Strip-Split plot design during 2002-03 in Kermanshah, Iran. Several morphological traits were studied. The results revealed that in tape irrigation the most efficient treatment was 70 cm lateral distances, 40%water requirement and 90m lateral length. Significant differences were observed between tape and surface irrigation methods. Though economic evaluation based on benefit/cost ratio revealed that the surface irrigation method was more economical, but the water productivity of drip irrigation (2.57) was almost doubled than the surface irrigation (1.38), which is very important in water limited areas such as dry lands. Feasibility of this method in large-scale wheat production is also presented in this paper.

2. Saffower as a new crop in the dryland of Iran

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There is a significant genetic variation in the accessions of safflower in Iran. The main breeding objective in cold drylands is drought resistance and used criterion is grain yield in the stress condition. Traits that are correlated with the grain yield may be useful for indirect selection. A total of 306 exotic and indigenous safflower lines were evaluated in cold stations of Dryland Agricultural Research Institute (DARI) during 2000-2003. In the winter seeding trials, all genotypes were lost due to poor germination and cold damage in Maragheh and Zanjan. However, some trials passed winter successfully in Shirvan and Sanandaj that was mainly due to no germination in autumn and conservation of seeds in soil until spring. In the spring planting, all genotypes grew normally and completed growth cycle. There was a considerable variation with regard to all characteristics under studying in the spring planting. Results of correlation studies showed that only number of seeds per head and plant height have recognisable relationship with seed yield in cold dryands of Iran.

3. Effect of different tillage and rotation on crop performance

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Both tillage and rotation affect crop growth and grain yield. Crop producers in Iran traditionally use conventional tillage (moldboard plowing followed by disc harrows) to grow their crops. Such a tillage system not only requires a high energy input, but also causes long-term soil physical degradation and consume more time. This study was conducted on a silty clay loam soil to determine whether tillage systems alter the agronomic performance of winter wheat (*Triticum aestivum* L.), sorghum (*Sorghum Vulgare L.*) and clover (*Trifolium alexsandarum* L.) in southwest Iran. Tillage treatments were: conventional tillage (CT) including moldboard plowing followed by disc harrowing;reduced tillage (RT) including disc plowing followed by disc harrowing; and no tillage (NT) in which crop was sown in uncultivated soil. Soil samples were collected before planting and after harvesting to a depth of 30 cm in 4 intervals. Infiltration rate and soil bulk density were determined. Wheat yield and clover dry matter were measured. Wheat yield was not significantly different among different tillage systems. Clover dry matter was significantly higher in RT (7.35 Mg ha^{-1}) compared to CT (5.93 Mg ha^{-1}) and NT (5.12 Mg ha^{-1}). Results of this study suggest that in this semi-arid region of Iran, NT and RT were as effective as CT treatment for winter wheat. It was also shown that RT is a more suitable tillage system for clover production compared to NT and CT. The results from the second year rotation showed no significant differences between tillage practices on wheat yield, but the yield of wheat following clover treatment was significantly greater compared to the wheat followingsorghum treatment. Also, the differences in straw, 1000-grain weight and the harvest index were measured.

4. Screening for wheat stem sawfly resistance and associated morphological traits under rainfed conditions of western Iran

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Sawfly (*Cephus pygmaeus* L.) is one of the most damaging insect pests of wheat and barley in the world. Wheat damage due to Sawfly (SF) is a growing concern in Iran also. There are no effective insecticides against it. Evidences indicate the existance of genetic diversity in wheat varieties for resistance against SF . Cultivation of sawfly resistant variety and improved agronomic practices are key to damage reduction. To identify the resistant genotypes among 297 breeding and promissing lines of wheat in rainfed condition an investigation was conducted using artifitial infestation. For each genotype, number of infested spikes per 0.5 m^2 were counted, and infestation persentage were calculated. 23 genotypes with lowest infestation were selected as resistant ones, and in the subsequent year, these genotypes along with susceptible check were evaluated again in a RCBD design with 4 replications. Out of 23 genotypes 12, 10 and 1 were infested lesser than 1% , 10% and 15% , respectively. Plant hieght and distances between the stem nodes had positive significant

correlation with infestation percentage. To predict the infestation percentage, a regression model was developed using three traits, i.e., plant hieght, distances between the stem nodes, and thickness of stem wall The multiple correlation coefficient obtained was R^2= 0.634, *which was* significant at P< 0.01.

5. Influence of supplementary irrigation and variety on yield and some agronomic characters of rapeseed and mustard under rainfed conditions in northern Syria

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West Asia and North Africa (WANA) region, with a mediterranean type climate, grows very little oilseed crops, especially rapeseed and mustard. There has been fast growth of these crops in the world in the last two decades. Rapeseed is gaining area fast for the production of good quality oil in western world. WANA is extremly short of edible oil, and depend on imports for its local consumption with a cost of over 3 billion US dollars annually. Introduction of rapeseed will help to increase local production of edible oil. Rainfed cropping in the region coincides with the relatively cool, rainy winter season, usually from October to May. Crop yields are low, *inter alia,* due to variable response to inadequate and erratic rainfall. In an area where rain is limited, small amount of supplementary irrigation can make up for the deficit in seasonal rain and produce acceptable yields. This field study over three crop seasons (1994-95, 1995-96 and 1996-97), was conducted at Tel Hadya farm of ICARDA, Syria, which has deep clay soil (a Calcixerollic Xerochrept) with pH of 7.5. The objective was to asses the effects of supplementary irrigation (SI) on seed yield. Treatments were rainfed, 50 % SI and 100 % SI combined with three agronomically different varieties, 'Shiralee', a *B. napus* from Australia; 'Rex' a *B. rapa* from Germany and 'Cutlass' a *B. juncea* from Canada. Sowing was after effective rains each year. Seed yields of rapeseed and musatard varied with seasonal rainfall and its distribution, with main factors of years and water level having different effects, some of which were significant. Differences in seed yield were high between rainfed and supplementary irrigations but yields between two supplementary irrigations were not much different. Three-year results favour irrigation of rapeseed to some extent, however a quantity of supplementary irrigation needs to be found which would increase the yield significantly and it would be economical. Suppementary irrigation need of these crops is more during full flowering and full podding stages, which at this location occurs in the months of April and May. April rains are usually low. Data also showed that in case of high rains effects of SI were reduced warranting that SI at higher level should only be resorted when there are predictions for low rain during the season or evapotranspiration is causing rapid depletion of soil moisture.

6. Study of drought tolerance in spring-type canola (*Brassica napus*) cultivars

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Farming under drought stress conditions is as an important source of food supply for developing countries. Drought stress brings huge yield losses worldwide every year. Canola is one of the promising crops that can be used in rainfed conditions, since it shows a good tolerance under drought stress conditions. Selecting drought tolerant cultivars is important for successful canola (Brassica napus) production under dryland conditions. A total of 23 spring-type canola cultivars were grown both under stress and non-stress conditions. The Experiment was carried out in Gonbad Kavoos and Gorgan in November 2002, where the mean annual rainfall of 300mm and 450mm, respectively. The results revealed that 'Hyola 401' had the highest yield of 4739 kg/h and 3223 kg/h in Gorgan and Gonbad Kavoos sites respectively. Sensitivity to stress index (SSI), tolerance (TOL), and stress tolerance index (STI) were used to evaluate cultivar resistance to drought stress. According to SSI, 'Rafaela' and 'Option 500' cultivars were the most tolerant and susceptible, respectively. According to TOL, however, 'Hyola 401 and 'Rafaela' were the most susceptible and tolerant varieties, respectively. Moreover, evaluation with STI showed that 'Hyola 401' and 'Dakini' were the most tolerant and susceptible varieties, respectively. STI seems to be better than TOL and SSI to evaluate cultivar drought tolerance.

7. Effect of drought stress on qualitive and and quantitive of yield, yield components and relative water content in rapeseed (*Brassica napus* L.) cultivars

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In order to study the effect of drought stress in generative growth period on agronomical and physiological characteristics in repeseed (*Brassica napus* L.) cultivars, a field experiment was conducted in split plot design with four replications at the experimental field of Seed and Plant Improvement Institue, Karaj in 2002/3. There were two factors, irrigation at two levels (irrigation after 80 mm evaporation from class "A" pan as control and drought stress from stem elongation stage until physiological maturity) as main plots and ten spring cultivars (Ogla, 19-H, Hyola 401 (Canada), Hyola 401 (Safiabad), Hyola 401 (Borazjan), Hyola 420, Syn-3, Option 500, Hyola 308 and Quantum) as sub plots. Agronomical and physiological characteristics were studied.

Results showed that the water interruption from stem elongation stage had undersirable effect on growth, yield and yield components. Number of pods/main stem, in lateral branches and seed yield were affected adversely by drought stress. Decreasing in number of grains per pod in main stem and lateral branches in drought stress was similar (11.3%). The number of pods per main stem and lateral branches also decreased similarley in drought stress condition (9%). 1000-seed weight decreased (8%) as also number of grains per pod (11.3%), both of which affected decrease in seed yield. Also, seed yield decreased more than biological yield and this resulted in decreasing the harvest index. The oil content decreasd by 3.3% and oil yield by 18.6% in drought stress condition, which were however not significant. Among cultivars, Syn-3, 19-H, Hyola 420, Hyola 401 (Canada) and Hyola 401 (Borazjan) produced more seed yield than the others, but Hyola 308 had the lowest seed yield. The decrease in relative water content was more in sensitive varieties. The amount of proline in leaves showed the degree of stress – induced injury and it was not related to drought stress telerance. On the basis of the results it is concluded that Syn-3,19-H, Hyola 420, Hyola 401 (Borazjan) and Hyola 401 (Canada), with higher STI could produce greater seed yield in both conditions.

8. Crop water productivity a strategy for sustainable development in drylands

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The great challenge of the agricultural sector in countries located in arid and semiarid environment, where they face water scarcity , is to produce more food from less water, which can be achieved by increasing the Crop Water Productivity (CWP). Based on the experiments inlast ten years, it was found that the range of CWP of wheat in Iran was higher than that reported by FAO earlier. The CWP of corn in the area located in North West of country was higher than that reported by FAO while it was less in the areas located in south west of the country. The wide range of CWP (0.65-2.07 kg m^{-3} for wheat and 0.33-2.19 for maize) give tremendous opportunities for organizing and increasing the agricultural productions with less water resources. The variability of CWP can be ascribed to (i) climate, (ii) cropping calendar, (iii) irrigation water management (irrigation scheduling, deficit irrigation, etc), and (iv) soil fertility management, among the others. Cropping pattern management based on the climate (and consequently based on locations) is most appropriate strategy. Another most outstanding conclusion was that CWP can be increased significantly if irrigation is reduced by introducing deficit irrigation.

9. Introducing and growing some fruiting columnar cacti in a new arid environment

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Several columnar fruiting cacti from USA and Mexico were introduced into UAE deserts as a drought-resistant crop. The introduced cacti are *Carnegiea gigantea*, *Myrtillocactus geometrizans*, *Pachycereus pecten-aboriginum*, *P. pringlei*, *Stenocereus griseus*, *S. stellatus* and *S. thurberi*. Plants were propagated by cuttings in the greenhouse. Cuttings developed roots within 2-4 weeks of planting. The propagated plants were acclimatized and transplanted into the field in a hot and dry desert. All the introduced cacti survived the conditions in the new environment, however they showed differences in growth and development. *Myrtillocactus geometrizans* was found to be the most promising in term of healthy growth and adaptability to the new environment. The introduced fruiting cacti would be an effective technology to curb rising demands of water and ideal to establish crop plantations in the arid environment.

10. Effect of water deficit and time of nitrogen application on yeld and water productivety of rice (*Oryza* sativa L.)

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Two field experiments were conducted at the Experimental Farm of Rice Research & Training Center, Sakha, Kafr El-Sheikh, Egypt during 2002 and 2003 rice seasons, to study the performance of four rice cultivars namely Sakha 103, Sakha 104, Giza 182 and Egyptian Yasmine, grown under four water management regimes (continuous flooding, continuous saturation, and irrigation every 6-day and every 9-day intervals) and three times of nitrogen application (T_1- all amount of nitrogen dose was applied as basal application, T_2 - ½ of nitrogen dose was applied as basal and ½ was top-dressed at panicle initiation stage and T_3 - $^2/_3$ was applied as basal and $^1/_3$ was top-dressed at PI stage.

The main results showed that most of yield and its attributes were significantly affected by the irrigation treatments. Plant height, number of panicles/m^2, panicle length, total grains/panicle, sink capacity, panicle weight, 1000-grain weight and grain yield were significantly decreased as irrigation intervals increased up to 9 days in both seasons. On the other hand, unfilled grain % was increased. The rice cultivars varied in their response to water stress. In both seasons, Sakha 104 and Giza 182 yielded similar and significantly higher than other cultivars. E. Yasmine was highly affected by water stress experienced in the irrigation every 9 days. Increasing the irrigation interval beyond 3 days yield reduced yield and the reduction varied according to the cultivars. Applying nitrogen in two splits was superior to single dose application. Generally, continuous saturation gave similar yield as yield of continuous flooding with only 3 to 5 % reduction in grain yield as well as it recorded the highest water productivity (0.85 kg/m^3). This means that almost 25 to 30 % of irrigation water can be saved if all farmers followed this practice.

11. Long-term effects of fertilizer and water availability on cereal yield and soil chemical properties in Northwest China

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Wheat- (Triticum aestivum L.) and corn- (Zea mays L.) rotation system is important for the region's food security in northwest China. Grain yield and water-use efficiency (WUE: grain yield / estimated evapotranspiration (ET)) trends, and changes in soil properties during a 24-year rainfed fertilization experiment in Pingliang, Gansu, China, were recorded. ETs were estimated by assuming fallow efficiency (soil water accumulation / precipitation received during fallow periods). Mean wheat yields for the 16-yr ranged from 1.29 Mg ha^{-1} for the unfertilized plots (CK) to 4.71 Mg ha^{-1} for the plots that received manure (M) annually with inorganic nitrogen (N) and phosphorus (P) fertilizers (MNP). Corn yields for the 6-yr averaged 2.29 and 5.61 Mg ha^{-1} in the same treatments. Yields and WUEs declined with year except in CK and MNP for wheat. Wheat yields for the N and M declined an average of 77 and 81 kg ha^{-1} yr^{-1}, but the decline of 57 kg ha^{-1} yr^{-1} for the NP was similar to that of 61 kg ha^{-1} yr^{-1} for the treatment receiving straw and N annually and P every second year (SNP). Likewise, the corn yields and WUEs declined significantly for all treatments. Grain yield-estimated ET relationships were linear with slopes ranging from 0.5 to 1.27 kg $ha^{-1}m^{-3}$ for wheat and 1.15 to 2.03 kg $ha^{-1}m^{-3}$ for corn. Soil organic C (SOC), total N (TN), and total P (TP) gradually increased with time except in the treatment CK, in which TN and TP remained unchanged but SOC and available P (AP) decreased. Soil AP decreased in the treatment N. Soil available K declined rapidly without straw or manure. The greatest SOC increases of about 160 mg kg^{-1} yr^{-1} occurred in SNP and MNP treated soils, suggesting that long-term additions of organic materials could increase water-holding capacity which, in return, improves water availability to plants and arrests grain yield declines, and sustain productivity.

12. Effect of nitrogen on wheat grain yield under terminal drought stress

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Because of uneven distribution of rain over the year and variable water supply, either due to shortage of water or failure of the irrigation system, terminal drought is a major problem for growing wheat and its yield stability for most regions in Iran. In addition, nitrogen deficiency is a major constraint to wheat production in this region. To evaluate the interaction between nitrogen and water supply, this experiment was conducted in year 2003/2004 at Ramin Agricultural Research Station, Ahwaz, Iran. Wheat was grown under three irrigation levels (50%, 75% and 100% full irrigation) using two wheat cultivars (Yawaroos and

Chamran) and four nitrogen fertilization applications (0, 80, 120 and 180 kg ha^{-1}). Results showed that grain yield increased with increasing N application. Grain yield at 0, 80, 120 and 180 kg N ha^{-1} was 341.04, 565.19, 625.66 and 651.52 g m^{-2} respectively. Grain yield at 50%, 75% and 100% full irrigation was 523.11, 553.58 and 560.80 g m^{-2}, respectively and the differences were significant. Yawaroos grain yield (558.45 g m^{-2}) was significantly higher than that of Chamran (533.21 g m^{-2}). The interaction between nitrogen and water supply on grain yield was significant. At zero N level, increasing water supply did not increase grain yield, but at 80, 120 and 180 kg N ha^{-1} levels, grain yield was improved by increasing water supply. Also, by increasing the amount of N levels at any water supply rates, grain yield increased. The difference between grain yield of varieties was due to the amount of harvest index (HI). It could be concluded that although reduced irrigation to 50% full irrigation may reduce the potential maximum yield obtained with full irrigation, the practice could benefit a larger number of farmers and result in greater overall wheat production. In addition, increased nitrogen prior to terminal drought would result in better effects.

13. Phenotypic stability in chickpea genotypes using nonparametric methods under rainfed conditions

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Chickpea (*Cicer arientinum* L.) is one of the most important legume plants grown in Iran. It has low production cost, high adaptability to different climates, and provides fertility benefit in crop rotation because of nitrogen fixation. To evaluate chickpea genotypes stability under rainfed condition an experiment was carried out for three years under stress and nonstress conditions in the ollege of Agricultural, Razi University, Kermanshah, Iran. A total of 19 genotypes originating from ICARDA and ICRISAT and two check cultivars (Bivanij as Local check and Jam) were used in this study. Combined analysis of variance showed significant G*E interactions. The $Si^{(1)}$ and $Si^{(2)}$ stability parameters were calculated from adjusted data and used to evaluate the phenotypic stability based on rank of each genotype in each environment. These parameters were calculated from original data (Xij) and adjusted data (Xij*) for each genotype in each environment. Smaller $Si^{(1)}$ and $Si^{(2)}$ indicated higher stability genotypes. Accordingly, genotype No. 8 (FLIP 92-9C) showed the highest stability in all environments and genotypes No. 10, 12, 14, 17 and 19 considered as genotypes with moderate stability for some environments. The stability of genotypes No. 3 , 5 and 20 was the lowest. Also, evaluation of genotypes based on stress tolerance index (STI) revealed that genotype No. 8 had high STI almost for all the years. Finally, we are suggesting genotype No. 8 (FLIP 92-9C) as a drought tolerant genotype with high stability in all environments.

14. The role of improved production technology in wheat self sufficiency

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Wheat is the major crop in the Islamic Republic of Iran, where it is grown on 6.4 million hectares, 63% of which is under rainfed cultivation. In 1995, ICARDA and DARI scientists identified several problems which affected wheat production in dry areas of Iran including *the* use of local varieties, and lack of appropriate soil and crop management practices. Researchers suggested improved wheat varieties associated with improved technologies (timely and cost-effective management practices including early tillage, good seed bed preparation, early drill planting, fertilizer banding, and proper weed control, along with the use of improved cultivars for dry conditions) to be used on farmers' fields on large scale with joint participation of extension agents and farmers as one team. In the 2003-2004growing season, recommended technologies were adopted over a large area (about 500,000 ha), a dramatic rise from the 85,000 ha in 2002-2003, and only 4000 ha in 2001-2002. On-farm results showed a 53% percent increase in wheat yield compared to yields of neighboring farmers using their own technology in 2001-2002, 60% in 2002-2003, and 65% in 2003-2004. Wheat production in Iran reached the self-sufficiency level during the 2003-2004, for the first time in over 40 years. These results testify the successful adoption of effective soil and crop management practices combined with improved cultivars for increasing the welfare of rural communities in dry areas of Iran through the sustainable use of land and water resources. The participation of farmers, researchers, and extension workers in the testing, demonstration and dissemination of improved technologies has led to better awareness of the technology and to its adoption by a large number of farmers. This will ensure a sustainable increase in wheat productivity in the rainfed areas of Iran.

15. Application of municipal treated sewage through drip irrigation and effect on soil properties in semiarid region

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In response to water scarcity in a semi-arid region, the treated municipal sewage water of Marvedasht, southern Iran was applied to irrigate an experimental plantation site with drip irrigation. The effect of utilizing effluent on the physical and chemical characteristics of the soil after 25 months of irrigation with effluent and borehole water was evaluated. The results showed that treated Marvedasht municipal effluent did not affect soil bulk density, but it reduced the soil infiltration rate. Effluent with 1.5 dS/m salinity decreased the soil salinity considerably. However, it raised pH of soil by 10% (8 units) and 8% (6 units) in the layers 0-30 and 30-60cm respectively. Soil organic carbon also increased. Application of 93,336 m^3 effluents per ha during the experiment caused an increase in nitrogen, phosphorus, potassium and boron by 73.38, 100.5, 69 and 3.73 kg respectively. In spite of not using any fertilizer

during the experiment and the uptake of some nutrients by the trees, the soil nutrient storage was increased.

16. Effect of mistletoe on macronutrients of hornbeam and ironwood trees in Hyrcanian forest

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Leaf analysis of plants can reveal plant's nutritional status (deficiencies, toxicities, amount of use and uptake of each nutrient). In this paper the effect of mistletoe on 4 primary macronutrients, Nitrogen, Phosphorus, Potassium and Calcium in two most prevalent mistletoe hosts in Hyrcanian Forests namely Hornbeam and Ironwood trees was studied. Leaf samples collected in July 2004 from infected and uninfected branches of mistletoe contaminated plants and from complete healthy nearby trees (without any mistletoe or other diseases) with approximately similar DBH, height, appearance and morphology conditionsr. The samples were oven dried for 48 hrs at 60 °C before being ground to a powder and then digested and analyzed for Nitrogen, Phosphorus, Potassium and Calcium. Results showed an increase in potassium content of the leaves from infected branches as compared with perfectly healthy (uninfected or control) trees, whereas the amount of total nitrogen was decreased in leaves of infected branches relative to uninfected trees. Other nutrient did not reveal any significant difference.

17. The characteristics of water status in *Populus euphratica* at foreland of oases on Taklamkan desert

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The water status of *Populus euphratica* Oliv. was studied in the southern rim of aklamakan desert. The results showed that, with the stable soil water content in habitat that resulted from permanent ground water table, the water stress of *P. euphratica* was not severe and drought stress was not the main factor to threaten the long-term survival of *Populus euphratica*. The characteristics of water statutes in *P. euphratica* indicated that the plant depended mainly on constant sufficient water supply to cope with the extremely drought environment at their growing sites. At the same time, the species developed physiological adaptation at cell level in transpiration. Therefore, the key factor that guaranteed a sustainable survival of *P. euphratica* in the foreland of oases is to keep the ground water table at a stable depth.

18. Breeding for cold tolerance in wheat and barley in cold dry areas in Iran

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Cold stress is a major factor limiting wheat and barley survival in cold high altitude mountainous areas of Iran. Consequently, the identification of sources of genetic variability, using appropriate methods of evaluation, and a clear understanding of the mechanisms that winter cereals use to survive periods of cold stress play an extremely important role in the design of production systems for these regions.This paper reports on the cold tolerance potential and vernalization and photoperiod requirements of Iranian and alien dry lands/irrigated wheat and barley genotypes with diverse origins from ICARDA, CIMMYT, Europe, USA, Russia and Iran that were screened under field and controlled conditions for adaptation in the cold regions of Iran. Morphological, physiological and phenological criteria useful in selecting cold tolerant wheat and barley genotypes and the role of transition from the vegetative to the reproductive phase, which is regulated by developmental genes are discussed. Suggestions are made as to how breeding strategies for improvement of cold tolerance in cereals in regions with long mild winters like those normally experienced in the cold regions of Iran might best proceed.

19. Study on rainfed wheat nutrient requirement in dry seasons on farmers' fields

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Wheat is one of the main sources of food which can be planted in dry regions of Iran because of its adaptability to this country's climatic conditions. Application of nutrient at proper time is essential to reduce various losses. Fertilizer application should be based on residual nutrient levels as indicated by a soil test, available soil water and soil type. On heavy-textured soils in cold region all fertilizer can be applied before sowing. Under dry conditions, which are most frequently encountered in lime-rich and some degraded soils of the region, researches have shown that some micronutrients like Zn and Mn are deficient. Since balanced nutrition constitutes one of the main factors in improving crop yield, this research-extension field experiment was carried out to test the effect of fertilizers on improving the yield of Sardari wheat variety. Nitrogen was supplied as ammonium nitrate and phosphorus as triple super phosphate, at the rate of N60P30 plus 20 kg/ha Zinc Sulphate and 20 kg/ha Mn Sulphate. Excessive N applications can result in excessive foliage which depletes available water before seed development, thus decreasing seed yield and quality. Application of more than required N and P often has adverse effect on seed yield of wheat. An application of 60 kg N and 30 kg P2 O5 plus 20 kg/ha Zinc Sulphate and 20 kg/ha Mn Sulphate gave maximum wheat grain yield (1200 kg/ha) in drought season condition that was much lower than normal years.

20. Evaluation of bread wheat genotypes for drought tolerance under rainfed conditions

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Drought stress is one of the most important abiotic stresses causing yield reduction in rainfed conditions. Evaluation and selection of germplasm from different sources such as international nurseries for improving drought tolerance is essentional to combat the stress. The present investigation was carried out on wheat germplasm received from ICARDA. The material was evaluated in 3 seperate observation nurseries including, 5th WWON-SA, 5th WWON-IR, 11th FAWWON with 406 genotypes. Out of 250 genotypes in 5th WWON-SA, and 5th WWON-IR, 28 performed better than the local check (LC). But no genotype was selected from 11th FAWWON. Two yield trials, i.e. 6th EYT-RF and 6th EYT-IRR with 25 genotypes in each nursery were also evaluated under both rainfed and irrigated conditions. Drought stress tolerance indices such as stress tolerance index (STI) and tolerance index (TOL) were calculated for each genotypes. STI of genotypes No. 16 (Cham6//1D13.1/MLT/3/SHI4414/Crow/4/KVZ/ AU // GRK), 21 (Saulesku #44/TR810200 Acc. 000421), 23(VRZ/3/OR F1.158/FDL//BLO/4/Seri), and 20 (Saulesku #44/TR810200 Acc. 000420) were greater than LC indicating superiority of these lines in coping with drought stress. According to principle component analysis and biplot, the performance of genotypes 16 and 21 were much better than the LC in both rainfed and irrigated conditions. These genotypes along with the LC were located in the region of high potential in both conditions (A-region) in the biplot. But the genotypes 20 and 23 were located in the region of high potential in irrigated conditions and relatively low potential in rainfed (B-region), indicating that these genotypes may be suitable for supplementary irrigation or rainfed condition with optimum amount of annual rainfall.

21. Sararood-1, a newly released barley variety for cold and moderately cold rainfed conditions

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Barley is a crop with considerable drought and salinity tolerance. Thus the coverage of the fields in dry and saline regions with barley results in more effective use of the resources of these stressed regions. Dryland farming is one of the most important aspects of agricultural in Iran. To make better use of the potentials in dry regions of Iran, regarding crop production, barley is playing a significant role. In cold and moderate-cold regions of Iran, farmers used to cultivate a local barley variety (LBV) with good adaptation but low grain yield potential in years of favourable rainfall. Moreover, LBV is susceptible to disease and lodging. A newly released variety, namely Sararood-1 (Chicm/ An 57// Albert) with outstanding performance at research station and farmers condition was adopted by farmers easily and LBV has been

replaced by it. Under experimental conditions, Sararood-1 had 16 per cent more grain yield (3066 kg/ha) than LBV (2640 kg/ha), and under farmer's condition the relative performance was even higher. According to official reports, its grain yield was 7000 and 4000 kg/ha from 6 and 20 hectares rainfed farmer's field, respectively. Under one time supplementary irrigation at flowering stage, its grain yield was reported 5.6 t/ha. Introduction of Sararood-1 is considered as a revolution in barley production on the cold and moderate cold rainfed regions of Iran.

22. Empowering rural communities for better management of collective rangelands in desert - from concept to implementation

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Sustainable development of pastoral and agro-pastoral systems, dominated by collective or tribal ownership of rangelands, is a key issue for the WANA region. These two systems are located in arid areas and are increasingly threatened by desertification process. The Policies responses to challenge this complexity have been sectorial and fragmented, « top-down » type, putting forward technical solutions and neglecting the social context. In response to the frequent failures, methods of "participatory development" emerged during the seventies within international development arenas. Adoption of participatory approaches by national governments and its translation into actual implementation appears not only partial, but also particularly slow. Recent experiences suggest that integrated and participatory approaches may lead to more efficient resources management and to more effective poverty reduction policies. Local development is the most recent approach to face these challenges. It aims at organizing people on a decentralized basis and at promoting participatory programming which could lead to an effective responsibility sharing by local population.

Donors and governments have not, so far, given a fair chance to decentralization to fulfill its promises of efficient, equitable and sustainable development. In addition, it has often been the case that responsibilities were transferred to local population without the means to carry them out. The collaborative research conducted by ICARDA and IFAD in Tunisia has led to the development of tools and methods adapted to the development of collective desert rangelands based on empowerment of local communities and using participatory methods. The pilot action conducted showed that participatory natural resources management in such areas can be instrumental in institutionalizing participatory approaches. In both democratic and non-democratic settings, these approaches foster inclusiveness, transparency and accountability of public services and policy making processes. The tools developed play an essential educational role in changing bureaucrats and people's mindsets and communication patterns. In a word it is a school of local democracy.

23. Prospects and progress of research on oilseed crops in drylands of Iran

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About 90 % of the vegetable edible oil need of Iran is met through imports, which amounts to around 900,000 tons and costs almost one million US $. The main reason for the shortage of local production of edible oil is that there is very little area under edible oilseed crops, and the crops like rapeseed and mustard are not grown at all commercially. From the last one decade Government of Iran is making proactive efforts to create and develop area under important oilseed crops with emphasis on cultivation of double low rapeseed, usually called 'Canola'. The planning is to enhance area of oilseed crops in the dry-land region, mostly winter grown oilseeds, which are suitable for rain-fed region, which is cold, semi-cold and warm in climate.

Oilseed crops research programme at Dry Land Agriculture Research Institute (DARI) is focused on three crops that can be grown under rain-fed condition of Iran i.e. rapeseed, safflower in winter and sunflower in spring and summer season. Results, so far obtained show that fall planting of rapeseed in cold areas where below zero temperatures occur for about 125 days when the rapeseed crop is in two cotyledon leaves stage, thus survival of rapeseed is not possible. In this climatic condition *B. juncea*, called mustard, can be grown as a spring crop. In semi-cold areas under pure rain-fed condition fall planting is possible, if the first effective rain falls by the end of October, otherwise it needs one or two initial irrigations at the planting time. Frost events in this region are about 90 days. Three winter type varieties Parade, Aviso and Modena had produced the highest average seed yield of 1605, 1439 and 1354 kg/ha, respectively over three crop seasons in semi-cold region. In warm southern rain fed areas of the country spring type rapeseed can easily be grown in winter season. Results obtained during three seasons revealed that in these areas hybrid varieties Hyola 401 and Hyola 308 had 13 to 23 per cent higher seed yield than open pollinated varieties, especially in those years when the drought stress was mild, but under harsh drought conditions (seasons with lower rain than long term average) OP varieties produced 11 to 21 per cent higher seed yield compared to these hybrids.

In another research programme to reduce shattering in rapeseed, inter-specific crosses between *B. napus* and *B. juncea* has been made, F1, BC1 and BC2 generations have been obtained. Also to increase cold tolerance and earliness in promising varieties crosses between winter and spring types of *B. napus* have been made.

Our research in the last few years show that safflower fall planting in semi-cold and warm rain-fed areas can be done easily. Average seed yield of several varieties is about 1100 to 2300 kg/ha in rain-fed semi-cold areas. Safflower fall planting has produced 60 to 140 per cent more seed yield compared to spring planting in these areas. In cold climate condition spring planting of safflower is recommended, which produces an average seed yield of about 500 kg/ha. On-farm as well as on-station trials always showed that local varieties of safflower 'Isfahan Local, and 'Zarghan279, had always produced less seed yield than promising varieties in spring and fall planting. Promising selected varieties showed 30 to 120 per cent

more seed yield than checks. Variety PI-537598 is a high yielding safflower line that has been selected from large germ-plasm.

24. Adaptability and stability analysis of grain yield in advanced bread wheat lines in cold and moderate dryland areas of Iran

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Wheat is the major crops grown in the Islamic Republic of Iran. The total area covered by wheat in dryland is, with about 3.8 to 4.2 million hectares. Average grain yield remains low, because of drought, excessive cold in mountainous areas, and high temperature during late spring in other areas and because of diseases and insect pests. After 12 years research activities in wheat breeding DARI could improve yield potentials and resistance of wheat to biotic and abiotic stresses for different agroecological regions of dryland rainfed areas of Iran. In order to study the adaptability and stability of grain yield of 16 advanced bread wheat lines, experiments were conducted for 3 during years (1999-2002) in 7 research stations. Combined analysis of variance showed the effect of Year×Line interaction was not significant. On the basis of means comparison selected superior winter lines were number 13 (Fenkang15/Sefid), 12 (Ogosta/Sefid) and 10 (Pvn"S"/Chi//Sabalan) (1997, 1922 and 1912 kg/h) and best facultative lines were number 5 and 6 (1945 and 1930 kg/h). In Maragheh station another irrigated set of experiment conducted to compute the drought tolerance indices such as STI, GMP and TOL. The vigorous line number 13 "Fenkang15/Sefid" was found more drought tolerant than Sardari (local check) but lower than Azar-2 (National check). This line produced highest grain yield (2851 kg/h) in Maragheh, the typical cold station. Considering the other good agronomic characteristics, cold tolerance and resistance to diseases, grain quality (10.5- 12% protein content), this variety can be introduced to cold dryland areas. Based on the results from the moderate cold site in Ilam station, the facultative line 87Zhong 291 which has high yield potential of 4167 kg/h and high grain yield stability, can be introduced to semi- cold dryland areas.

25. Constrains and future prospects of food legume production in dryland condition in Iran

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Food legumes in Iran including chickpea, lentil, dry bean, mungbean, cowpea and faba bean occupy 1.1 million hectares (2002) which is 9.9% of the country's cultivated area. Chickpea and lentil were grown on 740,000 and 260,000 hectares in Iran. Major areas of chickpea (95%) and lentil (94%) are in rainfed condition and they are grown in rotation with cereals. Other food legume crop are sown in irrigated conditions. Productivity of chickpea and lentil are less than half of the average yield of the world. These crops traditionally are planted during spring on conserved soil moisture and their productivity is constrained mainly due to

terminal drought along with high temperature. Also other constraints influencing the productivity of these crop include poor agronomic practices (preparation of land, method of sowing, seed rate, harvesting method), and Ascochyta blight , fusarium wilt and cold. Efforts were made to develop varieties that should mature in short-duration, tolerate high temperature for spring planting in harsh environment and change the practice of spring planting to autumn planting in milder environments. The agronomy of chickpea and lentil cultivation including date of sowing, seed rate, method of sowing, plant population, weed control, and method of harvesting, has been researched and recommendations developed for different areas. The efforts are being made to transfer these recommendations to farm level with the help of extension specialists through on-farm, research-extension demonstration fields. Research on exploration of possibility of winter planting of improved chickpea and lentil varieties in milder environments and Entezari planting in harsh (sever *cold)* environments has given fruitful results. Transfer of these technologies to farmers is in progress and in some areas farmers are getting almost 50% or more productivity with adoption of winter- or Entezari –sowing. Winter planting gives the crop the benefit of winter rainfall, and low evaportranspiraton, as maturity approaches during low temperatures. This environment allows optimum vegetative growth, development of higher yield potential, and higher water-use efficiency. The taller erect canopy of the crop allows for mechanical harvest. The increased biomass from the winter crop is highly prized for feeding small ruminants. The research efforts being made by DARI in collaboration with other research organizations in Iran and with ICARDA, to improve foodlegume production are presented and discussed in the paper.

26. Efeect of zinc and boron nutrition on the productivity of fingermillet and groundnut based cropping system in dryland conditions

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Increased removal of micronutrients as a consequence of adoption of high yielding varieties and intensive cropping systems together with a shift towards the use of high analysis NPK fertilizers has pushed the level of micronutrients in the soil below the critical level which is required for normal productivity of crops. Zinc and boron deficiencies (69.14% and 26.27% respectively) are most wide spread in *Alfisols* of deccan platue of India, more so in Karnataka.

In this context an experiment was conducted to study the effect of zinc and boron on growth, yield and seed quality of fingermillet and groundnut based cropping system for *Alfisols* of Karnataka at Dryland Agriculture Project, University of Agricultural Sciences, Bangalore during *kharif* seasons of 2002 to 2004. Fingermillet and groundnut responded significantly to the application of micronutrients such as boron and zinc. Pooled analysis of data revealed that soil application of Zn @ 12.5 kg ha^{-1} + B @ 1.0 kg ha^{-1} in fingermillet recorded significantly higher plant height (115.4 cm), total dry matter accumulation (41g $plant^{-1}$), grain yield (3812 kg ha^{-1}), straw yield (4984 kg ha^{-1}), B:C ratio (1.19), number of fingers per ear head (7.52), 1000- grain weight (2.97 g), earhead length (7.75 cm), seed germination (99 %) and vigour index (495). In case of groundnut, the foliar application of $ZnSO_4$ @ 2.5 kg ha^{-1} + borax @ 0.5 kg ha^{-1} along with recommended dose of NPK recorded

higher plant height (27.8 cm), dry matter accumulation (69.9 g plants^{-1}), pod yield (874.5 kg ha^{-1}), haulm yield (1407 kg ha^{-1}), B:C ratio (1.27),100 kernel weight (31.2 g), shelling per cent (45.7) and oil content (44.78%), which was followed by soil application of $ZnSO_4$ @ 25 kg ha^{-1} + borax @ 0.5 kg ha^{-1}. It is clear from this study that conjunctive use of boron and zinc is necessary in order to maintain a higher productivity of fingermillet and groundnut in alfisols of Karnakata dry areas.

27. Investigation on VAM fungi , phosphorus and drought stress effects on grain yield, phosphorus and water use efficiency in wheat

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In order to study of the effects of Vesicular Arbuscular Mycorrhiza fungi and phosphorus on wheat under drought stress conditions an experiment was conducted using Hanks method with three replications. Three factors including of Mycorrhiza (with and without application), phosphorus (0, 6 and 12 g P_2O_5 per m^2) and irrigation (10.5, 24.8, 36.1, 46.2 and 55.1 mm water for each irrigation interval) were investigated on wheat cv.Mahdavi. The results showed that applying Mycorrhiza caused an increase in grain yield, and phosphorus and water use efficiency significantly. Phosphorus had significant effects on these characters at 1% probability level. Mean comparison of triple interaction of fungus, phosphorus and irrigation levels on phosphorus use efficiency showed that applying of 55.1 mm water in each irrigation interval and 6 g P_2O_5 per m^2 had the highest phosphorus use efficiency. VAM-fungi improved phosphorus use efficiency (45.674 g/g) than without application of VAM fungi (38.664 g/g). The lowest of phosphorus use efficiency was with or without applying of VAM-fungi, 10.5 mm water and 12 g P_2O_5 per m^2.

28. ICARDA 's emerging experience in institutionalizing knowledge management and dissemination

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The international public goods (IPGs) generated by research must have an impact on rural communities and poverty. The creation of a KM&D program is considered by ICARDA as the best response to the growing concern about the cost effectiveness and impact of public investment in pro-poor research. The primary task of KM&D is to integrate the Center's work on knowledge management and dissemination into the overall research and capacity building program, and to enhance equitable access to pro-poor knowledge that contributes to ICARDA's goal of food security, poverty reduction and preservation of natural resources. The KM&D Program aims to address the following causes of poor access and adoption of agricultural knowledge: (a) limited and uncoordinated international and national support for

dissemination of available knowledge; (b) limited capacity of the national programs to take advantage of advances in information and communication technologies (ICT) to acquire, share and disseminate knowledge; (c) inadequate analysis of the existing knowledge pathways that emerged from research for development projects; and (d) lack of research programs exploring innovative methodologies and approaches for knowledge management (documenting, learning, sharing and dissemination).

The overall strategy is to develop and implement a systematic and consultative approach for knowledge management and dissemination to the widest possible segments of the rural poor, and to establish an integrated ICT-KM program supported by the following principles: ownership, coordination, capacity building, sustainability, impact and appropriateness. Two major approaches will be followed: (a) analysis of the knowledge available from closed projects (*exploring the background*), and identification of 'Best Bet Practices' and innovative approaches that enhance the capacity of a broad range of users to access packages of Technical, Institutional and Policy Options; and (b) identification and development of researchable programs in knowledge management and dissemination. This is a new area of research that aims to best capitalize on the experience gained by sharing and up-scaling, and to bring out a change in culture and behavior of all partners that assure equity, transparency and flexibility in order to achieve the maximum impacts.

29. Crop rotations in dryland agriculture of Central Asia: research achievements and challenges

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Dryland agriculture in Central Asia is based on rotations of small grains with summer fallow (SF) in general. In northern Kazakhstan (NK), generally adopted rotation is continuous spring wheat with SF while in southern Kazakhstan (SK) and in Kyrgyzstan winter wheat is rotated with SF, which is normally practiced once in three to five years. Among other crops some area in both regions is occupied with barley. Before recently, significant area in the north was devoted to maize for silage but it is no longer the case as it proved to be uneconomical practice in market oriented economy. Long-term research in the north and four year research in the south indicated that in both sub-regions there is no justification for SF to be a base for the crop rotation.

The SF practice is usually advocated as means of moisture conservation and weed control. Studies in all three sub-regions indicated that advantage of SF in accumulation of soil moisture on average are not remarkable to spend the whole year with no crop: just 15-25 mm more of available water in one meter soil layer. As to weed control, there are opportunities to control weeds using efficient chemicals. Besides, in farm conditions nobody does four-five

mechanical tillage operations necessary to destroy weeds efficiently because of resources shortage. SF however provides some advantages of more available nitrates before wheat planting because of accelerated organic matter decomposition during the year of summer fallow, which positively influences grain yield and its quality. However, additional N-fertilizer would solve such problem in the continuous cropping systems instead of leaving the land one year with no output.

The field trials in all three sites have shown that SF provides higher grain yields (10-20 %) as compared to continuous cropping but it is not enough to justify one crop in two years with such a marginal increase in yield. The best results where obtained when SF was replaced by oats or dry pea in NK, by chickpea and alfalfa in SK and by dry pea and safflower in Kyrgyzstan. But most important is the fact that SF combined with numerous mechanical tillage operations is major cause of soil erosion and land degradation. Yet, it is not economic compared with continuous cropping systems.

30. Deficit irrigation for improving water productivity of wheat in northwest Iran

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In the dry areas, water, not land, is the most limiting resource for improved agricultural production. Maximizing water productivity, and not yield per unit of land, is therefore a better strategy for dry farming systems. Under such conditions, more efficient water management techniques must be adopted. Deficit irrigation is a highly efficient practice with great potential for increasing agricultural production and improving livelihoods in the dry rainfed areas. In order to investigate the effects of irrigation and nitrogen on yield and its stability, this experiment was conducted as split plot arranged in a randomized complete block design (RCBD) with three replications during 2000-2002 for irrigated wheat variety (Alamout) at Maragheh Agricultural Research Station of DARI. The treatments included were four levels of irrigation (Rainfed, 1/3, 2/3 and 3/3 of full irrigation) and five nitrogen rates (0, 30, 60, 90 and 120 $kg.N.ha^{-1}$) applied split at planting time with $30kg.ha^{-1}P_2O_5$ and topdressing later. Observation included: grain, straw and biological yields, harvest index, productivity degree, plant height, kernel number per spike, spike number per square meter and thousand kernel weights. Yields of rainfed conditions varied with seasonal rainfall and its distribution, with all main factors having significant effects. Optimum level of deficit irrigation for Alamout was 2/3 of full irrigation, with $90kg.N.ha^{-1}$. Aalthough it reduced 19.8 percent of yield compared with full irrigation, it got maximum water productivity ($27.9kg.mm^{-1}$). In this treatment, with 27.3 percent reduction of water use, maximum net benefit was obtained and 37.5 percent increase of cropping area was possible so that 10.2 percent increased total production of grain was possible. Limit of profitability for optimum

level of deficit irrigation is when total costs of water and irrigation are $0.32US\$.m^{-3}$ water.

31. Supplemental irrigation for improving water productivity of wheat in northwest Iran

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Supplemental irrigation (SI) is a highly efficient practice with great potential for increasing agricultural production and improving livelihoods in the dry rainfed areas. In order to investigate the effects of irrigation and nitrogen on yield and its stability, this experiment was conducted as split plot arranged in a randomized complete block design (RCBD) with three replications during 1999-2002 for rainfed wheat variety (Sabalan) at Maragheh Agricultural Research Station of DARI. The treatments included four levels of irrigation (Rainfed, 1/3, 2/3 and 3/3 of full supplemental irrigation) and five nitrogen rates (0, 30, 60, 90 and 120 kg.N.ha^{-1}) applied split at planting time with 30kg.ha^{-1} P_2O_5 and topdressing later. Yields of rainfed conditions varied with seasonal rainfall and its distribution, with all main factors having significant effects. Optimal level of supplemental irrigation was 95mm water (1/3 of full supplemental irrigation). This combined with 60kg.N.ha^{-1} resulted in maximum water productivity (20.1kg.mm^{-1}). In spite of 20% reduction in yield in this treatment, maximum net benefit was obtained along with probability of 180% cropping area increase, which can lead to 74% increase in total grain production. The limit of profitability for optimum level of supplemental irrigation was 0.325US$.m^{-3}.

32. The effect of nitrogen on the yield of two wheat varieties under drought-stress conditions

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An experiment was carried out for three years starting from 1999 growing season at Karaj Soil and Water Research Station in Iran. Yields of wo varieties of wheat (Omid and Azadi) receiving three rates of nitrogen (45, 90 and 135 kg N/ha) under four different irrigation timings were compared. One half of nitrogen as urea was applied at planting and the other half as a sidedressing during tillering in spring. The main effect of nitrogen rates on grain yield was found to see significant at 1% level with yield increases up to the rate of 35 kgN/ha. The best results were obtained with irrigation at jointing, ear formation and milky growth stages. Eliminating irrigation at jointing caused the least harm to the yield level while eliminating it during ear formation produced the lowest yield. Azadi variety responded more effectively to fertilizer applications and to irrigation timing than Omid variety. The wheat yield increased with the number of irrigations with simultaneous improvement in the plant's response to fertilizer applications. Nitrogen at a rate of 90 kg /ha is recommended for yields of up to 4 tons/ha and at a rate of 135 kg /ha for higher yields. Nitrogen application did not increase the yield considerably when irrigation at the

time of ear formation was eliminated, while with irrigation at the three-stages, the yield increased in response to nitrogen application up to 135 kg N/ha.

33. Drip (tape) irrigation can reduce the risk in crop production in water-limited environments

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Drought stress is the major stress in many parts of the world. Yield reduction in crop plants due to limited water resources availability is frequently witnessed in large parts of the world. Increasing area under cultivation and productivity are the ways to increase production of crop plants to feed the ever increasing world population. The use of new cultivars, advance agricultural practices, and field management, such as new techniques in irrigation of field crops can efficiently decrease the risk of production and simultaneously increase the land resources availability. For example, with the same amount of irrigation water used in surface irrigation system, it is possible to irrigate almost double the area under cultivation of a crop with drip (tape) irrigation.

The present study was undertaken to investigate the possibility of tape (drip) irrigation in crops such maize, rapeseed, and wheat on field scale in areas facing water shortage. Various aspects of drip (tape) irrigation, its economic efficiency and water productivity were compared with the traditional (surface and sprinkler) irrigation in Kermanshah, Iran. Lateral length (m), lateral space (cm), and limited irrigation based on water requirement of crops were compared during 2002-03. The results revealed that in maize tape irrigation was significantly superior over the surface and sprinkler irrigation methods. The most efficient treatments were 80-90-60 and 80-120-60 (%water requirement-lateral length (m)-lateral distances (cm)) combinations. Economic evaluation of different treatment showed the yield superiority of treatments with 80% application of water requirement. On the other hand, it was clear that the tape irrigation system was much efficient than the surface and sprinkler irrigation systems. Water productivity of tape, sprinkler, and surface irrigation were 1.87, 0.82, and 0.6 kg/m3 irrigation water, respectively.

In wheat, the results revealed that in tape irrigation the most efficient treatment was 70-40-90 (lateral distances (cm) - %water requirement - lateral length (m)). Significant differences were observed between tape and surface irrigation methods. Though economic evaluation based on benefit/cost ratio revealed that the surface irrigation method is more economic, the water productivity of drip irrigation (2.57) was almost double than the surface irrigation (1.38), which is very important in water limited areas such as dry lands.

In rapeseed, no significant differences among the treatments were observed, therefore, the most efficient treatment was identified based on cost economy, i.e. 70-40-120 (lateral distances (cm) - %water requirement - lateral length (m)). Significant differences were observed between tape (1.44 kg/m3water) and surface irrigation (1.38 kg/m3water). Economic evaluation of tape irrigation system revealed its effectiveness and cost benefit in rapeseed.

34. *Gmelina arborea* and lemon grass based agroforestry system for sustainable development of degraded lands in Central India: an appraisal

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Wastelands constitute an extremely severe natural resource management problem in India. The acute pressure on land resources is quite evident especially in Central India. The geographical area of Central India, i.e. Madhya Pradesh, is 30.75 million hectare out of which 49 per cent is under cultivation and 19.3 percent is degraded land. Nearly one-third of the net sown area is unutilized culturable waste land, which can be brought under vegetative cover with reasonable efforts. The present paper advocates the role of *Gmelina arborea* and lemon grass based agroforestry systems for sustainable development of degraded lands. *Gmelina arborea* is a fast growing indigenous woody perennial tree species yielding timber, fuel wood and medicinally important root and bark. As a compatible component, lemongrass (*Cymbopogon flexuosus*) is a perennial aromatic grass, which is commercially cultivated for aromatic oil, containing 75-80% citrol.

Two months old seedlings of lemon grass were planted in rows (60 x 60 cm) in between tree row of *Gmelina arborea* under two planting geometry i.e. 5 x 2.5 m and 2.5 x 2.5 m. The tree crop interaction was evaluated by computing growth and physiological productivity parameters of both the agroforestry components. Under shaded condition of 5 x 2.5 m planting geometry of *Gemini arbor*, the growth and yield of lemon grass was found to be superior than close spacing of trees i.e. 2.5 x 2.5 m. This system not only provides the added biomas but also accelerates efficient nutrient cycling thereby halting the land degradation. It can be seen in phases as the development of productive agro-eco system and as an alternate land use system, particularly in fragile lands where farmers can manipulate and manage their degraded soils by growing trees and aromatic grasses for the services and/or for making products. The elaborate significant tree-crop interaction parameters quantified in the study clearly reveal the advantages of the system in improving soil conditions and boosting farm incomes under dry land situations.

35. Rubber and resin yield performance of *Parthenium argentatum* (A. Gray) as alternative crop for arid and semiarid areas

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In order to the develop guayule (*Parthenium argentatum* A. Gray) as a promising source of natural rubber for the semiarid regions of Iran, five lines of guayule were evaluated. Plant establishment, height, width, stem diameter, fresh and dry weight, rubber content, resin

content, rubber yield, resin yield were studied. All lines were established well (over 95%) except the line UC-100 (82.02%). Plant growth analysis showed that UC-103 produced the most vigorous plant growth with mean plant height and diameter of 63.25 cm and 2.9 cm, respectively, in the second year. The variation in spread was small and differences were mostly not significant. Fresh and dry weights varied greatly among the lines and line UC-103 produced the highest biomass, and line Cal-7 the least. Rubber concentration was highest in line UC-104 (9.35%) and lowest in lines UC-100 (4.67%). Resin concentration ranged between 6.9 % in line UC-104 to 10.30 % in line UC-100. Because of larger biomass of line UC-103, it yielded far more rubber and resin than other lines. The rubber yield of line UC-103 (38.31 g plant $^{-1}$) was almost double of the line UC-100. The rubber yield of Cal-7 was relatively poor (15.0 g plant $^{-1}$). Also the significant and positive correlation was found between rubber and resin yields on the one hand and the fresh and dry biomass of branches on the other hand. Rubber and resin yields were related to height too.

36. Experimental results of forestation in typical desertification areas of West China with water storage and controlled-release film

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In order to increase the survival rate of the trees planted in drought areas in West China, a project named "Water Storage and Controlled-Release Film (WSCF)" sponsored by the National "863" Program was carried out. WSCF supplies water to the roots of the trees with a controlled and steady rate. It would be enough for the trees to survive with only one irrigation. In five typical desertified areas more than 1 million meters of WSCF were tested and more than 1 million trees of 29 different kinds were planted. By the experiments carried out in Inner Mongol, Xinjiang, Hebei, Shanxi, Gansu, Shaanxi and Qinghai, it can be concluded that after applying WSCF, the survival rate increased by 20-40%, the irrigation cost cut off by 4/5-3/4, and about 1/40-1/20 of water was saved compared to the traditional ways.

37. Farming in the desert-advantage and limitation, the Israeli experience

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Only ten percent of Israel's population lives in its desert areas, which constitute about sixty percent of its total land area. Traditional agriculture in the desert, as practiced by the nomadic Bedouin population, is based on relatively small numbers of hardy livestock such as camels, sheep and goats kept on extensive pastureland, and on occasional planting of small amounts of low yielding drought resistant grain crops. Even though this traditional agriculture has been developed over thousands of years and it is well adapted to the harsh desert conditions, it nevertheless remains sensitive to climate excesses, such as frequently occurring droughts.

The topography of the desert and precipitation varies widely according to geographic zones, with every zone having its unique environmental characteristics. The main advantages of the desert are intensive sun radiation, wasteland and a very low population density. The main disadvantages are not only scarcity of water resources but also the high salinity, as well as frequently occurring extreme climate conditions. Modern agriculture is developed in the desert by using water from external resources, including the "National Water Carrier" transporting water from the Sea of Galilee, or recycled sewage water from the densely populated central urban part of the country. The local saline water resources are used for irrigating tolerant crops such as tomatoes, melons, grapes, olives, dates and others by drip irrigation systems. Also new crops like Jojoba, Pythaya and *Opuntia* cactus, and various flower crops have been successfully introduced. The harsh desert climate is successfully controlled by the greenhouse industry producing, mainly for export, off-season vegetables, flowers and herbs. Integrated Pest Management (IPM) methods are successfully applied, including zero cultivation periods, biological control, solarization and the release of sterile male flies for controlling the Med Fly.

The sand dune zone in the coastal area is made productive by successfully using recycled sewage water for irrigating citrus, avocado and mango plantations, and greenhouses for vegetable and flower production. For this purpose the most commonly used irrigation system is the integrated fertilization and drip irrigation system.

The hilly area with an annual precipitation of 200 mm, which was drastically eroded in the past, presently undergoes intensive reforestation. Advanced soil conservation methods and water harvesting methods are applied in this process. Livestock, such as dairy cattle, but also ostriches and Tilapia fish, are successfully raised under desert conditions.

The positive results achieved by developing modern agriculture in a desert region, can be mainly attributed to the human factor and a successfully managed Agriculture Regional R&D System, a system producing applied know-how and agro-techniques, as well as infrastructure and living conditions well adapted to the prevailing adverse environmental conditions.

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