

# Abstracts

## Eighth International Conference on Development of Drylands

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for Sustainable Development in Dry Lands

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## Table of Content

|                                                                                                                  | Page |
|------------------------------------------------------------------------------------------------------------------|------|
| Theme 1: Soil and water conservation and degradation ... ..                                                      | 3    |
| Theme 2: Dust-storm process ... ..                                                                               | 24   |
| Theme 3: Range management ... ..                                                                                 | 28   |
| Theme 4: Forage and livestock production ... ..                                                                  | 39   |
| Theme 5: Biodiversity and Ethnobotany ... ..                                                                     | 45   |
| Theme 6: Stress physiology ... ..                                                                                | 52   |
| Theme 7: Renewable energy ... ..                                                                                 | 62   |
| Theme 8: Indigenous/traditional knowledge and heritage ...                                                       | 63   |
| Theme 9: Sustainable development of oasis; desert communities<br>and socioeconomic studies; and role of NGOs ... | 64   |
| Theme 10: Application of new technologies and technology<br>transfer; crop improvement for dry areas ... ..      | 73   |

## **Theme 1: Soil and water conservation and degradation**

### **1. Effect of saline water management on rice production and soil improvement in salt accumulated rice fields**

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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<sup>-1</sup> throughout each season (T1), applying drainage water (DW) with EC of 4.69 - 5.2 dS m<sup>-1</sup> throughout each season (T2), applying MW up to the panicle initiation (PI) and then DW up to the end of each season (T3), and applying DW up to PI then MW up to the end of each season (T4). Water-management treatments were: water-saturated condition (0 cm water depth), 3 and 6 cm water depth with a watering interval of four 4 days. The observed parameters were: Na<sup>+</sup>, Ca<sup>2+</sup>, and K<sup>+</sup> contents in rice leaves, leaf area index (LAI), dry matter production per m<sup>2</sup>, grain yield, soil EC, soluble cations Ca<sup>2+</sup>, K<sup>+</sup> and Na<sup>2+</sup> at the end of each season.

All the parameters 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 T1 (with 6 cm water depth) gave the best results from the viewpoint of rice production and soil traits. Treatment T3 scored the second rank, followed by the treatment T4 and treatment T2 was at the last rank. The water-management treatment of 6 cm water depth reduced Na<sup>+</sup> and salinity level of saline paddy soil with the treatments T and T3.

### **2. Steps in protecting Gezira scheme against drifting sand in Sudan**

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The study investigated the main source of sand; the sand flux and duration; the physical potential of *Acacia tortilis*, *Leptadenia pyrotechnica*, *Prosopis juliflora*, *Salvadora persica* and *Panicum turgidum* to capture moving sand; and their establishment, survival and growth with and without protection from sand blasting and deposition. Remote sensing, on-farm experiments and field survey were the methods. The sand invasion (1972 -1985) was 34 km<sup>2</sup> per year. The origin of the sand is north Kordofan, through a corridor across the White Nile. The sand flux was 50 ton /100 m

width per month and the dune movement was 10 m per year. The planted species, with drip irrigation, in a field experiment were rated A-D for their establishing capability (A best D worst); and for erosion protection and for capturing drifting sand on 1-10 scale. They ranked as follows: *Leptadenia pyrotechnica* [A, 4, 10], *Acacia tortilis* [B, 1, 1]; *Prosopis juliflora* [C, 3, 9] and *Panicum turgidum* [D, 3, 9]; the first and second numbers refer to the rating for erosion protection and capturing drifting sand respectively}. Conclusions on design consequences for revegetation of such a completely desertified environment are drawn from the results.

### **3. Water resources optimization for the lower reaches of arid inland river basins in northwest China - a case study of Minqin oasis, the lower reaches of the Shiyanghe River Basin**

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Minqin Oasis is located in the lower reaches of the Shiyanghe River Basin, northeast of the Hexi Corridor, and at the middle of the Silk Road. It has always been an important green barrier to guarantee the eco-security of the Hexi Corridor and the Silk Road since thousands of years ago. But in recent decades, like many other oases in the lower reaches of arid inland river basins in northwest China, Minqin Oasis is disappearing due to water shortage. Therefore, the water resources planning and management for the whole river basin, especially for the lower reaches should be strengthened. As the runoff from the upper and middle reaches and the water transfer from other river basins have been allocated by the government, the total quantity of water resources in Minqin Oasis is fixed. Restricted by the total water resources, we take the maximum of water utilization benefits as the supreme target, and construct a System Dynamic Model to optimize the water utilization structure and industrial structure in Minqin Oasis, and water utilization for ecology, production, and domestic use is optimized. Results show that by simultaneous optimization, the water utilization structure system and the industrial structure system fit in with each other, and the ecology-production-domestic use system can realize sustainable development. So this paper provides an effective method for sustainable utilization of water resources in the lower reaches of arid inland river basins.

### **4. Management factors affecting flood water production in the national garden called Golestan**

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The studied area, located in Golestan province, has special conditions. There are a lot of factors related to the production of floods in this area. These are divided into three groups: climatic, edaphic, and management. Rapid survey with the people about their perceptions for the factors revealed that area affected by flood in Golestan can be

affected by climatic and management factors. Rainfall is the main factor affecting the flood. In the current year rain fell in larger amount in this area as compared to other areas in IRAN. The effect of management factor is also clear easily. Changes in land use and destruction of vegetations covers in addition to the losses in modified operation in watershed basin demonstrate that management is so important. This paper develops proposal as to how management can control the flood area. Some fifteen suggestions to reduce the dangers of flood are made.

## **5. The role of *Diplachne fusca* in saline – alkaline soil improvement**

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Salinity is one the most important productivity limitations in arid and semi-arid agricultural lands. The biological land improvement system by using tolerant plant species has been considered by countries like India and Pakistan in recent years. Plant species like *Diplachne fusca* have been introduced, which act as biological agents for soil and water improvement by absorbing the excess of mineral elements and producing forage usable for livestock. This plant is also able to improve and moderate the harsh saline and alkaline soil conditions for the subsequent crops in rotation.

## **6. Crop coefficients of sugarcane (ratoon) in Haft Tappeh of Iran**

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Crop coefficients of sugarcane are necessary for the water requirement estimation in irrigation water planning and management. This study was initiated to determine the crop coefficients (Kc) of sugarcane (ratoon) in Haft Tappeh sugarcane area, Khuzestan province, Iran. Main objectives of this research were to measure the crop evapotranspiration (ETc) using lysimeter; to estimate the reference evapotranspiration (ET0) using the pan evaporation method; and to compute the crop coefficients of sugarcane. The relationships between Kc, ETc/Ep, growth of sugarcane, days after cutting (DAS) and percent days after cutting (%DAS), were also investigated. Results showed that the seasonal ETc for sugarcane (ratoon) in the study area with an eight months growth period was 1925 mm and the pan evaporation method was preferable for estimating ET0. The mid-season and late-season Kc values for sugarcane were 1.45 and 1.14, respectively. These values are somewhat higher than those recommended by FAO. The ratio of ETc/Ep varied between 0.64 to 1.10, during the

period from the beginning to the end of the growing season The maximum ratio of  $ET_c/ET_0$  and  $ET_c/E_p$  occurred when the sugarcane was having a height of 126 cm. Furthermore, second order polynomials were presented to predict the  $K_c$  values from days after cutting (DAS) and percent days after cutting (%DAS).

## **7. Role of the olive tree in the reallocation of the land threatened by the desertification**

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The olive-tree is typically Mediterranean plant. It has a considerable ecological, social and economical importance. For its rusticity and adaptation flexibility, this species exceeds by far its ecological requirements. One of the most important factors delimiting the olive tree culture is the rainfall. Although 600 mm is the lower threshold required for its culture, this species also thrives in zones where the annual average rainfall does not exceed 112 mm. This is the case of Tunisia, where this tree is one of the pillars of the economy of the country. It is primarily concentrated in semi-arid and arid zones (350 to 112 mm rainfall average), characterized by very frequent irregularities and shortage of rain and by periodic drought cycles. The rationalization of the cropping of this species under such conditions (which until now is grown in a traditional way), must necessarily go through the evaluation and the aptitude and adaptive strategies of the main olive-tree variety (*Chemlali*), cultivated under these conditions. The morphological, anatomical and ecophysiological studies of several characters in connection with resistance to the dryness as well as the water consumption show us the great aptitudes of this variety to control the water loss and to manage the available water.

## **8. Interdecadal variability of seasonal frozen ground depth and Its Climatic Reasons in Hexi corridor of Gansu**

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According to the upper and lower limit of the depth of seasonal frozen ground, its main duration and ending date observed at 17 representative meteorological stations in Hexi corridor of Gansu province from 1958 to 2003, interdecadal variability of seasonal frozen ground depth and its relation with climate changing were investigated. The results indicated that the seasonal maximum frozen ground depth had 8~10a period oscillation. The inflexion date of the frozen ground depth emerged in the middle of 1980s, and the interdecadal variations showed the local warming trend in

winter since then. The significant cause affecting the seasonal frozen ground depth and its main duration is the minimum air temperature in winter. And melting of frozen ground and the ground temperature in winter present a negative correlation. We suggest that the changing of frozen ground in Heixi corridor of Gansu is associated closely with the difference in temperature 5cm under ground and air temperature 1.5m above surface, as well as with the daily range in winter.

## **9. Influence of check dam location on fine sediment retention**

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A study was carried out to assess the effectiveness of check dam location along the waterways in retention of the fine sediments. Five main streams with many stabilized cheek dams, more than 25-year old, in different parts of Droodzan watershed in southern Iran were selected. In each stream three check dams were studied along the stream: the first one at the very beginning (upstream), the second one at the middle and the third one at the downstream. Samples from retained sediment behind the selected cheek dams and also original soil in both sides of the corresponding dams were taken. Laboratory analysis on the size of particles and also texture of samples showed that in general, soil particle sizes and soil texture in both sides of check dams were more fine than sediments behind the corresponding check dams. Comparison of soil and sediment particle sizes showed in all streams except Joobkhaleh (with fairly extensive vegetation cover) showed that the performance of third check dam (down stream) in fine sediments retention is much better than the second one (at the middle); and the second one is more effective than the first one (upstream). Comparison of sand/silt and clay percent of sediment also showed that in all streams, except Joobkhaheh, clay and silt are more behind the third check dam than the second check dam and behind the second check dam are more than the third one (upstream). Same way, sands behind the first check dam was more than the second and third check dam respectively. In conclusion, if retention of fine sediments is the main purpose of check dam building, it is recommended to build it down stream rather than upstream.

## **10. Determination of a suitable method for runoff estimation – a case study of Taleghan Watershed**

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The knowledge of the depth and volume of runoff is important in watershed management. In watersheds having hydrometric stations, it is possible to measure the amount of runoff very easily, but in the watershed lacking the stations, the amount of

runoff has to be determined by the using empirical method. There are different empirical methods to determine the annual runoff amount. In this research, which was conducted in Taleghan watershed, in the north-west of Tehran, first by the use of 5 empirical methods (Longbein, Turk, Justin, Coutagne and Icar) the amount of annual runoff for each elevation class between 1970 and 1997 was determined. Then, considering elevation class area, the amount of runoff for the whole watershed was determined. Finally by the use of a t-test the determined and measured values were compared. The results showed that there are no significant differences between measured values and the amount determined by Justin method at 5% level of probability. But there was a significant difference between measured values and the amounts determined by Longbein, Turk, Coutagne and Icar methods.

### **11. Relationship between water quality parameters and flow and rain characteristics in individual flood events, a case study of Gharachai watershed**

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Today, water and water resources are considered as most vital human need. Agricultural, industry and human activity all have a role in water pollution. The knowledge about water quality parameters of a river, is important in assessing the effectiveness of the ecosystem of a watershed. In this research, which was conducted in Gharechai in Markazy Province of, Iran, the relationship between water quality parameters including EC, TDS, pH and sediment concentration in individual floods and flow and rain characteristics was surveyed. In four individual flood events, the EC, TDS, pH and sediment concentration were measured in samples collected at different time intervals. Then by using regression equation, the relationship between these parameters and peak discharge and excess rainfall was obtained. The results of this research showed that there is a low correlation between flood quality parameters and excess rainfall and there is a high correlation between flood quality parameters and flow characteristics (peak discharge) in Gharechai watershed.

### **12. Development of an automated suction controlled flux sampler for unsaturated sandy soil.**

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By application of improved fertilizer and irrigation system we are obtaining the agricultural products even in a sandy soil, which has low water holding capacity and low fertilizer retention. Agricultural activity is required in sand/sandy loam fields in the arid/semi-arid regions due to rapidly increasing population. A sandy field has the potential hazard of nitrate contamination or salt accumulation. Thus, accurate measurement of fertilizer leaching from the root zone is desirable. Sampling infiltrated water in a sandy soil is still a challenging task due to high variation in water content with small suction changes. A suction controlled flux sampler (SCFS) consisting of an automated vacuum system (AVS) and a sampling filter device has been developed to collect infiltrated water effectively without disturbing the infiltration stream line. An evaluation of filter materials showed that a glass filter (5-10  $\mu\text{m}$ -pore size) was the best for sandy soils. A sampling device with a selected glass filter was placed into the dune sand column and sampling conditions were examined. The water-collecting efficiency of the SCFS was excellent when the filter suction was controlled at 0 to 5 kPa ( $\approx 51$  cm  $\text{H}_2\text{O}$ ). The SCFS with the newly developed AVS could cope with stormy-rainfall as well as continuous long-term rainfall. The SCFS can also monitor the electrical conductivity of collected solution using a four-electrode sensor embedded in the sampling tube. Furthermore, the SCFS was applicable to long term field measurement without particular changing when we set it at the sandy field during shallot cultivation period. It is possible to monitor the fertilizer leaching in unsaturated sandy fields. By using SCFS together with sensors.

### **13. Precision of simultaneous determination of soil water content and solute concentration in saline sandy soil using dielectric soil moisture probes.**

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It is important to measure soil water content and salinity in space and time for proper management of agricultural soils. Many soil moisture probes based on dielectric constant are currently being marketed as measuring devices for irrigation management. A typical agricultural soil with good manure management has soil solution electrical conductivity range of 2 to 4 dS/m. The purpose of this study was to evaluate the precision of measuring the soil water content using commercially available soil moisture probes. Tottori dune sand and NaCl solution in range of up to 47dS/m were used as test materials in a calibration study. The influence of salt concentration on the measurement of soil water content was discussed. It was found that all commercially available soil moisture probes overestimated the soil water content when the salt concentration was high. We proposed a new technology using dielectric soil moisture probes to precisely and simultaneously measure soil water content and solute concentration in a saline sandy soil.

### **14. A study on the application of empirical equations in reconstructing the pan evaporation data a case study of Arazkuseh Station, Gonbad, Iran**

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In hydrology cycle, evaporation and transpiration are two reduction factors. They have an important role in changing the water supply and water budget in watersheds. In semiarid regions, up to 96% of yearly precipitation is lost by evaporative process. In our country majority of areas have arid and semiarid climate. So, this study was conducted. In this investigation, mean data on temperature, wind speed, numbers of sunny hours, minimum relative humidity, pan evaporation at Arazkuseh station were prepared monthly, for a-11 year period. Using empirical equations like those given by Torenth-waite and FAO Blaney-Criddle, the data of potential evapotranspiration was caculated monthly, seasonly and yearly. The data of class A pan evaporation was multiplied by pan coefficient. Thes data was used in statistical analysis.. The results showed that in some months and seasons Torenth-waite method and in other seasons FAO Blaney-Criddle could be used instead of pan evaporation and there is no statistical diffrence between them. In evaluation of yearly data there is no statistical difference between Torenth-waite data and the actually measured pan evaporation data, but between FAO Blaney-Criddle data and pan evaporation there was a statistically significant difference.

#### **15. A study on granulometry of sand dunes based on their dynamics – a case study of Khartooran, Iran**

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The studied area is located in southeastern part of Shahrood district between 55° 15' to 57° 15' E and 33° 15' to 36° 17' N. Sand dunes of Khartooran with an area about 165689 ha. is in southern part of Kale Shour basin. Texture and granulometric characteristic of sand dunes vary due to their dynamics (active, semi-active, fixed sand dunes). According to field observation and laboratory results, the amount of silt is more in fixed sand dunes covered with green vegetation than other dunes. The amount of silt in semi-active sand dunes is more than in active dunes. Also according to the results, eluviation of clay and silt in fixed dunes is more than in the other typess. This shows the effect of pedogenese in these sand dunes.

#### **17. Assessment and studying micromorphological and mineralogical charactricitics of some forest soils of Nowshahr Kheyroudkenar (Mazandaran province),Iran**

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The educational-experimental forest of Kheyroudkenar with 8017 hectare surface area is located about 7 km east of Nowshahr, Mazandaran province. This study included the soils genesis and development; physico-chemical and morphological characteristics of foregoing forest; mineralogical characteristics of the soils; micromorphological characteristics of the soil; compilation and confirmation the information of pedology with micromorphological and mineralogical studies; and exact classification of the soil.

Therefore, after primary study of the topography maps and with consideration of vegetative cover, climatic moisture conditions and calcareous parent material, some profiles were dug out from 30-1000 m above sea level and 6 profile on different physiography units were chosen for exact study. After field study of different horizons, disturbed samples were taken for studying physico-chemical and mineralogical characteristics and undisturbed samples for assessing micromorphological characteristics. Among soil forming factors climate, topography and plant cover appeared to be more important than other factors. Humification, decalcification, clay eluviation-illuviation, and gleization were the most important processes responsible for evolution of the studied soils. X-ray diffraction studies of the clay minerals showed that main clay minerals are: montmorillonite, vermiculite, illite, kaolinite, chlorite and hydroxyl inter layer minerals. The results of micromorphological studies showed that in subsurface horizons, argillic horizon, Fe and Mn nodules with clay film were present in many voids formed in juxtaposition and superimposed coating. High accumulation of clay in sub horizon of some soils was also seen. And finally change because of moisture supply were observed on textural, amorphous, crystalline and fabric pedofeatures in the soils.

#### **18. Effect of forest clearance and subsequent land use on erosion losses and soil properties in the Golestan National Park**

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As pressure on land and forest resources increases, there is a growing need to assess and improve the sustainability of slash-and-burn agriculture in Hyrcanian uplands. On steep hill slopes (24 to 32°) in the forest buffer zone of the Golestan National Park, following clearance of natural forest, the relative impact on surface runoff, soil erosion and soil properties of three land-use treatments: maintained weed-free without cultivation (bare); cultivated with herbaceous crops (agriculture); and cultivated with herbaceous crops and intercropped with *Pyrus boissieriana* contour hedges (agroforestry) was assessed over a 5-year period and compared with an uncleared secondary forest control (forest). The forest provided good protection against surface runoff (which was consistently less than 0.2% of rainfall) and soil erosion losses (less than 500 kg.ha<sup>-1</sup>.yr<sup>-1</sup>); agriculture caused a seven-fold increase in surface runoff and 21-fold increase in soil erosion. However, agro-forestry was effective in conservation of

water (45% reduction in runoff compared with agriculture) and soil (erosion reduced by 35%). The clearance of the secondary forest led to large changes in most measured soil properties. Over 5 years, concentration of organic matter declined by 31%, total N by 38%, exchangeable K by 47%, Ca by 43% and Mg by 56%; and over the same period bulk density increased by 48%. Of the soil properties more subject to year-to-year fluctuations, after 5 years, the concentration of available P was 36% less in cleared plots than in forest, exchangeable Na was 50% less and moisture content 43% less. Only total P concentration and pH were unaffected. Five years after forest clearance there was no good evidence that these changes had stabilized and very little difference in soil properties was found amongst the three land-use treatments. However, within the agro-forestry plots, exchangeable K, Na and sand concentrations became higher under the hedgerows than between them (by 14, 9 and 8%, respectively), whilst clay concentration became higher between them (by 9%). The results indicate that this low-input, contour-tree-hedgerow technology is effective at soil and water conservation through the sieve-barrier effect and increased water infiltration (respectively) and has the potential to enhance the sustainability of this land-use system at a plot scale.

## 19. Evapotranspiration over the grassland field in Liudaogou Basin of the Loess Plateau, China

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Serious desertification has occurred in the Loess Plateau of China since the seventeenth century from improper land use, which caused critical soil erosion and water shortages in the lower reaches of the Yellow River. It is very important to cover the bare land surface with natural vegetation for preventing the soil erosion. Evapotranspiration (ET) was estimated over the grassland (*Stipa bungeana*) in Shenmu country of the Loess Plateau during the growing season. ET is about 1 mm day<sup>-1</sup>, and the ratio of ET to reference Evapotranspiration (ET/ET<sub>0</sub>) is below 0.3. Evaporation from the bare soil surface simulated by three-layer soil model is smaller than the ET (i.e. the ET is 1.5 times as large as evaporation from the soil surface during the growing season). The relationship among the surface resistance  $r_s$  in the Penman-Monteith equation, solar radiation, vapor pressure deficit, temperature, wind speed, and soil water content were examined. The  $r_s$  is strongly affected by the vapor pressure deficit and soil water content. These results indicate that the *Stipa bungeana*, which is a dominant species in this district, adapts well to environmental conditions in the semi-arid region.

## 20. Water management to prevent salinization of irrigated lands under rice-based cropping system in the lower Syr Darya Basin

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In the Lower Syr Darya region of the Aral Sea Basin, irrigation-induced salinization of irrigated lands has been a crucial problem. To clarify the mechanism of land salinization, studies on water and salt behavior were carried out in an irrigation block where rice-based cropping system has been practiced. Results of on-site studies are summarized as follows: 1) Due to excessive amount of irrigation with slightly or moderately saline river water to rice fields, dissolved salts remained mainly in upland fields in the block and its periphery. The change of salt accumulation rate was dependent upon the scale of annual change in cropping pattern. 2) A remarkable finding was obtained on the salt behavior in shallow soil layers of rice fields. Accumulated salts in the shallow layers are leached under unsaturated flow condition at the beginning of irrigation season. Then, the subsequent gradual rise in groundwater with dissolved salts from salt accumulated layer at around 1.8 m depth as well as the mixing of the downward flowing water with the saline water in that remains in the finer soil pores combined with the concentrating effects of crop water uptake is likely to induce the gradual increase in soil water salinity in the shallow layers. This finding contradicts the hypothesis that rice cultivation practiced in arid areas is effective for leaching salts already accumulated in the soil. 3) Because of the movement of percolated water from rice fields, the rise of groundwater table and the salt accumulation are accelerated in the adjacent upland fields. Thus mixed cropping with rice and upland crops in an irrigation block accelerates waterlogging and salt accumulation in upland fields in the block. 4) Based on the obtained findings, several measures for preventing irrigation-induced salinization were recommended from the viewpoint of water management.

## **21. Causes and trend of ecological environment change in Hunshandake sandy land and its surrounding regions, Northern China**

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This paper reports research on ecological environment change and its causes and trend of steppe, sandy land and reclaimed steppes in the north of China, using diverse sources of data including aerial photos, MSS images, TM images, topography maps and a lot of statistical data and local literatures, field investigations and experiments, based on GIS platform. We found that ecological environment was experiencing huge change under the combination of climate change and irrational human activities. Regional climate change is evident through rise in temperature and gradient difference in precipitation among different regions. Temperature is obviously rising during the last over 40 years, its average value in 1990s had increased by about 1.5 °C than that in 1960s, and rainfall presents huge fluctuation and no obvious trend, while fluctuation of relative humidity has gradually increased along the rainfall gradient from east to west. Human activities have double-sided function, and their role vary with time. As the local residents and governments were short of enough experience and knowledge on their surrounding natural environment during the past, in addition, human behaviors often presented lag effect, which coincided with drought, the sandy desertification strongly spread, and it even induced frequent dust storms, especially when adverse climate conditions coupled with irrational human activities. Field investigation show, with the attention of governments and individuals at every social level regarding ecological environment, many protective efforts are being carried out,

and local sandy desertification lands are recovering or are getting ameliorated to vary degrees.

## **22. A study on morphology of sand dunes in order to determine prevailing wind direction - a case study of Khartouran Erg**

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Common landforms of Iranian desert zone landscapes are sandy deserts and sand dunes covering considerable area.. They are called *Ergs*. One of these Ergs is Kharturan Erg with an area of about 200,000 hectares, located in northeasrern Iran. The geomorphology studies have been done on Kharturan Erg from morphological view points on sand dunes and the prevailing wind direction. These studies have shown that Kharturan Erg has the active depositional dunes structure and it has two types of sand dunes: crescent type and transverse chains and linear or elongated dunes. The first type contains a prebarchanic landform, barchans and transverse dunes. The second type contains simple linear dunes (Seif) and bcomposite forms (silk). Analyzing of sand dune forms show that the prevailing wind blows from North and North-west direction.

## **23. Studying the credibility range of Dupuit-Forchheimer assumption in prediction of steady unconfined flow to a horizontal drain**

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Using Dupuit-Forchhaimer (DF) assumption for prediction of the steady-state flow to a horizontal flow make it very simple and applicable. In order to study the credibility range of DF assumption in prediction of steady-state flow to an infinite horizontal drain with a finite radius in an unconfined aquifer with variable thickness, we used analytical element method together with Genetic Algorithm (GA). We first determined the water table position by use of the GA optimization method, which is carried out by satisfying the zero pressure and perpendicularity of iso-potential and iso-pressure gradient on the water table. We then proposed two methods to calculate the flow rate to the drain. The first method determined the flow rate based on the water table elevation using Dupuit-Forchhaimer assumption. The second method determined the flow by differentiating the hydraulic head. We found that the flow rates calculated from these two methods agree to each other, specially in regions that are more than 1.8 dimensionless distance from the drain, where the dimensionless distance is defined as the ratio of distance over the drain elevation. The functionality of the flow rate in respect to different hydraulic head of the constant-head boundary,

drain radius, drain elevation, and the distance to the constant-head boundary is also studied. We also found that when the dimensionless distance between the constant head boundary and the drain center is about 10-12, DF assumption will results in almost exact flow rate.

#### **24. Sediment transport in littoral zones and its effect on the variation of topographical conditions of coast**

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Sediment transport is one of the most important processes of coastal areas. This process affects shoreline displacement and beach erosion and therefore causes variations in the topographical conditions of coastal zones. The waves dissipate their energy when they move and break near the shore. The current made by the waves transfers the sediment in littoral zones. Sediment transport is a complicated process because of interaction between factors such as waves, currents, tides, geological and topographical conditions, winds and the works of man that changes littoral zone. Therefore we can not predict the variation of topographical conditions of coast, accurately. There are few formulas that investigate the topography variations of coast and we can use them in coastal projects and studies.

#### **25. Micromorphology, SEM and genesis of some of saline gypseous soils of Bam area of southeastern Iran**

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Gypseous soils are a major part of the vast extensive soils of arid and semiarid regions of the World. However, there is a limited information on the mechanism of genesis, morphology and micromorphology of gypsum. This investigation was carried out to characterize the existing forms of gypsum crystals and more soluble salt minerals in some soils from southeastern Iran. Eight profiles were described according to soil survey manual 1993. Saline gypsic horizon (2Byz) with 60% gypsum and EC of 130 dS/m was observed at the depth of 5-15 cm and a saline petrogypsic horizon (3Byzm) with 20% of gypsum and higher EC (180dS/m) was underlain by the 2Byz horizon. Beneath the 3Byzm horizon, the 4Byz horizon with lower gypsum and EC was observed in all the studied pedons. The salts were classified as Petrogypsic Haplosalids according to Soil Survey Staff (2003). Physicochemical and micromorphological characteristics were determined using standard methods, EDS assisted SEM was used for detailed morphology and determination of minerals

composition. Pedogenic acicular and elongated fibrous crystals of gypsum in 2Byz horizon, lenticular gypsum in 3Byzm and long gypsum pendants with layered structure in thin sections of 4Byz horizons were frequently observed. Cubic Halite crystals as infillings of voids and engulfed by gypsum crystals were observed in thin sections of 3Byzm horizon. Considering the co-distribution of gypsum in relation with more soluble salt minerals at different horizons of the studied pedons, it appears that gypsum pendants, interlocked fibrous gypsum crystals at the 4Byz horizon have been formed under more humid climate, while 2Byz and 3Byzm horizons belong to present climate. The solubility of gypsum in 3Byzm horizon is controlled by low annual precipitation, high mean annual temperature, gypsum and halite enriched parent materials and ion effect of NaCl. Capillary rise of dissolved gypsum accompanied with halite followed by their redistribution due to evaporation, causes to form the 2Byz horizon near to the soil surface. SEM and EDS analysis satisfy the hypothesis of upward movement of gypsum and soluble salts from upper parts of 3Byzm horizon, while rapid leaching of more soluble salts to 3Byzm horizon causes to higher concentration of gypsum at 2Byz horizon.

## **26. Study draught trend in Isfahan Province. Iran**

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The drought consists of lack of rain in a long-term period so that it causes decrease in soil soil and lack of runoff. It changes the natural trend of human action, vegetation and animal living.

In order to determine the trend and frequency in drought occurrence in Esfahan province, we used 3, 5 and 7 year moving average over the period for thirty years [1970-1998].

The results show that drought is not clear in the west of the province and its process shows the normal state. As we go through the east of the province, the climate oscillation become more intensive and in central province, the drought presented itself more intensively and after a period of sufficient humidity. Maybe, drought will continue to occur in the future years. In the east part of the province drought occurred after 1981-82 and continued up to 1998 and would continue in the future years. The drought in the eastern part of the province has been more intensive and has continued longer as compared to west and central regions of the province. This would be the case in future as well.

## **27. Factors affecting formation of water-stable aggregates with sandy soil**

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Improvement of soil properties is beneficial for tree planting and food production in arid lands. Especially, water conductivity and water-holding capacity of the soil should be improved in these lands. To improve the two parameters simultaneously, the development of aggregates is necessary. Especially, the water-stable aggregates are important for agriculture. Several investigators have reported contributors to aggregates such as clay, humus, oligosaccharide, phenol compounds etc. However, the direct proof that those factors contribute to aggregates formation has not been reported. Therefore, in this paper, the degree of the contribution of those factors to aggregates formation has been quantified with sandy soil. Several materials (clay, oligosaccharide, humus, phenol compound, etc.) were examined for their effect on the formation of water-stable aggregates with sandy soil. The findings are as follows: 1) It is confirmed that water-stable aggregates is able to be formed even by using sandy soil as basic material; 2) It is suggested that oligosaccharide plays an essential role in the aggregate formation, and that humus reported as an important factor of aggregate formation does not contribute to the formation; and 3) Clay and silt (diatomaceous earth) synergistically interact with oligosaccharide in the aggregate formation. It is suggested that clay and silt are not able to contribute to aggregates alone, but they help the aggregate formation by oligosaccharide.

## **28. Effects of precipitation fluctuation on water table variation in Varamin Plain of Iran**

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Varamin plain, located in southeast of Tehran, is an arid region and has intensive cultivation. Lack of adequate surface water, inappropriate application and over-exploitation of ground water resources over past decades have lead to withdrawal of water table in this region. This research attempts to investigate the effects of precipitation fluctuation on water table variation in Varamin plain using the trend between these factors to find any probable correlation. Based on the results of current research over a period of 1964-2002, water table of the plain has withdraw with on annual average depth and total depth of 0.67 m and 22.33 m respectively. Also, the precipitation over the 38 years of study shows high variability without any trend. Also, the research determined that there is no significant correlation between the variables. It appears that annual precipitation does not directly affect the water table. Meanwhile, it shows that other factors such as inadequate surface water resources especially in Gajroud and high rate of exploitation from ground water resources without considering technical recommendations are responsible for water table withdrawal even in years with normal precipitation.

## **29. The effect of water flooding on soil characteristic and vegetation cover in south of Iran, a case study of Boushehr province**

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The large part of Iran is covered with desert and steppe and the main problem in these areas is that of availability of water supply. One of the methods for water supplying is the application of water flooding. This is able to control and use the surface water that results in enrichment of local ecosystems. The work reported here was conducted at the experimental station located in the northern side of Persian Gulf, situated between 51° 17' to 51° 20' E and 28° 55' to 29° 06' N, having warm and dry climate, with an average annual precipitation of 250 mm, average temperature of 25 °C and average annual evaporation of 2850 mm. The study basin has an area of 97 km<sup>2</sup> with 1200 ha on which flood spreading is possible. In this plan, plantation by different plant species such as *Eucalyptus* sp., *Ziziphus spina-christii*, *Prosopis spesigera*, *Acacia* sp., *Rhoenix dactilifera*, *Calotropis prosera* and other species was carried out with 120,000 trees.. Because of the water flooding plan, plants species specially *Ziziphus* and *Prosopis* (endemic species) have good natural regeneration, wind erosion is controlled, gully erosion is decreased, ground water surface has gone up by 80 cm/year and finally these changes has resulted in reclamation of 2000 ha of the area.

### **30. Application of vegetation information to estimate soil characteristics in arid environment - Estimation of spatial variability of soil permeability and soil layer thickness in Western Australia**

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Spatial variability of soil characteristics such as permeability and soil layer thickness controls the availability of agricultural land in arid environment. Soil permeability governs infiltration and runoff occurrence. Soil thickness of the surface layer above the underground hardpans is also significant because the hardpans limit water movement and root growth of vegetation. However a spatial variability of soil characteristics is often difficult to be evaluated especially on large scale. On the other hand, vegetation information on large scale may be easily obtained by application of the remote-sensing technique. Furthermore, vegetations in arid environment are greatly affected by water and soil conditions, and it is considered that some vegetation information have close relations with the permeability and the thickness of soil. This study presents an example of large scale estimation of soil characteristics information from vegetation information in Leonora, Western Australia. To obtain parameters on various kinds of soil permeability indices, double-ring infiltrometer tests were performed in 23 sites. Thickness of the surface soil layer was measured at 54 sites. At the same measurement sites, canopy coverage and stand biomass were measured as vegetation information indices. A biomass distribution map in the whole research area was also made by satellite images and aerial photographs. Linear regression analyses

were carried out to evaluate the relationships between those indices. Results showed that almost all indices of soil permeability and thickness have high correlations with the vegetation indices. Some of the correlations were enough high, so we can estimate the soil information from the vegetation information. Soil permeability and thickness of the surface layer in the whole research area may be estimated from the biomass distribution map.

### **31. Decreasing of environmental risk and improvement of soil condition by suitable management methods of plant remains at sugarcane farms**

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In this research the effects of some management methods of plant residues, specially restoring of sugarcane remains, and its effect on soil character in some countries were investigated. Returning sugarcane residues to the soil had good effect on soil, especially on heavy and light soils. Some of these effects are improvement of environmental conditions, decrease in anxiety of environmental risks, increase in production efficiency and decrease in soil erosion and evaporation. However, applying of GCTB method in farms has some limitations like ground problems, ratooning operation, farm recovery and irrigation.

### **32. Land use and desertification in the agro-pastoral ecotone of China**

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Desertification is a pressing environmental problem in China, especially in the agro-pastoral ecotone. Land use as the dominant anthropogenic activity to alter earth surface, has a great influence on desertification through a series of hydrological and biogeochemical processes. In order to document the desertification status and causes in this ecotone, we interpreted and analyzed the NOAA/AVHRR in 1983, 1990 and 1999 respectively, and classified six land use types based on NDVI. Results showed that the forest and grassland decreased by 50%-60%, while the cultivated and desertification areas increased by 60% and 300% respectively, and the desertification land occupied 2.93% of the total land of this zone. In addition, the cultivated lands would be degraded in short period due to lack of necessary protection in this zone. So it can be concluded that the irrational land use such as over cultivation, over grazing and over cutting, are largely responsible for the desertification development. In order to realize the land rehabilitation and harmony between environment protection and economic development, several suggestions especially the ecologically oriented land use are proposed.

### **33. Feature of seasonal rainfall and estimation of normals of monthly precipitation on the Loess Plateau of China**

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We proposed a simple statistical model to estimate the normals of the monthly mean of precipitation by using topographic factors calculated from the Digital Elevation Model (GTOPO30; USGS) on the Loess Plateau. This study first analyzed the relationship between the spatial distribution of monthly precipitation and aerological observation data to clarify the climate elements that dominate seasonal rainfall. Next, we analyzed the topographic elements that dominate seasonal rainfall on a local scale by using various topographic factors. Finally, we suggested a statistical model to estimate normals of the monthly mean of precipitation over the Loess Plateau, and made the maps of normals of monthly precipitation. Some rainfall occurs from spring to autumn on the Loess Plateau. The increase and decrease of the precipitation corresponded to synoptic seasonal changes in spring and autumn. It is thought that the synoptic disturbances on the polar front causes the rainfall. An ascending air current (a upslope wind) is generated by compensation air flow in the lower layer of the atmosphere when the middle layer of the atmosphere warms by the heating of the Tibet Plateau from spring to summer. This upslope wind causes stable rain on the western side of the Loess Plateau. In summer, a wind flow with the Indian southwest monsoon flows from the Bay of Bengal to the Loess Plateau, through the eastern edge of the Tibet Plateau. Topographic factors analysis revealed that much rain occurs in places with the following topographical features. A large mountainous region is located from the northwest to the east, but the topography is open to the southeast and the southwest. Under such topographical conditions, the wind flow due to the Indian southwest summer monsoon flows in easily, and rainfall is readily generated through the dynamic process of an ascending air current.

### **34. Nitrogen fixation by cryptogams in arid and semi arid environments, a case study from Iran**

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The study was carried out to find the effect of cryptogams (lichens and mosses) on nitrogen fixation in Qara Qir region, North of Aq Qala, in Iran. For this purpose, soil samples were taken from crusted (including lichens and mosses) and non-crusted areas. Soil sampling was done along each of two transverse 300m transects. Along each of transects, with 20m intervals, soil samples were collected from the upper soil layer (0-5 cm), where soil is mostly affected by cryptogams. Arbitrarily, beside

transect (left or right side), soil of the nearest non-crust area was taken for comparing. Results showed that there was a significant difference between amount of N in crusted and uncrusted soils. Nitrogen level in encrusted soils averaged about twice of uncrusted areas.

### **35. The shift of interaction between vegetation and its habitat from negative to positive with desertification**

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Desertification is invading the home and cities of the people living in arid areas. The interaction between vegetation and its habitat is an important ecological process in desertification. We hypothesized that the property of feedback between vegetation and its habitat may shift from negative to positive at a threshold with desertification. The theory was checked by a series of measurement along the ecotone between oasis and desert in the oasis of Heihe and Shiyanghe, northwest China. The process of desertification was simulated by the spatial gradient of desertification from oasis to desert. The exchange of energy and materials between surfaces of soil-plant-air, pattern of vegetation and the environment of its habitat was investigated.

The hypothesis was supported by results which showed that: (1) There is notable negative relationship between vegetation (such as rate of growth, flux of energy and material between soil-plant-air surface etc) and the related index in habitat in oasis; (2) The total property of the feedback between vegetation and habitat shifted from negative to positive along the ecotone from oasis to desert; (3) The interaction among individual plants shifted from negative to positive; with that the pattern of vegetation changed from even, strip, to patch along the ecotone; and (4) The shift of interaction from negative to positive is an important threshold at which the ecosystem change its direction of development. The ecosystem developed towards a healthy state (such as maximum coverage of vegetation) when the interaction is negative, and toward desertification when positive. The interaction between ecological processes such as vegetation and arid environment may be a key to understand the desertification and environmental change.

### **36. Hydrological characteristics of a dam farmland in the Loess Plateau of China**

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In the Loess Plateau of China, many dam reservoirs have been filled up with sediments mostly within one or two decades after the construction because of serious soil erosion. Filled reservoirs consist of fertile soils, so farmers use those reservoirs as dam farmlands. However the water supply of the dam farmlands usually depends only

on rainfall and overland flow. The economical condition cannot afford advanced irrigation system. This study deals with hydrological observation at a small dam farmland in the north of Loess Plateau. Rainfall, groundwater level, soil water content and discharge of a tributary at the upper boundary were observed. Numerical simulation on soil water movement was carried out to recommend a suitable way of the irrigation. Discharge of the tributary was recognized only in case of intensive rainfall and runoff water came into the upper side of the dam farmland. Overland flow passed through on the ground surface, so soil water content at shallow layer did not increase. Soil water content increased at deep layers prior to shallow layers. The lateral inflow to deep layer of the dam farmland was supposed due to the layered geological structure. High water content, almost saturated water content, at layers above the groundwater level was observed because of high capillary rise in clayey soil. From the view point of the hydrological characteristics of the dam farmland, the water harvesting method can be recommended as an economical and efficient way of the irrigation. Overland flow is intercepted and driven into the subsurface layer as groundwater recharge. High capillary capacity of clayey soil supports water supply to the root zones of plants from the groundwater level.

### **37. Application of a remotely-sensed index to detect desertification in Tibetan Plateau**

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Changes in climate and land management practices in Tibetan Plateau have resulted in grassland degradation and led to desertification. Desertification has become a major environmental and economic problem in this region. Therefore, there is a need to map the spatial and temporal distribution of desertification in order to understand how climate and human activities affect the ecosystem in Tibetan Plateau. Remote sensing provides a means to derive land surface properties. However, there is lack of indicators for detecting desertification using remote sensing imagery. In this study, we developed a new approach to combine information contained in the albedo-NDVI space and formed a new index, which is used to identify the severity of desertification. Linking this index with field survey, remotely sensed indicators of desertification can be derived and spatial distribution of desertification can be mapped on regional scale. Using this approach we monitored the extent and severity of desertification in study area from 1986 to 2000.

### **38. The studies of water resources utilization and ecology /-environment safety in northwest China**

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Northwestern China includes Xinjiang Burgh, Qinghai Province, Gansu Province, Ningxia Burgh, Shanxi Province, covering  $308 \times 10^5 \text{ km}^2$ . It is located in the warm-temperate zone and the climate belongs to arid or semi-arid. The precipitation is very little but the evaporation is extremely high. The climate is dry, the water resources are lacking, the ecological environment is weak, and the distribution of water resources is uneven. In this area, the precipitation is the only water input, and evaporation is the only output in Inner River, and precipitation, surface water and groundwater change with each other for many times, which benefit the storage and utilization of water resources. The average precipitation in the area was 232mm, folded total precipitation amounted to  $7003 \times 10^8 \text{ m}^3/\text{a}$ , the surface water resource was  $1891 \times 10^8 \text{ m}^3/\text{a}$ , the total natural groundwater resource was  $1150 \times 10^8 \text{ m}^3/\text{a}$ , the total adoptable water resource was  $438 \times 10^8 \text{ m}^3/\text{a}$ , and the total water resource was  $1996 \times 10^8 \text{ m}^3/\text{a}$ , per capita water resource availability was  $2278 \text{ m}^3$ . The water resource of the whole area is  $5.94 \times 10^4 \text{ m}^3/(\text{a} \cdot \text{km}^2)$ , which is only one fifth of the mean value in China. Now, the adoptable water resource is  $876 \times 10^8 \text{ m}^3/\text{a}$ , of which groundwater is approximate  $130 \times 10^8 \text{ m}^3/\text{a}$ .

### **39. The ion chemistry of natural waters in the Taklamakan desert, southern Xinjiang, China**

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Water quality and its temporal and spatial variations are of great significance for the sustainable development in the dry lands. In order to have a complete picture about the ion chemistry and the origin of ions in water in the south Taklamakan desert, we sampled both surface water (from rivers) and groundwater in 2003. The groundwater samples were taken from domestic wells in the oases. In the water samples, major and minor ions as well as the rare earth elements (REE) were examined by an ion chromatography and an ICP-MS, respectively. By comparative study of the REE and the minor elements we intended to trace the groundwater flow in the desert. Our chemical investigation showed that the concentration of various ions varied considerably within the Taklamakan desert both in the surface water and in the groundwater. Principal difference between rivers water and groundwater was recognized. Our analysis suggested that the ions in the water came mostly from the solution of bedrocks and evaporates, which may change locally, and not from the atmosphere. To date the degree of contamination caused by human activities is fortunately still low in the study area.

## **Theme 2: Dust-storm process**

### **1. Spatial distribution characteristic of dust in Northern Pacific -a simulation study**

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The dust aerosols, as a kind of aerosols of inverse-greenhouse, from the Asia dust storm provide fine particles to partake of the continent-ocean biochemical cycle in the Northern Pacific region. Studying on the spatial distribution and deposition of dust fluxes will be helpful to understand the significant impact on chemical and biological processes in the oceans. Based on the observation and simulation for a strong dust storm event at April 2001, the results show that the dust storm from mid-Asia can transport the fine dust particles to Korea, Japan, the Northern Pacific and Northern America through westerly jet. In the Northern Pacific region the dust deposition fluxes spatial distribution is dependent on some aspects as following: 1) it decreases exponentially with increase in transport distance, 2) the higher dust deposition fluxes occur over the trans-Pacific transport pathway, and 3) the dust deposition flux spatial distribution is mainly dependent on the precipitation spatial distribution during the dust storm.

### **2. Dust and salt transportation in the Aral Sea area during dust storms**

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One of the main aspects of Aral Sea problem is a wind transportation of salts from the drained bottom on to the surrounding territories. For the region with agrarian economy such as southern Aral Sea area, the salinization of soil has extremely unfavorable significance. Some 100 million. tons of salt might be annually falling out on the territory. In this connection, there is an urgent need for a detailed investigation of wind transportation of salt from the drained bottom of the Aral Sea. The application of quantitative methods has so far been limited to the empirical formulas and, at the best, by the simplified mathematical models with narrow area of application. Two main directions in the study of problems of the atmospheric diffusion are now defined. They are the statistical theory and theory of gradient transportation. The statistical models are based on setting of statistical connections between the concentration of impurity on the one hand, and source power and meteorological parameters – on the other hand. The most frequently used statistical models are box models and models of Gaussian plume. The work reported here is an

outcome of numerical experiments describing the developmental process of salts spreading in low layers of atmosphere during dust storms. The experiments were conducted for southern Aral Sea area. The sources of salt transportation in small saline lands represented as point sources. The sizes of particles of salt are equal to 10-20 microns, the average density of particles is  $1,8 \text{ g/m}^3$ . As the main salt transportation happens during dust storms, the large part of experiments was conducted for wind speeds equal to 7-10 m/sec under different meteorological parameters. The following characteristics of salt spreading in atmosphere were recognized through this study: (1) The critical speed of wind with which the horizontal scales of acute pollution reach hundreds of kilometers, is equal to 7 m/sec. (2) Maximal gradients of concentration are observed on the area of dust storm spreading. (3) The hysteresis of the area of dust storm spreads at small heights in comparison to higher layers of aerosol stream. (4) When the large speeds of wind are observed, the trace of pollution from small sources represents the laminated stream with the angle of divergence no more than  $3^\circ$ . (5) During dust storm with the average speed equal to 16 m/sec, the concentration of salts integrated on height reaches  $600 \text{ mg/m}^2$  near the source and  $80 \text{ mg/m}^2$  - at the distance of 100 km. (6) The minor concentration of salts – approximately  $15 \text{ mg/m}^3$  on the upper border of rated area allows to assume that the main transportation occurs in the lower two-kilometer atmospheric layer. (7) The distance of salt transportation from the drained bottom of the Aral Sea reaches 300-400 km during dust storms.

### **3. Experimental study on the characteristic of wind-sand movement on a bare furrow**

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The paper reports the results of an experiment on the wind velocity, the ground temperature and the amount of erosion, measured by hand anemometer, JY222-geothermometer and SC-I sediment collector on bare furrow in an agricultural cross bedding in north Yin Mountain of Inner Mongolia. It analyzed the factors affecting, and movement characteristics of, wind-sand movement based on measuring the amount of wind erosion in different wind velocities. The elementary data about sand starting velocity, variation in height, wind velocity and the amount of wind erosion, which can show the law of wind-sand movement, was obtain. It showed the difference in wind-sand movement between the bare furrow and the desert based on the study on the wind-sand movement law. The study lays foundation for dynamic wind-sand movement characteristic of bare furrow.

### **4. A study on the 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 researches. However, slope is also an important factor 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 blows 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 slope gradient as well as particle position have effects on the initiation of sand particles.

## **5. Artificial recharge in semi-arid region for sustainable development, a case study**

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An attempt has been made for the recharge of ground water in the Dhar district of the largest province of Madhya Pradesh of India through the soil and water conservation process for sustainable development. The region selected for the investigation is predominantly tribal district in the western part of the province of Madhya Pradesh having area of 8,153 sq. km. Hydro-geologically the region is occupied by basaltic lava flows of Deccan traps having very little natural recharge. Due to over exploitation of ground water and degraded forest cover the region experiences scarcity of drinking water and increased run-off and soil erosion. Geo-hydrological mapping and geo-electrical surveys were undertaken for understanding the aquifer geometry and to design the suitable cost-effective water conservation structures, which would enhance the ground water level and supply water for drinking as well as irrigation. Following the hill to valley approach the area of the region is treated through suitable soil and water conservation processes on watershed basis. This has resulted in the elevation of ground water levels and sustainability in drinking water and livelihood.

## **6. On near surface wind velocity affected by different cultivation modes in agri-agrigrating ecotone, Inner Mongolia**

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The results of this field experiment in Taipusi County, Inner Mongolia indicate that the different cultivation modes result in differential near-surface wind velocity. During the growth of crop, roughness and friction velocity are increased with the growth of crop in nine tillage modes, such as no-till, subsoiling, conventional plowing, plowing with stalk mulch, surface plowing and four ridges modes. The mean roughness and friction velocity of plowing with stalk mulch was the largest, being

24.21cm and 0.81m/s respectively, and it prevented the soil erosion the best. While the mean roughness and friction velocity of no-till was the smallest, being 8.21cm and 0.62m/s respectively, its ability of preventing soil erosion was the poorest. In fallow period, roughness and frictional velocity of ridge tillage 25cm (1:6) and high stubble of wheat (height of stubble 45cm) was largest, and its ability to prevent soil erosion was the best of eleven tillage modes. Conclusions were drawn in this paper to control wind erosion of dryland agriculture in agri-grazing ecotone.

## **7. Time series fractal characteristic and tendency forecast of the severe dust storm in North China**

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Dust storm is a kind of catastrophic weather, which is caused by the specific circulation background and weather system under the specific geographical environment. Because the severe dust storm can carry a mass of dust and sand to the farther distances, it often brings serious danger to the properties, lives, and even the regional social and economic development. This paper analyzes the fractal characteristic of the time series in recent 49 years of severe dust storm by the phase space rebuilding method. Then, the R/S analytical method was used to predict the mutative tendency of the severe dust storm. The result showed that: (1) The time series of the severe dust storm from 1954 to 2002 in North China has fractal characteristics and its correlative dimension is 3.34. That is to say, we need 4 state variables to describe the mutative tendency of the severe dust storm and to set up the research model of the dynamical system at least. The Kolmogorov entropy of the time series is 0.1142, which indicates that the dynamical system is chaotic and the forecastable time period is about 8 to 9 years. R/S analysis showed that the Hurst indexes can reflect the rule of severe dust storm that had happened. So, we can forecast the mutative tendency of the severe dust storm in North China with the aid of the Hurst exponent.

### **Theme 3: Range management**

#### **1. Improving rangeland plants health in relict dry farming in grassland type**

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Rangelands contain various plants that have evolved to tolerate naturally occurring stresses. Change in rangeland land use to dry farming is the most important factor in disturbing rangeland in Iran. Land cultivation disturbs the habitat and changes the rangeland condition. Over time, re-establishing the vegetation improves the rangeland health. Vegetation health have important role in range management. Therefore in this study, grassland selected in the Orazan region and currently cultivated land and relict area that were cultivated in the past years were chosen and the result compared with reference area. In each treatment, using 9 indicators (soil surface resistance to disturbance, soil surface loss and degradation, soil compaction, structural and functional groups, plant mortality, litter amount, annual production, invasive plant, perennial plant reproduction) the vegetation health was investigated. Results show that cultivation reduces the vegetation health and in relict area during the time this attribute does not have significant differences with cultivated area. This result show the large disturbance that has occurred with cultivation and it is time consuming to get the area e re-vegetated.

#### **2. Determination and comparison of forage quality of five range species in semi-arid rangelands of Alborz(Iran)**

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In order to evaluate grazing capacity and integrated management of rangelands, it is necessary to be aware of forage quality of range plants. The most important factor influencing forage quality is growth stage which represents the suitable time for animal grazing. In this research, samples of three grasses and two forbs (*Agropyron tauri*, *Dactylis glomerata*, *Bromus tomentellus*, *Ferula ovina* and *Coronilla varia*). were collected at tree phenological stages (growth nitiation, full flowering, and seed ripening) in semi-arid ranges of central Alborz (Vardavard and Gachsar) area. Plant samples were dried and milled in lab and analyzed by wet chemistry for important qualitative factors such as: DM, NDF, ADF, CP, ME, DDM, DMI, WSC, RFV, etc. Except for DM, there were significant differences ( $p<0.01$ ) between different species and phenological stages. Also, interaction effects of plant species and growth stages

were significant for these attributes. Almost in all species, the amount of CP, DDM and ME decreased with progress in growth stages while ADF and NDF contents increased. Totally, *Coronilla varia* had highest forage quality based on estimated factors (RFV=257.9) and in this aspect, *Agropyron tauri* was the poorest (RFV=92.1). *F. ovina*, *D.glomerata* and *B. tomentellus* had grater nutritive value after *C.varia*. Initiatial growing stage (the first phenological stage) resulted in the highest nutritive factor (except WSC). Considering low energy differences between first and second phenological stages and also because of higher production and range readiness, second stage (flowering) was the most suitable period for animal grazing.

### **3. Investigation on variation quality forage of two species in different phenological stages**

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Understanding about forage quality is fundamental to measure the grazing capacity. The objective of this study was to investigate the effects phenological stages on forage quality indices of two range species, *Dactylis glomerata* as grass and *Coronilla varia* as forb. Samples were collected from two highland range of Vard Avard and Gachsar regions. They were dried and ground and analayzed according to standard methods. Results showed that there were significant differences between amount of crud protein (CP), acid detergent fiber (ADF), digestible dry matter (DDM), and metabolism energy in different species and phenological stages. The quality indices (CP, ME, DDM) decreased and amount of ADF increased with the progress in phenological stages, vegetative stage gave high quality and amongst the two species, *Coronilla varia* showed high quality.

### **4. Investigation on morphological effects in vegetation using GIS, a case study from Hezarzarib Rangelands, Mazandaran province, Iran**

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Correct and efficient management of rangelands at each site is possible on the basis of exact quantitative and qualitative information on the plants and knowledge of associations between the plant attributes and also environmental factors. This research was undertaken to define correlation between vegetation and morphologic units in Hezarjarib rangelands in Mazandaran province. Slope, aspect and height maps were overlaid using GIS as foundation of sampling of vegetation. Then pant cover parameters (canopy and density) were measured for some species. Using multivariate

analysis, the variation in percentage of canopy cover and density of the species as well as vegetation type influenced by land units as well as aspect, slope and height, was studied. Results showed that each plant species grows and lives in special morphological conditions that are different for others.

#### **5. Developing a production estimating model for *Atriplex verruciferum* and *Salsola dendroides* using canopy cover and volume**

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This study investigated the relationships between production of *Atriplex verruciferum* and *Salsola dendroides* as a dependent variable versus canopy cover and volume as independent variables. Data including height, small diameter and large diameter were collected by a 100 m line transect sampling method. The best production estimated variable of these species were selected using double sampling method. Multiple and stepwise regressions were applied for the analysis of relationship between variables and the selection of the best models for each species. These models were compared as basis on measured variables that were related to the statistical accuracy, simplicity and applicability. The results showed that in *Atriplex verruciferum* canopy cover and volume and in *Salsola dendroides* only canopy cover were significant variables for the production estimation.

#### **6. Determination of the best sample number to optimize accuracy and expenses in forage production estimation of important range plants in Iran**

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Double sampling method is a common system of forage production estimation of different range plants in Iran. In this method special proportion of the total samples are harvested to correct and optimize sample number for accuracy and expenses. To determine the optimized sample number for forage estimation of *Eurotia ceratoides*, *Bromus tomentalis* and *Astragalus siphophilus* species, proper mathematical equations were employed. The experiment was conducted at Hanna Excloser rangelands in Isfahan, Iran. The results showed that out of total samples between 20 to 28.2, 17 to 32.2 and 16 to 37.6 percent should be harvested and measured to achieve a correct estimation of forage production of *Bromus tomentalis*, *Astragalus siphophilus* and *Eurotia ceratoides*, respectively.

## **7. The effects of range enclosure on vegetation composition and density**

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Range enclosure has always been considered as one of the management practices to study the vegetation succession, vegetation production potential and providing the opportunity for reclamation of destroyed vegetative cover and decrease in seed production.. This experiment was conducted to study some important vegetation traits of rangelands in Isfahan, Iran. The vegetation cover and edaphic characteristics were studied simultaneously in both excluded and exposed range sites. Floristic characters as well as vegetation and canopy cover, plant density, plant composition and other ecologic characteristics were recorded. Results indicated that there were significant differences between excluded and exposed range sites. The vegetation cover in excluded site manly comprised of I and II class plants while III class plant mainly occupied the exposed site. In other words closing the range enhanced plant succession towards climax and sub-climax and helped decrease in density and cover.

## **8. Adequate plot number to estimate sedge brush and wheatgrass forage production in double sampling method**

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Double sampling method is an important way to assess forage production of range plants. The accuracy of estimation in these methods depends on the number of plots which will be harvested. To assess the forage production of two important range species of sedge brush (*Artemisia sieberi*) and wheatgrass (*Agropyron trichophorum*), randomized-systematic samples were collected from two sites. The data were statically analyzed for precision and expenses. The results showed that to have an acceptable estimation of forage production (through regression analysis) for sedge brush, in double sampling system, between 14% to 35% and for wheatgrass between 14% to 30% of samples should be harvested. To create a significant regression curve for forage estimation of the two range species in double sampling system at least 14% of total sampling plots should be harvested.

## **9. Application of Inventory program in grassland management**

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For suitable range management the main factors firstly should be determined. Rangeland analysis and evaluation create suitable information for management. Grazing is the main cause of rangeland degradation and by determination of the grazing system and restoration program sustainable utilization can be suggested. In this research grassland types were selected and grazing capacity determined by using forage factors. Based on the collected information and field investigation, suitable management practices were suggested for different types. Type 3, 8, 16 are very disturbed and have to be treated with reclamation program. Therefore, seeding was selected as suitable treatment. Other types have an acceptable condition and grazing systems prescribed for them.

## **10. Variation of range condition and range condition trend in grassland types, a case study in Shahrak region**

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Rangeland contains different structural patterns and this spatial variation increase the rangeland stability. Vegetation types are the most important unit in rangeland inventory. Determination status and condition of types helps researcher to select the best management treatment. Range trend is useful indicator for determination of management effects on rangeland. In this study range types were determined using geomorphological method and for each type the range condition assessed by using 4 factors (soil erosion, soil surface cover, vegetation production, and plant vigor) and range trend by using score card. Result showed that all types had weak and moderate condition and for range trend, it was mostly upward and in a few cases downward. In these types the main reason of decreasing range condition were grazing intensity and geographic sensitivity.

## **11. Physical land evaluation for extensive grazing using GIS in a watershed of Khorasan Province, northeast Iran**

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Overgrazing is the most important agent which causes accelerated soil erosion and land degradation in semi-arid and arid zones of Iran. Appropriate land use planning in these areas, based on land suitability evaluation, provide a suitable base for conserving the land and control desertification. Land evaluation identifies possible alternatives in land use, which will more effectively meet national or local needs and in assessing the consequences of these alternatives. 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 study area had an annual precipitation of about 250mm and average temperature of about 12° C. The physical potential of the given watershed for grazing by sheep and goats, and the limiting factors for this type of land utilization were assessed. Land qualities evaluated included accessibility to animals, soil erodibility, moisture availability, flooding hazard, salinity and alkalinity, and drinking water availability for animals. Above mentioned land qualities were assessed by appropriate land characteristics. The requirement of grazing land utilization type (LUT) was defined in terms of rated land characteristics. Then matching of 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. Finally land index for every pixel was calculated by square root method. Finally, qualitative and physical land suitability classes were determined based on land indices and classified. As a result, with analysis of spatial modeling, it was possible to assess the land suitability with higher accuracy. Overall results showed that the given area was only marginally suitable or non-suitable. The most limiting 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 rinking water, the limitation of given area is decreased and subsequently in some management units moderate suitability is observed for given LUT. In conclusion, overgrazing in the watershed must be controlled and managed in the season and in the suitable land units to conserve soil and natural vegetation for sustainable land use in future.

## **12. The relationship between the density of *Cyamophila dicora* and vegetation parameters of *Astragalus adscendens* in semi-arid region of Isfahan, Iran**

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Feeding by an insect (*Cyamophila dicora* Logvina) on spiny shrub, *Astragalus adscendes* (Boiss & Haussk.), produces a kind of manna named Gaz-angubin. The harvesting of Gaz-angubin has a long history in Isfahan, Iran. We have produced spatial distribution map of the shrub and by random-systematic sampling along line transects, we measured biological and environmental criteria such as insect density, canopy cover, tissue moisture and soil moisture. The results showed that *Astragalus*

*adscendens* occupied the wetter parts of mountainous areas near Isfahan and the densities of insects is highly related to the age and canopy cover of *A. adscendens*, and to soil moisture. Older and larger shrubs had the highest densities of insect. Regression analysis confirmed that the age of plant, and soil moisture were important in affecting insect density. When moisture is not limiting, plant age has the primary effect on the insect density.

### **13. The essential conservation of Charbagh grasslands as a forage resource for supporting semi-arid rangelands of northern part of Iran**

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The semi-rid rangelands of Golestan Province, which are located in the northern part of the main source for animal feeding and are degraded by grazing animals. The cold season grasslands can be used as supplementary forage for livestock animal during the warm season grazing. The objectives of this study was to introduce important species of Charbagh grasslands and some important ecological and nutritional values of this species. There are 20 important grass species and *Agropyron cristatum*, *A. desertorum*, *Festuca ovina*, *Bromus tomentolus*, *Dactylis glomerata* and *Poa bulbosa* in the area. Some 80% of the grassland species of these area are perennial species and 45% are in class II. The Charbagh grasslands can be used as a restoration grazing time and a source for animal feeding for semi-arid rangelands of northern part of Iran.

### **14. Ecological effects of *Atriplex canescens* on planted areas in Iran**

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Planting is one of the common methods among the range improvement practices especially for arid and semi-arid regions. In recent decays, this method was done in several regions of Iran by using some exotic species of *Atriplex* genus such as *Atriplex canescens*, *A. lentiformis*, and *A. halimus*. Of the mentioned species, *A. canescens* has a greater distribution in the Iran and it was introduced in Iran in 1965. For the first time it was cultivated in Qazvin plain. This species originally is endemic of western United States and Mexico, where it grows in saline and alkali regions. Occasionally, it thrives in saline and swampy areas. This plant absorbs large amount of salts and then exudes them. Therefore its organs are a place for accumulation of salt. Considering resistance of this species in harsh climatic condition, great forage yield, palatability, relative quality of forage, being evergreen, ability to stand in saline and alkali areas as well as in poor soils, big canopy cover and relatively deep roots, it is cultivated for different objectives such as forage production, soil conservation and reduction of erosion, desertification. The aim of this paper was to summarize results of recent research activities about cultivation of *A. canescens* in different parts of Iran with various

climatic conditions. The conclusion is that *A. canescens* can be referred to as a pioneer species, suitable for the conditions of planted area, and consequently it can be used in reclamation of degraded ranges in arid environments.

### **15. Study of applied halophytes in east of Golestan province**

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Arid and semi-arid zone are principle habitat for halophytes. It could provide human emergency needs. These plants grow in grassy, shrub, small tree and grass form. The most important role of halophytes in this area is for human use and environmental purposes. These roles are land rehabilitations, as irrigated crops using saline water as feed for livestock, as medicinal plants, as fuel woods, as shade and shelter and for sequestration of carbon dioxide. The goals of this study was to assess halophytes vegetation environmental parameters and the importance of this plant for different areas. This study used topographic map and special aerial photographs and field sampling of 47 plots of 1m<sup>2</sup> each on the 100m. Canopy covers of all specie were evaluated. Soil sampling was performed with attention to mountain physiography, plain and restricted area. Physical parameters evaluated were texture, structure and chemical parameters for example pH and EC. Results showed that three original groups make bank river plants which are density shrub, annual forb, prenal grass and halophyte grasses and small trees.

### **16. The effects of exclosure on carbon sequestration in the dominant species and soil surface in saline range lands, a case study of Gomishan rangelands**

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Carbon is the main part of the green house gasses so increasing of carbon sequestration in biomass plants and the soil under this biomass is the easiest and economically the most practical approach to managing and facing climate change crisis and decreasing air pollution. This research was conducted on the effects of protection on carbon sequestration in dominant species and soil surface. The area was protected from grazing for 15 years. Two key areas were selected within and outside the excluded area and four transects of 100m were selected on each key area and 10 random plots of 4-m<sup>2</sup> were sampled systematically. Production and density of different species were measured using quadrates. To assess the soil carbon sequestration, 30 profiles were dug along each transect, one of which was under story

and the other was outside of the canopy coverage of the shrubs. Production was measured by double sampling. Carbon sequestration of the dominant species and soil under of them in two zones with was determined in the laboratory. The result of this study showed that carbon sequestration in the enclosure plot for dominant species was significantly more than in the controlled plot. But carbon sequestration in soil did not change by protection.

#### **17. Rangeland analysis, evaluation and improvement in Taleghan Region, a case study of Khosban sub-watershed**

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Vegetation types are known as management units in a lot of rangeland inventory programs. Necessary information for determination of management practices is provided by analysis and evaluation of these types. This study was a planning exercise in Taleghan region (Khosban sub-watershed). By using aerial photograph method range types were determined. For each type, vegetation and soil attributes were measured and later range condition, range trend, plants vigor, grazing capacity for each type were calculated. Management plans by interpreting this information were developed. Results showed that grazing pressure, premature grazing and changing land use had important role in management variation. Most types had a weak and moderate condition and the range trends were mostly downward and a few cases upward. Based on the collected information and field investigations, suitable management practices were suggested for different types. In spite of 5, 6, 7, 8, 9, 12, 13, 14 and 15 other types are disturbed and treated with reclamation programs. Types 13, 14, 15 have a good condition and types 5, 6, 7, 8,9, and 12 had a moderate condition. Therefore, seeding, enclosure, dry land cultivation in relict area and prevention from shifting cultivation in rangelands was selected as feasible programs. Types 5, 6, and 12 had good condition therefore rotational grazing system was chosen and for other types rest-rotation system was prescribed.

#### **18. Indicators and diagnostic estimation of degradation of pasture of Uzbekistan**

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The development of the methods of estimation of the present condition and the questions of prognostics of vegetation dynamics and pasture productivity are of paramount importance in designing proper use of rangelands. One of the major factors influencing vegetative cover of arid territories of Uzbekistan is the overgrazing of pasture by animals. Therefore, our research work was directed on the working out of questions of origin and development of desertification during grazing of animals in arid zone. On the basis of long-term investigations, it was determined that at present, as a result of destruction of desert forests, shrub-semi and shrub vegetation, and overgrazing, the degradation of vegetative cover of the arid zone of Uzbekistan was nearly 35.7% ( about 10 million ha). Over the last 70 years the vegetative cover of shrub grass pastures has significantly changed. The constant grazing of sheep is the main cause of destruction of 16-22% of plant species, of which 3-12% are shrubs. The yearly increase of perennial grasses has been 3%, and annual grasses has been 11%. The main biological indicator of desertification is the vegetative cover. Under different regimes of grazing by karakul sheep, goats and camels, 18 plant species can be served as the indicators of desertification of shrub-grass pastures. Some diagnostic characters of pasture degradation were revealed and a diagnostic table for determination of the degree of degradation, under weak, average, strong and very strong grazing of animals, was compiled. By determining the quantity of *Carex physodes* M.B. one can estimate the degree of desertification of sandy pastures. It is necessary to stop the use of pastures between second and third stages of degradation. It is exactly from this time, that the vegetative cover can be regenerated.

#### 19. Investigation of the ecological needs of *Astragalus adscendens* (producer of Gaz) in Lorestan Shoulabad region of Iran

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Ecological studies of important range plants is an important factor in range improvement and development programs. *Astragalus adscendens* is an important range plant, which has occupied vast mountainous rangelands in Iran. In this project, the ecological requirements of this species were investigated in Shoulabad rangelands in Aligoudarz, Iran. The environmental conditions along with edaphic characteristics of regions over dominated by this species were recorded by observing 144 sampling plots of 10x10m in 9 sampling sites representing different range conditions. The results showed that the climatic conditions of rangelands over-dominated by this species could be classified as semi-arid cold according to Amberjeh Category. The highest intensity and vegetation cover of *A. adscendens* was found at 2300-2700 and 2250-2550 meter from sea level, respectively. The dominate soil type in these elevations was inceptisol. Slope variation imposed no significant effects on density and vegetation cover of *A. adscendens*.

## 20. Experience of overcoming seed hardness of *Alhagi pseudalhagi*

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The camel thorn (*Alhagi tourn.* Ex Adans) is a grassy perennial plant of family Leguminosae, widely spread in desert and foothill semi-desert on different soils. In Uzbekistans there are four species of *Alhagi*: *A. pseudalhagi* (M.B.) Desv., *A. sparifolia* Shap., *A. canescens* (Rgl.) Shap., and *A. persarum* Boiss. et Buhce. In the Middle Asia the *Alhagi* is stored up for hay, used for sheep, and camels, and partly for fuel. In the nature it is mainly propagated by root sprouts. The intensity of vegetative propagation depends up on water, physical soil qualities, level of subsoil waters and other anthropogenic influences. Therefore, numerous root sprouts of *Alhagi* are observed only on loose, well, moistened substrates. With the increase of density and dryness of soil and subsoil and also turf covering, the rate of vegetative propagation sharply decreases. The seed regeneration is limited due to high percent of hard seeds and low rates of their propagation, but also due to weak competitive ability of shoots, and their high demand for stable watering in the first year of vegetation. In this connection, it is necessary to develop and improve methods of overcoming seed hardness of *Alhagi*. The treatment of seeds of *Alhagi* by sulphuric acid for 40 minutes was found to enhance germination.

## Theme 4: Forage and livestock production

### 1. Study on effects of phenological stage on forage quality of *Medicago sativa* and *Poa bulbosa*

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Forage quality information is important for determination of grazing and range management. Forage quality is affected by location and phenological stage. Different factors influence the forage quality. The phenological stage is one of the most important factors affecting forage quality. During this study, samples were collected of *M. sativa* and *P. bulbosa* plants in ten replications from Gharnaove region. Crude protein (CP), total energy (TE), crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), and dry matter digestibility (DMD) were measured using in vitro procedures. The results showed that forage quality of both species was higher in the initial growth stage than that at flowering stage. This is because of high amount of CP and low amount of ADF, NDF and CF. The forage quality of *M.sativa* in growth stage was higher than that of *P.bulbosa* while it was reverse at the flowering stage.

### 2. Influence of gamma-radiation on seed germination of desert fodder plants

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The improvement of natural pasture lands is slow because of the shortage of quality seeds of pasture fodder plants. It is known, that the main criteria of seed quality is their germination power. However, there has been little work on improving the germination percentage of seeds of desert fodder plants, and the increase of their seed production and yield. In this connection, the aim of our investigation was the selection of appropriate doses of gamma irradiation, to induce useful mutations, increasing field germinating power and seed productivity of desert fodder plants. Gamma-irradiation of *Kochia prostrata* (L.) Schrad seeds at dose 3-5 kGr increased their laboratory germination power by 1.5 – 2.0. For *Halothamnus subaphyllus* (C.A.Mey) Botsch seeds the stimulating dose for increase of laboratory germinating power was 1-4 kGr. The field germinating power of *Halothamnus* seed, irradiated by doses 1-3 kGr and 3-4 kGr exceeded control by 1.8-1.7. For *Kochia* the stimulating

dose is 1-3 kGr. The mass of 1000 seeds of *Kochia* collected from plants propagated from seeds irradiated by doses 1-5 kGr, exceeded control by 1.20-1.24. The mass of 1000 seeds for *Halothamnus* under the doses of irradiation 1-4 kGr was twice as much as in control. The irradiation of seeds of *Kochia* and *Halothamnus* by doses 1-3 kGr and 4-5 kGr improved the development of above – ground organs, increased seed size, their seed productivity by 10-15% and increased the quality of pasture fodder.

### **3. Techniques to increase karakul sheep breeding efficiency in Uzbekistan**

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Desert and semi-deserts of Uzbekistan occupy more than 67 % of all territory. These areas serve as a main forage base for raising sheep from ancient times. However in the last 10-15 years there have been frequent shortages of forages, which recur 5-7 times every 10 years. The Karakul Sheep Breeding and Ecology Institute has the goal to elaborate efficient techniques for preparation of forages. Particularly interesting are the techniques for preparation of feed blocks and ammonization of roughages by treatment with 2-2.5 % solution of urea. Also, efficiency of usage of protein-extractive pastes to feed sheep was studied. All investigations were conducted in collaboration with ICARDA. Efficiency of usage of feed blocks was studied on 4 groups - analogues of 7-7.5 month age old and 17-18 month old ram-lambs (25 head in each group). The experimental groups of animals consumed feed blocks, control groups got feed mixture. The duration of fattening was 60 days. The diets with ammonized straw was tested on 3 groups of ram-lambs of 7-7.5 month age (15 heads in each). The duration of fattening was 60 days. The new protein supplements – protein extraction paste (PEP) was studied on 3 groups of ram-lambs of 6.5-7 month age, with 10 heads in each. This product was obtained from cotton cake.

The indexes of fattening of ram-lambs on fodder blocks showed, that the difference of live weight and gains between compared groups of animals is statistically significant ( $P < 0,05$  and  $P < 0,001$ ). For 1 kg of live weight gain, the ram-lambs of experimental group used 21.2-24.4 % less fodder units, in comparison with control. The analysis of the results on ammoniated straw showed that ram-lambs of control gained 10 kg (daily 167 g), using fodder mixture with ammonized straw resulted in a gain of 10.7 kg (daily 178 g) or a 7.0 % increase, and when the fodder blocks were used with ammonized straw the gain was 11.76 kg (daily 196 g), which was 17.6 % higher in comparison with control. The analysis of use of PEP also showed superiority over control. Thus for karakul sheep breeding introduction of simple and cheap methods of preparation of fodder, in the form fodder blocks, ammonization of straw, and the use of protein – extraction paste has proved very effective.

#### **4. The effect of sowing date on forage yield and some quantitative and qualitative characteristics of bitter vetch (*Vicia ervilia* L.) under rainfed conditions**

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Bitter vetch (*Vicia ervilia* L.) is widely used as feed for livestock. An experiment was conducted at Grizeh experimental station in western part of Iran in 2003 to investigate the effects of planting date on forage yield and some other characteristics of bitter vetch. The characters studied were hay yield, plant height, number of branches, and weight /plant. Some quality parameters including crude protein, digestibility, water soluble carbohydrates, and acid detergent fibers were also measured. Fall sown bitter vetch crops had greater hay and green forage yield production than spring sown crops. Regarding the quality of forage, there was no difference between main winter sown and fall sown crops, which leaved a good scope for early planting.

#### **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. Study of effects of phenological stages on forage quality of two halophytic species *Halocnemum strobilaceum* and *Halostachys caspica***

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Determination of forage quality of available species is one of the fundamental factors for the management rangelands. Forage quality is affected by location and phenological stages. In this study we investigated forage quality of two halophyte species, *Halocnemum strobilaceum* and *Halostachys caspica*, at three phenological stages (vegetation growth, flowering and seeding). For this purpose, 10 replications were randomly selected from each phenological stage in Gomishan range. In this

experiment crude protein, ADF, metabolizable energy and dry matter digestibility were measured using in vitro procedures. than flowering and seedling stages. Comparing forage of two species showed that in *Halostachys caspica* crude protein, metabolizable energy and dry matter digestibility indices were better than in *Halocnemum strobilaceum* while ADF was low in all stages. These result suggested that forage quality of *Halostachys caspica* was more than *Halocnemum strobilaceum*.

## **7. Productivity of vetches under alpine grassland conditions in China**

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A 3-year study was conducted to evaluate the potential of improved lines of common vetch (*Vicia sativa*), woolly-pod vetch (*V. villosa*) and narbon vetch (*V. narbonensis*) obtained from the International Centre for Agricultural Research in the Dry Areas (ICARDA) for seed and forage production at 4 sites in the alpine grassland of China. Differences in productivity were found among species and lines. Common vetch lines 2505, 2556, 2560 and 2566 and narbon vetch line 2561 were identified to have potential for seed and forage production in the study area.

## **8. Intensive technology of fodder production on irrigated lands in the karakul sheep breeding zone**

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In Uzbekistan, the natural pastures are the main fodder base of Karakul sheep breeding. The scientific investigations and practice of Karakul sheep breeding during many years show, that full feeding of sheep and other animals was provided by the combination of grazing and feeding. There are no natural meadows in the desert zone, the guaranteed fodder stock for sheep and other animals can be created only with the irrigated fodder production. The sources of water in all natural zone of karakul sheep breeding are limited and the question of their rational use is very urgent. However, for livestock development it is necessary to strengthen fodder base and improve technology of cultivation of fodder crops on arable lands. The research carried out shows that the perspective for fodder crops here is not large. These are alfalfa, sorghum, winter secale, Triticale and *Avena sativa*, which can give a high yield of valuable fodder. In the conditions of desert, the most high yielding and perspective sort of Alfalfa is Tashkent skaya 3192, which gives 70.5 t/ha green forage in 4 cuts and 14.4 t/ha of dry mass. Thus the production of total fodder units is 7073, kg/ha. In the conditions of desert the more high yielding possibility is by use of Triticale. It gives 42.2 t/ha green matter, 8.6 t/ha dry mass and 3.3 t/ha grain, and the the total fodder units are 6130 kg/ha. According to the two-year data from the farm studies, with the help of the whole year round use of land, we can obtain the high yield of

Triticale and Sorghum. They give 109,9 t/ha green mass and 25,4 t/ha dry mass, and can be introduced for cultivation on the large territories.

#### **9. Effect of drought stress on alfalfa cultivars at germination stage in dryland condition**

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Drought is one of the most important limiting factors in plant growth. In order to determination of seed germination percentage and rate, root and shoot length and vigor under drought stress an experiment was carried out in laboratory conditions using polyethylen glycol 6000 with four osmotic potentials: 0(control), -3, -6 and -9 bars. Six cultivars were used namely Yazdy, Hamedani, Ghareh, Maopa, Cimer Chenskaya and CUF101. The results showed that with increasing osmotic potential the germination rate and percentage, roots and shoots length and vigor were decreased. But root/shoot length ratio increased. Correlation coefficients showed that there is positive and significant correlation between germination percentage and rate of shoot growth. But there was negative and significant correlation with root/shoot ratio. Yazdy cultivar was more tolerant to drought stress during seed germination stage than other cultivars.

#### **10. Meat production for self-consumption by nomadic herders in the Gobi Desert region of Mongolia**

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A field study was conducted of a total of 42 nomadic families in the Gobi Desert region. The studied families were divided into two family groups: those located in the semi-desert area (FG1) and those in the semi-mountainous area (FG2). The herds were structured as follows: sheep and camels were dominant in FG1; goats and cattle were dominant in FG2, and horses were prevalent in nearly all families in both groups. The total number of animals per family tended to be greater in FG1 than in FG2 ( $p < 0.1$ ). In general, sheep were chosen, instead of goats, for slaughtering. The animals in large herds tended to be slaughtered frequently. In FG2, the numbers of slaughtered sheep and goats were similar; horses were not generally slaughtered; camels were slaughtered in nearly all of the studied families, and the number of slaughtered camels was the greatest of all the animals slaughtered in both groups. There was no difference ( $p > 0.1$ ) in the annual total number of animals slaughtered between the two groups. Strong seasonality differences by animal types or family groups were found with regard to slaughtering: the large animals were slaughtered only in the winter, from November to December; the herders irregularly slaughtered sheep and goats during April and June, and they constantly slaughtered during July

and October; the FG1 families slaughtered sheep more frequently throughout the year than did the FG2; the FG2 families slaughtered more cattle than did the FG1 ( $p<0.05$ ). Overall, the results showed the following: the adaptation of herders to the differences in topography and herd sizes and their adaptation to meat quality by animal types; the herders' economic strategies; and their intent to enrich their diets.

## **11. The whole year round pasture grazing and reproduction strategy of sheep in Uzbekistan**

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Historically the karakul sheep breeding is one of the leading and traditional branches of agricultural production in Uzbekistan. The development of karakul sheep breeding depends to a large extent on proper organization of flock reproduction and providing animals fodder during critical periods. The peculiarity of karakul sheep breeding is that it is based on the whole year round pasture grazing. The pasture lands are suitable for use almost during the whole year and provide the cheapest fodder. However, their yield capacity is low and in different years the nutritive value of their feed depends on meteorological conditions. The fodder yield on pastures and their nutritive value can be twice as high or low in average for yield years. The great difference of the yield of the pasture lands are marked according to the seasons of the year. In this connection, the development of effective technology of grazing and sheep reproduction is necessary for providing the largest profits under the maximum use of natural pastures. During the last decades, in the karakul sheep breeding the tradition to carry out sheep lambing in March-April was used, when the vegetation of cover on pastures starts and lactating ewes can produce full-value milk and rear lambs. Such technology, with its positive aspects is extensive and makes the livestock production dependent on climatic conditions. The lambs can not fully eat the green fodder rich with vitamins, because it is burnt down. Besides, the hot days negatively influence the growth and development of lambs on account of which they can not gain weight and fatten. That is why in critical days of wintering, frequent cases of lambs death is observed and as a consequence the production decreases. To cope with such situation it is necessary to organize winter and early-spring lambings. The winter and early – spring lambing, and also the optimal system of pasture usage and norms of winter sheep supplementary feeding are proposed.

## Theme 5: Biodiversity and Ethnobotany

### 1. A study of distribution and ecological characteristics of halophytes in Aqala-Gorgan plain

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Plants growing anywhere usually meet with different stresses. These stress conditions limit the chance of survival of the plants. The arid and semiarid areas also have vast stretches covered with saline soils. This condition creates a special ecosystem where halophytes grow. Halophytes have different adaptive mechanisms to withstand high salt content in the salty ecosystem. The aim of this experiment was to study distribution and ecological adaptation characteristics of halophytic plants in the plains in the northern Iran, near Caspian sea, with varying elevation (- 20 to 40 meter above the mean sea level), Quaternary sediment and the mean annual precipitation of about 230 mm. This study took in consideration aerial photographs, landscape satellite pictures, topographic maps and field maps. The floristic physiognomy method was used for assessment of vegetation in different physiographic conditions likes lakes and channels, hilly lands, marshland etc. The halophytic association in the margins of lakes and channels had *Tamarix rosisima*, in hilly land *Salsola aurantica* and *Artemisia herba alba*, and in marshland *Halocnemum strobilaceum* and *Aeluropus litoralis*.

### 2. Chaharbagh range lands as a natural pharmacy

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Chaharbagh rangelands is located in northern part of Iran and southern slope of Alborz mountain chain. Its climate is semi-arid and this area has good species diversity. It is a place for recreation. Because of no availability to polyclinic, shepherds and emigrants have to know medicinal plants and traditional cure of their ailments. In this study several plots were sampled in the area and medicinal plants were recognized. The soil characteristics were also analyzed and related to the

diversity of the medicinal plants. This research led to scatter-map for medicinal plants with their properties for traditional cure identified.

### **3. Test on the Seed Vigor of Chinese Traditional Medicine and Sand Plants in *Cistanche* spp.**

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Study on test of seed vigor of *Cistanche deserticola*, *C. tubulosa* and *C. salsa* was done by the cyto-chemical methods and TTC-test. The TTC permeates into live cell of embryo, and turns red (TTH) after being reduced by  $H^+$  of NADH<sub>2</sub> or NAPPH<sub>2</sub> as the  $H^+$  receptor. It is with certain difficulty that seeds of parasitic plant *Cistanche* germinate. Although a large number of seeds are produced, only a small amount quantity can germinate, and live on in the root of host plant. There are some seeds that do not have any embryo, or have no the endosperm. The sprouting of this kind of parasitic plant's seeds is very difficult whether it is in natural states or in laboratory states. By using this method, the high vigor seeds can be selected and the percentage of germinated plants can be improved. Through this experiment, we found out that the seed vigor of some samples was much lower, but of the others that were derived after filtering was much higher. To select the seeds of the high vitality that have high seminal germination capacity and could be used for artificially connecting with *Cistanche*, this test is very useful for this valuable Chinese herbal medicinal plant and for its GAP (good agricultural practice of medicinal plants).

### **4. Ethno-botanical use of *Typha domingensis* Pers. (Typhaceae) in an arid zone-Sistan, Iran.**

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*Typha domingensis* is a species with economic importance in Sistan (Zabol), Iran. The distribution of this species are the aquatic environments in the wet (north Iran), semi arid (northeastern Iran), and arid zones (centre and southeastern Iran). Hamun, a shallow lake in Sistan (Iran & Afghanistan) had a vast and dense distribution of *T. domingensis* around and inside it, but the lake dried up several years ago (1996), and currently the region is a dry desert. In this situation *T. domingensis* grows only rarely now. Since Iranian part of Sistan have had periodical dryness in Hamun in the past (1969 - 1975), it seems that the lake perhaps have a chance to come back again. The indigenous people of many villages around the former lake are still dependent on this plant, using it for making "*pardeh*" (a kind of curtain). Thus, they provide the plant from other parts of Hamun Lake in Afghanistan. When the lake had water, many people fished and hunted wild birds. They had made some kinds of boats for this

purpose from *T. domingensis*, which can be found in a few local museums or in the costal regions of the old lake at present.

## **5. Ecological characteristics and traditional cure methods of Incheboroon halophytic plants**

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Incheboroon is an arid zone that is located in north eastern part of Iran. Halophytic plants are natural vegetative cover in the range lands of this area. They are used both as camel forage and in local medicine. So it is necessary to know ecological characteristics of these plants. Recognition of these species was done in a field survey and their use in traditional cure methods was asked from the local people. To study about their ecology we tested the pH, EC, and ESP of the soil. We recognized eight plant species that have both the properties, use as forage for camel and the medicinal use. These species are *Malva neglecta*, *Artemisia herba alba*, *Plantago cornopus*, *Capsella bursa-pastoris*, *Cressa certica*, *Melilotus officinalis*, *Alhagi camelorum*, and *Salicornia herbacea*. Most of the medicinal halophyte plants were shrubs and forbs and were perennial and their biologic types were therophyte and chameophyte. There is a need for systematic study of all plants used in native medicine or folk medicine as no pharmaceutical and chemical research has yet been done on these species.

## **6. Ecological characteristics of *Smirnovia iranica* in sand dunes A case study from Kashan, Iran**

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Deserts include valuable reserves of plants. This part of ecosystem is adaptable with various ecological conditions of ecosystem and can be used in de-desertification plans. Thus, conserving native suitable species is of high importance in reclamation of degraded rangelands of arid environments. To do this, first of all it is necessary to collect and define suitable species of desert lands. In this, the next stage is developing an understanding of the ecological characteristics of species. *Smirnovia iranica*, a native and rare species from Fabaceae family, has considerable adoptability for desert conditions. This species, was collected for the first time from Rig Boland sand dunes in Kashan (a region with arid climate in the center of Iran). This study focused on

some properties of the above mentioned species such as botanical characteristics, reproduction, phenology, rooting, chemical composition (amount of protein, ash, fiber), and cover percentage. Soil variables of *S. iranica* habitat in the region of Rig Boland strip in Kashan were also investigated.

## **7. Investigation of the most important medicinal trees and shrubs in Golestan province**

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Some trees or shrubs have been used in traditional medicine and food consumption for centuries and there is a general lack of biological information in relation to phytochemical and medicinal importance. The objectives of this study were to introduce important useful plants and their medicinal characteristics in Charbagh region of Gorgan. Charbagh is located 70 km SE of Gorgan city, at latitude and longitude of 36° 37' to 36° 34' and 54° 35' to 54° 24', respectively. Its average elevation is 1800-3500 meter from sea level. The average annual rainfall in this area is 305mm. There are a huge variety of vegetation in Golestan province. About 22 species of trees or shrubs from 200 species of medicinal plants grows in this region. The result of this study showed that more than 22 trees or shrub in this region have been used by the people in traditional medicinal uses and for food consumption in the villages. Roots, stem, leaf, fruit and secondary products have been used for cooking, and in making tincture, infusion and lotions for treatment and medicinal purposes. They have been used by traditional physicians as the only source of remedy for diseases in this region. The main species included: *Juniperus communis*, *Berberis vulgaris*, *Alnus glutinosa*, *Carpinus betulus*, *Colutea arborescens*, *Cornus australis*, *Carylus arelana*, *Crataegus oxyantha*, *Rhamnus palassi*, *Ilex aquifolium*, *Lonicera caprifolia*, *Mespilus germaniac*, *Tillia begonifolia*, *Paliurus spina christi*, *Prunus spinosa*, *Quercus castaneaefolia*, *Rosa canina*, *Rubus fruticosus*, *Salix alba*, *Smilax excelsa*, *Taxus baccata*, *Viscum album*, *Cerasus* spp., *Mespilus* sp., and *Pyrus spinosa*.

## **8. A study on natural semi-arid forest stands in Tehran province**

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Tehran province falls in Irano-Turanian vegetation zone. This is an arid and semi-arid zone, so there were no typical forest stands and trees and shrubs generally grew here in a scattered manner. However in some places they grow thick stands and organize some semi-arid forest stands or bushwoods in a clumped pattern. These stands are special parts of Irano-Turanian zone and they create the habitat for numerous animals

and birds. In fact, these stands form a special and valuable ecosystem. In this research these ecosystems in Tehran province were studied. More than 50 forest stands were examined. Semi-arid forests of Tehran province were divided into 3 types: 1. Conifer stands, 2. Tree hardwood stands, and 3. Shrub hardwood stands; and data were analyzed on the base of this division. In the first group *Juniperus polycarpus*, in the second group *Pistacia mutica* and in the third group *Cotoneaster* spp. and *Amygdalus lycioides* are dominant tree or shrub species. Also, there are some sites with other dominant species such as *Rhus coriaria*, *Populus nigra* and *Amygdalus scoparia*. The tree and shrub flora of Tehran province observed include more than 110 species. Some 37% of the flora belong to Rosaceae family. *Juniperus polycarpus*, *Amygdalus lycioides*, *Berberis* spp., *Rosa* spp., *Pistacia mutica*, *Cotoneaster* spp., *Rhamnus pallasii*, *Cerasus microcarpa*, *Amygdalus scoparia*, *Celtis caucasica*, *Rhus coriaria* and *Salix* spp. are the main native tree or shrub species of semi-arid forests in Tehran province. In this research we introduced some tree communities for the first time.

## **9. Evaluation of wheat landraces as a genetic source using for wheat improvement in cold dryland areas of Iran**

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The importance of genetic variation for crop improvement programs is well recognized. Natural variations in the form of landraces are the major genetic resources for plant breeders. The gene bank institute of Iran conserves over 17,517 wheat genotypes, which are mostly landraces. Since 1998, in order to evaluate these genotypes for using in rainfed wheat improvement program, 500 landraces each year were studied in observation nurseries. Cold and drought stress are main limiting factors for crop production in cold dryland areas of Iran. Previously, researchers in DARI considered that the most important selection factors are earliness in heading and maturity, tall plant type and long peduncle, and high thousand-kernel weight. For additional testing, after getting uniformity in the material, we selected vigorous landraces and evaluated them in preliminary yield trials and then in advanced replicated yield trials. After 7 years work, two landraces number 4-78 and 914-78 were identified, which could produce 3-16% more grain yield comparing to Sardari as national check in several on-farm yield trials. Additional 30 landraces were selected from previous tests and 3 promising landraces are being tested in uniform regional yield trials. Studying the morpho-physiological characters of selected genotypes showed high genetic variations for several characteristics. Some of awnless and red-spike lines were found to have high yield potential in dryland conditions.

## **10. Variations of vernal annual plants species at different relief forms in the arid zone of Iran**

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Variation of vernal annual plants species at different relief forms was investigated in arid zone of Semnan province in Iran. For this purpose 10 plots of 2x2 m<sup>2</sup> were established in each main geographical slope, as well as in *barkhan* pikes and flat areas between *barkhans*. Soil moisture and quantity of vernal annual plants were determined in April. The results show that soil moisture content as well as plant weight was significantly different, on slopes, *barkhans* and flat areas between *barkhans*, whereas in flat areas between *barkhan* soil moisture was greater than in slopes *barkhans*.

# 11. Differences in understory species diversity between artificial *Robinia* forests and natural *Quercus* forests in the Loess Plateau near Yanan, China

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Differences in understory species composition and diversity were compared between indigenous *Quercus liaotungensis* forests and exotic *Robinia pseudoacacia* forests. Four *Quercus* forests (Q0, Q1, Q2, Q3) and four *Robinia* forests (R0, R1, R2, R3) were selected around the Mt. Gonglushan (ca 36°25' N, 109°31' E, 1300 m a.s.l.) near Yanan city in the loess plateau. Mean annual precipitation and air temperature are 528 mm and 9.5°C, respectively. All *Quercus* forests investigated were secondary forests 30-50 yr-old and *Robinia* forests were artificial forests about 25yr-old. In August 2004, we demarcated 4 study plots of 5m x 5m in each forest. All plant species found in the understory (DBH. ≤ 1.0cm) were identified and the percent coverage in each study plot was measured. Understory species composition was widely different between *Robinia* and *Quercus* forests. From the view point of life type composition, grass and herb species were dominant in *Robinia* forests. Dominant species in the understory of *Robinia* forests were grass species of *Cleistogenes squarrosa* and *Achnatherum splendens*. Seedlings of *R. pseudoacacia* were rarely found in *Robinias* forests. On the contrary to *Robinia* forests, tree and shrub species were dominant in *Quercus* forests. Dominant species in the understory of *Quercus* forests was grass species of *Cyperus fuscus*, which was scarcely found in *Robinia* forests. Shrubs of *Cotoneaster multiflorus*, *Caragana microphylla* and *Spiraea pubescens* were also dominant and Seedlings of *Q. liaotungensis* were found frequently in *Quercus* forests. Number of species per plot was larger in *Quercus* forests than *Robinia* forests.

## 12. Distributive fragmentation of *Tetraena mongolica* and its viability analysis

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Through a study and an analysis of the habitat fragmentation in the distributive area of Si He-mu (*Tetraena mongolica*) and its population viability, following results were achieved: 1. There is a severe sterility phenomenon in spore and embryo; there is a productive pattern of more flowers and less fruits. The population regeneration has not yet been affected; 2. About 70% of plant individuals aggregated in 4 to 7 year age-class, which displayed the degenerated characteristics of Si He-mu population; 3. Owing to city construction and development of mineral resources in this area of Si He-mu, the landscape was broken into many small population patches that hasled to a decrease of individual numbers and shrinkage of the area of population patches; 4. The results of RAPDs analysis show that genetic diversity of Si He-mu came mainly from the genetic variation among individuals within population and the genetic differentiation among populations was small; and 5. The extremely narrower distribution of Si He-mu indicates that it belonged to endangered plant; but from the standpoint of population genetics, it had not yet reached to small population degree. The problem is that its developing tendency is not very optimistic and if no optimum conservative measures are taken Si He-mu population will be in potential danger.

## Theme 6: Stress physiology

### 1. Structure and possible contribution of root system to fruit yield in watermelon grafted on gourd rootstock

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The watermelon (*Citrullus lanatus* (Thunb.) Matsum. et Nakai) is often grafted on the rootstock of white flowered gourd (*Lagenaria siceraria* (Molina) Standl. var. *hispida* (Thunb.) H.Hara) to avoid soil-borne diseases. The contribution of root system to the economical fruit yield was examined in wet and dry years. The watermelon plants (c.v. Kabuki) grafted on gourd rootstock were cultivated in Tokyo, Japan from May to the beginning of August in 2003 and 2004. Some of the roots were manually cut at the base when the first fruit was ca 1kg by fresh weight in late June. It rained much in the fruit growing period in 2003 (ca 180mm precipitation in a month), while it was very dry in 2004 (ca 20mm). The root system consisted of 10-15 thick roots that elongated horizontally (10-20cm in the soil depth) to same length as vines (5-8m long). These thick roots formed numerous thin lateral roots, many of which elongated downward more than 1.2m deep. The weight of vines, leaves and non-economical fruit was significantly lower in 2004 than in 2003, but the weight of economical fruit was not declined by the dry climate in 2004. The pruning of half of the roots decreased the weight of non-economical portion but did not decrease the yield or sugar content of economical fruit in wet 2003. In dry 2004, the economical fruit yield was significantly declined by root pruning, but it showed a logarithmic relation to the amount of remained roots, whereas the weight of non-economical portion and the bleeding rate decreased linearly with the degree of root pruning. In conclusion, the large root system of gourd rootstocks supports the vigorous shoot growth of watermelon, but it is useful for economical fruit yield only in dry years.

### 2. Study on drought tolerance of barley genotypes in eastern dryland region of Iran

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This experiment was conducted with 11 genotypes of barley in northern Khorasan Dryland Research Station in four growing season from 2000-2001 to 2003-2004. In the 2003-2004 growing season, in order to evaluate drought tolerance index the experiment was conducted under dryland and irrigated conditions. Drought tolerance of genotypes was studied by determining the Drought Sensitivity Index of Fisher and Mourer (SSI), Fernandez drought tolerance index (STI), cell membrane stability and

leaf relative water content. The design was randomized complete block with 4 replications. The results showed that the effect of year, genotype and interaction between year and genotype on days to heading, days to maturity, plant height, TKW and seed yield were significant. Days to heading in first, second and third growing season were 192, 191 and 178 days and average of seed yield were 450, 486 and 2324 kg/ha respectively. Plant height and TKW in third growing season - that was a wet season - were significantly higher than in other two growing seasons. Days to heading in genotypes number 8 and 10 were 185 and 171 days and days to maturity in were 203 and 200 days, which were significantly lower than check. Average seed yield in genotypes number 8 and 10 were 1272 and 1248 kg/ha, which were significantly higher than the yield of check cultivar. These traits indicated that these genotypes are early maturing and well adapted to grow in dry areas. The results of drought tolerance index study confirmed this conclusion. Relative water content in genotypes number 8 and 10 were higher and electrolyte leakage lower than check. These genotypes also showed the highest STI and lowest SSI.

### **3. Post-anthesis water stress and nitrogen rate effects on dry matter and nitrogen remobilization in wheat cultivars**

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Grain yield and protein content in wheat are determined by the plant efficiency in partitioning dry matter and nitrogen to the grain. The interaction between post-anthesis water stress and nitrogen rate was examined in six wheat cultivars. Plants were grown in a glasshouse of Khouzistan Agricultural Sciences and Technology University, Ahwaz at 2 rates of N under well-watered conditions until 7 days after ear emergence, when the stress treatment was started. Yield and grain protein concentration (GPC) responses and changes in the dry matter and N content of the straw and grain in the main stem and tillers were examined. Nitrogen increased grain yield in all cultivars except Fong, with Atila and Falat being the most responsive. Yields at the low N rate did not reduce by post-anthesis stress, but large reductions occurred at the high N rate in all cultivars; the yield of Falat, Showa, and Atila were most affected. At the low N rate, stress did not significantly affect kernel weight and GPC, but kernel weight declined and GPC increased at the high N rate. Tillers produced smaller grain with a lower GPC than main stem. The responses to N and water stress, and the different sensitivities of cultivars to stress, were largely due to the effects of the treatments on the growth of the tillers. Post-anthesis stress increased the N content per kernel and net remobilization of N at the high N rate. Although genotypes differed in the net amount of N remobilized and in the N harvest index, there was little variation in GPC between cultivars. Results showed that reductions in yield and kernel weight and increase in GPC from post-anthesis stress can be greater when plants are grown at a high rate of N than when the supply of N is limited. The different responses to stress and N among the six wheat cultivars were associated, in part, with the pattern of tiller development. However, there appeared to be differences in the sensitivity of grain filling to stress independent of the responses in tillering. While the net remobilization of dry matter and N differed between cultivars, the

amounts did not appear to be related to differences in GPC.

#### **4. Effects of seeding date and water stress on yield, water-use efficiency and physiological response of two wheat cultivars on the dryland of pacific Northwest in the United States**

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Post-anthesis drought stress is a major problem in dryland wheat production in the inland Pacific Northwest. The objectives of this study were to investigate the different responses of soft white (Alpowa) and hard red (ID485) spring wheat (*Triticum aestivum* L.) cultivars grown under 1) fall and spring seeding dates and 2) post-anthesis well-water and water-stress conditions. Field and greenhouse studies were conducted in Oregon of USA in 1998 and 1999. Spring wheat cultivars Alpowa and ID485 were planted on October 20, 1998 and on February 26, 1999 in the field experiment. In the greenhouse study, the wheat cultivars were planted in pots and well-watered until the booting stage. Then, water-stress was imposed on one group of the pots while the other group of pots remained well-watered. Leaf water potential, osmotic potential and canopy temperature measured at noon reflected water status of plants and soils. Fall-seeded wheat had greater total evapotranspiration (ET) than spring-seeded, but the water use patterns and soil water contents were very similar in the spring and summer seasons. Alpowa has faster leaf appearance and elongation as well as biomass accumulation rate, taller plant height, later maturity, and larger but fewer seeds per head than ID485. While planted in the fall and well-watered conditions, Alpowa exhibited yield advantage over ID485. Post-anthesis water stress reduced biomass accumulation in leaves, stems, and heads for both cultivars. ID485 had a lower carbon-isotope discrimination value than Alpowa, which was related to the greater grain yield, water-use efficiency, and harvest index of ID485 in water-stress treatment. In addition, ID485 demonstrated higher ratio of root to shoot, and ratio of pre- to post heading ET in pot experiment. Early maturing cultivar ID485 could partially avoid post-anthesis drought stress.

#### **5. Salt uptake by plants grown in salt affected areas**

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Salt uptake by plants was examined to know the role of plants in mineral cycling on regional scale. Study site was the Luo Hui Qu irrigation areas in Dali, Weinan, Shaanxi, China, where salinization and alkalization had been serious problem since the ancient era. At present, salt damage is controlled by the measures of construction of drainage canals, adoption of a salt tolerant crop, cotton, and raising the ground level through sedimentation of silt in irrigation water. Forty species and 10 species of plant were collected around 80 wells for monitoring ground water levels on June and October, 2004. Soil electric conductivity ranged 0.92 to 4.09 dS/m in June and 0.77 to 5.88 dS/m in October. Plant samples were dried and ashed. In a few cases, Na, K, Ca and Mg were analysed by atomic absorption photometry. Among the 40 species collected in June, 5 species contained 17 to 20 % ash in their leaves. Those were *Equisetum romosissimum*, *Chenopodium album*, *Portulaca oleracea*, *Gossypium indicum* and *Suaeda glauca*. Five species had 4 to 6 % ash. Those were *Hemerocallis fulva*, *Triticum aestivum*, *Imperata cylindrical*, *Pyrus serotica* and *Zizyphus jujube*. Halophytic plants like *Suaeda glauca* were observed to be abundant in the areas and they tended to accumulate more salt. Cereal crops and fruit trees tended to accumulate less salt. No significant correlation was found between leaf ash content and soil EC for the 9 species collected in June. In case of cotton, a negative correlation was observed between leaf ash content and soil EC. Na, K, Ca and Mg tended to increase in response to soil EC.

## 6. Study on chickpea drought tolerance lines under dryland condition of Iran

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Drought is one of the most important abiotic stresses, which limits crop production in different parts of the world. Estimates of yield losses due to drought range from 15 to 60%, which depend on geographical region and length of crop season. Plants adapt to drought environment either through escape, avoidance, or tolerance mechanisms. Chickpea is planted on 700,000 hectares in Iran. Most of this area (95%) is rainfed. Chickpea is grown in rotation with cereals, mainly wheat and barely. Most of the farmers grow this crop on marginal areas in the spring season. Terminal drought stress is one of the major yield reducers in chickpea in Iran. Major successes due to breeding have been achieved in the selection for drought escape. The aim of the present study was to find early maturing chickpea lines, which can escape terminal drought stress. The experimental material comprised 40 kabuli chickpea lines, which along with a susceptible check (ILC 3279) were evaluated in a RCBD design with two replications at research stations of Kermanshah, Kurdistan, Shirvan, Orumieh and Zanzan Province during 2002-03 and 2003-04. The experiments were sown late (10 April) by 20 days in comparison to normal sowing date for terminal drought stress. These materials were sent by ICARDA as CIDTN through Iran-ICARDA cooperation. The genotypes were evaluated for drought tolerance on a 1-9 scale on the basis of ICARDA recommendation. The result of pooled analysis of this study showed that difference between yield and drought tolerance of lines were significant. The results showed that 33 lines had significant difference at 1% level of probability over

susceptible check for drought tolerance. These lines produced higher yield than check significantly. Superior lines for yield and drought tolerance were ILC 1799, ILC 3832, FLIP 98-141, ILC 3182, FLIP 98-142C, ILC 3101, ILC 588. ILC 1799 produced the highest yield, which was due to its high drought tolerance, good adaptability, early maturity and large seed size.

## **7. Morphophysiological effects in sorghum seedlings under PEG 6000 and NaCl in light and Darkness**

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The effect of PEG 6000 and NaCl treatments on growth, water content, fresh weight, dry weight and soluble sugar level in 3d-old seedlings of *Sorghum bicolor* cv. Jambo were studied. Under these stress conditions, RWC (Relative water Content) and  $\psi_w$  of seedlings decreased dramatically. Subsequently, this reduction resulted in the marked decrease in fresh weight of different parts of stress imposed seedlings. On the contrary, a substantial increase in dry weight was observed. Furthermore, a considerable increase in the sugar levels in different plant parts was detected. The fructose level was always higher than that of the glucose and sucrose in response to various treatments. The stressed light grown seedlings showed an elevated content of sugars in comparison with dark grown seedlings. Based on these studies, a possible relationship between seedling growth, water content and soluble sugar content with regard to various abiotic stresses are discussed

## **8. Response in growth and water relation of sorghum [*Sorghum bicolor* (L.) Moench] to osmotic stress and silicon application**

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Gramineous plants such as rice and wheat that accumulate more silicon than other plants are called silicon accumulators. Silicon application to these plants has been

found to enhance tolerance against various biotic and abiotic stresses. This study focused on the effects of silicon application on drought tolerance of sorghum [*Sorghum bicolor* (L.) Moench], one of the most important gramineous crops in the drylands. A hydroponic culture experiment was conducted. Sorghum was grown with (50 ppm) or without silicon and subjected to osmotic stress simulating water deficit stress. There was no effect of silicon application in the non-stressed treatment. In contrast, under water-deficit stress silicon application significantly ameliorated the reduction in dry weight by maintaining higher photosynthetic rate. Regardless of silicon application or osmotic stress, the photosynthetic rate increased in proportion to increasing stomatal conductance which also changed depending on leaf water potential. Thus growth promotion by silicon application under water-deficit stress could probably be attributed to the higher stomatal conductance resulted from higher leaf water potential. Comparison of the hydraulic resistance to water flow between silicon-treated and silicon-deficient sorghum revealed that silicon application could ameliorate stress-induced increases in hydraulic resistance. In conclusion, the beneficial effect of silicon application observed under water-deficit stress could be attributed to the improvement of water uptake by sorghum. There was a similar effect of silicon on photosynthesis rate and stomatal conductance of sorghum under water deficit stress. Cuticular transpiration rate was not influenced by silicon application. The hydraulic resistance was calculated by the evaporative-flux (EF) method. In sorghum grown without silicon, the hydraulic resistance was significantly increased by water deficit stress, but this increase was ameliorated in sorghum grown with silicon.

#### **9. Effect of soil matric potential on tomato yield and water use under drip irrigation condition**

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Field experiment was carried out to investigate the effect of soil matric potential (SMP) on tomato yield, evapotranspiration (ET), water use efficiency (WUE) and irrigation water use efficiency (IWUE) under drip irrigation condition in North China Plain. The experiment included five treatments, which controlled SMP at 0.2 m depth immediately under drip emitter higher than -10 (S1), -20 (S2), -30 (S3), -40 (S4) and -50kPa (S5) after tomato plant establishment. The results showed that different SMP affected irrigation amount and tomato ET. Irrigation amount decreased from 185 mm (S1) to 83.6 mm (S5) in 2004, and from 165 mm (S1) to 109 mm (S5) in 2005. The ET decreased from 270 mm (S1) to 202 mm (S5) in both years. However, it was found that SMP didn't affect the tomato yield significantly. Both WUE and IWUE increased as SMP decreased. The maximum WUE (253 and 217 kg/ha mm) and IWUE (585 and 427 kg/ha mm) were for S5 in two years, whereas the minimum WUE (178 and 155 kg/ha mm) and IWUE (259 and 155 kg/ha mm) were for S1 in 2004 and 2005.

## **10. An estimation of swampy meadow evapotranspiration in arid areas in northwest China: a case study in the middle reach of Heihe River basin**

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Swampy meadow in arid area is widely distributed near the riverside or in lowland where water level is very high. The characteristics of evapotranspiration of swampy meadow are little studied. Based on high-quality meteorological data, the reference evapotranspiration ( $ET_0$ ) was calculated for swampy meadow in the middle reach of Heihe River basin, using FAO Penman-Monteith equation. It shows that in a whole year (2003. 09 - 2004.08), the total  $ET_0$  is 1194.3mm and a daily mean of 3.26mm d<sup>-1</sup>. The  $ET_0$  varies from different growing stages and different months. In no growing period(NGP), initial growing period(IGP), middle growing period(MGP) and the end growing period(EGP), the  $ET_0$  are 0.92 mm d<sup>-1</sup>, 2.13 mm d<sup>-1</sup>, 5.33 mm d<sup>-1</sup> and 2.52 mm d<sup>-1</sup> respectively. In the middle and end of Feb.,  $ET_0$  increases rapidly. But in April, the  $ET_0$  increases most. After that, the  $ET_0$  increases gradually and gets the maximal value in July. From then on, the  $ET_0$  decreases gradually and in the middle of November gets its minimal value. Hourly  $ET_0$  analysis shows that at 8:00 in the morning( during MGP usually at 7:00), the evapotranspiration begins, at 13:00 gets its maximal value and at 18:00( during MGP usually at 19:00), the evapotranspiration stops. The crop coefficient ( $K_c$ ) is also obtained after adjusting the recommended value in FAO-56 with local meteorological and growing conditions. Thus, an estimation of evapotranspiration for swampy meadow can be determined. The actual evapotranspiration is nearly 1100 mm in a whole year and a daily mean 3.0 mm d<sup>-1</sup>.

## **11. Study the effect of calcium on salt and cold resistance during seed germination stage of *Medicago polymorpha***

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In order to examine the effect of calcium on salt and cold resistance during seed germination stage of *Medicago polymorpha* an experiment was conducted in the laboratory of the Agronomy College Agriculture of Tehran University. The seeds were sterilized and incubated in the presence of various concentrations of CaCl<sub>2</sub> (5, 10, 15, or 20 mM) at 20 °C. After 24h the seeds were transferred to one concentration of NaCl and incubated at 5 or 15 °C for two week in germination chamber. Then the seed germination percentage, number of normal and abnormal seedling, fresh, dry weight and length of root and shoot, and their ratios were determined. Results of the analysis of variance showed that the treatments and their interaction significantly influenced all measured parameters. The results indicated that calcium has a significant effect on the reduction of the effect of stress condition during seed germination.

## **12. Transpiration efficiency of eight alfalfa (*Medicago sativa* L.) cultivars under mild water stress condition in dryland farms**

Zoheir Yaghobi Ashrafi, Hamid Rahimian and Farrokh Rahimzadeh Khoie  
Tehran University, Tehran, Iran

A pot experiment was conducted under a shelter in order to compare transpiration efficiency of eight alfalfa (*Medicago sativa* L.) cultivars. Pots were made of 80 cm long P.V.C. tubes with 10 cm diameter. During the experiment, five cuts of alfalfa plants were taken. Each time pots were weighted and the amount of water used and dry matter produced were recorded. Cultivars used different amount of water and produced different amount of dry matter in each growth period. However, differences were not significant for data added for the whole growth period. Cultivars Hamedani and Diabloverde, which showed the highest value of transpiration efficiency also had the highest values of relative water content at 65% soil water content while Sequel and Yazdi had the lowest values. Cultivars with highest values of transpiration efficiency are suggested to be better for cultivation under mild water stress conditions.

## **13. The Physiological role of Nitrate on resistance of water stress in two sainfoin species**

Zoheir Yaghobi Ashrafi and Farrokh Rahimzadeh Khoie  
Tehran University, Tehran, Iran

The effect of water deficient stress on total non-structural carbohydrates in two sainfoin species (*Onobrychis radiata* and *Onobrychis viciifolia*) was studied. The experimental design was a RCD with 4 replication. The plants under study were in the greenhouse environment with the maximum temperature of 38°C and the minimum temperature of 14°C. Forty days after the cultivation, both types were put under the water-deficit stress based on the reduction in moisture (irrigation at 75% field capacity (FC) and 50%FC), with irrigation level of 100% FC being taken as control. Samplings were carried out during the vegetative and reproductive stages. The biochemical analysis showed that root and shoot nitrate contents in both species increased under stress conditions as compared to that of control. *O. radiata* contained higher osmotic metabolites such as nitrate than *O. viciifolia* under stress.

## **14. Responses of *Salix psammophila* and *S. matsudana* to drought stress**

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Water potential and transpiration rate responses to drought stress were investigated in cuttings of *S. psammophila* (C. Wang et Ch. Y. Yang) and *S. matsudana* (Koidz.). These species are widely used for reforestation in the Mu-us sandy land of Inner

Mongolia, China. One-year-old cuttings were prepared in pots and subjected to water stress by withholding irrigation. Volumetric soil water contents, predawn and midday leaf water potentials, and transpiration rate of them were measured. The volumetric soil water contents in *S. matsudana* decreased more rapidly than in *S. psammophila*. The predawn and midday leaf water potentials decreased as a result of drought stress, and these decreases appeared earlier in *S. matsudana* than in *S. psammophila*. The level of soil water contents was same for both species at which predawn and midday leaf water potentials began to decrease. The predawn and midday leaf water potentials in both species did not show marked changes until the soil volumetric water content declined to less than 5%. Similarly, decrease in transpiration rate occurred earlier in *S. matsudana* than in *S. psammophila*. There was no difference in leaf water potentials between two species when transpiration rate began to decrease. However, the soil volumetric water content at which steep decline of transpiration rate appeared was lower for *S. matsudana* than for *S. psammophila*. The results suggest that both *S. psammophila* and *S. matsudana* are sensitive to leaf water deficit, but differ in their response of transpiration rates to soil water depletion. *S. psammophila* is able to tolerate withholding water longer than *S. matsudana* as a result of less water consumption.

#### **15. Effects of sprinkler irrigation on soil nitrate-N distribution and nitrogen uptake by winter wheat under field condition**

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Sprinkler irrigation is applied widely as a modern water-saving irrigation technique. The effects of sprinkler irrigation on soil nitrate-N distribution and nitrogen uptake of winter wheat were analyzed in the experiment. The control treatment was traditional surface irrigation (border irrigation). The experimental results indicated that the peak of soil nitrate-N content under sprinkler irrigation was distributed shallower than that under surface irrigation. In the layer under the root zone of winter wheat, soil nitrate-N accumulated under surface irrigation to various degrees and there was no soil nitrate-N accumulation under sprinkler irrigation condition. The amount of soil nitrate-N leached was 8.68kg/ha and 7.70kg/ha under surface irrigation in 2003 and 2004, respectively. The soil nitrate-N leached under sprinkler irrigation was very small, about less than 3% of surface irrigation conditions. The amount of nitrogen uptake by winter wheat under sprinkler irrigation was 235.7kg/ha and 161.7kg/ha in the two years, respectively. Sprinkler irrigation had the effect of repression in nitrogen uptake by winter wheat in the beginning and promotion later. The difference of nitrogen uptake by winter wheat during different growing periods between years under sprinkler irrigation was smaller than that under surface irrigation. The nitrogen use efficiency of winter wheat under sprinkler irrigation was 20.2kg/kg and 30.0kg/kg in two years, respectively. In the year of less precipitation, the nitrogen use efficiency of winter wheat could be improved by sprinkler irrigation. In the year of more

precipitation, the nitrogen use efficiency of winter wheat under sprinkler irrigation was same as under surface irrigation.

#### **16. Study on the stem sap flux of *Populus euphratica* in the lower reaches of the Heihe River**

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The stem sap flow characteristics of 25-year-old *Populus euphratica* trees and their relation to environmental factors were studied based on the heat diffusion principle and using ICT200TE. The results showed the following: (1) The daily variation of stem sap flow of *P. euphratica* on clear days in the whole growing season exhibited a unimodal curve. The sap flow rates in June, July, August and September were 13.39, 12.07, 12.69 and 5.1 L·d<sup>-1</sup> respectively. (2) In the night there was a weak rise in the sap flow, suggesting the presence of root pressure. (3) The stepwise regression analytical results of the sap flow rate per hour and environmental factors showed that the stem sap flow can be affected by a number of environmental factors. In terms of the influential degree they can be arranged in the descending order: air temperature, soil moisture content, relative humidity, total solar radiation, soil temperature and wind velocity.

## **Theme 7: Renewable energy**

### **1. On potential ways of utilization of solar energy and heat resources in Xinjiang**

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Located inland, Xinjiang is characterized by high aridity. The territory consists of vast Gobi and deserts stretched from west to east. Presently, most of these areas are not utilized and developed owing to their harsh natural environment. In addition, the special events such as sandstorm, heat wave, dry and heat gale, and quicksand become a big obstruction in developing these areas. In the past, much has been spent on combating the desertification and other sand-related disasters, however, little has been gained from these efforts. Apart from harsh environmental settings, Gobi and desert areas have a plentiful reserve of energy resources, such as solar energy and heat resources. If utilized perfectly, lots of ecological, environmental, and economic benefits could be gained. In Gobi and desert in Xinjiang the estimated annual solar energy reaches to about 130-140cal/m<sup>2</sup>. The surface temperature of earth in summer can reach to 50-70°C, which could be used to generate electric power. Given the present stage of technique development, the cost of harnessing these kinds of potential energies could be relatively high, which would obstruct development of these energies. However, it will be easier and cheaper in case of combining the present structures for prevention of sand-related harms with the structures intended for solar energy and heat resources utilization. Substitution of the present structures for controlling the sand-related harms with such structures as a huge matrix of solar cell covering the sand dune surface, can not only generate plentiful electric power, but reduce dust volume blown up into the air, prevent the movement of sand dune, and mitigate the sand-related disasters.

## **Theme 8: Indigenous/traditional knowledge and heritage**

### **1. Empirical knowledge of pastoralists on the palatability for livestock of halophytes and glycophytes, a case study from the Beja on the Sudanese Red Sea coast**

Hiroshi Nawata

The purpose of this work was to reveal palatability of halophytes for livestock, based on an empirical knowledge among the herders of Beja on the Sudanese Red Sea Coast. Interviews were done with five individuals about the palatability for each plant species of halophytes and glycophytes, based on the observed herding conditions of camels, cattle, goats, sheep and donkeys. As a result of these analyses, it was clear that livestock shows various degrees of palatability preferences depending on taxon of the forage plants. In conclusion, the most distinctive characteristics of high palatability of halophytes on the Sudanese Red Sea Coast would be that which was presented by half-shrub halophytes, which are highly palatable for camels. Therefore, it would be necessary to assess and develop a potential role of forage halophytes as camel diet.

### **2. The role of indigenous and traditional knowledge in management of sustainable development**

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Development is not an economic entity but it is a multidimensional phenomenon including various aspect and above all culture and social activities. This paper is an attempt to investigate and demonstrate how development is a crucial criterion in all societies while trying to show the important role of research on traditional knowledge in management of sustainable development as a cornerstone of progress in many developed countries. Moreover, it focuses on education in development to eradicate ignorance and poverty in human and natural resources in every society and enumerates the required development criteria for national development. This paper refers to the development theory proposing that development is an evolutionary movement in every society and the society needs to pass through three phases, traditional society, transitional society and modern society. However, the distance among these phases is not equal. It also classifies the existing resources into four categories, the last of which is to be considered as management of sustainable development and finally it accounts for the people's contribution in cultural development.

## **Theme 9: Sustainable development of oasis; desert communities and socioeconomic studies; and role of NGOs**

### **1. Improving sustainable rural development as a key to fight dust storms: an example in North China**

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As stated by the UNCCD study "Prevention and Control of Dust Storm in the North of China" (2005), the demonstration projects are 'the main vehicle for attaining the objective of reducing the intensity of DSS (Dust and Sand Storms) and mitigating the impact'. In the framework of the Sino-Italian Cooperation Program, a pilot project of energy substitution and energy/water saving in agriculture has been developed in the Alashan Prefecture, one of the four focus regions of China. Two urgent ecological problems are faced, recognized among the major causes of desertification in this region: overexploitation of groundwater and over-cutting of forestry resources.

An integrated systems is proposed, that includes a fully renewable energies-based drip irrigation system, a short-rotation plantation to produce biomass using fast growing cover plants (i.e. *Populus alba*, *Rubinia pseudoacacia*, *Salix matsudana*) and a plantation of *Haloxylon ammodendron*, a key ecological resource in the region.

The project is located in a 2 ha area of rural farm, 20 km south of Jartai. The renewable energy based drip irrigation system is a clean and ecologically sustainable way to manage groundwater resources. Carefully using water to irrigate desert species can give the suitable added value to families' economy, needed to develop new profitable uses of local resources.

The rationale of the project is to provide an example of how local resources, when used in an ecologically and economically advantageous manner, can contribute to sustain rural economy, virtually without negative impact on the environment. During the second half of 2005 the test area was equipped with a gravity drip irrigation system (Tiphon 150 –Netafim) that was connected with a solar pump (Solaflux – Fluxinos) alimented with solar panel array (EurosolarePN8 – Eni). Preliminary results obtained during the spring 2005 are shown and discussed.

### **3. Research on edatope evolution of the land reclaimed from solinization in arid area**

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Land degeneration caused by salinization has always been the main problem constraining the development of oases. This paper took Manas river valley oasis of Xing Jiang as a case, analyzed the edatope change process of reclaimed degeneration

land in alluvial fan oases. Result showed that as the year passed by perennial haloduric weed colony was succeeded by the therophyte. This sequence developed for 6-8 years and then became stable. The total salinity content appeared to first increase and then decrease, and reached to the lowest after reclamation in 9.45 years. The soil nutrients showed reversed trend. Principal component analysis showed that the comprehensive soil quality appeared to be come very good immediately after the reclamation and then became degenerated. Soil conditions became best 10 years after reclamation then started becoming bad. So 10-15 years could be taken as the early-warning time to reflect comprehensively on soil quality.

#### **4. Numerical simulation of the critical scale of oasis maintenance and development in the arid regions of NW China**

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Oasis is a special geographic landscape among vast desert/Gobi in NW China., The surface sensitive heat flux and latent heat flux at Zhangye oasis during August 1 ~ 11, 1991 are 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 is proved that the model can 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 were studied dynamically. The following conclusions were 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 4km. 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/Gobi close by the oasis to supply relative plentiful water vapor for growing up of desert crops on the fringe of the oasis. So, it is advantageous for oasis extension. While, if the scale of oasis is smaller than 4km, it is not easy for local thermal circulation between the oasis and the desert/Gobi taking shape. This study provided a new standpoint for oasis maintenance and development.

#### **5. Using of PRA method of designing rural management model**

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P.R.A means Participatory Rural Appraisal which is a method to encourage the local people to participate in problem identification, solution designing and testing these solutions. Nowadays, social change process, difference of age classes and education level in rural areas have caused changes in the methods of social management of villages according to time, place and culture. In this paper the practical outcomes of a P.R.A in one of the villages of Semnan, called Abdol-Abad are discussed. This village is located in the northwest of Semnan province on Alborz Mountains. The project was run within the framework of "Hableh Sustainable Management of Soil and Water Plan", which has been implemented by with U.N.D.P cooperation since 2003. Outcomes include identification of the best way to adjust local society and the way for financial management in a village. Many social problems were also identified and these included great difference in the age classes, low education level, and poor livelihood.

## **6. Study on sustainable development in Hexi Corridor**

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Hexi corridor of Gansu province belongs to arid region. It is the commercial base of agriculture in the province. The study reported in this paper is based on Shiyang River basin of Wuwei county. The water resources characters and use- methods in the respect of rainfall, surface water and ground water have been analyzed. The relationship of features of water resources and agricultural development was analyzed and calculated. The shortage of water resources has an adverse affect on agriculture. The main characteristic of water resources is the conversion and reuse of surface water and groundwater in the region. The precipitation and runoff does not meet the need of the consumptive use of water by crops, which influences the farm development and it is the key reason for preventing agriculture production, especially from April to June. Therefore, several measure have been suggested.

## **7. Investigation of the implementation of the policy of returning cultivated land to forest in arid areas, a case study of Minqin County**

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This study utilized the WSU-PRA method to investigate time course of implementation and impact of the policy of returning cultivated land to forest in arid areas. The result showed that the utilization of land resources of the whole society rose by 14.7% in 2003 after the implementation of the policy of returning cultivated land to forest. The expanded exploitation of groundwater for tree plantation was  $0.39 \times 10^8 \text{ m}^3$ , and the economized water due to the forage plantation was  $0.1076 \times 10^8 \text{ m}^3$ , and the actual expanded exploitation of groundwater was 9.63 to 10.37 %.

## **8. Study on the dynamic evolvement of urbanization in Jiu-Jia-Yu region based on the self-organizing model**

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Based on the self-organizing modeling principle in the dissipative structure theory and considering the migration between the regions as the influencing factor in bringing regional urbanization, a prediction model was developed to simulate the space-time and dynamic evolvement character of regional urbanization. On the basis of the historical data about the population and urbanization level of Jiuquan, Jiayuguan and Yumen cities, the past 50 years' dynamic evolvement trend is simulated and the following 50 years' dynamic evolvement trend is predicted. The effect of such factors as raise in economy, resource exploitation, ecosystem construction, traffic location, national policies, population movevement etc., on the regional urbanization is analyzed and conclusions are drawn on the reasons for the difference in the dynamic evolvlution of the urbanization in the three cities. The study suggests that, the self-organizing model is suitable to the simulation of Jiuquan-Jiayuguan-Yumen regional urbanization level in the past 50 years and the departure between the stimulated and the actual data is under 5%. So it can be used to predict the future urbanization level of the three cities. The predicted results show that the regional population will reach 1.074 million and the regionl urbanization level will be 72.56%.

## **9. The eco-industry development strategy and demonstrating-region construction in Sanjiangyuan**

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Sanjiangyuan, which is the most important ecologically-adjusting area having high fragility in China, plays a unique and pivotal role in water-resource safety, eco-safety, nationality solidarity and country safety. However, it is also the lowest in the level of economic development. This paper analyzes Sanjiangyuan's strategic influence on Western area, the Qing-Zang Plateau and Qinghai, based on the double aims of protection and construction. The authors think that the fragility of environment, uniqueness with respect to cold, low-efficiency, poor economy, single agriculture-pastoral economy, the typical in-put and overfull out-put industry-structure, excessive pressure of population and livestock, and close headstream economy are the basic characters of Sabjiangyuan economic and social development. The authors suggest that the key to development are eco-industry development, eco-forest-pasturage, eco-industry, eco-tourism, eco-city in Sanjiangyuan area.. Measures for developing eco-industry in Sanjiangyuan natural protection region are suggested. These include, among othersing. creating enabling policy environment, building infrastructure, outlay support, dynamic evaluation, monitoring, etc.

## **10. Health related quality of life (QOL) level and recognition of desertification in inhabitants of the loess plateau region of China**

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This study aimed to clarify health-related quality of life (HR-QOL, SF-36) and recognition of desertification in people living in the semi-arid loess plateau of China. We chose three communities in Yan'an City, Shanxi Province, and four farm village communities around the city, and considered their socio-economic and geometric situation. A questionnaire survey on HR-QOL, recognition of desertification, health conditions and income/year were carried out in August and September 2005. Subjects were heads of households in the communities chosen. Responses from 443 subjects (city 195, village 248) showed that HR-QOL levels were approximately equal between city and rural communities in spite of the economic gap between them. HR-QOL was significantly related to average income in both rural and city communities. The inhabitants in the rural communities were more satisfied with their current life situation than those in the city. Levels of recognition of desertification and attitudes towards health conditions were lower in village inhabitants than in those living in the city.

## **11. Water Resources Managment in Desert Villages of Iran**

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More than eighty percent of Iran is placed in arid and semi-arid conditions and the mean rainfall of this country is less than 250mm. Historical evidences and records confirm that residents of rural areas in Iran dry regions are familiar with desert ecology from the old times. Applying traditional and sustainable methods in use of natural resources, especially water, they have adapted themselves with desert life. But today's population growth and change in social and economical structures on one hand and the change in weather conditions on the other has resulted in an imbalance in the ecological equilibrium between men and environment. Desert development leads to gradual decrease of basic resources especially water, change in social relations and economical foundations, and ultimately to abandoned villages because of out migration. Water crisis challenges in Iranian desert villages are much and some of the ways to face these challenges are application of correct management approaches and the use of different techniques for better usage of water resources. In order to sustain desert villages and to prevent them from becoming abandoned, this article tries to argue on different techniques' especially domestic ones' to decrease water waste and increase use-efficiency of water in Iranian desert villages. It is hoped

that application of these methods would be a positive step toward the sustainable development of desert rural areas.

## **12. Sulfate exploiters and factors affecting emerging of sodium sulfate layer in margin of desert, a case study of Garmsar, Iran**

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Sodium sulfate is a valuable chemical compound that has an important role in production of detergents, papers and glasses. This compound is produced naturally in desert margins under special conditions. Garmsar is a semi-desert region in southeast of Tehran. It is separated from north of the country by Alborz Mountains and is located on the southern slopes. It is in northeast of great desert of Iran. Due to special geology and geomorphologic conditions a semi desert climate dominates here.

The most important permanent river of Semnan province (Hablherod) originating from Damavand and Firoozkoh area, passing through long valley, enters Garmsar plain and constructs the fan of Garmsar. Most of northern mountains in these two areas are composed of gypsum and salt. The tools used in this study were: topographic 1/250000 map, geological and geomorphologic studies of the region, results of soil and water analysis, field works on green cover of sulfate zone and a study on economic and social condition of exploiters. Existence of necessary ions, geomorphology of the area, water media, slow motion of water near the margin of desert, desert climate (cold in winter and hot in summer), special Halophyte green cover, water table level, are the most important factors affecting production of sodium sulfate in a special zone of desert margin. Exploiters are old mine owners of different parts of country.

## **13. Model and application of ecological risk appraisal in the course of urbanization in Arid Area**

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Urbanization is the only way of sustainable development of the Hexi Corridor. However, there are various contradictions between the urbanization course and ecological environment, which also engenders ecological risk. It therefore makes sense to appraise the ecological risk brought out by the urbanization course and then put forward scientific countermeasure for future development of cities in Hexi corridors. Natural forces, economy and social activities contribute to the cause of ecological risk. The ecological risk in the urbanization originates mainly from the development of economy and the social activities. On the basis of research on the intensification and the cause of the ecological risk, the author sets up the mathematical model for the ecological risk appraisal and then use this model to calculate the intensity of ecological risk of 7 cities in Hexi Corridor from different perspective. On this foundation, the author analyses the regularities of ecological risk change in the urbanization course of Hexi corridor: (1) Ecological risk that the economic

urbanization brings out is greater than the ecological risk that population urbanization and social urbanization bring out; (2) The ecological risk brought out by the first industry development is greater than the secondary and tertiary industries; (3) The ecological risk brought out by agricultural water is greater than the industry and the tertiary industry; (4) The ecological risk of the low reaches is greater than the middle and upper reaches; (5) The comprehensive ecological risk of each city demonstrates the precedence order of Yumen > Dunhuang > Wuwei > Jinchang > Jiuquan > Jiayuguan > Zhangye. By careful analysis on the characteristics and laws of the ecological risk in Hexi urbanization course, countermeasure and ways to reducing the ecological risk of cities in the Hexi Corridor are suggested. These include: make the economic development more intensive in style; develop the secondary and tertiary industries such as tourism which have relatively low ecological risk in a more cost-effective manner; improve the proportion of industrial water and reduce the proportion of agricultural water; stress the work of the ecological constructions of the lower reaches and the integrated development of each drainage.

#### **14. Spatial dynamics in vegetation structure along the oasis-desert ecotone in northwest China**

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The vegetation structure was examined to explore change in environment along oasis-desert ecotone (ODE) during oasis degeneration. In this study six parallel sample bands were selected from oasis to desert in natural and semi-natural vegetation region. The biomass, coverage and density of every species were quantified using quadrates of 10×10 m plots at intervals of 50 m along each ODE of Minqin oasis in northwest China. The soil resource was examined in each quadrate. Results indicate large variations in the distribution and spotty patterns in vegetation structure of dominant species and soil resource along ODE. The vegetation structure has changed in semi-natural ODE under human disturbance. The structure of individual plant showed differential response along ODE to oasis degeneration and natural plants were more stable than artificial plants. Oasis health may be assessed according to dominant species variation along the ODE.

#### **15. Ecological-economic analysis on benefit of water conveyance to the lower reaches of Tarim River**

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It took 6 years to carry out the project of ecological water conveyance to the lower reaches of Tarim River. The water transport to the downriver has successfully been increased by six times (  $20 \times 10^8 \text{ m}^3$  volume) in 2000-2005. In order to more accurately

reflect the ecological and economical benefits of water transporting to the lower reaches of Tarim River, we investigated social and economic status of goatherds and the residents involved in goatherds' standard of living, income, economical structure, migratory change before and after water conveyance, willingness and sensitivity to water conveyance project and so on. We designed questionnaire including 36 questions and sent 300 copies to the dwellers with different occupation and education. The investigated results of 37 families of goatherds show that goatherds' income, the ecological structure and total number of livestock increased after water conveyances. In addition, the response of goatherds on water conveyance in different sections of the lower reaches of Tarim river is also greatly different. The more serious intensity of water conveyance on the lower reaches of Tarim River, the stronger response of goatherds on water conveyances. The results adequately testify that the ecological and economic benefit of water conveyances to the lower reaches of Tarim River is evident.

#### **16. The research on environmental vulnerable change and administration model in Mu Us desert**

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Based on investigation and research on the spot in Mu Us desert, using deserticulture and sustainable development theory, the paper analyzed and researched the vulnerability characteristics of environmental change and the problems existing in the course of controlling desertification.. In the area, the climate is warming and drying, climate calamities are frequent, water and biodiversity are reducing, desertification is serious, fluctuation of agricultural production is large and economic development is very vulnerable. In the course of controlling desertification, there exist many problems such as lack of incentive mechanism, dropping of ground water level, inconvenient transportation, redensification, input deficiency of fund and scientific technology etc. Deserticulture has brought great economic and environmental benefits in the area. And the area has superior conditions to develop green deserticulture without pollution, so it can be scientifically, rationally and appropriately developed in the future. The paper puts forward implementing ways of desertification control and deserticulture and sustainable development strategy measures.

#### **17. The role of Haloxylon planting on the socio -economic conditions of the population in Kerman province, Iran**

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Different activities of desertification, mostly in the form of plantations and implementation of man made woods have been going on in different regions of Kerman province since 1966 in regions like Kerman plains and other similar areas as well. The result of these activities has been significant resulting in the improvement of economical and social conditions of residence in this regions. The improvement is occurring in all the aspects, particularly in the economical and social conditions of this province. People's living conditions have improved and more native residents are happy to remain in their current homes. It can be noted that these activities can also affect on increase of population and cultivation, expansion and development of the existing cities and villages in this province.

## **18. Primary analysis of the successional regulation on agro-ecosystem in Manas oasis**

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The regularity and directionality of ecosystem has been hot spot in succession study. Based on the succession theory of ecosystem, this paper analyses succession process of industrial structure, cultivation structure, variety structure and the corresponding ecological environment in recent 50 years, which mainly analyses the succession on development and utilization of water and soil resource in Shihezi oasis in Manas River. It shows that oasis agricultural productivity is in the process of normal succession and the relevant ecology environment becomes retrogressive succession with technical input and market opening. Human's activity is the essential cause of oasis succession and environment accelerating the process of oasis succession, among which the distribution and pattern of using water resource becomes predominant factor. Positive succession should base on temporal and spatial distribution and coordinated utilization of oasis resource factors in agro-ecosystem in Manas River.

## **19. Studying the characteristic of improving temperature effect of desert and the distribution regulation of oasis heat resource**

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In order to further understand the heat resource about oases high-efficiency agriculture, the study focused on characteristic of the improving temperature effect of desert and affect on oases agriculture. The results showed temperature-improving effect of desert would change along with the distance from desert, desert will add temperature about 1.76°C to oasis up to 100 km in regions. Moreover, the improving temperature effect of desert cause some weather characteristic, such as the differences in temperature of day and year, dry heat breeze, and cold damage in oasis.

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

### **1. High Density Cropping System for Cash Crop Production in Marginal Land with Less Water**

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The production of high value crops requires a certain quantity and quality of water that is practically impossible to obtain in such a dry region as the Arabian Peninsula. The underground water level has been rapidly declining and becoming more brackish with higher salt content. Good quality fresh water can only be obtained by using expensive desalination equipment and techniques. Soilless techniques offer a way of improving water-use efficiency and obtaining better water and fertilizer management in crop production. The main objectives are to increase yield quality and quantity per unit of water, area and manpower. Soilless growing techniques were developed by ICARDA-APRP and adopted in Arabian Peninsula countries. High density cropping or vertical soilless growing system is an excellent system to grow many herbs and specialty leafy green vegetables and strawberries. The system uses a tower of interlocking stackable pots. The Styrofoam pots have drainage holes and are filled with soilless media. Nutrient solution is collected in catchments channels under the bottom pot. This solution will be recirculated. The system was adapted for the production of the strawberries in marginal and none-productive lands with less water in Kuwait, Oman, Saudi Arabia and Bahrain. The vertical expansion increases the productivity per unit of area. Planting and harvesting becomes much easier and capital outlay per plants will reduce.

Since the year 2000, several joint adoptive research and agro-economic studies were conducted by ICARDA in collaboration with NARS scientists in AP countries. The results are promising. The yield was increased significantly and productivity of unit of water increased more than 70% comparing to normal soil based systems. This would enable growers to increase their production area with same amount of water. Transferring this technique to grower's field has started in Oman and Kuwait through on-farm research activities. Nine growers in Kuwait and one in Oman have adopted the system. The success of the pilot growers was encouraging for neighboring farmers.

### **2. Agro-climatical zoning of Iran by UNESCO approach**

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The dryland areas of Iran are characterized by considerable weather variability, as well as major abiotic stresses, in particular drought and cold. The intensification of

crop production in these areas needs to take into consideration the agroclimatical diversity, and adapt cropping and land use patterns to the opportunities and constraints of each agroclimatical zone. In view of the very diverse climates, an agroclimatic zone map is of vital importance to achieve this purpose. In this study, long term climatic data (1973-1998) of monthly averages of precipitation, temperature, relative humidity, total incoming solar radiation and wind speed for the main stations in Iran and neighboring countries were collected and stored in GIS. In addition to raw climate data, evapotranspiration (ETP) calculated and added to GIS. An integrated climate-site model applied to create the single and overlay maps by using digital elevation model (DEM) and GIS softwares. On the basis of the three criteria in the UNESCO approach: moisture regime, winter type and summer type, a total of 28 agroclimatic zones have been differentiated, of which only six (arid-cool winter-warm summer, arid-cool winter-very warm summer, arid-mild winter-very warm summer, semi arid-cold winter-warm summer, semi arid-cool winter-warm summer, and semi arid-cold winter-mild summer) occupy nearly 90% of Iran. The objective of this study is to present climatic information of importance to agriculture and to make that information easily available to the agricultural community including agricultural producers, researchers and agricultural planning and decision-making. Also, research result finding may potentially be applied to other parts of the region that fall within the same agroclimate zone.

### **3. Selection of drought tolerant genotypes using morphological and physiological traits in durum wheat**

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Drought stress is one of the most important abiotic stresses which play an important role in yield reduction in rainfed conditions. Physiological studies in crops under stress will help to verify effective mechanism/ traits that influence drought tolerance. In order to study the effect of drought stress on important physiological and morphological traits, the present investigation was conducted under field and green house conditions using 22 genotypes of durum wheat under water stress and normal condition in 2003-04 cropping season, in Kermanshah, Iran. The effect of drought on proline concentration in leaves, electrolyte leakage in the cell solution after stress, leaf relative water content (RWC), relative water loss (RWL), chlorophyll fluorescence (CHF), amount of chlorophylls a and b, cellular membrane stability, grain yield, biological yield, stress tolerance index (STI), tolerance index (Tol), thousand kernel weight (TKW), and earliness were studied. Mean comparison of grain yield of the genotypes under stress condition and Stress tolerance index (STI) grouped the genotypes in to three classes, susceptible, moderately tolerant, and tolerant groups. Three lines with highest STI were identified as tolerant genotypes and three as the susceptible with the lowest STI. The lines with highest STI, showed the minimum fluctuation on yield under both the conditions. Proline concentration in leaves was increased significantly under stress condition. The lowest concentration of Proline was in the lines with highest STI. The lowest level of Proline was in the local check and the highest in lines with highest STI. The 3 lines with highest STI and Proline

concentration also showed highest membrane stability and yield level compared to the other lines. The field study showed similar results and revealed the potential of these lines, which could be used in the breeding program and also released as new varieties. Conventional breeding schemes along with physiological studies can ensure selection of right genotypes for specific trait and condition of interest.

#### **4. Effect of potassium on drought tolerance in Canola (*Brassica napus* L.) cultivars**

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In order to study the effect of water deficit stress on Canola (*Brassica napus* L.) cultivars, an experiment was conducted in split-split plot design at Seed and Plant Improvement Institute (SPII), Karaj, Iran during 2001-2003. Irrigation with three levels as normal irrigation, no irrigation from flowering stage to maturity, no irrigation from seed filling stage to maturity created differential water supply. Potassium with three levels as 0, 75 and 150 kg.ha<sup>-1</sup> K<sub>2</sub>O was allocated to main plots and cultivar as Zarfam, Quantum, Hyola401 were assigned in sub-plots. Results showed that irrigation had significant effect ( $p<0/01$ ) on yield and yield components and oil content. Potassium had significant effect ( $p<0/01$ ) on all characteristics except oil content. Cultivars had significant effect ( $p<0/01$ ) on seed yield, oil yield and thousand seed weight. Double interaction between irrigation and potassium for seed yield, oil yield and thousand seed weights were significant ( $p<0/01$ ). Although in this research it was noted that the tolerance of cultivars was increased by potassium but potassium was effective when water deficit occurred on seed filling stage to maturity. Zarfam was superior to other varieties in seed and oil yield, and yield stability.

#### **5. Optimal levels for some characteristics in *Brassica* oilseed crops in the cold drylands of Iran**

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The breeding programs are rarely based on single characters. When selecting for various traits simultaneously, a correlation between them may restrict the response to selection. Key question is as to which characteristics are important and where attention should be directed for the greatest prospect of breeding gain in dryland condition. Studying some important crop characteristics in a population, taking into consideration the limitations and facilities, is a reliable way to select the suitable genotypes. In this way, a part of the population is used as a standard for evaluation of other parts and an optimal level is defined for each characteristic. In order to determine the optimal levels of some characteristics in *Brassica* oilseed crops in the

cold dry lands of Iran, a broad information bank was collected using results of 4 years trials on *Brassica* oilseed crops in the cold region. Optimal levels of some crop characteristics including days to flowering, days to physiological maturity, duration of grain filling, number of pods per plant, number of seeds per pod, plant height and thousand kernel weight were determined as, 77.7 days, 122.8 days, 43.8 days, 111.5, 17.3, 92.2 centimeter and 1.79 gram, respectively. These data were closely related to optimal levels in averaging method.

## **6. Drought stress effect on agronomic characteristics of open pollinated cultivars and new hybrid of sunflower (*Helianthus annuus* L.)**

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In order to study drought stress effect on sunflower agronomic traits, a strip plot design was conducted in SPII, Iran. Drought stress as irrigation after 60 and 180 mm evaporation from pan class A and sunflower genotypes including 5 open pollinated (OP) cultivars, six Iranian hybrids (IH) and three foreign hybrids (FH) were considered as horizontal and vertical factors, respectively. Analyses of variance showed that all factors and interaction between them had significant effects on measured characteristics. Drought stress declined the yield (30%) by decreasing head diameter and fertile seeds. Drought caused decrease in the seed oil content by 8%.

Hybrids produced more yield, seed number per head than OP, but Iranian hybrids were superior than foreign hybrids for seed number per head and seed yield in full irrigation condition. New foreign hybrids produced more yield than Iranian hybrids and OP cultivars in drought condition. OP cultivars produced less oil seed content than hybrids. However oil content of Iranian hybrids was more than foreign cultivars in control conditions. Foreign hybrids produced the highest oil content (%) in drought condition. Comparison of mean showed that Zaria (OP) and Shafagh (IH) had the highest and least yield and head diameter among genotypes, respectively. Hysun (FH) produced the most seed number per head. The highest seed oil content was in Azargol (IH). Armavirski (OP) had the highest yield and 1000-kernel weight, but Azargol hybrid showed the most seed number on the head and head diameter in control condition. Chernianka (OP) had the most infertility seed in control condition.

## **7. Isolation of Actinomycetes from soils of Iran and evaluation of their antagonistic activities**

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Actinomycetes are one of the most attractive sources of antibiotics and other biologically-active substances such as vitamins, alkaloids, plant growth factors and enzymes. They also enhance soil fertility. These microorganisms were isolated from soils of Kerman province as pure cultures. The isolates were used against *Phytophthora drechsleri* Tucker (Syn *P. ramorum*) that causes gummosis and root rot of pistachio trees, which are the most resistant trees to saline soils and dry weather. From 130 tested isolates, 12 isolates inhibited growth of the pathogen of pistachio gummosis in culture plates. Antifungal activity was of fungistatic type on the pathogen mycelia. From the stand point of dryland development goals, the results indicate that the active isolates can be investigated for use as biofertilizers, biofungicides.

#### **8. Exploitation of adaptive faculty of the olive tree to the water deficit and to the brackish water irrigation for a rational use in arid environment**

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In Tunisia, the olive tree prospers in semi arid to arid environment where the yearly average rainfall varies from 112 to 350 mm. With the ageing and the deterioration of the traditional maintenance practices, this species is currently facing difficulties. In this context, the research of new methods of exploitation has been started. We tested the plantation of olive tree issued from semi-woody cuttings with densities varying from 51 to

The results revealed better production efficiency of plant developed from semi woody cuttings in comparison with those from traditional methods. Irrigation with brackish water gave better efficiency of water use and a bigger faculty to support a longer interval between two irrigations. These features are favourable to a denser plantation of olive trees and to an intensive exploitation while foreseeing a lesser life span of the grove than the traditional one, estimated in the best conditions at 150 years.

#### **9. Effect of drought stress on qualitative and quantitative 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 at experimental field of Seed and Plant Improvement Institute, 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).

Results showed that the water interruption at stem elongation stage had undesirable effect on growth activities, yield and yield components. Number of pods/main stem, in lateral branches and seed yield were affected by drought stress. Decrease 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 similarly in drought stress condition (9%). Among yield components, decreasing 1000-seed weight (8%) and specially number of grains per pod (11.3%) had the most proportion in decreasing seed yield. Also, seed yield decreased more than biological yield and this resulted in decreasing the harvest index. Results indicated a decrease in the oil percent of 3.3% and oil yield of 18.6% in drought stress condition, which was 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 the lowest seed yield was in Hyola 308. The decrease in relative water content was more in the sensitive varieties. Under drought stress condition, the cultivars that maintained their relative water content in high levels, could produce greater seed yield. In drought stress condition, cultivars had higher content of proline, whereas the relative water content was lower. The amounts of proline in leaves showed the degree of stress – induced injury and it was not related to drought stress tolerance. 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 stress tolerance index (STI) had better compatibility to drought stress and could produce greater seed yield in both conditions. In contrast with the cultivars listed above, Hyola 308 had the most sensitivity to drought stress.

## **10. Response of selected chickpea genotypes relative to water stress**

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Selection for improved performance under drought based on grain yield alone has often been considered inefficient. Secondary traits show differential expression between optimal and stress conditions, are genetically variable and are associated with grain yield (e.g., pod number, grain number and seed weight). Different developmental and quantities traits were recorded in 25 Kabul type chickpea genotypes under water stress condition. The experiment was laid out following a randomized complete block design with four replications under two irrigation and rainfed conditions in 2002-2003 cropping season in Kermanshah, where the crop faces terminal drought as it is sown when most of the winter rains have already fallen. Spring planted chickpea experiences drought stress at flowering and pod setting. This stress reduces the yield considerably. Genotypic and phenotypic correlation coefficients and path coefficients were estimated to determine the association and direct and indirect effects of different characters on seed yield per plant. Seed yield was correlated with yield components (e.g., pod number, grain number and seed weight) significantly and positively in stressed experiment. Direct effects of day from sowing to flowering on number of seeds and number of pods per plant were strong. It can be summarized that selection of early flowering genotypes will be more effective criterion to increase seed yield under drought prone climates.

## **11. Path analysis in maize inbred lines under irrigation deficit**

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Path analysis has been increasingly utilized to determine the best trait for selection in agronomic studies and relative importance of direct and indirect effects on grain yield. For this purpose, in this study different traits were recorded in 25 maize inbred lines under irrigation deficit. The experiment was conducted in field conditions, using randomized complete block design with three replications under two irrigation deficit regimes (vegetative irrigation deficit and reproductive irrigation deficit). Phenotypic correlation coefficients and path coefficients were estimated to determine the association and direct and indirect effects of different traits on grain yield. In vegetative irrigation deficit, number of kernel per row (0.956), ear diameter (0.917) and number of row per ear (0.462) had significantly positive correlation with grain yield. In addition, path analysis showed that number of kernel per row and ear diameter had positive and strongly direct effects on the grain yield (0.665 and 0.431 respectively) while number of row per ear had negative direct effect (-0.0142). Also

number of kernel per row had most positive indirect effect via ear diameter. The results of reproductive irrigation deficit indicated that ear diameter and number of row per ear had significantly positive direct effects on the grain yield (0.432 and 0.449 respectively) while number of row per ear had most positive indirect effect via ear diameter. Also, the traits had most correlation with grain yield (0.954 and 0.947 respectively). Results revealed that for grain yield enhancement these traits can be used.

## **12. Evaluations of inbred lines maize for drought tolerance based on resistance indices and biplot method**

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Water deficit during vegetative and reproductive decreases grain yield in maize. In this study in order to determine the most desirable index for drought tolerance and determining tolerant genotypes under irrigation deficit, an experiment was conducted in field conditions during 2003, using randomized complete block design with three replications under three irrigations regimes (normal irrigation, vegetative irrigation deficit, reproductive irrigation deficit). Based on the yield of genotypes in the two environments (normal irrigation and irrigation deficit), different indices, Mean productivity (MP), Geometric mean productivity (GMP), stress susceptibility index (SSI), stress tolerance (TOL) and stress tolerance index (STI), were calculated. Coefficient of correlation among these indices with yield showed that in vegetative irrigation deficit MP, GMP and STI indices were successful in separating genotypes of group A (the genotypes that have higher yield both under stress and non-stress conditions) from other groups and in reproductive irrigation deficit indices GMP and STI are the most desirable indices. In this study, relationship among above indices, were demonstrated with Biplot display method, that showed in vegetative irrigation deficit seven inbred lines (25, 5, 19, 8, 12, 14, 3 and 1) and in reproductive irrigation deficit five inbred lines (25, 5, 8, 9 and 6) were located at part of the plot of high yield potential and low sensitivity to drought.

## **13. Study of some physiological indexes for drought resistance selection in rapeseed cultivars**

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To evaluate reaction of winter rapeseed in drought conditions and to determine physiologic indexes related to drought resistance selection in rapeseed this experiment was conducted with 20 treatments in Ardabil Agricultural Research Center farm Moghan during 2002-2003 and 2003-2004 with 3 Replication and experimental design was RCBD. Two separate experiments were done. First was in normal irrigation

condition and the second was in dry condition with only one time irrigation after planting. During growth season some physiologic and morphologic traits were studied. The results showed that drought has large effect on grain yield, pods filling,, number of pods per plant, plant height, and maturity date. Drought stress caused increase in the EC of leaf tissues through cell membrane damage and ion leakage.. Genotypes more resistant to drought stress during growth season have less EC, more leaf water content and more cell membrane stability. Researchers can use these physiological methods for screening of genotypes at primary levels for drought resistance. Finally, results showed that Hyola 401, Owerka , Herald and Darmoy cultivars respectively have the highest yield grain in stress condition and Ceres and VDH8003 and Gyder have the lowest grain yield in such condition.

#### **14. Evaluation of adaptability and yield stability of barley in semi-arid drylands in Iran**

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A total of 24 genotypes of spring barley were planted for two years (1999 and 2000) in Agricultural research center of Moghan field to study the effect of varieties, years, and years x varieties interaction. Results, showed that 8, 15, and 12, genotypes were better than check and classified as A class. Stability parameters were calculated with environmental variance, standard deviation and ranking methods. With using standard deviation and ranking methods genotypes 5, 8, 9, 10, 12 and 15 and with using standard deviation method genotypes 3, 7, 10, 15, 18, 20 and 22 showed the lowest standard deviation respectively. Environmental variance among genotypes in first year showed high changes because water stress was very severe. Simple correlation for maturity date, heading date, 1000-seed weight, plant height and yield were calculated. Positive correlation was found between yield and maturity period and 1000 seed weight. Therefore increasing in growth period and seed filling period and 1000- seed weight will increase yield potential.

#### **15. Conservation tillage and crop diversification in rainfed agriculture of southeastern Kazakhstan**

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In semiarid southeastern Kazakhstan, in rainfed agriculture small grains, primarily winter wheat, have been grown in rotation with summer fallow. Study on soil tillage

and crop diversification has been carried out in area with long-term annual precipitation of 414 mm during 2001-2005. Traditionally, soil tillage has been made using conventional moldboard plows 20-22 cm deep (control) in the fall before sowing winter wheat, while barley has been sown in spring. Conservation tillage was made with V-type sweeps 20-22 cm deep and with wide blades 10-12 cm deep. These were compared with no main tillage in the fall. However it wasn't complete zero tillage treatment because sowing has been done with stubble drills equipped with duck-foot shovels. In case of control, sowing was done with double disk drills after tillage with duck-foot cultivators.

Five year data on winter wheat and spring barley grain yields have shown that if tillage has been done at the same depth of 20-22 cm, conservation tillage provided the same yields as in control moldboard plowing. Shallow conservation tillage provided the same yields with control or slightly lower, while no main tillage in the fall reduced the grain yields considerably. Soil bulk density in 0-30 cm soil layer on plowed land was 1.14 g/cm<sup>3</sup> in spring and 1.23 g/cm<sup>3</sup> in summer, while no main tillage increased bulk density up to 1.28 in spring and to 1.31 g/cm<sup>3</sup> in summer which was one of reasons of reduced yields on no tillage. Soil moisture accumulation in 0-100 cm soil layer in spring was affected by tillage: 183-188 mm of available water in tilled soil while it was 168 mm in no tillage. Yield in no tillage was also decreased because of less nitrates availability and higher weed infestation. Thus, moldboard tillage can be replaced with conservation tillage but for successful introduction of minimum tillage or no tillage soil compactness, soil nutrients and weed management issues should be addressed.

A number of alternative crops were tested during five years as compared to bread wheat. Winter wheat in rainfed conditions produced on average for five years 2.72 t/ha of grain (100%). Both spring wheat and spring barley produced very much lower yields as compared to control (59-48%) but oat proved to be the best as far as the grain yield concerned (106%). Strangely, but farmers prefer to sow spring barley as second crop in case when cropland area was not planted with winter wheat. Millet and buckwheat are low yielding spring grain crops (47-45%) and can be grown only provided good market and good prices. Chickpea yields for rainfed agriculture were quite good (48%) making half of winter wheat. Lentil yields look low compared to wheat (28%) but they should not be compared only in quantities. Economical assessment was made based on product value in the local market. Prices for lentil were taken the same as for wheat as there was no market for this crop. Chickpea price was taken almost double price of wheat which shows that this crop is more familiar to local people. This is why for the time being these crops are not grown in southeastern Kazakhstan. Chickpea and lentil yields in the world market are at least two-three times higher compared to wheat. Although lentil prices are 50-60% higher than of chickpea but local economists estimated lentils cheaper than chickpea. The challenge is how to access to world markets.

## **16. Minimum tillage in large scale farm in northern Kazakhstan**

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During 1954-1956, 25 million hectares of grassland were developed in Kazakhstan to produce grain of high quality spring wheat. Since collapse of Soviet Union in 1991, state owned large farms were dismantled and land shares were distributed to farm members proportionately to their input to a farm development. Dismantling of large scale farms and establishment of small size private farms and various types of cooperative enterprises during mid-nineties resulted in bankruptcy of many farm businesses leading to large areas of marginal lands earlier used for grain production abandoned.

A grain marketing company Logo Straight decided to make investment into agricultural production by buying out 90% of shares of a farm "Zelyenoye" taking management of 10,000 ha of cropland of which large part was abandoned during transition. The farm is located on dark brown soils with organic matter content of about 3% in semiarid climate with total annual precipitation of 320 mm distributed through the year with maximum of rainfall in summer when spring cereals are grown. Average annual temperature is about 1.2°C. Spring wheat is major crop sown in a second half of May and harvested in September. Generally adopted practice is leaving 20% of cropland under summer fallow while 80% is occupied with small grains primarily with spring wheat.

Farm management in consultation with ICARDA decided to gradually reduce area under summer fallow and introduce no-tillage technology. In 2005, for the first time 4,635 ha of wheat was planted on no-tillage technology by application of 2.5 l/ha of Roundup herbicide with Summers boom sprayer ten days before sowing spring wheat with a Horsh no-till planter. According to traditional technology, 5,214 ha were sown with common cultivator-drills followed with harrowing and spraying at wheat tillering stage with mixture of herbicides Topic and Loren. Spring wheat grain yield was rather low in 2005 because of very wet weather during grain filling but it was 1.04 t/ha on no-tillage against 0.77 t/ha in control. Cost of production was higher on no-tillage but net profit was slightly (US\$ 6/ha) higher in new technology. It is very important to indicate that two tractors with no-till planters replaced work of five tractors with common cultivator-drills. This will allow to plant timely and faster. Farm management believes that very soon summer fallow area will be significantly reduced and no-tillage technology used on the whole farmland.

## **17. Effects of nitrogen application on three new dryland wheat varieties for cold regions in drought years**

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In order to determine the effects of different levels of N fertilizer on yield and other agronomic traits of new wheat genotypes, a study was carried out in 3 different dryland research stations (Maragheh, Ormey, Iilam) in Iran. The experiment was set up with 4 N fertilizer levels (0,30,60,90) kg/ha and 3 cold tolerant promising wheat genotypes (KVZ/TM71/3/ , SBN/TRM/K253 and SBN/1-27-56-4) in factorial RCBD with 4 replications for 3 years (1999-2001). The results showed that using 60 kg/ha.N in line KVZ/TM71/3/ gave highest grain yield, nutrient (N.P.K) content and harvest index. This line namely Azar2, is comparable with Sardari, the common previous dryland wheat variety. Increasing nitrogen level from 60 to 90 kg/ha didn't increase grain yield, but increased straw in different wheat genotypes. Regarding the amount of precipitation and biomass yield of different wheat varieties, application of 60 kg N together with 50 kg/ha P2O5 is recommended for wheat production in dry lands.

#### **18. Quantitative land Evaluation on Dryland Agricultural Research Station of Maragheh for Rainfed Wheat by using Parametric Methods**

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Quantitative land suitability evaluation for rainfed wheat was carried out on 500 ha lands of Maragheh Dryland Agricultural Research Station. The main objective of the study was identification of land suitability classes and limitation factors for wheat production in the region. Detailed soil survey studies and climatological figures were used as the physical parameters, as compared with the requirements of wheat using the standard rating tables of Sys and parametric methods proposed by FAO in 1973. The Square root and Storie index methods were used for calculation of the parameters on parametric method. The common farming systems in the study area are mainly Wheat-Chickpea and some alternative Cereal-Legumes and fallow. The results showed that there are two recognized soil series namely Chohraq and Rejal Abad and 5 soil phases. Availability of soil moisture at early and the end of growing season and also low organic matter content, seems to be main constraints and most limiting factors on wheat production in the region. This land evaluation method (FAO, 1973) has shown to be a relevant evaluation method for certain crops in Iran. Based on the findings of present research the results of Parametric, Square Root method is more acceptable and practically has a good correlation with the farmer's field's production. Also the results of this study showed that the rating tables .proposed by Sys in 1993 must be revised and calibrated for the region

#### **19. Physiological characteristics of advanced durum wheat genotypes under rainfed condition**

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Drought stress is the most important abiotic stress with significant role in decreasing crop production worldwide. Therefore, development of resistant or tolerant varieties to environmental stresses is an important aim in breeding programmes. To evaluate the drought tolerance of advanced durum wheat genotypes, this experiment was carried out with 13 advanced genotypes and national check (Zardak) under rainfed and low irrigation (one irrigation at flowering stage) at dry land agricultural research institute, Kermanshah, Iran. Genotypes studied for some important physiological indices such as leaf relative water content (RWC), relative water loss (RWL), proline, chlorophyll fluorescence (CHF), amount of chlorophylls a and b, cellular membrane stability and stress tolerance index (STI), tolerance index (Tol) and characters such as grain yield in both conditions, thousand kernel weight (TKW) and earliness. Results of statistical analysis showed significant differences between genotypes for all studied traits. Correlation coefficients among the traits revealed that correlation of STI with earliness and RWC was positive and with proline was negative. Earliness showed negative correlation with proline. Based on these results, the genotypes 1 (Omgenil-3), 3 (Syrian-4) and 6 (Man-1/Rfm-7) were selected as the best genotypes. STI showed nonsignificant positive correlation with Chlorophylls a and b, and negative correlation with chlorophyll fluorescence. Positive correlation was observed between STI and cellular membrane stability. The most cellular membrane stability was in genotypes No. 1, 3 and 6. In addition these genotypes had high yield in rainfed (Ys) and low irrigated (Yp) conditions. According to three dimensional plot (3-D) using STI, Yp and Ys, genotypes No. 1, 3 and 6 located in high yield potential region (A region). These genotypes were classified in the same group, using cluster and discriminate analysis for STI, RWC, proline and cellular membrane stability. Beside these genotypes were the superior than local check (Zardak) and other genotypes.

## **20. The first safflower candidate variety for release in drylands of Iran.**

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In Iran annually 3000-4000 ha of safflower is grown mostly near big cities mainly for its flower petals and bird feed. Iran's annual consumption of edible vegetable oil is about 850,000 tons. About 90 % of the need of edible oil is met through imports. There are now proactive efforts to create and develop area for important oilseed crops; in line with this government is now encouraging safflower cultivation for edible oil purpose. In the last few years safflower area has increased and was 15,000 ha in 2002-03. Our extensive trials in rainfed areas, in climatically different regions, show that this crop is suitable for low-rainfall lands, receiving winter and spring rainfall, and has dry atmosphere during flowering, heading and maturation of the crop. There are two main Iranian commercial varieties called 'Zarghan279' and 'Local Isfahan' which are commercially cultivated by the farmers in different areas in

both the fall and spring season. Farmer variety is more suitable for fall and the latter for spring planting.

An accession PI-537598 was selected for the first time in a collection of varieties received from ICARDA. This line was preliminary screened and evaluated within the country in observation nursery at Kermanshah (semi-cold region) in 1996-97. This line exhibited superior genotype and was therefore selected for advance trials and included in trials for fall planting during 8 years in A, B, adaptation and on-farm trials under rain-fed condition of Kermanshah. PI-537598 was also selected as high seed yielder line in 1998 at Shirvan (cold region), in 1999 at Kurdistan (cold region) in different on-station and on-farm trials. This line also showed good performance in Khoramabad and Ilam (semi-cold region) in fall planting. At locations in Ardabil and Zanzan (cold region) excelled both in fall and spring planting during 2001 to 2003.

In all on-station and on-farm trials PI-537598 always had significantly more seed yield than Zarghan 279 (check variety) in fall planting over locations and years. This promising line produced average seed yield of 2387, 1308, 1198, 1159, 650 and 590 Kg/ha during three years in fall planting under rain-fed condition in Ilam, Kermanshah, Ardabil, Khoramabad, Shirvan and Kordestan, respectively. In general, this line produced about 45 per cent more seed yield compared to commercial check variety (Zarghan 279) in fall planting over different locations.

## **21. Comparison of autumn over spring planting in lentil under dry land condition in Iran**

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Lentil (*Lens culinaris*) is grown on 237,000 hectares in Iran and ranks fourth in the world after India, Turkey and Canada. Major lentil area (94%) is planted in rainfed condition and is grown in rotation with cereals mainly wheat and barely. Most of the farmers grow this crop on marginal areas in the spring season. The rainfed and irrigated yield for lentil are 456 and 1066 kg/ha. These are indications that improving moisture conservation in rainfed area may improve the rainfed yield. Drought is the common abiotic stress limiting chickpea production in different parts of Iran. Lentil frequently suffers from drought stress towards the end of growing season after flowering, during pod setting and seed formation, drought is also accompanied by heat stress in rain-fed conditions. The objective of this study was to compare yield of autumn with spring planting in moderate region of Iran. The experimental material comprised 11 lentil lines in four replications under rain fed condition at Kermanshah research station during 2001/2002, 2002/2003 and 2003/2004. For finding of significance yield of autumn compare to spring planting t test was used. The results of present study showed that autumn sowing had significantly ( $\alpha = 1\%$ ) different higher plant height than spring sowing. Result of this investigation indicated that date of sowing has no effect on seed size of lentil. The lentil lines yield in autumn planting were 69 percent higher than spring planting in Kermanshah province. Average yield of lines in autumn planting was 1159 kg/ha while for spring planting was 687 kg/ha. The results of these studies showed that autumn planting have significantly ( $\alpha = 1\%$ ) different higher yield compared to spring planting due to benefit of winter rainfall,

and low evapotranspiration, as temperatures are low when the crop approaches maturity. Autumn environment allows optimum vegetative growth, development of higher yield potential, and higher water-use efficiency. The canopy is taller which allows for mechanical harvest.

## **22. High potential yield and adaptability lentil variety candidate for releasing in dryland condition of Iran**

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Lentil is one of the most important food legumes in Iran and occupies nearly 23% of the food legume area. Major lentil area (94%) is planted in rainfed condition. Most of the farmers grow this crop in marginal lands in the spring season. The highest and lowest lentil yields are produced by Canada and Iran with 1306 and 457 kg/ha. The objective of these studies was to find variety which produce higher yield than local check with high adaptability. FLIP 92-12L was selected from the material sent by ICARDA through Iran-ICARDA cooperation. The variety was selected and evaluated in LISN-L experiments in 1993 at Research Station in Zanjan province. The results of performance of varieties in LISN-L, A test, B test, , adaptation yield trial, On-farm and extension-research experiment during 10 years showed that the variety FLIP 92-12L has produced higher significant yield than local checks in Ardebil, Maragheh, Zanjan, Gazvin, Kermanshah, Lorestan, Ilam, Gachsaran , Shirvan and Golestan provinces. Evaluation were taken out to assess yield potential and adaptability FLIP 92-12L variety in comparison with local varieties in adaptation yield trail at research station in 10 provinces under rainfed condition for autumn and spring planting during three years (2001-04). The results showed that FLIP 92-12L produced 1263 kg/ha in autumn (moderate areas) and 683 kg/ha in spring planting (cold areas ) which were significantly higher yield than local check at 1% level of probability. The variety had the highest adaptability in both areas. The productivity of FLIP 92-12L variety was 1623 kg/ha on Research–Extension experiment at farmer field in Kermanshah Province under rainfed condition in 2003-04, which was significantly higher yield than local variety at 1% level of probability.

## **23. Relationship between grain yield and some agronomic characters in durum wheat in the highlands of Iran**

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Durum wheat (*Triticum turgidum* L.) is cultivated in about 200-300 thousand hectares across arable lands in Iran from which, about 65% is under rainfed condition. The main breeding objective in dry lands 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. Correlation between some agronomic traits were studied in 151 exotic and indigenous durum lines in main station of Dryland Agricultural Research Institute (DARI) during 1998-2001 in Iran. Negative significant correlation was obtained only between days to heading and thousand kernel weight in facultative types. In the spring types of durum wheat, days to maturity, grain filling period, plant height and days to heading were the most important traits for increasing grain yield, respectively. In the facultative types, days to maturity, plant height, grain filling period and days to heading were important but in winter types only days to maturity had positive significant correlation with grain yield. Path analysis showed that days to maturity has the highest contribution in grain yield of durum wheat in the highlands of the country.

#### **24. Fertilizer management in mulberry-based intercropping system for rainfed conditions**

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The cost of fertilizer is increasing day by day and the chemical fertilizers have also proved to affect soil health when used continuously. The integrated nutrient management may help in long run in minimizing these problems. To optimize the production and to reduce the risk of crop failure due to erratic and non dependable rainfall, farmers have evolved various cropping patterns. One of the ways of overcoming the losses caused due to unscientific, unhygienic handling and management of mulberry garden as well as silkworm rearing is by growing intercrops within main crop which source of additional income, besides risk bearing. With this background a field experiment was conducted for four consecutive *kharif* seasons of 2000-01 through 2003-04 to study the fertilizer management practices for maximization of leaf yield and quality of M<sub>5</sub> mulberry under cereal based intercropping system in rainfed conditions in *Alfisols* at Bangalore, Karnataka, India. Application of recommended fertilizer + FYM+ Biofertilizer (*Azotobacter* + *Aspergillus* 10 kg/ha/year) resulted in significantly higher leaf yield (12577 kg/ha/year) with higher nutritional status of leaf compared to growing only on chemical fertilizers. Further, the same treatment recorded higher monetary returns and Benefit: Cost ratio. Whereas, the cultivation of intercrops (Finger millet and Foxtail millet) did not have any adverse effect on the growth and yield of main crop which shows the feasibility of these crops as inter crops in mulberry garden. Besides, there was no adverse effect on silkworm growth (3.02 g of mature worm weight and 1.47 g of single cocoon weight) and cocoon characters (1.47 g, 0.272 g, 18.48 % and 812.50 m of single cocoon weight, shell weight, shell percent and single filament length respectively) when silk worm were fed on leaf raised by combined application of recommended fertilizer + FYM+ both biofertilizers.

#### **25. Response of chillies to sources of potassium, age of seedlings and nipping under rainfed conditions**

M.A. Shankar and B.J. Sumangala

India is the largest producer of chillies in the world sharing nearly 47.11 per cent of world cultivation. There is need to develop more efficient, economic and integrated system of crop management to sustain the productivity without degrading soil fertility. Presently, NPK balance is precariously poised particularly in respect of K. Even after making allowance for possible K additions through natural resources, a deficit of nearly 8 mt K per annum may present. The situation demands on evolving strategies and policies to boost K supplies. Therefore an experiment was conducted to study the response of chillies to sources of potassium, age of seedlings and nipping under rainfed conditions during *kharif* 2002-03 to 2003-04. Chilli fertilized with SOP + with nipping + 45 days old seedlings produced significantly higher fruit length (9.50 and 9.71 cm), number of fruits per plant (55.3 and 62.9), 100 fruit weight (49.6 and 46.3 g), yield per plant (44.41 and 48.42 g) and dry chilli yield (1060.0 and 1189.57 kg/ha/year during the year 2002-03 and 2003-04, respectively). The magnitude of increase in yield was to an extent of 43 per cent and 38 per cent over control (0 kg K<sub>2</sub>O/ha + without nipping + 45 days old seedlings) with higher available nutrients in the soil (204.35 and 201.88 kg N/ha, 119.22 and 200.5 kg P<sub>2</sub>O<sub>5</sub>/ha and 204.45 and 202.76 kg K<sub>2</sub>O/ha during 2002-03 and 2003-04, respectively) besides higher monetary returns

## **26. Response of chilli to sources and levels of potassium under rainfed conditions**

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An investigation was carried out under field condition for two consecutive *Kharif* seasons of 2002-03 and 2003-04 to assess the impact of potassium sources (SOP & MOP) and their levels (50, 75 & 100 kg K<sub>2</sub>O/ha) on growth and yield of chilli Cv. Samrudhi under rainfed conditions in *Alfisols* of Bangalore. Application of potassium as sulphate of potassium (SOP) @ 50 kg K<sub>2</sub>O/ha resulted in significantly higher growth parameters (90.30 & 101.1 cm of plant height, 10 & 10.5 of number of primary branches and 19.42 & 19.0 of secondary branches during the year 2002-03 and 2003-04, respectively) and yield parameters (8.02 & 8.35 cm of fruit length, 48.5 & 50.7 of number of fruits per plant, 47.30 & 51.6 g of 100 fruit weight and 40.27 & 49.1 g dry fruit yield per plant during 2002-03 and 2003-04 respectively). Chilli fertilized with SOP @ 50 kg K<sub>2</sub>O/ha produced significantly higher dry chilli yield (1055.36 and 1118.50 kg/ha) registering an increase to a magnitude of 40 per cent and 37 per cent over control (0 kg K<sub>2</sub>O/ha) during 2002-03 and 2003-04, respectively.

## **27. Effect of drip irrigation with saline water on tomato and cucumber yield and water use**

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Because of the increasing water competition between human, industry and agriculture, use of saline water for irrigation is gaining more and more interests. It is essential that the effects of salinity on crops be understood, and optimal management strategies be developed. A three-year field experiment was carried out to investigate the effect of saline water on tomato and cucumber yield and water use under drip irrigation in North China Plain in 2003, 2004 and 2005. Five treatments of irrigation water with average salinity levels of 1.1 (fresh water), 2.2, 2.9, 3.5 and 4.2 dS/m in 2003 and 2004, and 1.1, 2.2, 3.5, 4.2 and 4.9 dS/m in 2005 were tested. Throughout the tomato and cucumber growing season, the soil matric potentials at 0.2 m depth immediately under drip emitters of all treatments were kept higher than -20 kPa. The experimental results showed that irrigation water salinity ranging from 1.1 to 4.9 dS/m had little effect on tomato yield, but had some effect on tomato seasonal cumulative water use and water use efficiency (WUE). With the increasing irrigation water salinity, tomato seasonal cumulative water use decreased, and WUE increased. However, it was quite different for cucumber. The cucumber total yield decreased linearly with increasing salinity of irrigation water and the yield reduced about 28% when irrigated with saline water of 4.9 dS/m compared with that irrigated with fresh water. Cucumber seasonal accumulative water use and WUE both decreased linearly with the increasing salinity of irrigation water.

## **28. Effect of different irrigation methods on winter wheat yield and water use efficiency**

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Water is one of important factors affecting crop yield. A field experiment was carried out to study the effect of irrigation methods on winter wheat yield and water use efficiency under sprinkler, drip and surface irrigation conditions in 2005. The results showed different irrigation methods had significant effects on winter wheat yield. The winter wheat yield under drip irrigation was the highest, and was 15.1% higher than that under sprinkler irrigation and was 25.3% higher than that under surface irrigation. The winter wheat yield under sprinkler irrigation was 8.9% higher than that under surface irrigation. There was a very significant different on winter wheat yields between drip and sprinkler irrigation, drip and surface irrigation. There was a significant difference in yields between sprinkler and surface irrigation. Water use efficiency was 1.89, 1.65 and 1.51 kg/m<sup>3</sup> for drip irrigation, sprinkle irrigation and surface irrigation, respectively.

## **29. Evaluation of subsurface irrigation with saline water at two depths in a sandy soil**

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Irrigation with saline water frequently causes salt accumulation and soil degradation in agricultural fields, especially in arid and semi-arid region. The relationship between saline irrigation and salt accumulation is obvious, however, because of water scarcity, use of saline water is inevitable in those dry areas. Preventing from salt accumulation and managing sustainable irrigated agriculture with saline water need proper irrigation systems and scheduling programs. Water conservation also must be considered in sustainable agriculture. Therefore, designing the appropriate water saving irrigation system with saline water is needed in dryland.

Microirrigation, such as drip irrigation and subsurface irrigation, is suitable for saving the irrigation water. The subsurface irrigation is becoming more popular, but when the method is applied to a sandy soil, some problems occur. Generally, sandy soils have high hydraulic conductivity; the drainage water loss increases. For minimisation of the loss, we developed a new subsurface irrigation method; subsurface irrigation at two depths. To evaluate the benefit of this new irrigation method with saline water, dry matter and water use efficiency (WUE) of sorghum and soil salinity by this method were compared with those by the sprinkler irrigation. Fresh water ( $EC=0.06dS/m$ ) and saline water ( $EC=7.43dS/m$ ) were applied for both irrigation methods.

With saline water, dry matter and WUE of sorghum were increased by new method, but topsoil salinity also increased extremely. High salinity of soil surface indicated that there were no downward fluxes of water and solute at surface with subsurface irrigation, and leaching has never occurred, but upward fluxes like evaporation have occurred. As a result, solutes were accumulated at surface. In conclusion, this two depths subsurface irrigation is considered beneficial for water saving irrigation with saline water, though removing the salts in soil surface of applied fields is necessary to manage the sustainable irrigated agriculture.

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