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Sustainable agricultural and rural development in semi-arid environment when supplementing rainfall with 200mm irrigation water per year

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Introduction An Irrigation Public Perimeter , Oued Rmel IPP , was created in a semi arid region of Tunisia , providing 200mm/year complementary irrigation (CI) . Rainy season occurs from autumn to spring , with annual rainfall varying between 200 and 700mm . The potential evapotranspiration is of 1250mm . More than 90% of days are windy . Seventy percent of the farms are 3 or 6 ha in area , rented by 1100 families with low incomes . A six hectare Research and Extension Station (RES) was created in the IPP to try different production systems with the aim to create a sustainable biophysical and socioeconomic environment by (1) CI to improve and stabilize yields , (2) introducing multipurpose tree and shrub (MPT) planting technologies , (3) adapting animal farming .

Material and methods Crops : Several varieties of wheat , barley and oat were sowed to compare their yield (Y) and water use efficiency (WUE) . Three sowing dates (D1 to D3) between 20th November and 24th December were tried for a variety of wheat . A bi-annual forage crop , sulla (*Hedysarum coronarium*) cultivar Bikra21 , was introduced ; it has a very high and nutritious yield potential , very melliferous with a mutual beneficial effect (between bee and flower) .

MPT : Numerous fast growing MPT were introduced in various designs . For sustainable windbreaks , we used *Casuarina glauca* , *Pinus alepensis* , *Cupressus sempervirens* hor . and an olive tree (Olivier franjivento) ; for alley cropping , we used *Acacia cyanophylla* , *Atriplex numularia* , *Medicago arborea* , *Albizia lebeck* ; for fences or borders of rural tracks , we used *A . cyanophylla* , *A . numularia* , *Melia azedarach* , *A . lebeck* and *Opuntia indica* mainly as green fodder reserves from trees , as well as *Geranium rosa* (beehive , oil) , *Saccharum aegyptiacum* (canes) .

Animals : CI makes possible an on-farm feed program (green , silage , hay , straw , green fodder reserves in trees) ; an adapted sheep race was introduced (Noire de Thibar" instead of the traditional Barbarine") ; one cow with calf was introduced for an economical evaluation . One beehive was also installed on the station .

Results and discussion Cereals : During a very dry year (rainfall campaign : 140mm , CI : 150 to 200mm) , the best cereals grain yields obtained were 5 .6tons (T)/ha with Rezzak (wheat) , 4T/ha with Manel (barley) and 5 .7T/ha with TCL83 (triticale) ; Water Use Efficiency (WUE) was higher than the national mean (1 .3 kg/m³) for irrigated cereals , it averaged 1 .65 , 1 .4 and 1 .9kg/m³ respectively . For D1 to D3 , grain yields were equal (5T/ha) , but straw height and yield decreased (D1>D2>D3) ; straw was important as animal feed , D1 was recommended .

Fodder oats : Meliane cultivar performed the best in the dry year (CI : 160mm) as well as in the rainy year (CI : 60mm) with 43T green matter (GM)/ha when the local cultivar (irrigated) produces only 29T GM/ha . Dual harvesting is possible when CI is used ; a trial with Meliane cultivar dual compared to a single harvest produced (1) a higher total yield , with 60T GM/ha vs 42T/ha , corresponding to 10T dry matter (DM) , vs 8 .5T/ha and (2) a better hay quality with a higher leaf/stem ratio (0 .56 vs 0 .24) .

MPT : As windbreak , the superiority of *C . glauca* was confirmed with regard to survival percentage and speed of growth , important results for the forestry nurseries when considering changes in their production program (still actually , more cypress than any other) . In Alley cropping , at one year old , *A . cyanophylla* and *A . numularia* did not suffer from barley competition , in contrasty to *A . lebeck* ; *M . arborea* flowered abundantly during winter because of crop competition , which is more beneficial for bees (usually flowers are rare in winter) than for forage production . *A . numularia* was the best in term of quantity and quality of forage production ; *A . cyanophylla* was second . But the one preferred by animals was *A . lebeck* , but it produced the lowest yield .

Stock farming : Comparing three years costs , sheep were less costly than cattle , giving more flexibility and less financial hazards . The first honey harvest was enough for return on beehive expenses .

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