RESPONSE OF DRY BEANS TO TILLAGE SYSTEMS AND *IN SITU* RAINWATER CONSERVATION TECHNIQUE IN THE SEMIARID HIGHLANDS OF MEXICO[1]

J. S. Padilla-Ramírez[2], E. Martínez-Meza[2], E. S. Osuna-Ceja[2], M. A. Martínez-Gamiño[2] and J. A. Acosta-Gallegos[2]

[1]Research partially financed through the project 175 (SAGARPA-CONACYT). PRECI 6055905 A.
[2]INIFAP Bean Research Program Group. Apdo. Postal 20 Pabellón de Arteaga Aguascalientes, México. C.P. 20660. jsaulpr@yahoo.com.

Introduction. The state of Aguascalientes, is located within the semiarid highlands of Mexico, where dry beans in one the most important crops. In Aguascalientes there are almost 100 thousands hectares cultivated under rainfed conditions and dry beans has occupied approximately 13% of that area last five years period (2000-2004). The average seed yield of dry beans in the state is about 327 kg ha^{-1}, and it is one of the lowest in region. This low yield of dry beans has been attributed to several factors such as: climatic restrictions especially moisture stress, degraded soil conditions because of inadequate soil management practices and use of non improved dry bean varieties. Conservation tillage systems that contribute to minimize soil erosion and reduce costs in semiarid conditions have been reported to increase productivity of rainfed crops (2). Similarly, soil water conservation practices that help to reduce runoff and increase water infiltration have shown positive effect on dry beans production under semiarid conditions. The utilization of early and drought resistant dry bean varieties has been suggested as an alternative to reduce production risks in this area (1). Thus, the objective of this study was to evaluate an integral dry beans production strategy to stabilize crop production by including improved bean varieties in combination with conservation tillage systems and soil water conservation techniques.

Materials and Methods. The study was conducted at the region known as "El Llano" located in the northeast of Aguascalientes state (21° 54' N; 102° 04' W and 2000 masl) during the summer of 2005. Experiments were conducted on four sites (El Tildio I, El Tildio II, El Copetillo and Sandovales). Plots were planted on July 5th at the beginning of the rainfall season. Size of Plots consisted of one hectare each. Three technological components were evaluated: 1) Dry bean cultivars: "Flor de Mayo Bajio" (FMB) and "Flor de Mayo Sol" (FMSol); 2) Tillage methods: Conventional Tillage (CT) including disc plowing plus harrowing and "Multiarado" (*Mult*) which has a wider horizontal knives to break ground without soil inversion and 3) *In situ* water conservation: Ridges (R) (mound of soil raised approximately 20 cm high from the bottom of the furrows during crop cultivation) and No Ridges (NR). Ridges were raised 3.0 m apart along rows by using a kind of mechanical shovels ("pileteadora") attached to the rear rigid tines of cultivator at the time of crop cultivation. Ridges were made during the first (20 to 25 days after planting) or second cultivation (35 to 40 days after planting) or in both, except at "El Copetillo" where not ridges were made. The treatments were established on strips of six to eight furrows 0.76 m wide and 100 to 150 m long. Grain yield was estimated from four to six samples of 6.08 m^2 (2 x 0.76 x 4.0) per treatment.

Results and Discussion. Clear differences were observed in the grain yield of dry beans among experimental sites, being the highest "El Tildio I" with an average of 996 kg ha^{-1}, while at "El

Tildio II" the grain yield averaged 390 kg ha^{-1} (Table 1). These differences could be attributed to the amount and distribution of rainfall at the specific site, since in the area an uneven space pattern of the rainfall in not uncommon. Another possible reason for the low grain yield at "El Tildio II" may be due to the presence of weeds, which were more a problem in this site than all others. The cultivars showed an interaction with the location, since FMB had the highest grain yield at "El Tildio I and II", whereas seed yield of FMSol was higher at "EL Copetillo" and "Sandovales". The grain yield average considering all locations was slightly higher for FMSol (721 kg ha^{-1}) as compared to FMB (690 kg ha^{-1}). Regarding to the Tillage methods, only at "EL Tildio II" grain yield was greater with "Multiarado", while in the rest of the experimental sites CT exceed the "Multiarado". However, the grain yield average of the four sites was similar (CT=704 kg ha^{-1} vs Mult=707 kg ha^{-1}). It is important to mention that "Multiarado" can reduce the time and costs of soil preparation since it is wider than plowing discs. The *in situ* water conservation practice (Ridges) to improve water infiltration increased grain yield of dry beans from 11 to 40% depending of date when ridges were raised. The greatest increase was observed when ridges were raised along with the first cultivation. This suggest that ridges must be raised at early stages of bean crop to extend the availability of soil moisture. These results are similar to those reported from Durango and Chihuahua states were grain yield of dry beans was increased 30% and 6.5 to 122% respectively (3). In contrast, corn yield under rainfed conditions was not increased by ridges when rainfall was low (200 mm) and unevenly distributed during crop growing season (4). The results suggest that timing implementation of *in situ* water conservation practices such as ridges in conjunction with early and drought resistance dry bean cultivars and conservation tillage systems could be a beneficial integrated strategy to minimize environmental risks and ensure crop production for the semiarid conditions of Mexico highlands.

Table 1. Mean grain yield of dry beans (kg ha^{-1}) for the three technological components evaluated in each experimental site at "El Llano", Aguascalientes, Mexico. 2005

Technological Component	Experimental Site				Average
	El Tildio I	El Tildio II	El Copetillo	Sandovales	
Cultivar:					
FMB	1035[+]	416	527	782	690
FMSol	957	365	581	980	721
Tillage Methods:					
CT	1028	333	560	893	704
Mult	964	447	547	868	707
Water Conservation:					
NR	931	428	554	789	676
R at 1st cultivation	---	---	---	956	956
R at 2ed cultivation	1061	353	---	834	749
R at 1st and 2ed cultivation	---	---	---	942	942

[+] Each value represent the mean of 4 or 6 samples per treatment of two rows 4.0 m length (6.08 m^2).

References. 1) Padilla-Ramírez, J.S. *et al.*, 2004. Bean Improvement Cooperative. 47:291-292. 2) Martínez-Gamiño, M.A. y Jasso-Chaverría, C. 2004. Folleto Técnico No. 23. SAGARPA-INIFAP-CIRNE-Campo Experimental San Luis. 3) Fernández-Hernández P. *et al.*, 2004. Desplegable Técnica No. 5. SAGARPA-INIFAP-CIRNOC-Campo Experimental "Sierra de Chihuahua. 4) Luna-Flores M. y Gaytán-Bautista R. 2001. Rev. Agric. Téc. Méx. 27(2):