Report of mission

from 17/07 to 26/07/95

Report on the mission to C.E.R.A.A.S.

by

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REPORT ON THE MISSION TO CERAAS (From 17th to 26th July 1995)

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This mission was undertaken at C.E.R.A.A.S. (Centre d'Etude Régional pour l'Amélioration de l'Adaptation à la Sécheresse) within a project entitled "*Physiologie de l'adaptation à la sécheresse et création variétale pour les régions sèches*", and funded by the European Union through the *Sciences et Techniques pour le Développement* programm DGXII (Contract Number TS3/CT9235).

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OBJECTIVE OF THE MISSION

The objectives of the mission were as follows:

1 To validate the soil water balance model ARABHY version 2.0 (1) for environmental conditions at Manfredi (Córdoba, Argentina), during the 1993194 cropping season,

2 To discuss the feasibility and use of the model ARABHY on soybean cultivated on a regional scale, over several years.

3 To discuss with scientists at Bambey, the experimental procedures used in the evaluation and breeding for drought resistance. At CERAAS experiments are carried out on peanuts, sorghum, cowpea and maize, among other crops.

1. VALIDATION OF ARABHY

This was possible due to the collaboration between Dr Daniel Annerose, Miss Couna Sylla, and myself. The model ARABHY (version 2.0) was calibrated for use on the Florman INTA cultivar of peanuts (1)(2), using experimental field data from the 1992/93 cropping season (3) at Estación Experimental Agropecuaria Manfredi, Instituto Nacional de Tecnologia Agropecuaria (INTA). The model was programmed to simulate the growth and development of peanuts in a single site over a two year period.

Diskettes containing the model were sent to us at INTA in Argentina. Due to some en-ors in the programme, we had problems running it. These errors were, however, identified and corrected at CERAAS. Miiss C. Sylla, the computer analyst in the Center, working on the model, indicated her willingness to install and explain the operation of the model ARABHY to me. With the recent modifications made to the programme, we were confident that no further problems would be encountered.

The data obtained during the 1993/94 cropping season (23/Nov/93 - 17/May/94; from sowing to harvest) on the same Florman cultivar (3) were used to validate the model ARABHY. The experiments consisted of two treatments: fully irrigated and rainfed plots, in three replications. There was a little amount of rain in the latter part of the 1993/94 season at Manfredi (82 mm, from pod development to harvest) resulting to a severe drought stress in the rainfed plots.The results obtained, based on mean plot, were analysed. A range of soil water content was thus obtained for validating the model.

From an initial data processing, it was noticed that the model systematically underestimated the soil water content. According to Dr D. Annerose, the model starts simulating from the first significant rain, based on the hypothesis on which it was designed. In our own case, however, we preferred that ARABHY starts simulation on the sowing date. The programme was thus modified as such, after which analysis were made.

Table 1 shows the regression of observed vs. ARABHY-predicted soil water content for both the fully irrigated and rainfed treatments.

Table 1. Linear regression analysis of observed vs ARABHY-predicted soil water content in irrigated and in rainfed peanut plots during the 1993194 cropping season at Manfredi. (Intc = intercept)

source	df	Mean Squares	Prob.	Coefficient	St. Error	tc	Prob.
a. Fully Irrigated Treatment							
Regression	1	22972.78	<0.0001	Intc = 151	42.32	3.57	0.01
Residual	18	500.54		Slope = 0.63	0.09	6.78	~0.0001
Total	19	168.33					
b. Rainfed Treatment							
Regression	1	24111.76	40001	Intc. = -88	37.10	-2.37	0.029
Residual	18	200.71		Slope = 1.24	0.11	10.96	e0.001
Total	19	145.92					

From statistical analysis, the observed and predicted data fit (r^2 = 0.72, P<0.0001), in the case of the fully irrigated treatment (Table la). This result indicates that within the fully irrigated soil water content range, ARABHY is adequate for simulating soil water balance at Manfredi. Both a significant intercept (151 mm) and a significant slope (0.63) were detected (Table la). This result could be interpreted as an underestimation by ARABHY, of the highest observed values.

The observed and predicted data also fit (r^2 = 0.88, P < 0.0001) in the case of the rainfed treatment (Table lb). This result indicates that ARABHY is adequate for simulating soil water balance at Manfredi for rainfed peanut even at lower soil water content values, registered during a severe drought period. A significant intercept (-88 mm) and slope (0.62) were detected (Table lb). This was probably caused by a systematic difference between observed and predicted values, during the latter part of the season, i.e from 23 march . The suspected data were eliminated and the regression analysis was perfonned on the remaining series. The results were practically the same (r^2 = 0.89, P<0.0001; data not shown) and therefore did not necessitate the elimination of the suspected data It was thus recovered and used in further analysis.

In conclusion, the results shown in table 1 indicate that ARABHY is fairly adequate for simulating soil water balance of peanut at Manfredi. This is valid both for irrigated and rainfed conditions. It should be emphasized that the model adequately simulates the entire range of soil water content in tlhat particular location. The records at Manfredi should however be verified, in order to find an explanation for the mentioned differences observed in the case of the rainfed treatment, during the latter part of the season

The observed vs ARABHY-predicted daily average real evapotranspiration (ETR) regression, for both the fully irrigated and rainfed treatments is shown in table 2. In the case of the rainfed treatment, it was necessary to drop out three outliers from the observed values. These would be revised at Manfredi. The output for the remaining series is shown in table 2b.

Table 2. Linear regression analysis of observed vs ARABHY-predicted ETR (mm/day) in inigated and rainfed peanut plots during the 1993/94 cropping season at Manfredi

Source	df	Mean Squares	Prob.	Coefficient	St. Error	tc	Prob.
a. Full Irrigated Treatment							
Regression	1	16.27	<0.0001	Intc = 0.92	0.37	2.50	0.02
Residual	17	0.27		Slope = 0.64	0.08	7.78	<0.0001
Total	18	1.16					
b. Rainfed Treatment							
Regression	1	21.19	<0.0001	Intc. = 0.35	0.40	2.89	0.01
Residual	14	0.49		Slope.= 0.62	0.13	4.95	<0.001
Total	15	1.87					

The data fit both for the irrigated (r^2 = 0.78, P < 0.001) and rainfed (r^2 = 0.76, P<0.0001) treatments. Positive significant intercepts were obtained, for both the ir,igated (0.92 mm/day) and rainfed (0.35 mm/day) treatments (Table 2). Significant slopes were also obtained (0.64 and 0.62). In summary, ARABHY probably tends to underestimate the highest ETR values.

The relationship between cumulative diegreedays, observed % crop cover (OC) and predicted % crop cover (PC) was analysed. This was in order to obtain a more realistic srmulation of water demand by peanuts at Manfredi under high ETP conditions, particularly during the latter part of the crop's cycle. Characteristic sigmoid curves were obtained (data not shown). The family curve used in ARABHY simulation was revised at CERAAS. In Argentina, the cultivar coefficients would be changed to obtain a better OC-PC fit.

2.. ADAPTING THE MODEL ARABHY TO SOYBEANS CULTIVATED ON A REGIONAL SCALE, OVER SEVERAL YEARS

Due to time limitations, only general discussions were carried out on this aspect. It was finally agreed that as much precise information as possible should be recorded in our current experiments in Argentina, which in the future, could be used in adapting the model ARABHY to soybean. It was also agreed that a collaborative research work be established.

3 DISCUSSION ON THE EXPERIMENTAL PROCEDURES USED IN EVALUATING AND BREEDING FOR DROUGHT RESISTANCE AT CERAAS

3.1 - Breeding peanuts for drought resistance

Mrs Danièle Clavel, a plant breeder at the Center, explained the peanut hreeding programme she is ooordinating at Bambey. At present, her research work involves the evaluation of genotypic differences of peanuts, based on physiological parameters, stomatal closure and protoplasmic resistance. She also explained the experiments conducted on the evaluation of root growth in rhizotrons.

3.2. - Evaluation of plant reaction to drought in the field

The warm climate, limited annual rain fall (about 400 mm) and the sandy soil prevafent in this location, makes Bambey an ideal environment for the study of plant reactions to drought. I visited the field experiments and noted the existing facilities and equipment used in the study of plant reactions to drought. Controlled irrigation and rain shelters are used to plan drought occurrence. During my visit, experiments on maize and sorghum were being carried out.

ACKNOWLEDGEMENT

I appreciate the invitation offered to me by Dr. Daniel Annerose, Director of the CERAAS project. This visit was entirely sponsored by CERAAS and I am greatly indebted.

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(2) **Dardanelli, J. L.** 1993. Rapport de Mission au CERAAS. CERAAS, Bambey, Senegal, 4 pp.

(3) **Dardanelli, J. L.; and Lorenzo,, N.** 1994. Informe Final de Plan de Trabajo. Evapotranspiracion de cultivos de cosecha del area central de Córdoba. Documento Interno EEA INTA Manfredi, Córdoba, Argentina.

ANNEXE

NOTE

Introduce the following in the model:

1) If actual **rainfall** $\leq$ 14 mm, then effective rainfall (ER) = actual rainfall (AR)
if actual rainfall > 14 mm, then effective rainfall (ER) = $2.93*AR^{0.525}$
If AR < 14 then ER = 14
tf AR $\geq$ 14 then ER = $2.93*AR^{0.525}$

3) Replace **01/01**, indicated under the column day, in the table of simulated values, by **01/01** of the second year of simulation.

4) For cumulative degreesdays not **coming back** :

$$dD = \frac{T\max - T\min}{2} - 11$$

dD = degree days
If dD < 0 then dD = 0.

5) "Date de semis" and "Date de **recolte"** are shown as outputs in wrong days.

6) **Expect** simulating for **many** sites, taking into **consideration** that **each** site has its characteristic **soil** conditions **such** as permanent wilting point (PWP), **field capacity**, **initial soil** water content etc.

WORK FILES

*KCOUV.**	Referred to evolution of **% cover**
New test.ASC	Output from ARABHY (Irrigated **1993/94)**
OUTPUT 9293.XLS:	Rainfed output from ARABHY **1992/93**
OUTPUT 9293.XLS:	Rainfed **ouput** from ARABHY 1993194
OUTPUT 9394.XLS:	Irrigated output from ARABHY **1993/94**
IRSOWC.XLS	Figure on **soil** water content (irrigated)
RASOWC.XLS	Figure on **soil** water content (Rainfed)
IRET.XLS	Figure on real ET (Irrigated)
RAET.XLS	Figure on **real** ET (Rainfed)
WORKSHIT.XLS	Worksheet **with** calculated and predicted values.