Provisional Land Evaluation for Irrigation of Onion (*Allium Cepa*) and Livestock Production (Cow Meat)

At the Hilario Ascasubi Agricultural Experimental Station, INTA, Buenos Aires Province, Argentina at a Scale of 1:20.000

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1. Actual situation and antecedents

The study area is situated in the southern part of Buenos Aires province, in the semiarid region, in Villarino District. Regionally it comprises plains, slightly undulating and with isolated depressions. According to the hydrological balance, the annual soil water deficiency (evapotranspiration minus precipitation) is about 350 mm per year. Precipitation is about 500 mm per year in the North part and 300 mm in the South. This variation is not reflected in the water deficiency value, because the area with high precipitation is also the area of high temperature and therefore higher evapotranspiration. This suggests that the minimum and maximum temperatures are very important, just as the free-frost period.

So, considering the regional precipitation variation, frost regime and coldest and warmest temperature, the following agroclimatic regionalization was made. From North to South, three zones were recognized whose differences were determined by the free-frost periods, with value ranging from 260 to 220 days respectively. The climatic suitability of A.E.St of Ascasubi is rated 'medium', with high a probability of success for crops under irrigation; the sowing period is very important in the sense that the young plants should grow without any risk of frost.

The soil has a very low water-holding capacity, and is susceptible to eolic and hydric erosion, and soil depth poses a constraint due to the presence of a petrocalcic horizon in some sectors. The dominant soil of the region is the loamy Aridic Haplustoll, situated predominantly on higher parts, with a typic Calciortid in the depression area between hills and a shallow Aridic Haplustoll in the highest parts with superficial calcium carbonate (tosca) or near the surface. Occurrences of Typic Cambortid are present in the depression sector (Soil Map of Buenos Aires province, 1989, scale 1:500.000). The soils of the study area range from loamy sandy to loamy clay sandy; therefore permeability of most soils is adequate for irrigation. The water table is deep, enough to allow irrigation with gravitational flooding.

In this paper the land utilization types are evaluated based on onion (*Allium cepa L.*) and Livestock Production (Cow meat) and use surface irrigation. According to crop requirement data obtained, onion has a growing period of 200 days and needs about 1500 mm of water (evapotranspiration) under the local conditions.

The effective precipitation sum is about 500 mm; consequently, the water deficit for this crop is some 1.000 mm of water per year (R.Sanchez, 1991). Although onion is relatively tolerant of soil salinity, it is recommended not to sow onion on soils with a high content of salts (3-7 dSm^{-1}) in the topsoil. The irrigation water may not contain more than 0.8-1.5 dSm^{-1} (R.Sanchez, 1991)

Objectives:
The objective of this paper is to evaluate the land under irrigation for onion (*Allium cepa L*. var. *valencia*) and Livestock Production (Cow meat), to determine its geographic distribution, and to produce a land inventory for the Agricultural Experimental Station of H. Ascasubi through the development of an Automated Land Evaluation System (ALES) following the FAO framework (1976).

2. Materials and Method

For this land evaluation the following materials were used:

- Digitized soil map and legend at 1:10.000 scale of the A.E.St H.Ascasubi, (Taxonomic unit, Cartographic Unit, land suitability unit, land inventory).
- Agroclimatic data (SMN, Burgos y Vidal).
- Crop edaphic and climatic requirements
- Soil and crop management
- Soil data bank
- Socio economic data
- Automated Land Evaluation System (ALES) program. Cornell University.
- Geographic Information System (GIS), ILWIS, IDRISI.
- Color Print
- Digitizing desk
- Personal Computer (PC, IBM or compatible).

The principle of the FAO framework for Land Evaluation was applied to create a land evaluation system using data generated in the local area.

In this study, soil and climate data were collected and used (land characteristics and land qualities) for all soil cartographic units. Later, they were matched with the land use requirements for systems with onion at various phenological stages and livestock production. Finally an agricultural suitability map was produced for the two land utilization types.

2.1 Land Utilization Type with Onion

Onion (*Allium cepa, cv. valenciana*) under irrigation using gravitational flooding of river water. This LUT is marked by a high input of fertilizer and herbicide, use of modern technology, labour intensive, using conventional machinery and moderate capital, and producing for internal consumption and export. Expected yield: 37.000 kg/ha. The irrigation water is not considered a limiting factor.

Key attributes of land use:

Product	Onion (*Allium cepa*)
Market orientation	Internal consumption and for export
Capital intensity	medium
Labor intensity	high
Know how level	moderate
Energy Source	moderate
Implements	conventional
Size and shape	regular, 50 ha,
Land tenure	80 % private property
Input of fertilizer and herbicide:	moderate to high
Tillage:	Land preparation, land leveling, cleaning, sowing, weed control, fertilization, sanitary control and irrigation by flooding.
Optimum yield expected:	30.000 kg/ha/year

Table 1. Physical land requirements. Onion Proportional yield factor

Severity level	Nd	Od	Pca	Pe	Pos	Rna	Rpen	RNa
Very low	1	1	1	1	1	1	1	1
Low	0.95	0.95	0.95	1	0.95	1	1	1
Moderate	0.90	0.85	--	1	0.85	0.95	0.90	0.95
Medium	0.85	0.80	--	0.95	0.50	0.80	0.85	0.90
High	0.80	0.50	--	0.85	--	--	--	--
very high	0.75	0.50	--	--	--	--	--	--

Nd: Nutrient availability. **Od: Oxygen availability** **Pos: Relief position** **Pna: Sodium depth**
Pca: Presence of Calcium **Pe: Efective depth** **Rpen: Slope hazard** **Rna: Sodium hazard**

2.2 Livestock Production (Cow meat) based Land Utilization Types

Livestock Production in an irrigation area with annual pasture (*Bromus unioloides*, *Dactylis Glomerata*, etc) and perennial plants (alfalfa: *medicago sativa*), with gravity irrigation of river water, with low input of fertilizer and herbicide, with medium level technology and moderate capital investment, and for local consumption. Irrigation water is not considered a limiting factor.

Key attributes of land use:

Product	meat
Market orientation	Internal consume
Capital intensity	medium
Labor intensity	medium
Know-how level	moderate
Energy Source	moderate
Implements	conventional
Size and shape	irregular, 211 ha,
Land tenure	INTA property
Input of fertilizer and herbicide	moderate
Tillage	Land preparation, land leveling, cleaning, sowing,weed control, fertilization, sanitary control and irrigation by flooding.
Optimum yield expected	700 kg/ha/year (animal charge = 4.8 animals/ha/year.x gain weight live/day = 0.600kg/animal/ha/day = 2.880kg/ha/day x 8 months x 30.5 days= approximately 700 kg/ha/year).

Table 2. Physical land use requirements. Livestock production, Physical Suitability Decision Tree

Severity level &Suitability	Water availability mm/m	Oxygen Availability (Od) Class	Water table depth (PNAP)	Relief position (POSI) Class	Effective depth (Pe) cm
Low S1	>100	Well drained	> 3	Upland plain	>100
Medium S2	100-80	Moderate well drained	2-3	Slope	100-150
High S3	80-60	Imperfectly & excessively drained	1- 2		50-25
Very High NS	<60		< 1	Lowlands Depression	<25

S1=Very Suitable S2= Suitable S3=Marginaly Suitable NS=Not Suitable

Table 3. Physical land use requirements. Livestock production, Proportional yield factor

Severity level & Suitability	Water availability mm/m	Oxygen Availability (Od) Class	Water table depth (PNAP)	Relief position (POSI) Class	Effective depth (Pe) cm
Low S1	1	1	1	1	1
Medium S2	0.9	0.9	1	1	0.95
High S3	0.8	0.8	0.95	1	0.8
Very High NS	0.6	0.5	0.6	0.7	0.5

S1=Very Suitable S2= Suitable S3=Marginaly Suitable NS= Not Suitable

2.3 Land Characteristics and Land Qualities

Nd: Nutrient availability.
Pca: Presence of Calcium carbonates
Pos: Relief position
Rpen: Slope hazard
Sa: Salinity
Od: Oxygen availability
Pe: Effective depth
Pna: Sodium depth
Rna: Sodium hazard

2.4 Matching

Taking into account the land characteristics and land qualities, all information was put in the data base (ALES) in coded form to compare the results with the corresponding land use requirements and to determine suitability class values.

2.5 Products

- Physical and Economic Land Suitability maps.
- Land Inventory
- Automated Land Evaluation System Development, complemented by Geographic Information System.(ALES-IDRISI)

2.6 Results

Table 4. E.E.A.Hilario Ascasubi.INTA Pcia Buenos Aires. Physical Land Suitability Evaluation for onion.

Suitability	Cartographic Units	Surface	
kg/ha/year		Ha	%
S1= > 31.000	As,LE,LM,SI,Univ,CO	144	68.0
S2= 31.000-29.000	Bu, Co,LS,	36	17.0
S3= 29.000-27.000	Ca	21	10.0
NS= < 27.000	Miscelánea	10	5.0
Total		**211**	**100%**

S1=Very Suitable S2= Suitable S3=Marginaly Suitable NS= Not Suitable Optimum yield: 37.500 kg/ha/year

Table 5. E.E.A.Hilario Ascasubi.INTA Pcia Buenos Aires. Economic Land Suitability Evaluation for onion. Gross Margin.

Gross Margin	Cartographic Units	Surface	
$/ha/year		ha	%
S1= > 2.000	As,CO,LE,LM,SI,Univ	144	68.0
S2= 2.000-1.500	Bu, LS	36	17.0
S3= 1.500-1.000	Ca	21	10.0
NS= < 1.000	Miscelenea	10	5.0
Total		**211**	**100%**

S1=Very Suitable S2= Suitable S3=Marginaly Suitable NS=Not Suitable. Price: $ 0.18/kg

Table 6. E.E.A.Hilario Ascasubi.INTA Pcia Buenos Aires. Economic Land Suitability Evaluation for onion. Benefit/cost ratio:

Benefit/Cost	Cartographic Units	Surface	
$/ha/year		ha	%
S1= > 1.50	As, LE,LM	65	31.0
S2= 1.50-1.30	CO,SI,Univ,Bu,LS	115	54.0
S3= 1.30-1.00	Ca	21	10.0
NA= < 1.00	Miscelanea	10	5.0
Total		**211**	**100%**

S1=Very Suitable S2= Suitable S3=Marginaly Suitable NS=Not Suitable. Price: $ 0.18/kg

Table 7. E.E.A.Hilario Ascasubi.INTA Pcia Buenos Aires. Physical Land suitability Evaluation for Livestock Production

Suitability	Cartographic Units	Surface	
kg/ha/year		ha	%
S1= > 600	CO, LE, LM, Univ,As	128	60
S2= 600-500	SI, LS	31	15
S3= 500-350	Bu, Ca	42	20
NS= < 350	Miscelánea	10	5
Total		**211**	**100**

S1=Very Suitable S2= Suitable S3=Marginaly Suitable NS=Not Suitable Optimum yield: 700 kg/ha/year

Table 8. E.E.A.Hilario Ascasubi. INTA Pcia Buenos Aires. Economic Land Suitability Evaluation for Livestock Production. Gross Margin

Gross Margin	Cartographic Units	Surface	
$/ha/year		ha	%
S1= > 2.50	CO, LE, LM, Univ,As	144	68
S2= 250-150	LS, SI	15	7
S3= 1.50-0.50	Bu, Ca	42	20
NS= < 500	Miscelánea	10	5
Total		**211**	**100**

S1=Very Suitable S2= Suitable S3=Marginaly Suitable NS=Not Suitable

Table 9. E.E.A.Hilario Ascasubi.INTA Pcia Buenos Aires. Economic Land Suitability Evaluation for Livestock Production Benefit/cost ratio

Benefit/Cost	Cartographic Units	Surface	
$/ha/year		ha	%
S1= > 1.80	CO, LE, LM, Univ,As	128	60
S2= 1.80-1.60	SI, LS	31	15
S3= 1.60-1.20	Bu, Ca	42	20
NS= < 1.20	Miscelánea	10	5
Total		**211**	**100**

S1=Very Suitable S2= Suitable S3=Marginaly Suitable NS=Not Suitable

Note: Structural costs (tax, etc.) are not included in the economic calculation.

3. Conclusion and Recomendation

It was observed that 95 % of the area is suitable for irrigated agriculture. The most important limitations are:

- Excessive drainage or imperfect drainage
- Sodicity of fine texured soils
- Relief position
- shallow soil depths
- shallow water table
- Presence of calcium carbonate (tosca) at shallow depth

According to the limitations of this area, land management should preferably be as follows:

- more frequent irrigation of soils with excessive drainage.
- control of irrigation on units with limitations of drainage and shallow water table.
- liming of sodic soils with good drainage, and
- surface tillage of units with shallow soils.

The economic results allow identifying the more profitable cartographic units.

The digitized maps of physical and economic suitability evaluations on the basis of data processed by ALES and IDRISI allow us to analyze the land, taking into account not only the analytical data themselves but also their distribution, thus facilitating decision making.

The development of an ALES model allows us to evaluate lands that were not included in the present study but that have similar edaphic and ecological conditions.

4. References

Beek,K.J (1978). Land Evaluation for Agricultural Developnent. I.L.R.I. Wageningen, The Netherlands.

Cappanini D.A. & R.R.Lores (1966). Los suelos del valle inferior del Río Colorado. INTA-Colección Suelos No 1.

Dent, D & A.Young(1983). Soil Survey & Land Evaluation .

FAO (1976). A Framework for Land Evaluation.FAo Soil Bulletin No 32. I.L.R.I.

FAO (1976).Las necesidades de agua de los cultivos.Roma. Estudio de FAO: Riego y Drenaje. No 24

FAO (19790). Land Evaluation criteria for irrigation. Report of an Expert Consultation.No 50 Rome.

FAO (1990). Land Evaluation for Irrigation.. Soil Bulletin No 55.

Godagnone R. (1994).Mapa de Suelos de la E.E.A. Hilario Ascasubi, Buenos Aires province.

INTA-CERBAS- E.E.A. H.Ascasubi(1991). El cultivo de la cebolla en el valle Bonaerense del Río Colorado. Manual técnico. Proyecto Regional Hortalizas para exportación.

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE (1987). Irrigation Management for diversified cropping. Sri Lanka

Luque A.J.(1979) 2da edición. Administración y manejo de sistemas de riego. Editorial Hemisferio Sur.

Luque A.J.(1980) Proyectos agr+_colas de riego.editorial Hemisferio Sur.

Mc Rae, S.G. & C.P. Burnhan (1981). Land Evaluation. Clarendon Press. Oxford U.K.

Nakama V et al (1985). Esquema para evaluación de tierras de la FAO para usos específicos y su posible aplicación en la Argentina a nivel de reconocimiento para el desarrollo de la planificación regional. Un ejemplo: Maíz. CIRN INTA Castelar.

Nakama V. et al (1986). Evaluación de la Aptitud de las Tierras de la Región Pampeana para el cultivo de trigo. CIRN INTA Castelar.

Nakama V., R.R. Sobral (1987). Indices de Productividad. Método paramétrico de Evaluación de Tierras. S.A.G.y P.-INTA CIRN. Documento Poryecto PNUD Arg 85/019. Buenos Aires.

Rossiter, D.G.,A.Gimenez, A.van Wambeke (1994). Sistema Automático de Evaluación de Tierras (ALES), versión 4.1.. Cornell University, Ithaca, N.Y. USA.

S.A.G.y P.-INTA (1989). Mapa de Suelos de la Provincia de Buenos Aires. Escala 1:500.000. Proyecto PNUD ARG 85/019. CIRN INTA Castelar.

Sanchez R.(1993). Suelo, Riego y Fertilización en el cultivo de cebolla (Allium cepa). INTA Ascasubi. Boletín No 3.

Sobral R.E. & V.NAkama (1993). Evaluación de Tierras del Partido de General Villegas, provincia de Buenos Aires, escala 1:50.000. INTA CIRN INstituto de suelos, Castelar.

Soil mapa of the E.E.A.Hilario Ascasubi.INTA Pcia Buenos Aires.scale 1:10.000.