Table 1: Characteristic agroclimatic indexes of winter rapeseed and those selected for zoning suitable regions in Argentina.

	Mean temperature (°C)				Hydric condition *		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Sowing month	9,9	15,0-17,8	23,3	10,0	25(.)	32to152 (.)	250(.)
Coldest month with temperatures higher than 0°C	0,3	0,3- 4,9	9,2	9,0			
Flowering month	8,1	10,0-15,0	18,0	--	-20	-5to+6	+129
Ripening month	14,6	16,3-21,4	22,7	15.0	-61	-30to 0	+145

*: (+) surplus in mm; (-) deficiencies in mm; (.) expresed as monthly rainfall.

Lack of winter cold temperatures can promote disturbances or winter rapeseed: a continuons vegetative growth in absence of reproductive structures, reproductive development in only few plants of the whole stand abnormal structures and early abscission of blooms.

These was confirmed in Argentina in investigations using Matador, Quinta and Garant cultivars (Canullo y Pascale, 1984; Pascale, 1985).

Monthly mean temperature of the coldest month with temperatures higher than 0°C, was used to quantify coldness availability of regions, since temperature bellow that value are not effective for vernalization (Hansel, 1967).

Only at Concepción (Chile) winter rapeseed is cultivated with temperatures of the coldest month somewhat superior to 9°C, so that, it was the chosen value to delimit the regions where vernalization requeriments can be satisfied.

Water requeriments of the crop increase up to a maximum during flowering period (Debinska, 1970; Rollier, 1974; Parodi Pinedo, 1987).

Hydric condition during flowering month was used to characterize world producing areas. In general, flowering develops during light deficiencies or light surplus with extreme values of -20 mm at Toulouse (France) and +129 mm at Puerto Montt (Chile).

Temperatures vary, in general, from 10°C to 15°C.

According to Rollier (1979) from physiological maturity in grains up to harvest, water lost is somewhat irregular and depends, specially, on air temperature and air water content.

So, these are indexes to be considered at harvest stage.

The lower mean temperature of the harvest month was 14,6°C at Puerto Montt (Chile), so, it was accepted that 15°C was a suitable limit between areas where ripening energy requeriments could be fulfilled or not.

1b. Zoning of winter rapeseed in Argentina.

Isotherm of 9°C (monthly mean temperature of July) delimites to the south a region where minimum vernalization requeriments of winter cultivars could be satisfied.

Thornthwaite hydric index of -20 could subdivide the previons region in two rainfed sub-regions: "pampeana" and "patagónica" and between them, another that could require irrigation.

Within "pampeana" sub-region -5, 0, 10, 20 and 30 isolines show hydric condition during flowering month and delimite areas where yields could be favored at different degrees, but never injuring them seriously.

The 15°C isotherm (warmest month mean temperature) becomes the southern limit of the "patagónica" sub-region, since grains maturity could be hardly attained at highest latitudes.(Fig. 1a).

Probable cicle of winter rapeseed at different sub-regions could be:

Patagónica Sub-region		Pampeana Sub-region	
sowing:	middle of March	sowing:	May
flowering:	middle of November	flowering:	end of September
harvest:	middle of January	harvest:	end of December

The analysis of agroclimatic characteristics of locations included within "pampeana" sub-region shows that there would be no difficulties at sowing, flowering or maturity stages in relation with hydric conditions.

Neither, there would be difficulties during flowering and maturity stages respect of temperatures.

There could be some difficulties respect of winter coldness availability and this will be a matter to take into account when introducing materials or in breeding programs.

"Patagónica" sub-region do not show difficulties respect of winter availability and temperatures during sowing are higher compared with those of previons sub-region. Cool summers could, occasionaly, enlarge maturity stage.

First and last frosts in Argentina have a marked dispersion around the mean date (standart deviation 20 to 30 days) and this promotes a high ocurrence probability at emergence and flowering dates. Their negative consequences at early vegetative stages or flowering stages have been recorded during experiments carried out in "pampeana" subregion.

2a. <u>Agroclimatic indexes used in spring rapeseed</u>.

Characteristic agroclimatic indexes in spring rapeseed were deduced from the climatic data analysis of 57 locations in Australia, Brazil, Canada, Chile, France, Spain and Sweden.

Table 2 summarizes thermic and hydric conditions during sowing date, the coldest month, flowering and ripening dates of producing areas, with their lowest value (1), the highest (3) and the rank where 60 percent of locations are included (2). Selected indexes to characterize suitable growing regions in Argentina are included, too (4).

Monthly mean temperatures during sowing vary from 5,1°C at Fallum (Sweden) up to 17,9°C at Passo Fundo (Brazil), but most of the locations are included between 9,4°C and 13,8°C. Even when it is possible to sow with temperatures bellow 10°C, this value was selected as an appropiate agroclimatic index in Argentina to allow a quick germination and decrease frosts risk.

Hydric index selected was that of rainfall milimeters during sowing month varying from 6 mm at Quillota (Chile) up to 218 mm at Concepción (Chile). Most of the locations make sowings with 30 mm to 68 mm.

Vernalization requirements in spring rapeseed are not so high as in winter types. The bioclimatic index selected to represent this requirement was monthly mean temperature of the coldest month during the whole cicle.

The lowest value was found at Granada, Spain (6,9°C) and the highest at Geraldton, Australia, (15,3°C). So, it was selected 15°C temperature as a value limiting the possibility of the fulfillment of vernalization requirements in spring rapeseed.

Flowering, critic stage respect of water requirements, takes place with values ranging from marked deficiencies (-66 mm at Regina, Canada) up to marked surplus (99 mm at Passo Fundo, Brazil), but in most of locations ligh deficiencies occur (-1 to -19 mm).

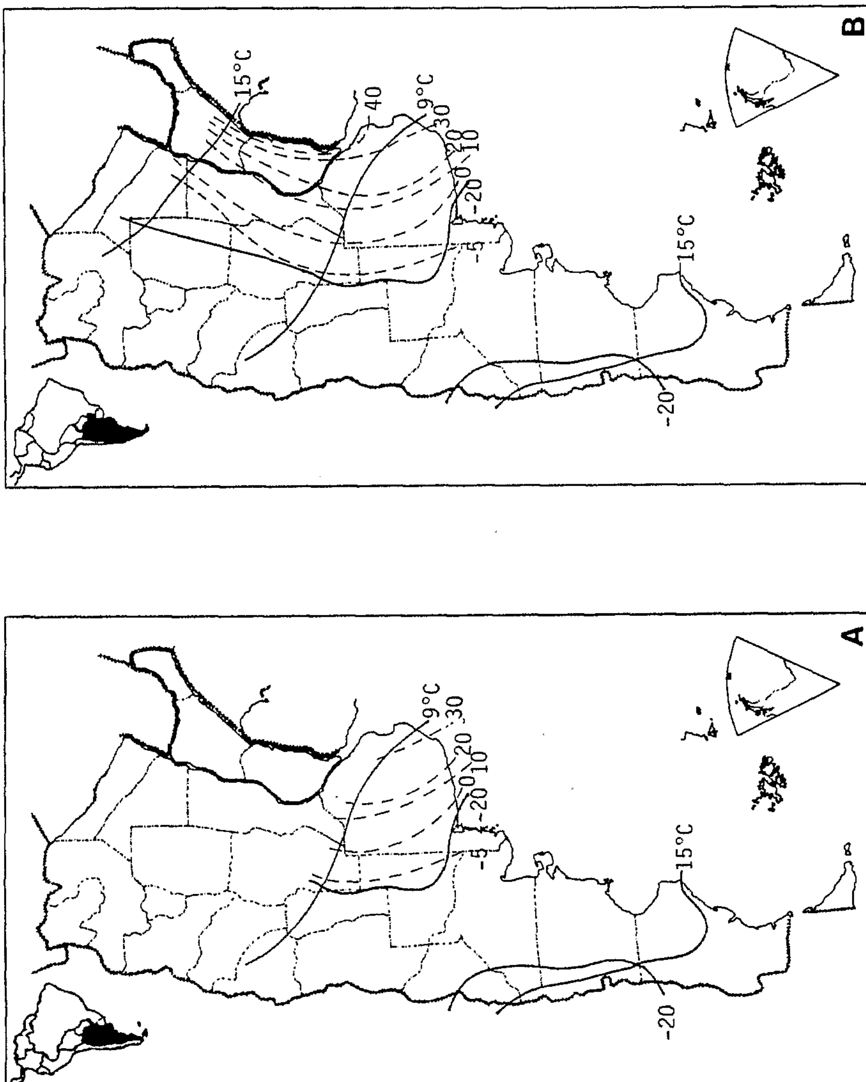

Fig. 1: Cultivation areas of winter rapeseed (a) and spring rapeseed (b) in Argentina.

Table 2: Characteristic agroclimatic indexes in spring rapeseed.

	Mean temperature (°C)				Hydric condition (mm)		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
Sowing month	5,1	9,4to13,8	17,9	10	6 .	30to68 .	218 .
Coldest mont	6,9	9,1to11,8	15,3	15			
Flowering month	10	13,0to17,7	20,8	--	-66	-19to-1	+99
Ripening month	14,9	16,8to20,1	27,9	15	-127	-49to-10	+95

. rainfall, (-) deficiencies, (+) surplus

2b. Zoning of winter rapeseed in Argentina.

Isotherm of 15°C is the Northen limit of a region where vernalization requirements can be satisfied. The southern limit is set by the isotherm of 15°C, mean temperature of the warmest month, that allow ripening of grains.(Fig. 1b).

Thornthwaite hydric index (HI) of -20, could delimit two rainfed sub-regions "pampeana" and "patagónica", and an intermediate with irrigation requirements.

Within "pampeana" subregion, isolines of -5, 0, 10, 20, 30 and 40 mm representing hydric conditions at flowering month, delimits areas where grain yields could show variability but, by no means, be seriously injured.

Expected cicles in both sub-regions are as follow:

Pampeana Subregion

sowing date: May
flowering date: end of September
harvesting date:November

Patagónica Subregion

sowing date: October
flowering date: December
harvesting date:February

The analysis of agroclimatic indexes at argentine locations in both sub-regions show that they are included within the more representative values of agroclimatic characteristics of spring rapeseed in the world or near to the extreme, but never out of them.

None of the regions show difficulties for the fulfillment of the low vernalization requirements.

As in the case of winter types, a high frost risk probability at emergence and flowering stages was recorded at various locations, so that areas with a differential yielding aptitude could be pointed out, when considering this climatic injury.

CONCLUSIONS

The analysis of winter and spring rapeseed agroclimate in the world allow the selection of agroclimatic indexes and the delimitation of regions in Argentina where the crop is possible.

In both cases, two sub-regions could be differentiated: "pampeana" and "patagónica"

Winter rapeseed "pampeana" subregion is smaller than spring rapeseed's because of vernalization requirements of winter types that can only be fulfilled at Southern locations.

In general, all sub-regions present similar characteristics to other world agroclimates.

Within "pampeana" subregions a differential yielding aptitude is supposed, considering variable hydric conditions at flowering stage, but in no case, will yields be seriously damaged.

Frosts at emergence or flowering stages could also, be a climatic parameter to evaluate subregions yielding aptitude.

REFERENCES

1) ARGENTINA, Servicio Meteorológico Nacional. 1958. Estadística climatológica. 1941-1950. Publ. B1 N°3. 1958.
2) ARGENTINA. Servicio Meteorológico Nacional. 1972. Normales climatológicas. 1931-1960. Serie B N°7. 1972.
3) ARGENTINA. Servicio Meteorológico Nacional. 1986. Estadística climatológica. 1971-1980. Estadística N°36. 1986.
4) BURGOS, J.J. 1958. Agroclimatic classifications and representation. CAgM II. Doc 18/24 IX 1958. Item 10. World Meteorological Organization Com for Agricultural Meteorology, Second Session, Varsaw, 1958.
5) CANULLO, Graciela y PASCALE, NildaC. 1985. "Exigencia en frío de dos cultivares de colza invernal (Brassica napus, var. oleifera)".Oleico 32: 29-39.
6) GREAT BRITAIN. 1958. Meteorological Office. Her Majesty's Stationery Office. Tables of temperature, relative humidity and precipitation for the world. London.
7) HANSEL, H. 1967. Vernalization of winter rye by negative temperatures and the influence upon lamina length of the first and second leaf in winter rye, spring barley and winter barley. Ann. of Bot, N.S. 17 (67): 417-432.
8) MURPHY, G.M.; E.M. SIERRA y V.J. KOPP. 1983. Comparación agroclimática de las regiones donde tuvo lugar la evolución genealógica de los cultivares de soja más difundidos en la Argentina. VIII Reunión Técnica Nacional de Soja. S.M. de Tucumán. Trabajos Presentados B:37-64.
9) PARODI PINEDO, P.C. 1987. Manual de producción de raps. 318 págs. Convenio Pontificia Univ. Católica de Chile. Compañía Industrial S.A.
10) PASCALE, A.J. 1969. Tipos agroclimáticos para el cultivo de la soja en la Argentina. Rev. Fac. de Agronomía y Vet. Bs. As., 17 (3): 31-48.
11) PASCALE, A.J.; C.R.O. MIACZYNSKI; R.O. RODRIGUEZ y E.R. TRIGO. 1983. Aptitud ecológica de la región oriental argentina para el cultivo de la soja. VIII Reunión Técnica Nacional de Soja. S.M. de Tucumán. Trabajos Presentados B: 1-19.
12) PASCALE, N.C. 1985. Comportamiento bioclimático de siete cultivares de colza en Buenos Aires. Oleico, 32: 9-23.
13) ROLLIER, M. 1974. Influence des facteurs climatiques sur le rendement du colza d' hiver. Informations techniques CETIOM, 37: 9-12.
14) SIERRA, E.M. y G.M. MURPHY. 1986. Agroclimas del cultivo de girasol en la Argentina. Rev. Fac. de Agronomía, Bs. As. 7 (1): 25-44.
15) USA. 1959. Weather Bureau. U.S. Departament of Commerce. World Weather Records 1941-1950. Washington D.C.