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Water is the Basic Element in the Development of Agriculture

Water for agriculture is essential to meet the world´s growing demand for planting. Actually, with the heavy weather, we need to change our agricultural methods to plant in a productive way, like our ancestors did; the way they planted is not the same as ours. In Mexico, one of the best ethnic groups were the Aztecs. They were forced to invent methods to increase productivity; these methods included the use of irrigation, fertilizers, and even building terraces on hills. But one of the most important was the system, known as chinampas (resembling man-made floating gardens). Another ingenious solution of theirs was draining swamps and building up fields in the shallow basin of Mexico´s lakebeds, used to feed the population. These methods were very well controlled by their calendar --which was so precise and punctual that there were no farming problems.

Nowadays, the conditions have modified the climatic changes, which harm everybody, but mainly farmers since they depend so much on predictable weather. In Mexico, like in other countries around the world, the drastic changes of the weather are one of the biggest problems we have. The worldwide level temperature has ascended 5.4 degrees. The rain zones ascend toward the northern part of the country, that is why in the arid zones of Mexico it rains more than ever before; this is going to provoke an environmental imbalance in abundance of water and in droughts like it happened in the years 1110, 1500 and, most recently, in 1930.

The climatic changes in Mexico for its geographical location in relation to the world, takes place in the same parallel that in the oriental coasts of India and China, which is the most affected zone for the climatic changes.

On the other hand this problem affect the coasts provoking flows of migration to the northeast of the country, especially to altered zones by storms and hurricanes, which are located in the coasts of Central Mexico, Sonora and Baja California.

The dry zones experiment a salinization and blighting of the cultivated areas provoking a reduction in agriculture and cattle farming. The higher concentration of carbon dioxide reduces the capacity of the plants to absorb the water of the floor and expel the excessive humidity.

That is why the crops will be more productive in those zones of different altitude where it is estimated that the temperature will increase from 1 to 3 degrees; the change will be smoother.

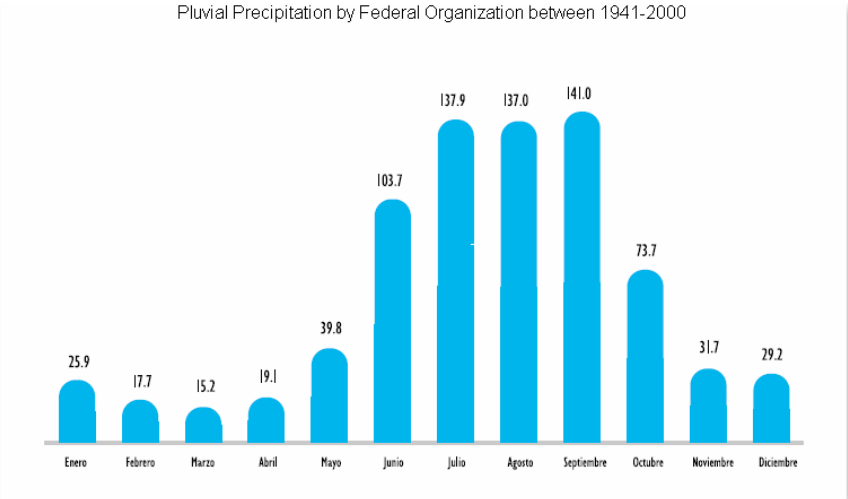
In the lowest latitudes the crops will be reduced, increasing the risk of extreme hunger, drought frequency, and floods that will negatively affect the production of foods, especially in the areas that rely on agriculture in order to subsist.

Reference: González R. 2008. El cambio climático en el sur del país. www.lajornada.com.mx

Pluvial Precipitation in Mexico

The normal precipitations in the country between 1941 and 2000 were 771.8 mm. The normal values correspond to periodic measures, calculating from the 1st of January of a year that finishes in one, and finalizes the 31 of December of the year that finishes in zero. It is possible to emphasize that the

monthly distribution of precipitation in particular stresses the problems related to water availability, since 67.3% of the monthly normal precipitation fall between the months of June, July, August and September (graph of world-wide precipitation 1941-2000)



FUENTE: Conagua. Subdirección General Técnica, Coordinación General del Servicio Meteorológico Nacional.

PRECIPITACIÓN PLUVIAL NORMAL MENSUAL HISTÓRICA POR ENTIDAD FEDERATIVA, EN EL PERIODO DE 1941 A 2000
(Milímetros)

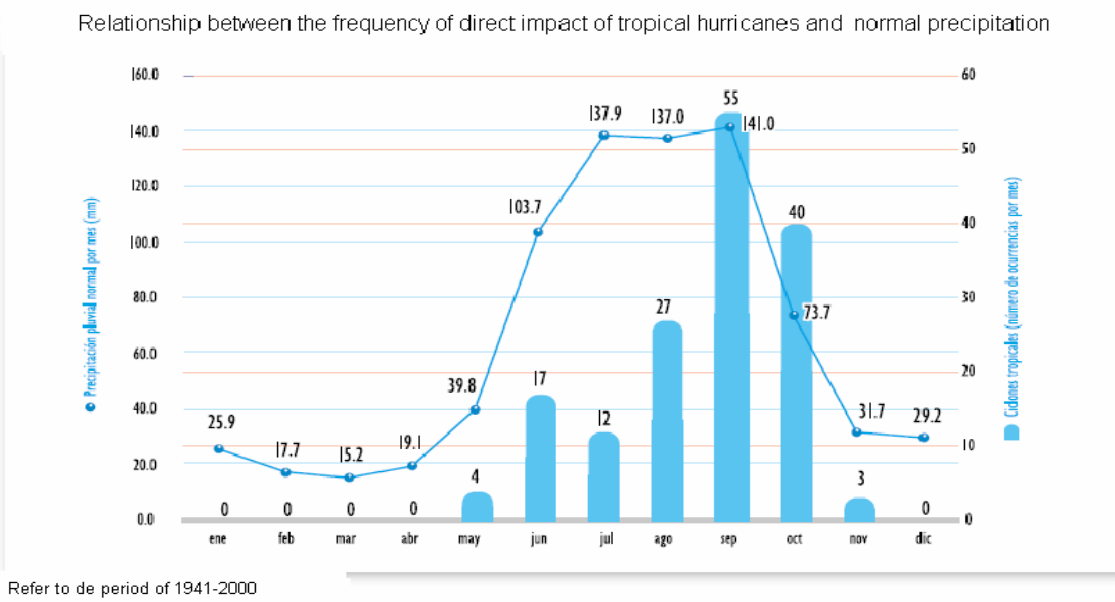
	ENTIDAD FEDERATIVA	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC	ANUAL
1	Aguascalientes	12.3	5.9	3.3	7.5	16.3	71.7	98.7	101.7	76.5	32.5	11.4	10.1	447.8
2	Baja California	37.3	32.5	38.0	15.4	4.4	1.3	1.3	4.8	6.2	8.8	21.1	31.9	203.1
3	Baja California Sur	13.3	4.4	2.2	0.9	0.6	1.0	18.3	43.1	54.1	17.1	6.4	14.1	175.6
4	Campeche	28.1	20.1	18.4	16.3	61.0	161.7	189.1	203.8	213.2	130.4	59.4	35.9	1 137.3
5	Coahuila	12.4	11.8	8.0	19.3	36.2	40.1	32.8	43.1	55.4	31.1	13.7	11.9	315.8
6	Colima	20.8	6.7	3.7	2.2	8.3	114.4	163.6	202.9	223.7	101.0	24.8	13.7	885.9
7	Chiapas	78.6	57.0	46.9	56.4	131.4	269.1	270.6	268.1	340.8	230.9	111.8	101.8	1 963.4
8	Chihuahua	15.9	9.4	6.7	7.9	9.8	36.2	108.4	99.8	69.7	28.3	10.6	18.3	421.0
9	Distrito Federal	7.9	4.5	9.0	23.0	51.1	124.1	154.8	145.8	124.3	53.2	11.4	7.1	716.2
10	Durango	20.0	9.3	5.7	5.3	11.0	60.1	114.0	116.1	91.1	35.2	13.1	24.9	505.6
11	Guanajuato	11.8	6.4	8.0	15.1	36.4	105.2	124.1	123.8	98.4	41.1	11.5	10.1	591.7
12	Guerrero	9.7	2.8	2.5	8.9	48.7	199.0	221.5	220.7	255.5	108.3	24.8	6.5	1 108.8
13	Hidalgo	20.4	17.4	22.2	40.7	66.0	123.5	116.4	112.4	156.8	82.4	36.2	21.2	815.7
14	Jalisco	14.4	7.5	6.6	6.7	24.9	144.6	203.2	182.7	142.5	61.9	16.0	12.8	823.7
15	México	13.0	6.3	9.1	23.8	61.7	156.5	183.2	176.9	160.3	72.6	19.9	8.8	892.1
16	Michoacán	13.3	4.3	3.9	9.9	32.1	137.5	184.0	170.3	156.5	65.2	15.7	9.4	802.0
17	Morelos	9.9	2.9	4.2	13.6	54.9	182.9	170.3	165.5	180.9	70.4	14.0	5.3	875.0
18	Nayarit	19.1	8.7	4.4	4.3	8.0	139.3	279.9	273.8	216.3	74.7	15.8	17.5	1 061.6
19	Nuevo León	20.5	17.2	17.5	36.1	60.3	72.5	53.2	86.5	125.8	63.1	19.2	17.0	588.9
20	Oaxaca	30.2	26.2	21.9	31.2	87.5	253.6	266.9	257.0	291.0	150.9	63.9	37.7	1 518.0
21	Puebla	29.8	26.1	26.5	45.5	83.2	186.3	198.3	194.6	233.0	138.8	63.9	36.5	1 262.4
22	Querétaro	11.4	5.4	8.0	20.2	41.1	101.3	105.7	100.3	98.6	42.2	12.7	7.5	554.4
23	Quintana Roo	66.6	38.3	31.2	33.6	96.4	177.4	121.7	137.1	208.2	164.1	95.3	80.6	1 250.6
24	San Luis Potosí	19.2	16.7	17.7	35.5	66.5	149.3	142.6	150.2	203.1	96.3	36.4	24.5	957.9
25	Sinaloa	28.4	13.4	11.8	8.6	9.9	58.6	187.7	195.2	156.3	59.0	23.5	32.9	785.3
26	Sonora	23.5	15.0	10.5	4.1	3.5	19.9	117.4	110.1	56.1	26.1	13.8	27.4	427.3
27	Tabasco	181.6	110.2	80.6	75.2	122.3	246.4	213.5	251.7	383.7	349.7	210.1	191.1	2 424.1
28	Tamaulipas	19.3	15.3	19.0	35.3	66.7	124.4	102.1	108.0	151.4	77.3	26.5	20.2	765.4
29	Tlaxcala	8.0	6.3	11.7	34.0	73.8	130.6	124.3	129.9	110.8	54.7	17.0	8.0	709.0
30	Veracruz	42.0	33.9	33.2	44.8	76.8	205.5	239.4	203.0	291.2	160.0	87.9	57.8	1 475.7
31	Yucatán	34.9	32.9	30.4	31.7	79.8	162.8	167.4	165.5	185.0	113.9	52.1	45.3	1 101.6
32	Zacatecas	16.0	7.7	5.5	7.4	18.5	82.0	117.4	112.3	83.5	35.7	12.8	16.6	515.4
	Total	25.9	17.7	15.2	19.1	39.8	103.7	137.9	137.0	141.0	73.7	31.7	29.2	771.8

FUENTE: Conagua. Subdirección General Técnica, Coordinación General del Servicio Meteorológico Nacional.

Reference: SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). Agosto del 2007.

On the other hand, the accumulated precipitation occurred in Mexico in 2006 surpassed 808.2 mm which was 4.7% higher than the normal historical value.

The tropical hurricanes arrive with abnormal rhythm in this time since most of the transport of humidity of the sea toward the semi-arid zones of the country occurs for these phenomena. In diverse regions of the country, the cyclonic rains represent most of the annual precipitation. In the following graph the frequency of the tropical hurricanes is shown per month, in the period of 1970-2006, compared with the normal precipitation in the period of 1941-2000.



FUENTE: Conagua. Subdirección General de Programación. Elaborado a partir de datos de la Subdirección General Técnica, Coordinación General del Servicio Meteorológico Nacional.

The droughts in Mexico are introduced with intensity every 10 years, with variable duration, being the most affected regions the arid and semi-arid, where the precipitation average is of 400 mm per year.

The droughts are located more frequently in the states of Chihuahua, Coahuila, Durango, Nuevo Leon, Baja California, Sonora, Zacatecas, San Luis Potosi, Aguascalientes, Guanajuato, Queretaro, Hidalgo, and Tlaxcala.

Reference: SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). Agosto del 2007.

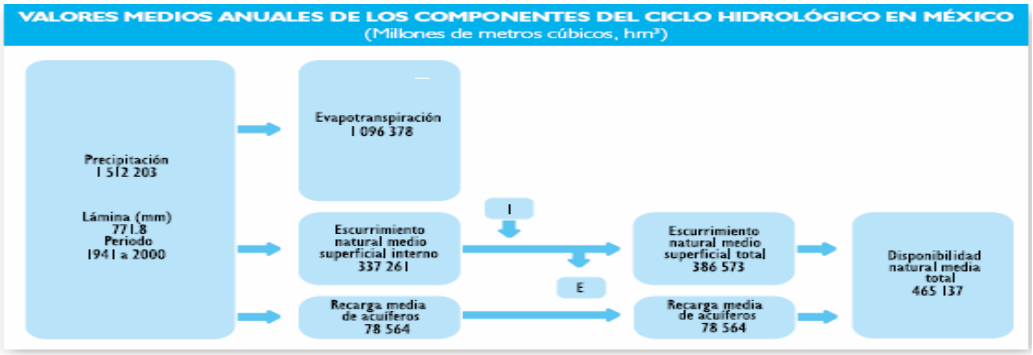
The rivers of the country drain 400km3 of water, approximately, annually, including the imports of other countries but excluding the exports. Approximately, 87% is introduced in the 39 principal rivers whose basins occupy 58% of the territorial extension.

The main river basins in Mexico are 13, and they subdivide into 718 rivers throughout the country.

1. Baja California Peninsula: north of Mexicali
2. The northeast located in Hermosillo, Sonora
3. Pacific in the north of Culiacán, Sinaloa
4. Balsas in Cuernavaca, Morelos
5. South Pacific in Oaxaca, Oaxaca
6. Bravo river Monterrey, Nuevo León
7. Central Basin of Torreón, Coahuila
8. Pacific Lerma-Santiago in Guadalajara, Jalisco
9. North Gulf in Ciudad Victoria, Tamaulipas
10. Center Gulf in Xalapa, Veracruz
11. South of Tuxltla Gutierrez, Chiapas
12. Yucatán Mérida Peninsula, Yucatán
13. Aguas del valle in Mexico city

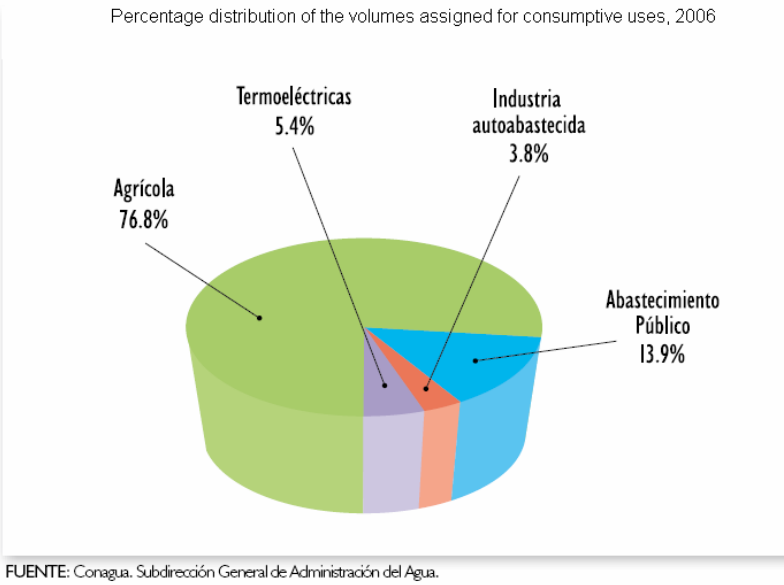
Reference: SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). Agosto del 2007.

returns to the atmosphere, 25.6% slips by the rivers and the rest, 1.9%, infiltrates to the subsoil and recharges the water-bearing. That is why, annually, the country counts with 465 billion m3 of renewable fresh water, which is called “natural average availability.” The following graph shows the values of this readiness.



Use of water in Mexico

Out of 100% of the water available in Mexico, 63% of the water used comes from superficial sources (rivers, streams and lakes), while 37% comes from underground sources. These volumes of water are classified according to their usage as shown in the following graph.



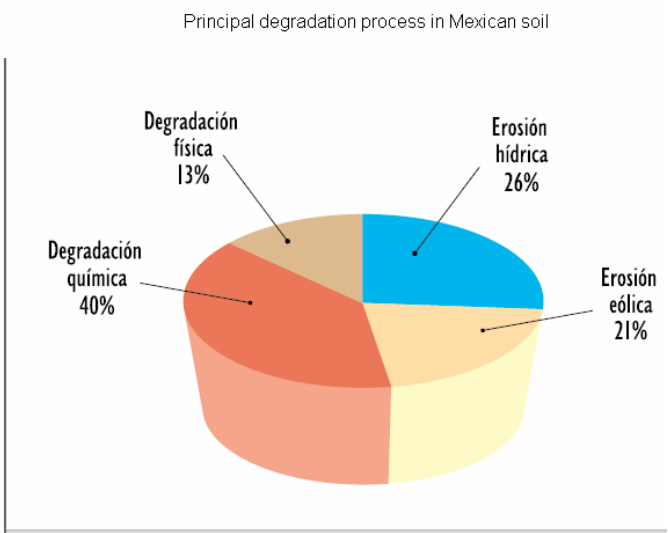
Reference: SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). Agosto del 2007.

Comisión Nacional del Agua. 2007

the irrigation of 20-25 million hectares to harvest between 18 and 22 millions hectares of crops, which places the country in the 6th place world-wide in terms of surface irrigation infrastructure. 54% of the surface under irrigation belongs to 85 districts of irrigation and 46% to 39,000 units of irrigation. The productivity in the irrigation area is 3.7 times greater than that owed to weather, reason why these activities represent more than half of the national agricultural production.

Degradation process of the Mexican Soil

The SEMARNAT estimates that around 45% of the surface of the national territory is affected by diverse processes and intensities of the ground. The main causal processes are chemical degradation, hydric erosion, and aeolian, responsible for 87% of the affected surface, as it is indicated in the following graph.



TE: Semarnat. Sistema Nacional de Información Ambiental y de Recursos Naturales. Compendio ntales 2006, México, 2007.

Reference: SEMARNAT (Secretaría de Medio Ambiente y Recursos Naturales). Agosto del 2007.

Comisión Nacional del Agua. 2007

Over-exploitation

In agreement with the Food and Agriculture Organization of the United Nations (FAO), agriculture is the major user of water with a world-wide average of 69% of the total of the extractions of the liquid. Therefore, the efficient and automated use of irrigation is fundamental to lower the water consumption for planting.

For example the planting of a maize grain requires a world-wide average of 240 gallons of water, while 2.2 pounds of rice require 605 gallons and 2.2 pounds of meat need 4,093 gallons, which is what one animal drinks during its life. This serves as a guideline so that we increment the investigations for planting maize with as little water as possible.

That´s why we need to think in an economical way to preserve water for planting. We can use “aljibes,” which is a word used in Latin America that means deep “wells” or “reservoirs” of water. It can be created artificially or naturally.

Another way to save water in agriculture by changing the type of seed that is used commonly for improved seeds.

The importance of seeds

We need to improve seeds that resist new conditions, such as, high temperatures, droughts, and sometimes floods, depending on the geographic location, for these situations, since a long time ago scientists have been studying and improving seeds and hybrids.

A maize hybrid is the crossover between two genetically different individuals, in its simplest form, that is the result of a cross of two lines that generate the maximum level of the phenomenon of the heterosis, also known like hybrid vigor. This process has helped to produce great amounts of maize grains in the entire world.

Within the maize hybrids different types exist:

- simple hybrids
- double hybrid
- trilinear hybrids
- simple modified hybrids
- varietal nonconventional hybrids

In addition, there are those called varieties of free pollination as they are the synthetic variety, the improved variety, the native variety, and the last ones are generated by methods of selection.

Each one of the types of hybrids or varieties has its specific geographic location so as to respond better to certain conditions of agronomic handling and climate, being valuable, especially for Mexico, due to the diverse production systems for which it is better to use the different variety types.

One of these recent and beneficial varieties was developed at the Scientific Research Center in Yucatan (CICY, in Spanish), which allows growing the plant year-round and not only during certain seasons.

This method is named System of Continuous Production of Maize (SPCM, in Spanish), and it was developed to produce ears of maize in only 12 weeks, half the normal time, which was 25 weeks. With this method it is also possible to grow maize continuously, because it reinitiates, on its own, the cycle of introduction of nutrients to the earth.

With an appropriate irrigation system for maize plants, the necessary amount of water based on the stage of its growth is administered to them daily. In the first stages, approximately weeks of life, each plant must receive 250 daily milliliters, and in the last one, around the ninth week, it requires a liter and a half.

Also the maize planted must be protected with pesticides because it is in the four first weeks of life that it is more susceptible to the presence of insects, and it also must become fertile in the second week, the sixth, and the ninth week.

Currently the SPCM is applied in several communities of the state of Yucatan, and even in other organizations of the country, like Puebla, producing a minimum of 5 tons of grain besides 20 tons of green forage for the cattle by hectare.

Taking into account all the previous data, we can compare it with our world 20 years ago. Now drastic changes are taking place, such as, water scarcity, increased temperature, more frequent natural disasters, contamination, and overpopulation, among other social aspects. These changes affect us all, but some more than others.

Reference: Tadeo R. Esterilidad masculina para producir semillas hibridas de maíz. Conacyt.

SAGARPA. Información sobre granos y semillas en la Secretaria de Agricultura, Ganadería, Desarrollo rural, Pesca y Alimentación

Conclusion

Water has a fundamental role in agricultural cycles, but the percentage of potable water that we have in the world is worrisome, and every day the media reports the causes and what the consequences will be if we continue wasting it. When we listen to these reports, we worry, but only for some time, then we occupy ourselves with other everyday matters and don´t think about it.

In Mexico, most of the water is spent in the agricultural sector, 76, 8%, followed by population consumption, industries, and others. For this we must change our agricultural methods in order to cease using water so irrationally.

Currently, farmers plant their seeds in certain periods of the year in order to take advantage of the rain seasons. But what happens when instead of the expected “normal” rains we get natural storms and deluges that almost always affect the country with disasters? Farmers lose their crops, partially or completely. Also, when it stops raining, the seeds do not germinate suitably and the crop is of very poor quality and perhaps of reduced quantity. We need to change our agricultural methods to save water as well as to avoid losses that complicate our economy.

Many methods of irrigation exist; one of the most efficient is “Drip” irrigation. This method just places the water around the roots, which absorb it and thus we reduce evaporation and other, such as, roots growing upwards in search of water. By using this drip method the roots will grow downwards, as they should: this is an intelligent use of water.

As well as changing our methods of irrigation, we must think about another way of taking advantage of water so that it will not be expensive. Planting improved seeds is a very good option because they grow twice as fast, thus producing twice the harvests per year. It is not necessary to buy so many fertilizers and pesticides to protect them against plagues or insects. It does not need as much water either. These are the most important benefits of these types of seeds.

If we manage to change all of the previously mentioned points, we will obtain cultures of very good quality, with a minimum of water.

Therefore, I propose making a better use of water and of land by cultivating in circular pieces of land, approximately 400 square meters each, surrounded by 4 *jagueys* or *aljibes* to catch the rainwater. It is not an expensive technique. To make the *jagueys*, you dig a hole in the ground, and to retain the water you line it with one of many possible water-resistant materials to avoid filtrations, and then we cover the surface with plastic to avoid evaporation. We can keep and take rainwater from these containers on a more continuous basis without needing so much rain.

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- Tadeo R. *et al.* Esterilidad masculina para producir semillas hibridas de maíz. Revista del Conacyt Ciencia y Desarrollo. Abril del 2001 p.p. 64-75