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2020

Development of Agriculture Production in The World

I- Increasing Cultivated Area and Other Agricultural Resources.

II- Agricultural Intensification:

A- Intensification of crop production :

1- Raising yields of crops per hectare without lengthing the growing periods.

2- Increasing the crop yields per ha per day.

3- Increasing the off-take from cattle herds

4- Shifting from less valuable to more valuable crops on the same land.

B- Crop Intensification through multiple cropping systems.

Cropping Systems

- A cropping system refers to a combination of crops in space and time.
- An ideal cropping system should make the most efficient use of the natural resources, and provide stable and high returns.
- Cropping systems should also be ecologically sustainable.

Other terminology are related to multiple cropping systems :

1- Cropping index: The number of crops grown per annum a given area of land X 100.

2- Land Equivalent Ratio (LER): The ratio of the area needed under sole cropping to one of intercropping at the same management level to give an equal amount of yield. LER is the sum of the fractions of the yields of the intercrop components relative to their sole crop yields (Andrews and Kassam, 1976).

Multiple cropping means

the intensification of cropping in time and space dimensions (growing two or more crops on the same field in a year).

It includes the following :

1- SEQUENTIAL CROPPING SYSTEM :

Growing two or more crops in sequence on the same field per year. The succeeding crop is planted after the preceeding crop has been harvested . Crop intensification is only in the time dimension.

Depend on :

1-Early maturing varieties.

2- Minimum (zero) tillage.

it includes:

1- DOUBLE CROPPING SYSTEM :

Growing Two Crops /year.

Early and late maturing varieties of soybean

Planting seed at Rice School, at Los Banos in the Philippines

Planting Rice after Wheat per year in double cropping system

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Planting soybean after wheat without tillage.

Double cropping soybean after wheat, no tillage. Maryland USA. (cropping index 200 %)

2- TRIPLE CROPPING SYSTEM:

Growing Three Crops / year in Sequence .

Corn

Beans

Potatoes

In South India (Tropics):

1- Rice → Rice → Sesbania

2- Sorghum → Corn → Rice

3- Sorghum → Sorghum → Corn

Depending on date of maturing Varieties

(Cropping index 300 %).

4- QUADRUBLE CROPPING SYSTEM:

Growing Four Crops / year in Sequence

(cropping index 400%)

Maximum Annual rice production in Tropics (IRRI)

Crop	Growth period	Rice strain	N. Applied kg ha-1	Yield (ton ha^{-1})	
				Crop	Cumulative
1	June18-May7	IR 8	130	8.78	8.78
2	May10-July22	IR747 B2	125	5.35	14.13
3	July26-Oct. 6	IR747 B2	125	6.35	20.48
4	Oct. 11-Dec. 27	IR667-98	150	5.17	25.65

Sterling *et a.*(1978)

•Seedlings were grown in separate nursery and transplanted when 20 days old.

• Rough rice at 14 % moisture.

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5- RATOON CROPPING SYSTEM:

This system:

- Minimizes the cost of cultivation.

- Avoids the risks associated with sowing a second crop in rainfed conditions.

- Provide additional returns.

Ratoon Pigeonpea

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- - **Ratoon cropping refers to a multiple- harvest system in which regenerating stubbles of the established crop in the field are managed for subsequent production.**

II- INTERCROPPING SYSTEMS:

Growing two or more crops simultaneously on the same field. Crop intensification is in both time and space dimensions. There is intercrop competition during all or part of crop growth, and farmers manage more than one crop at a time in the same field.

PATTERNS of INTERCROPPING

1- MIXED INTERCROPPING :

Growing Two or More Crops Simultaneously without Distinct Row Arrangement.

- **Mixed cropping refers to growing more than one crop in the same land area as a mixture. The crops are grown without any definite proportion or pattern.**
- **Mixed cropping is practiced in traditional subsisting farming to meet the domestic needs of the farmer's family. Thus, the number of crops grown mixed vary depending on the family needs.**

Intercropping corn with climbing beans in China.

2- ROW INTERCROPPING SYSTEM:

Growing Two or More Crops Simultaneously where One or More Crops are Planted in Rows.

Intercropping soybean with corn in alternating ridges 1 :1 , Egypt

Inter. Patterns 2 corn & 2 soybean. Corn var. Giza 2. Soybean var. Crawford , Gharbia prov.

Intercropping corn and soybean in Egypt, 1987 season.

Intercropping pattern 2&2 corn variety Cairo 1

Soybean variety crawford Sharkia province.


29/06/2006

Field day of intercropping soybean with corn

Intercropping soybean with corn in alternating ridges 2 corn : 4 soybean, Egypt.

A comparison between four options of cropping patterns for solid and intercropping corn and soybean

Options	Yield per Faddan		LER
	Corn (ardab)	Soybean (kg)	
1- Solid corn	23.0	-	1.00
2- Solid Soybean	-	1200	1.00
3- 50% area , solid corn 50% area solid soybean	11.5	600	1.00
4- Intercropping corn with soybean	20 (87 %)	750 (63 %)	1.50

Intercropping corn with peanut, Maryland, USA. (Two isolines).

80 % of the cultivated area of peanut intercropped with maize or grain sorghum in west Africa (Stern, 1984)

Intercropping peanut with corn in Ismaelia , Egypt.


Monocropping


Intercropping

Intercropping corn with water melon (seeds) in Reclaimed land (drip irrigation), Egypt..

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Intercropping maize & cotton in a field under permanent arable cultivation in India and Egypt

Intercropping Safflower & Chickpea

3- STRIP INTERCROPPING SYSTEM :

Growing Two or More Crops Simultaneously in Different Strips Wide Enough to Permit Independent Cultivation and for Interacting Agronomically.

Intercropping corn with soybean in China Jillin Prov. At Manchuria.

4- RELAY INTERCROPPING SYSTEM :

Growing Two or More Crops Simultaneously During Part of The Life Cycle of Each, Second Crop is planted after the first crop has reached its Reproductive Stage of Growth and Before Harvesting. (Francis, 1987).

Intercropping onion with cotton and some winter crops is conventional practice in Egypt; yield of intercropped onion was 6.63 tons fad.$^{-1}$, in 1995; whereas, it was 9.93 of solid planting (40144 faddan). Intercropping system increased the cropping area by about 72,120 faddan (in addition to 102144 fed)Without more agricultural resources.

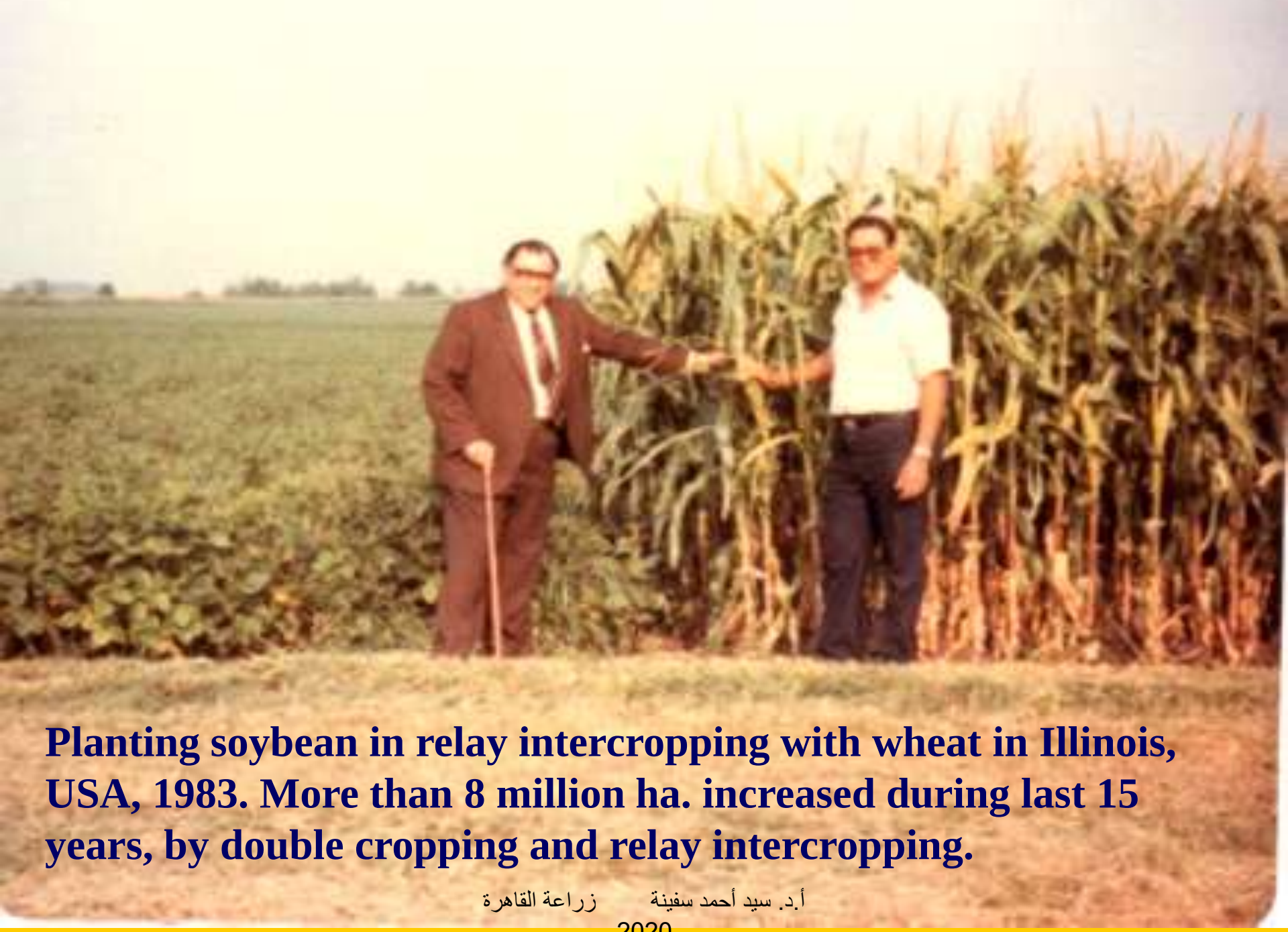
القمح مزروع على مصاطب وتترك مسافة
لزراعة القطن على جانبى المصطبة

Relay intercropping of cotton with wheat in Egypt (ARC – 2003)

Relay intercropping of Cotton with some crops in Egypt

References	Cropping patterns	Yield Faddan		LER
		Wheat (ardab)	Cotton (Kentar)	
Samira,M.A. Hussein(ARC) Bull. Fac. Agric. Cairo Un. 1998.	Solid	15.0	8.4	1.00
	Relay intercropping	14.8	8.2	1.96
	Double cropping (solid).	-	5.4 (date of planting mid-May)	-
Zohry, A.A. (ARC) 2004.	Solid	23.40	10.56	1.00
	Relay intercropping	21.42	8.76	1.75
	Solid onion	13.03 (ton)	-	1.00
	Relay intercropping	10.90 (ton) onion	9.20	1.70
	Solid faba bean	13.03 (ardab)	-	1.00
	Relay intercropping	11.62 (ardab)	9.84	1.82

Intercropping corn , onion and beans with colcasia in Monoufia Prov. Egypt (conventional practice).



Planting soybean in relay intercropping with wheat in Illinois, USA, 1983. More than 8 million ha. increased during last 15 years, by double cropping and relay intercropping.

Relay intercropping cantaloupe with wheat before planting rice in Ismaelia, Egypt.

Wheat is harvested with little disturbance to the growing soybean crop.

Two 10-inch rows of wheat were planted between two rows of seed corn planted on 30-inch centers. Wheat was seeded between the corn rows in late September after the seed corn was harvested. The beans were seeded in late May on top of the old corn rows (thus in 30-inch rows). A tractor with narrow tracks was used to seed soybeans, and the wheat was cut about knee high to avoid clipping off the tops of the beans. The 20-inch spaces between the wheat rows where the soybeans were planted allowed more sunlight to penetrate to the beans and the narrow tracks didn't disrupt the wheat canopy.

in one year, 900 m² produced U.S.$ 772 in net family income + family labour.

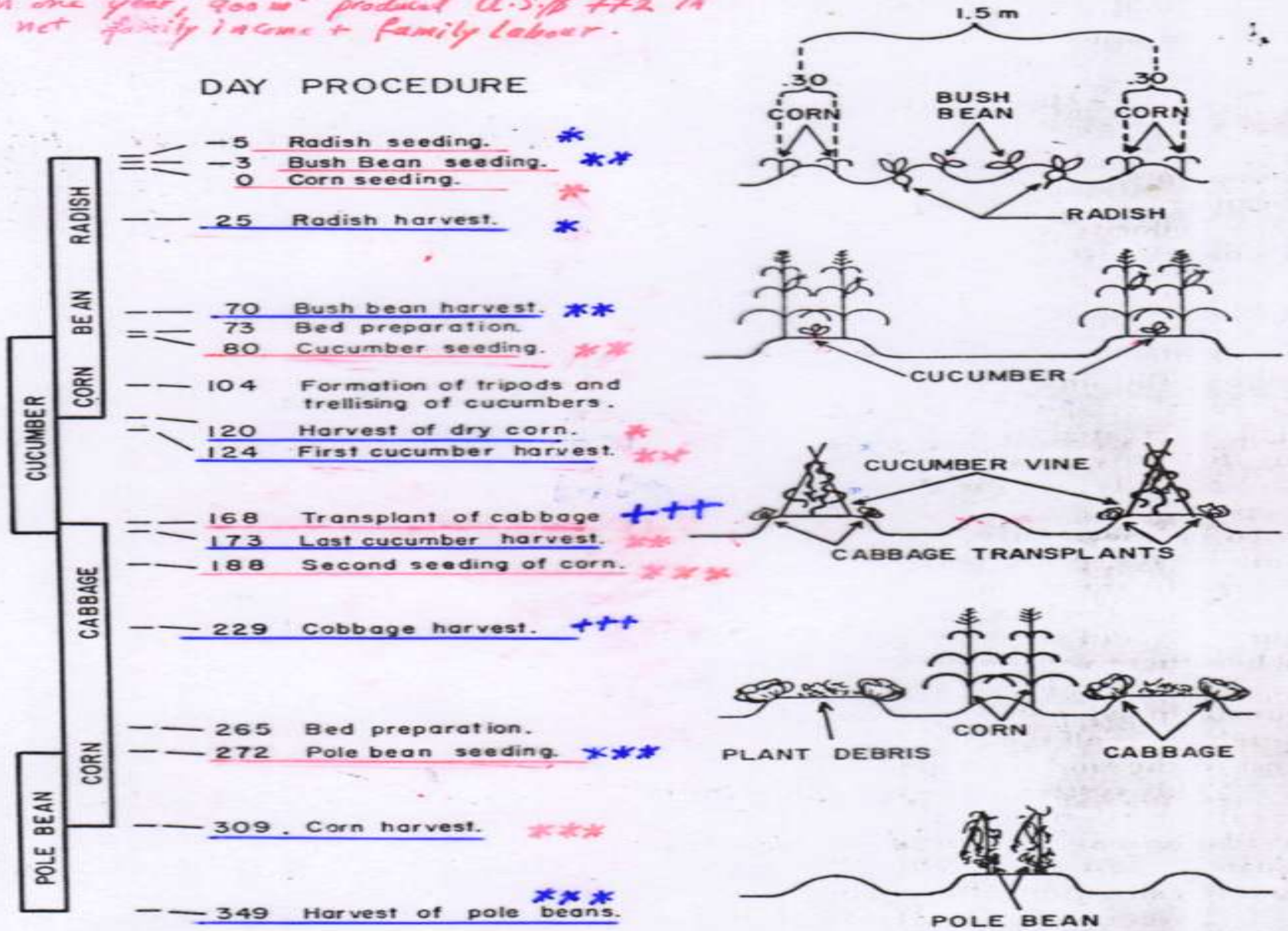


Figure 10. Basic multiple cropping system developed for El Salvador.

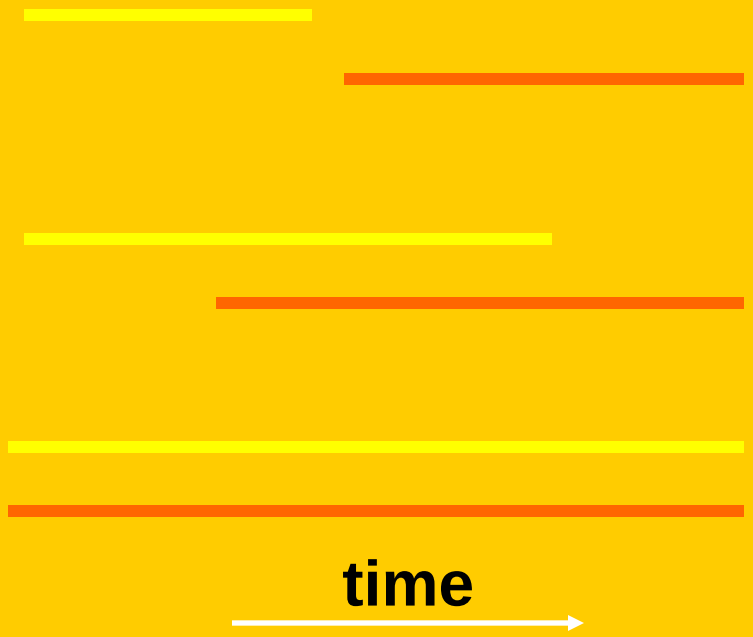
Multiple cropping

Growing two or more crops on the same field in a year

- *sequential cropping*

- *relay intercropping*

- *full intercropping*



Complementary effects between corn and soybean

Compl.	Intercropping ridges	
	2-Corn	2-Soybean
Co_2-fixation	C_4-Plant	C_3-Plant
* Light saturation	100 %	33 %
* Co_2-fertilization	Benefitted	Release (Photorespiration)
*N-fixation	Benefitted	33 Kg N/fad. (release)
*Cation exchange Capacity (roots)	K^+ → Release	← P^{+++}, Mg^{++}, Ca^{++} Release
Water requirement	The same amount	→

Relative light intensity in intercropping Plantings Compared to solid ones.

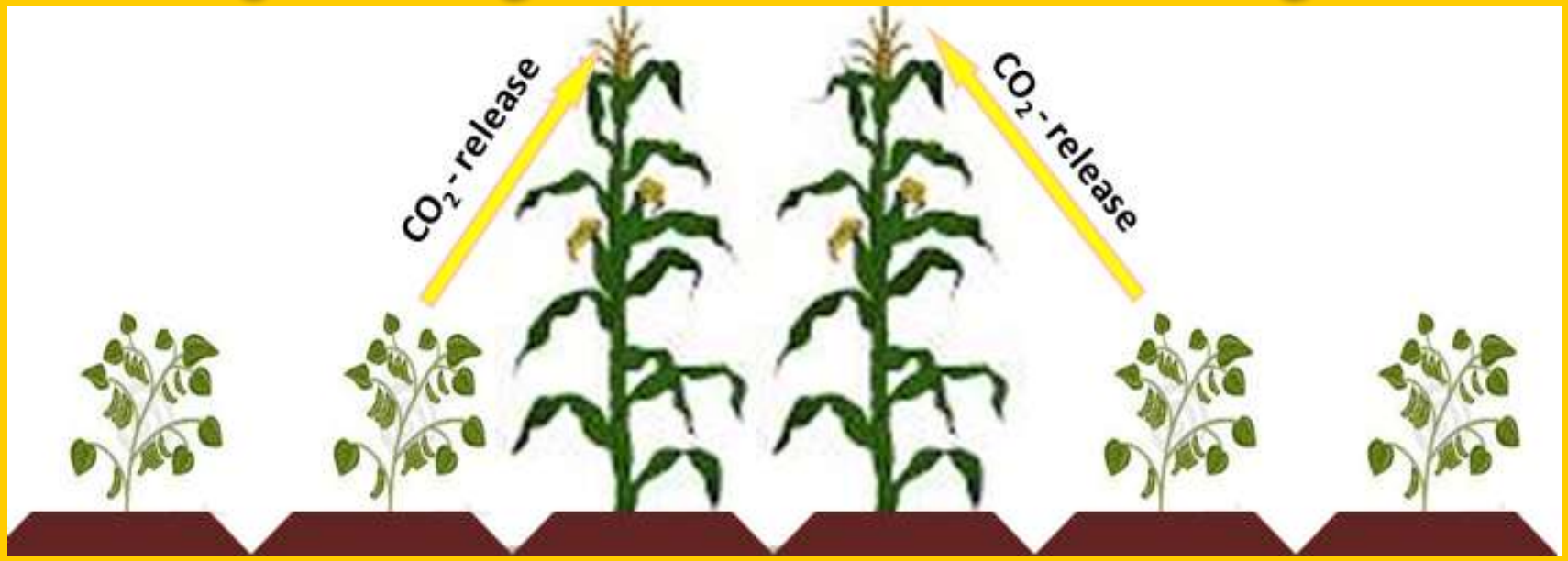
Plantings	Corn		Soybean	
	Over	Within	Over	Within
Solid	100	50	100	37.0
Inter.2&2	100	75	80	27.0
Inter.2&4	100	87	89	29.5

Abd El-Lateef (1988)

تركيزات CO_2

CO_2 concentrations

Complementary effects between corn and soybean



Complementary effects	Intercropping ridges (2:2)	
	Corn	Soybean
CO_2 – fixation	C_4 – plant	C_3 – plant
Light saturation	100 %	33 %
CO_2 – fertilization	benefited	Release (Photorespiration)
N – fertilization	benefited	Residual (80 kg N/ha)
Cation exchange capacity (Roots)	Release K^+ →	Release P^{+++}, Mg^{++}, Ca^{++} ←

Some international reports indicated that:

Increase

Relative atmospheric humidity	3.49-5.13%

Decrease

Atmospheric CO^2	16.1-20.32μmol·mol^{-1}
Air temperature	1.55-2.65℃
Wind speed	39.2%-53.6%
Soil temperature	2.02-3.4℃

Reasons for intercropping

- **Better use of available resources**

  (land, labour, light, water, nutrients)
- **Reduction in pest pressure + associated damage**

  (diseases, insects, weeds)
- **Socio-economic**

  (greater stability, risk avoidance, food/cash crops)
- **Sustainability**

  (erosion, soil fertility)

Evaluation in practice

- **Experiment with three treatments:**
  - **Monoculture of species 1→ $Y_{1,mono}$**
  - **Monoculture of species 2 →$Y_{2,mono}$**
  - **Mixture of species 1 and 2 →$Y_{1,mix}$, $Y_{2,mix}$**

- **Calculation of Relative Yield**
  - **$RY_1 = Y_{1,mix}/Y_{1,mono}$**
  - **$RY_2 = Y_{2,mix}/Y_{2,mono}$**

- **Land Equivalent Ratio (LER)**
  - **$LER = RY_1 + RY_2$**
  - **relative land area under sole crops required to produce the yields achieved in intercropping**

Land Equivalent Ratios (LERs)

$$LER = (Y_{ab}/Y_{aa}) + (Y_{ba}/Y_{bb})$$

LER = ——— + ——— =

= 1

>1

< 1

Two basic designs

- **Additive design**

0 0 0 0 x x x x 0 x 0 x 0 x 0 x
0 0 0 0 x x x x 0 x 0 x 0 x 0 x
0 0 0 0 x x x x 0 x 0 x 0 x 0 x
0 0 0 0 x x x x 0 x 0 x 0 x 0 x
0 0 0 0 x x x x 0 x 0 x 0 x 0 x

species 1 species 2 mixture

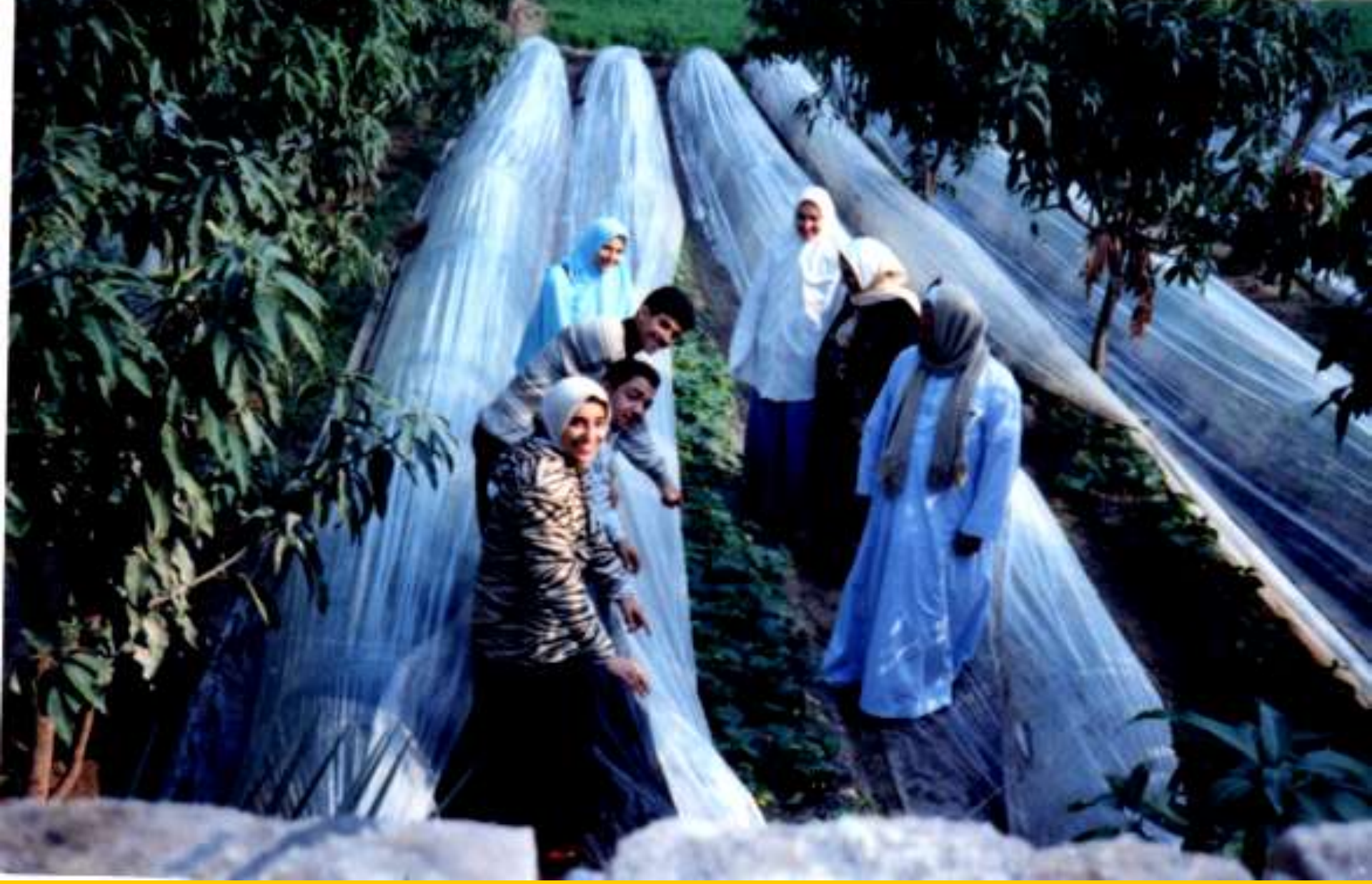
Two basic designs

- **Replacement design**

0	**0**	**0**	**0**		**x**	**x**	**x**	**x**		**0**	**x**	**0**	**x**
0	**0**	**0**	**0**		**x**	**x**	**x**	**x**		**0**	**x**	**0**	**x**
0	**0**	**0**	**0**		**x**	**x**	**x**	**x**		**0**	**x**	**0**	**x**
0	**0**	**0**	**0**		**x**	**x**	**x**	**x**		**0**	**x**	**0**	**x**
0	**0**	**0**	**0**		**x**	**x**	**x**	**x**		**0**	**x**	**0**	**x**
		mixture				**species 2**					**species 1**		

III- INTERPLANTING SYSTEM:

Growing annual crops under stands of perennial crops (Harwood, 1979).



Intercropping vegetables with orchards, Ismaelia, Egypt.

Interplanting Tomato with grape trees in reclaimed land (drip irrigation), Egypt

Interplanting grasses with grapes.

Interplanting winter crops with mango trees Ismaelia, Egypt.

Interplanting Peanut with mango trees in reclaimed land, Egypt.

Some conventional intercropping practices in Egypt :

1- Intercropping onion with cotton.

2- Intercropping soybean with corn.

3- Intercropping faba bean with autumn planting of sugar cane.

4- Intercropping beans with ratoon crop of sugar cane.

5- Intercropping peas with wheat after corn (Relay inter.).

6- Intercropping sesame with corn.

7- Intercropping cowpea with corn.

8- Intercropping pepper or other vegetables with corn.

9- Intercropping faba bean with tomatoes.

10- Intercropping tomato with wheat (Relay inter.).

11- Intercropping onion, beans, corn with colcasia (in Relay inter.)

12- Intercropping Egyptian clover (var fahl) with wheat (in Mixed inter.).

13- Interplanting Egyptian clover with evergreen orchards.

14- Interplanting potato with grapes (winter season).

15- Interplanting cabbage with banana.

16- Interplanting barley with different orchards in north Egypt.

17- Interplanting soybean with grapes.

The most important intercropping patterns in the world:

1- Intercropping climbing beans with corn in China, Central America, and north countries of South America.

2- Intercropping soybean with corn in China (about 8 million acres)

3- Interplanting soybean under trees in the countries of the east-south of Asia.

4- Intercropping cowpea with corn or cassava in Africa.

5- Intercropping between each of corn, radish, bush bean, cucumber, cabbage, bole beans and second planting of corn per a year by relay intercropping system at Salvador republic (Hildebrand, 1976).

6- Intercropping soybean with wheat in some states of USA in relay cropping pattern and double cropping system.

- **An ideal intercropping should aim to:**

  produce higher yields per unit area through better use of natural resources.

- **Offer greater stability in production under biotic and abiotic stresses.**
- **Provide an equitable distribution of farm resources.**

- **Advantages of Intercropping:**

- **Potential for increased farm profitability.**
- **Lower fixed costs for land and machinery as a result of the production of a second crop in the same field.**
- **Better utilization of farm management labor, time, and equipment.**
- **Low cost of production for MRI soybeans (as a result of a lower weed-control cost).**
- **, 2001.)**

- **Hedge production risk (two crops in one growing season).**
- **Hedge commodity price risk by being able to market both wheat and soybeans.**
- **May be used for conservation compliance planning.**
- **May be adapted to most available farm equipment.**
- **Perhaps more consistent yield results for both wheat and soybeans than in other double-crop systems. (McCoy**

Disadvantages of Intercropping:

- Not adaptable to droughty, poorly drained, or very heavy clay soils.
- Potential increase in soybean pests such as Soybean Cyst Nematode.
- Success of soybean crop is highly dependent on timely and adequate July and August rainfall.

Soybeans are susceptible to early fall frost damage.

- **Wheat susceptibility to Fusarium head scab (not worse in wheat to be interplanted). In the event of severe infection, may greatly reduce the potential profitability of the system.**
- **Possible additional machinery cost.**
- **Requires very timely field operations**


THANKS