Sequence 2 : The farm model

Unit 2.1 : Enriching the base model

Lesson 11 : Representing production technologies

Florence Jacquet

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Introduction

Modelling the agricultural activity :

What to produce ?

$\left\{ \right.$ Available resources $\left. \right\}$ →

But, preoccupations :

$\left\{ \right.$ Impacts on resources

Environment

Health

Social issues $\left. \right\}$

→

How ?
What technologies ?
?
What to produce ?

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Issues

o More inputs
o Producing more
o Increasing income
o Increasing food availability

Issues
Less inputs

↓

Reducing negative impacts on the environment and health

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Intensification vs extensification

Intensification = $\dfrac{\text{production factors other than land}}{\text{land}}$
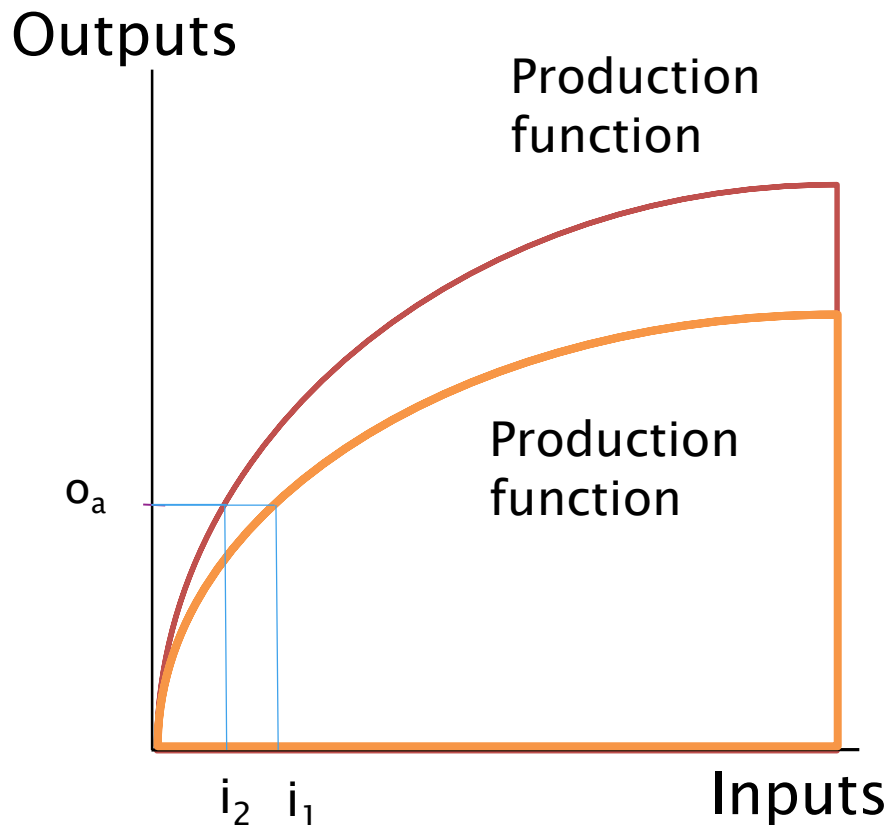
Ex : seeds, fertilizers, treatment products

Extensification= $\dfrac{\text{Production factors other than land}}{\text{land}}$
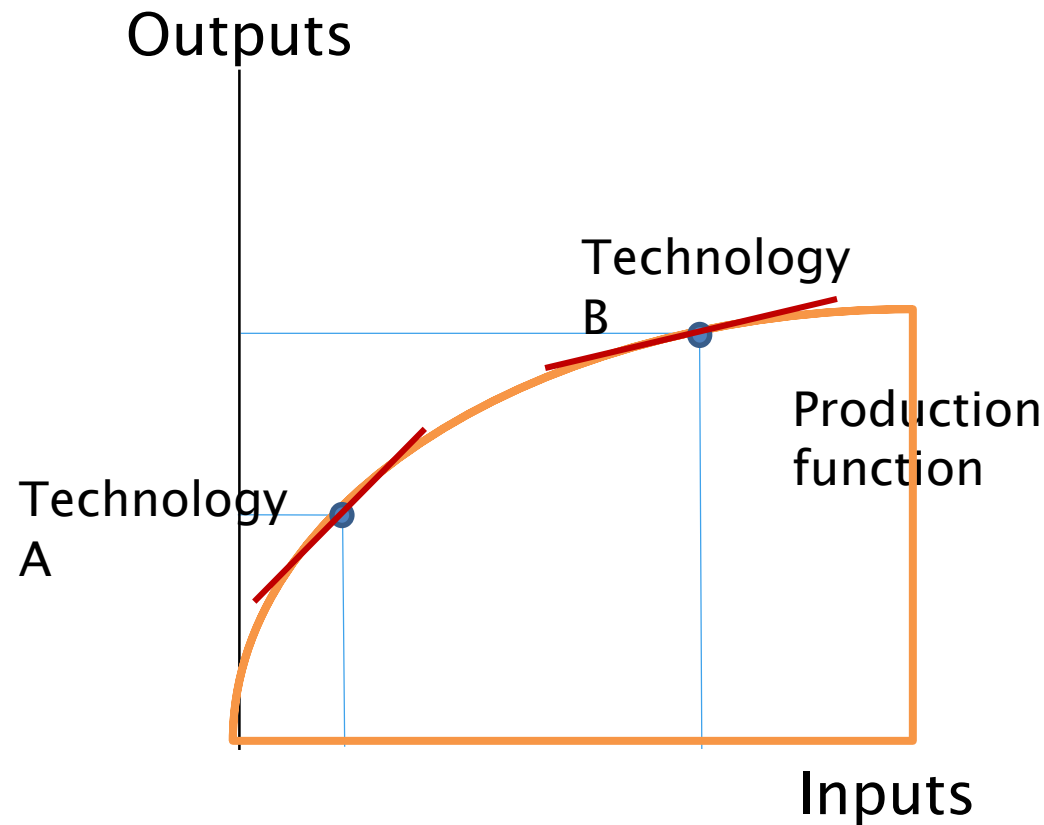
Ex : livestock density

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Technological progress vs different technologies

▸ Technological progress :

▸ Different production technologies :

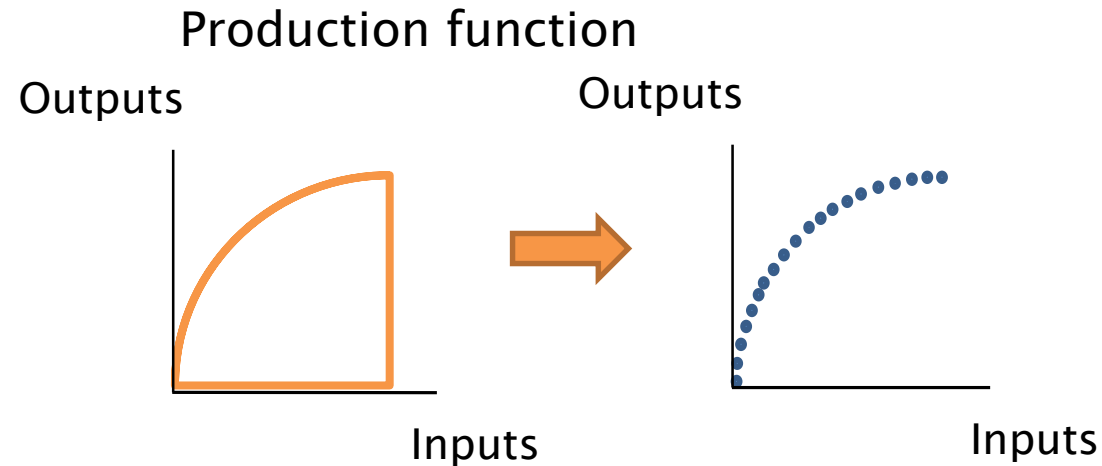Choice depending on : input prices, prices of farm products

Intervention of public policies

Outputs

Production function

o_a

Production function

Inputs

i_2 i_1

Outputs

Technology B

Technology A

Production function

Inputs

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Substitution or complementary factors and technological leaps

Production function

Outputs

Outputs

Inputs

Inputs

(ex : mechanical weeding)

Firstly :

➢ Complementary factors :
  Land + labour
  Seeds + land + fertilizer
  Treatment products + labour + fertilizer

➢ Substitution factors :
  Mechanization : substitution of labour for capital
  Substitution of land for fertilizers (partial)
  Substitution of chemical products for labour or capital

Secondly :

➢ Technological leaps
  For example : the purchase of a
  new machine, system change

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Representing production technologies

Outputs

Production technologies

Technology =
(~crop practices)
Quantity of inputs
Calendar of operations
…

Production function

A

B

C

Inputs

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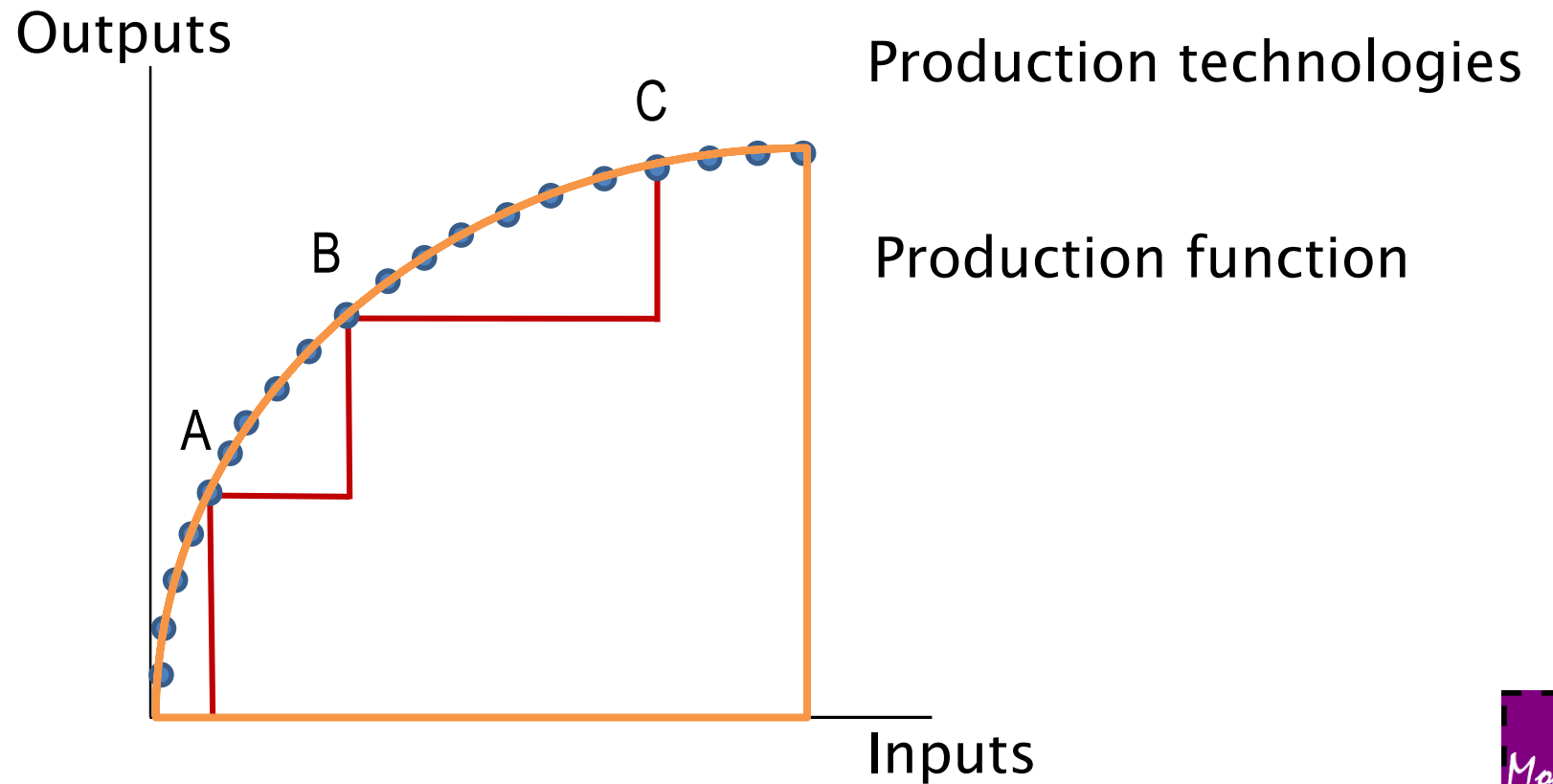
Wheat/maize model with two production technologies

Maximize $\quad\quad Z = 450\,X_1 + 1000\,X_2$

With $\quad\quad\quad X_1 + X_2 \leq 50$

$\quad\quad\quad\quad\quad 25\,X_1 + 50\,X_2 \leq 2000$

$\quad\quad\quad\quad\quad X_1 \geq 0 \; ; X_2 \geq 0$

X_1 area dedicated to wheat (ha)

X_2 area dedicated to maize (ha)

Maximize $\quad\quad Z = 425\,X_{1E} + 450\,X_{1I} + 800\,X_{2E} + 1000\,X_{2I}$

With $\quad\quad\quad X_{1E} + X_{1I} + X_{2E} + X_{2I} \leq 50$

$\quad\quad\quad\quad\quad 15\,X_{1E} + 25\,X_{1I} + 45\,X_{2E} + 50\,X_{2I} \leq 2000$

$\quad\quad\quad\quad\quad X_{1E} \geq 0 \; ; X_{1I} \geq 0 \;\; X_{2E} \geq 0 \; ; X_{2I} \geq 0$

X_{1E} extensive wheat area (ha)
X_{1I} intensive wheat area (ha)
X_{2E} extensive maize area (ha)
X_{2I} intensive maize area (ha)

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Modifying the objective function

$$Z = 425X_{1E} + 450X_{1I} + 800X_{2E} + 1000X_{2I}$$

(Indices)　　　With　　$C=\{1,2\}$ et $T=\{E,I\}$

(Variable)　　　$X_{C,T}$　　　Area per crop and per technology

(Data)　　　$GM_{C,T}$　　　Gross margin per crop and per technology

$$Z=\sum_C \left[\sum_T (GM_{C,T}*X_{C,T})\right]$$

```
Z =e= sum[C,{sum(T, GM(C,T)*X(C,T)}]
```

OR　　　　　　　　　　　　　　　OR

$$Z=\sum_{C,T} \left[GM_{C,T}*X_{C,T}\right]$$

```
Z =e= sum[(C, T), GM(C,T)*X(C,T)]
```

Condensed writing　　　　　　　Writing in GAMS

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Modifying constraints

$$X_{1E} + X_{1I} + X_{2E} + X_{2I} \leq 50$$

$$15\,X_{1E} + 25\,X_{1I} + 45\,X_{2E} + 50\,X_{2I} \leq 2000$$

(Variable)　　　$X_{C,T}$　　　Area per crop and per technology

→ (Data)　　　$LN_{C,T}$　　　Labour needs per crop and per technology

$$\sum_{C,T} X_{C,T} \leq 50$$　　Land constraint　　　`sum[(C,T),X(C,T)] =l= 50`

$$\sum_{C,T} LN_{C,T}*X_{C,T} \leq 2000$$　　Labour constraint　　`sum[(C,T), LN(C,T)*X(C,T)] =l= 2000`

Condensed writing　　　　　　　　　　Writing in GAMS

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Modifying variables

$$X_{1E} \geq 0 \; ; X_{1I} \geq 0 \;\; X_{2E} \geq 0 \; ; X_{2I} \geq 0$$

→ (Variable) $\quad X_{C,T} \quad$ Area per crop and per technology

$$X_{C,T} \geq 0 \; \forall \; C,T$$

POSITIVE VARIABLE
X ;

Condensed writing

Writing in GAMS

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Modifying data

	Initial model	Model with crop practices
SET	C /wheat, maize/	C /wheat, maize/ T /ext, int/
DATA	GM(C)	GM(C, T)
	LN(C)	LN(C, T)

Example LN(C,T)

	Labour needs	
	BMO(C, T)	
Technology	EXT	INT
WHEAT	15	25
MAIZE	45	50

Writing in GAMS

```
TABLE
LN(C,T)      labour needs per crop and per technology
           ext       int
wheat      15        25
maize      45        50          ;
```