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ANALYTICAL TOOLS

Module 021

# WinDASI Exercise

## NGAMO 1 - An Irrigation Project: Impacts of Irrigation on Traditional Farms

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# WinDASI Exercise

## NGAMO 1 - An Irrigation Project: Impacts of Irrigation on Traditional Farms

by

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**About EASYPol**
EASYPol is a an on-line, interactive multilingual repository of downloadable resource materials for capacity development in policy making for food, agriculture and rural development. The EASYPol home page is available at: ***www.fao.org/tc/easypol***.
EASYPol has been developed and is maintained by the Agricultural Policy Support Service, FAO.

**Acknowledgements**

This module draws upon the TCAS publication: WinDASI User Manual, Training Materials for Agricultural Planning, 43 FAO - Rome 2000, whose main contributors are Carlo Cappi, who is also the main designer of the computer software, and Lorenzo Giovanni Bellù. The author would like to acknowledge with thanks the contribution of Francesca Petrina, who volunteered for reviewing the first draft of this module and to all the others who contributed in different ways to this final version. The WinDASI software was developed by Laurent Cazalet and Gilles Cappella under the supervision of Mahmoud Allaya at the "Institut Agronomique Méditerraneén de Montpellier (IAM-M)-France.

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# 1 SUMMARY

This module presents NGAMO1, the first of the four practical step-by-step exercises in Cost Benefit Analysis (CBA) of investment projects, to be run with the WinDASI software (the word NGAMO comes from the name of the zone of the original project that was located in Myanmar).

The goal of this module is to analyze the technical feasibility at farm level of an irrigation project. That means processing the data set on the activities of a specific farm model for both With-Project and Without-Project (WiP and WoP) situations. The analyst addresses feasibility issues in terms of labour requirements and needs of draught animal services at farm level, whose lack is one of the main constraints identified by the project. Moreover, the analyst calculates costs, benefits, **net cash flow** and **incremental net cash flow** at farm level over the duration of the irrigation project, identifying also the main changes related to the WiP versus WoP situations.

# 2 INTRODUCTION

### Objectives

The main objective of this module is to allow the user to practice the analysis of a real, although simplified, project by using the WinDASI software. The user is guided through a path from the initial phase of the exercise to its solution.

### Target audience

This module targets current or future project analysts in the public administration or in Non-Governmental Organizations (NGOs), professional organizations, consulting firms willing to enhance their expertise in financial and economic analyses of agricultural investment projects.

### Required background

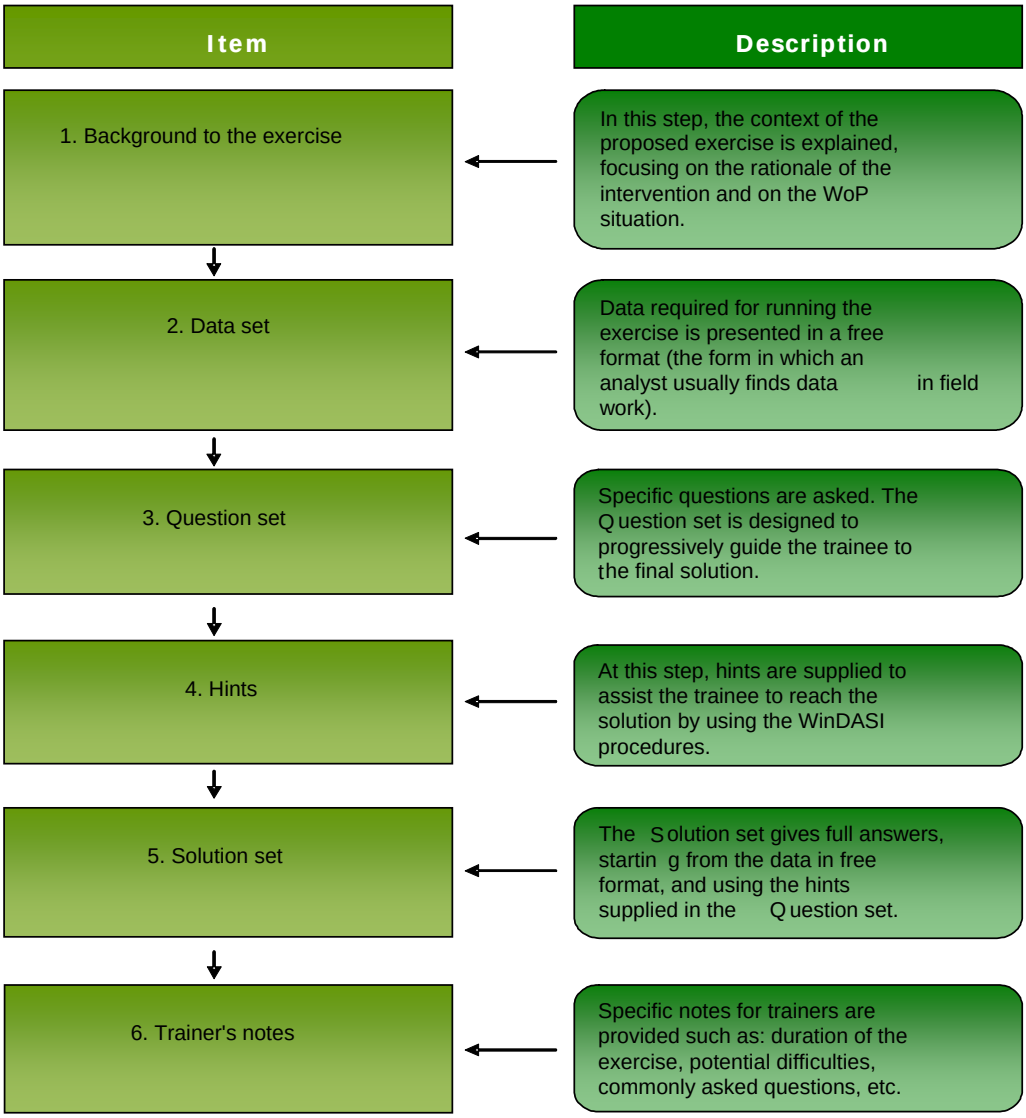
In order to fully understand the content of this module the user must be familiar with:

- concepts of project cycle management;
- concepts of project financial analysis;
- concepts of project economic analysis.

- To find relevant material in the areas above, the reader can follow the links to other EASYPol modules included in the text or in the footnotes[1]. A set of linked EASYPol modules is reported in a section at the end od this document..

[1] EASYPol hyperlinks are shown in blue, as follows :
a) training paths are shown in **underlined bold**;
b) other EASYPol modules or complementary EASYPol materials are in ***bold underlined italics***;
c) links to the glossary are in **bold**; and
d) external links are in *italics*

**Figure 1: Structure of the NGAMO Exercises**




## 3 BACKGROUND TO THE EXERCISE

A project formulation mission in the region of NGAMO, situated at about two hours by car from the capital, identified the lack of irrigation water in the dry season and an irregular supply of water for the rest of the year as being two of the major causes of poor agricultural development.

On the ground of this information, a project formulation team is designing a development project to restructure the irrigation network in the lowlands near the river. One of the principal tasks of the formulation team is to analyze the impact of the envisaged project options on the farmers in the area.

In order to accomplish this task, the analysts decide to divide the existing farms into classes according to their agronomic and socio-economic features and to outline some farm models. Each farm model should allow a schematic description of the farming activities, investments and other socio-economic features pertaining to the class it belongs to, taking into consideration both WoP and WiP scenarios. The possible impact of the project on such enterprises would then be considered and used to investigate the overall impact of the project by aggregation, taking into account also the existing number of farms described in each farm model.

In the project area there are about 1 000 farms, characterized by a relative agronomic, socio-economic and cultural homogeneity. This homogeneity allows the analysts to work with a single farm model that satisfactorily describes almost all the farms.

The prevailing type of farm in the area is one of about 5.5 hectares, run by one household. During the humid season, most of the farmers grow paddy rice, both traditional and high yielding varieties (HYVs). This crop is used mainly for home consumption. In the dry season, only a portion of land is cultivated to sunflower and sesame. In the absence of a project this practice is expected to.

The irrigation project should aim at both an intensification of crops production and an increase in crop yields. For paddy, an increase of about 15 percent would be envisaged and this should result in higher food supplies for the rural people. Furthermore, the project should allow a sharp increase in sunflower and sesame production, typical cash crops, thus increasing the purchasing power of farming households. The expected increase in cash crops, requires that marketing issues be adequately addressed by the project formulation team. For this purpose, the existence of appropriate and efficient commodity chains should be ascertained and targeted actions defined in order to reinforce them or create new ones, as necessary.

Without the project, almost all the agricultural tasks are carried out by the household labour force, estimated by the analysts to be 555 working days. Currently, labour force is not hired.

Even if the farms in the project area are very similar, some differences can be pointed out. Only some households have bullocks at their disposal, which provide animal traction for agricultural work and transportation. This uneven distribution of animals, however, does not cause major problems in the project area, because a market for animal traction services is well developed. Indeed, the observed market price of the animal services corresponds to the opportunity cost of renting out animals.

In order to assess the viability of the project, data on the activities of the selected farm model, in both WiP and WoP scenarios, have been collected and forecasted. They are considered in detail below.

# 4 DATA SET

## 4.1 Tabulated data used as the basis for calculations

Table 1 reports the forecasts for the cultivated area with and without the irrigation project. It is to be noted that the project's main outputs are: (i) a shift of land use from traditional paddy to high yield (HY) paddy cultivation; and (ii) a progressive increase in the cultivated area during the dry season.

Without the project, the cultivated area and its use is deemed to continue unchanged for the duration of the project.

**Table 1a: Plan TRADIT – forecast of the cultivated area WiP scenario (hectares)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| a) Humid season | | | | | | | |
| - high yield paddy | CUL-HYV | 3.85 | 3.85 | 3.90 | 3.95 | 4.00 | 4.05 |
| - traditional paddy | CUL-TRA | 1.65 | 1.65 | 1.60 | 1.55 | 1.50 | 1.45 |
| **Total** | | **5.50** | **5.50** | **5.50** | **5.50** | **5.50** | **5.50** |
| b) Dry season | | | | | | | |
| - sunflower | CUL-SUN | 0.10 | 0.10 | 0.20 | 0.25 | 0.35 | 0.45 |
| - sesame | CUL-SES | 1.10 | 1.10 | 1.25 | 1.45 | 1.65 | 1.80 |
| **Total** | | **1.20** | **1.20** | **1.45** | **1.70** | **2.00** | **2.25** |

**Table 1b : Plan TRADIT – forecast of the cultivated area WoP scenario (hectares)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| a) Humid season | | | | | | | |
| - high yield paddy | CUL-HYV | 3.85 | → | → | → | → | → |
| - traditional paddy | CUL-TRA | 1.65 | → | → | → | → | → |
| **Total** | | **5.50** | → | → | → | → | → |
| b) Dry season | | | | | | | |
| - sunflower | CUL-SUN | 0.10 | → | → | → | → | → |
| - sesame | CUL-SES | 1.10 | → | → | → | → | → |
| **Total** | | **1.20** | → | → | → | → | → |

Note: The arrows mean that the coefficients are constant for the remaining periods.

**Table 2 - Inputs and outputs per hectare for high yield paddy variety (CUL-HYV)**

As far as paddy is concerned, the project is expected to lead to a progressive increase in yields from year three.

**Table 2a : WiP HY paddy variety (CUL-HYV)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Seeds (kg) | S-PADDY | 70.0 | 70.0 | 70.0 | 70.0 | 70.0 | 70.0 |
| Urea (kg) | UREA | 112.0 | 112.0 | 112.0 | 112.0 | 112.0 | 112.0 |
| TSP (kg) | TSP | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 |
| MOP (kg) | MOP | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 |
| Manure (carts) | MANURE | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Pesticides (francs) | PESTIC | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Workforce (man/days) | LABOUR | 102.0 | 102.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Draft Animals (days) | BULLOCKS | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 | 32.0 |
| Yield Paddy H.Y. (tons) | Pad-HY | 3.6 | 3.6 | 3.8 | 3.8 | 4.2 | 4.2 |

**Table 2b : WoP HY paddy variety (CUL-HYV)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Seeds (kg) | S-PADDY | 70.0 | → | → | → | → | → |
| Urea (kg) | UREA | 112.0 | → | → | → | → | → |
| TSP (kg) | TSP | 56.0 | → | → | → | → | → |
| MOP (kg) | MOP | 28.0 | → | → | → | → | → |
| Manure (carts) | MANURE | 1.0 | → | → | → | → | → |
| Pesticides (francs) | PESTIC | 5.0 | → | → | → | → | → |
| Workforce (man/days) | LABOUR | 102.0 | → | → | → | → | → |
| Draft Animals (days) | BULLOCKS | 32.0 | → | → | → | → | → |
| Yield Paddy H.Y. (tons) | Pad-HY | 3.6 | → | → | → | → | → |

**Table 3 - Inputs and outputs per hectare for traditional paddy (CUL-TRA)**

The project will also lead to an increase in yields of traditional paddy, but this increase will need to be supported by an increased use of labour and draught animals.

**Table 3a: WiP traditional paddy (CUL-TRA)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Seeds (Kg) | S-PADDY | 46.0 | 46.0 | 46.0 | 46.0 | 46.0 | 46.0 |
| Urea (kg) | UREA | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 |
| TSP (kg) | TSP | - | - | - | - | - | - |
| MOP (kg) | MOP | - | - | - | - | - | - |
| Manure (carts) | MANURE | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Pesticides (francs) | PESTIC | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Workforce (man/days) | LABOUR | 68.0 | 68.0 | 86.0 | 86.0 | 86.0 | 86.0 |
| Draft Animals (days) | BULLOCKS | 22.0 | 22.0 | 26.0 | 26.0 | 26.0 | 26.0 |
| Yield Paddy Traditional (tons) | Pad-TRA | 2.0 | 2.0 | 2.2 | 2.2 | 2.2 | 2.2 |

**Table 3b : WoP traditional paddy (CUL-TRA)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Seeds (Kg) | S-PADDY | 46.0 | → | → | → | → | → |
| Urea (kg) | UREA | 28.0 | → | → | → | → | → |
| TSP (kg) | TSP | - | → | → | → | → | → |
| MOP (kg) | MOP | - | → | → | → | → | → |
| Manure (carts) | MANURE | 1.0 | → | → | → | → | → |
| Pesticides (francs) | PESTIC | 5.0 | → | → | → | → | → |
| Workforce (man/days) | LABOUR | 68.0 | → | → | → | → | → |
| Draft Animals (days) | BULLOCKS | 22.0 | → | → | → | → | → |
| Yield Paddy Traditional ( | Pad-TRA | 2.0 | → | → | → | → | → |

**Table 4 - Inputs and outputs per hectare for sunflower (CUL-SUN)**

Sunflower yields will increase without any change in the inputs, except for the increased availability of water in the dry season. The forecast yields are shown below.

**Table 4a : WiP sunflower (CUL-SUN)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Seeds (kg) | S-SUNF | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 | 11.0 |
| Urea (kg) | UREA | 84.0 | 84.0 | 84.0 | 84.0 | 84.0 | 84.0 |
| TSP (kg) | TSP | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 |
| MOP (kg) | MOP | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 |
| Manure (carts) | MANURE | - | - | - | - | - | - |
| Pesticides (francs) | PESTIC | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Workforce (man/days) | LABOUR | 32.0 | 32.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Draft Animals (days) | BULLOCKS | 12.0 | 12.0 | 18.0 | 18.0 | 18.0 | 18.0 |
| Yield Sunflower (tons) | SUNF | 0.8 | 0.8 | 0.8 | 1.2 | 1.2 | 1.2 |

**Table 4b : WoP sunflower (CUL-SUN)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Seeds (kg) | S-SUNF | 11.0 | → | → | → | → | → |
| Urea (kg) | UREA | 84.0 | → | → | → | → | → |
| TSP (kg) | TSP | 56.0 | → | → | → | → | → |
| MOP (kg) | MOP | 28.0 | → | → | → | → | → |
| Manure (carts) | MANURE | - | → | → | → | → | → |
| Pesticides (francs) | PESTIC | 5.0 | → | → | → | → | → |
| Workforce (man/days) | LABOUR | 32.0 | → | → | → | → | → |
| Draft Animals (days) | BULLOCKS | 12.0 | → | → | → | → | → |
| Yield Sunflower (tons) | SUNF | 0.8 | → | → | → | → | → |

**Table 5 - Inputs and outputs per hectare for sesame (CUL-SES)**

The increased yields of sesame forecast in the WiP scenario need to be supported by the growth both in the number of person/days per hectare and days of draught animal use, as shown in the table below.

**Table 5a : WiP sesame (CUL-SES)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Seeds (kg) | S-SESAME | 15.0 | 15.0 | 17.0 | 17.0 | 17.0 | 17.0 |
| Urea (kg) | UREA | 84.0 | 84.0 | 84.0 | 84.0 | 84.0 | 84.0 |
| TSP (kg) | TSP | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 |
| MOP (kg) | MOP | - | - | - | - | - | - |
| Manure (carts) | MANURE | - | - | - | - | - | - |
| Pesticides (francs) | PESTIC | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Workforce (man/days) | LABOUR | 42.0 | 42.0 | 66.0 | 66.0 | 66.0 | 66.0 |
| Draft Animals (days) | BULLOCKS | 18.0 | 18.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| Yield Sesame (tons) | SESAME | 0.2 | 0.2 | 0.4 | 0.6 | 0.6 | 0.6 |

**Table 5b : WoP sesame (CUL-SES)**

| Item | Code | Years | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Seeds (kg) | S-SESAME | 15.0 | → | → | → | → | → |
| Urea (kg) | UREA | 84.0 | → | → | → | → | → |
| TSP (kg) | TSP | 56.0 | → | → | → | → | → |
| MOP (kg) | MOP | - | → | → | → | → | → |
| Manure (carts) | MANURE | - | → | → | → | → | → |
| Pesticides (francs) | PESTIC | 20.0 | → | → | → | → | → |
| Workforce (man/days) | LABOUR | 42.0 | → | → | → | → | → |
| Draft Animals (days) | BULLOCKS | 18.0 | → | → | → | → | → |
| Yield Sesame (tons) | SESAME | 0.2 | → | → | → | → | → |

**Table 6 - Prices of inputs and outputs**

The prices, which are expressed in Francs, are assumed to remain constant for the time span of the project, in both WiP and WoP scenarios.

**Table 6 : Prices of inputs and outputs**

| Item | Code | Price Francs |
|---|---|---|
| Seeds H.Y.paddy (kg) | S-PADDY | 0.60 |
| Seeds trad. paddy (kg) | S-PADDY | 0.60 |
| Seeds sunflower (kg) | S-SUNF | 6.00 |
| Seeds sesame (kg) | S-SESAME | 10.40 |
| Urea (kg) | UREA | 0.34 |
| TSP (kg) | TSP | 1.14 |
| MOP (kg) | MOP | 0.54 |
| Manure (carts) | MANURE | 15.00 |
| Pesticides (francs) | PESTIC | 1.00 |
| Hired labour (man/day) | HIR-LAB | 7.00 |
| Workforce (man/day) | LABOUR | - |
| Draft animals (days) | BULLOCKS | 30.00 |
| Land tax (francs)* | LAND-TAX | 1.00 |
| Irrigation tax (francs) * | IRR-TAX | 1.00 |
| Other (francs) * | OTHER | 1.00 |
| Paddy high yield (ton) | Pad-HY | 441.0 |
| Paddy traditional (ton) | Pad-TRA | 662.0 |
| Sunflower (ton) | SUNF | 4,550.0 |
| Sesame (ton) | SESAME | 7,674.0 |

* These items are expressed in monetary units, therefore, their price is 1.

**Table 7 - Other data**

In the WiP situation, the farmers will be charged with an irrigation tax, levied to the end of partially recovering the investment related to the irrigation scheme. The project will also involve a progressive increase in other farm expenses, as summarized below.

**Table 7a : Other data for WiP scenario**

| Item | Code | Year | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7-15 |
| Land tax (francs/farm) | LAND-TAX | 28.0 → | | | | | | |
| Irrigation tax (fr./farm) | IRR-TAX | - | - | 110.0 | 110.0 | 110.0 | 110.0 | 110.0 |
| Other expenses (fr./farm) | OTHER | 90.0 | 90.0 | 120.0 | 136.0 | 152.0 | 169.0 | 185.0 |
| Hous. work (man/day farm) | LABOUR | 555.0 → | | | | | | |

**Table 7b : Other data for WoP scenario**

| Item | Code | Year | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7-15 |
| Land tax (francs/farm) | LAND-TAX | 28.0 | → | → | → | → | → | → |
| Irigation tax (fr./farm) | IRR-TAX | - | → | → | → | → | → | → |
| Other expenses (fr./farm) | OTHER | 90.0 | → | → | → | → | → | → |
| Hous. work (man/day farm) | LABOUR | 555.0 | → | → | → | → | → | → |

## 5 QUESTION SET

The project analyst is faced with the following set of questions:

### 5.1 Main question

(i) For the definition of the project feasibility in terms of labour requirements at farm level:

Is the annual household labour force (555 person/days) sufficient to support the planned shifts of activity in the humid season and the increased cultivated land in the dry season?

(ii) For the Calculation of the required draught animal services at farm level in the WiP situation:

Does the project lead to a substantial change in the draught service requirements?

Is this change likely to be sustainable for the farm?[2]

### 5.2 Additional questions

(iii) Are the changes in the quantities of inputs and outputs likely to generate stocking facility problems for the farm?

(iv) What main aspects should be verified by the formulation team in order to secure the marketing of the cash crops?

(v) How do the costs, benefits and net cash flow change over the duration of the project?

(vi) For the calculation of the profits/household workforce and profits/land ratios, both in the WiP situation and at the full development of the project: How do the ratios vary?

[2] It is mandatory to work through the main questions to follow the whole flow of the NGAMO exercise.

From the cost/benefit table, derive the net cash flow and the net incremental cash flow during a full year of implementation for the farmers hiring the bullocks, knowing that about three tons of paddy are home-consumed. Why, in project analysis is it useful, besides costs and benefits flows, to also consider cash flows?

## 6 HINTS

To work out the answers, follow the hints listed below[3].

(i) Codify all the goods, services, charges (inputs and outputs) to be used in the analysis (e.g., manure, paddy, irrigation tax, etc. For example, use the codification listed in the tables of the data set). Then enter each component following the instructions given in section 2.4.2, part 1 of the WinDASI manual.

(ii) Create a commodity for each good and service and insert the appropriate price.

(iii) Assign a code to the activities of the project, i.e., to all operations requiring some inputs and delivering one or more outputs (production of HY paddy, production of sesame, etc. For example, use the codification listed in the tables of the data set).

(iv) Create a record for each activity, specifying the unit of the activity (hectares) and the technical coefficients of the activity, i.e., the quantity of each input and output for one unit of activity (hectare) for all the years of the project.

(v) Create a record for the farm plan, named, for example, TRADIT, indicating the "quantity" of each activity per year, i.e., the number of hectares for each activity for a typical farm and the charges not related to any specific activity.

(vi) Obtain the totals of inputs and outputs in physical terms for the plan TRADIT.

(vii) Obtain the totals of inputs and outputs in monetary terms, the net cash flow and the net incremental cash flow for the plan TRADIT.

[3] For steps one to five, refer EASYPol Module 019: ***WinDASI: A Software for Cost-Benefit Analysis of Investment Projects: Inserting and Managing Data***. For steps five and six, see EASYPol Module 020 ***WinDASI: A Software for Cost Benefit Analysis of Investment Projects: Calculations Performed by the Software***
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# 7 SOLUTION SET

## 7.1 Answer to question (i)

To answer Question i, the inputs in physical units need to be analyzed. They are reported in Table 8.

**Table 8: Inputs requirements of the plan TRADIT in physical terms**

| Inputs | Unit | WoP | Years | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 - 15 |
| BULLOCKS | DAYS | 180.50 | 180.50 | 180.50 | 195.00 | 200.20 | 206.30 | 211.40 | 211.40 |
| IRR-TAX | FRANC | | | | 110.00 | 110.00 | 110.00 | 110.00 | 110.00 |
| LABOUR | DAYS | 554.30 | 554.30 | 554.30 | 620.10 | 636.50 | 655.40 | 671.00 | 671.00 |
| LAND-TAX | FRANC | 28.00 | 28.00 | 28.00 | 28.00 | 28.00 | 28.00 | 28.00 | 28.00 |
| MANURE | CART | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 | 5.50 |
| MOP | KG | 110.60 | 110.60 | 110.60 | 114.80 | 117.60 | 121.80 | 126.00 | 126.00 |
| OTHER | FRANC | 90.00 | 90.00 | 90.00 | 120.00 | 136.00 | 152.00 | 169.00 | 185.00 |
| PESTIC | FRANC | 50.00 | 50.00 | 50.00 | 53.50 | 57.75 | 62.25 | 65.75 | 65.75 |
| S-PADDY | KG | 345.40 | 345.40 | 345.40 | 346.60 | 347.80 | 349.00 | 350.20 | 350.20 |
| S-SESAME | KG | 16.50 | 16.50 | 16.50 | 21.25 | 24.65 | 28.05 | 30.60 | 30.60 |
| S-SUNF | KG | 1.10 | 1.10 | 1.10 | 2.20 | 2.75 | 3.85 | 4.95 | 4.95 |
| TSP | KG | 282.80 | 282.80 | 282.80 | 299.60 | 316.40 | 336.00 | 352.80 | 352.80 |
| UREA | KG | 578.20 | 578.20 | 578.20 | 603.40 | 628.60 | 658.00 | 683.20 | 683.20 |

The detail of the calculation concerning the input requirements in physical terms, such as the labour force requirements in the WoP situation, is shown in Table 9.

**Table 9: Detail of the calculation of the WoP labour requirements in physical terms**

| WoP situation | Man/day/ha (activity) (a) | Ha (plan) (b) | Man/day (result) (c=a * b) |
|---|---|---|---|
| 1) Pad-HY | 102.00 | 3.85 | 392.70 |
| 2) Pad-TRA | 68.00 | 1.65 | 112.20 |
| 3) SESAME | 42.00 | 1.10 | 46.20 |
| 4) SUNF | 32.00 | 0.10 | 3.20 |
| **Total** (from 1 to 4) | | | **554.30** |

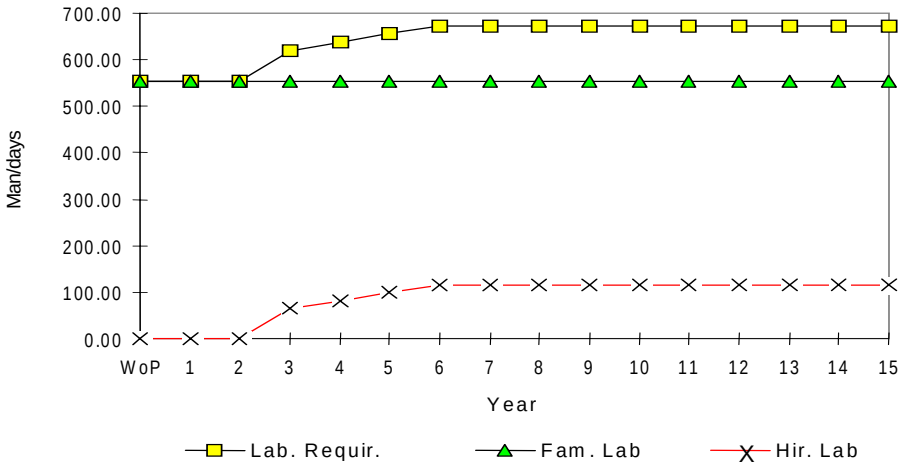
It is to be noted that the labour requirements (row *LABOUR*) from year three are well above the available household labour. To fill this gap, some labour force must be hired. The calculation of the labour force to be hired is shown in Table 10.

**Table 10: Hired labour requirements**

| Item | Years | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6-15 |
| Labour requirements (m/days) | 554.3 | 554.3 | 620.1 | 636.5 | 655.4 | 671.0 |
| Labour availability (man/days) | 555.0 | 555.0 | 555.0 | 555.0 | 555.0 | 555.0 |
| Hired-Labour (man/days) | - | - | 65.1 | 81.5 | 100.4 | 116.0 |
| Share of hir.lab.on tot. | 0.00% | 0.00% | 10.50% | 12.80% | 15.32% | 17.29% |

The labour requirements for plan *TRADIT* are shown graphically in Figure 2.

**Figure 2: Labour requirements for the plan TRADIT**



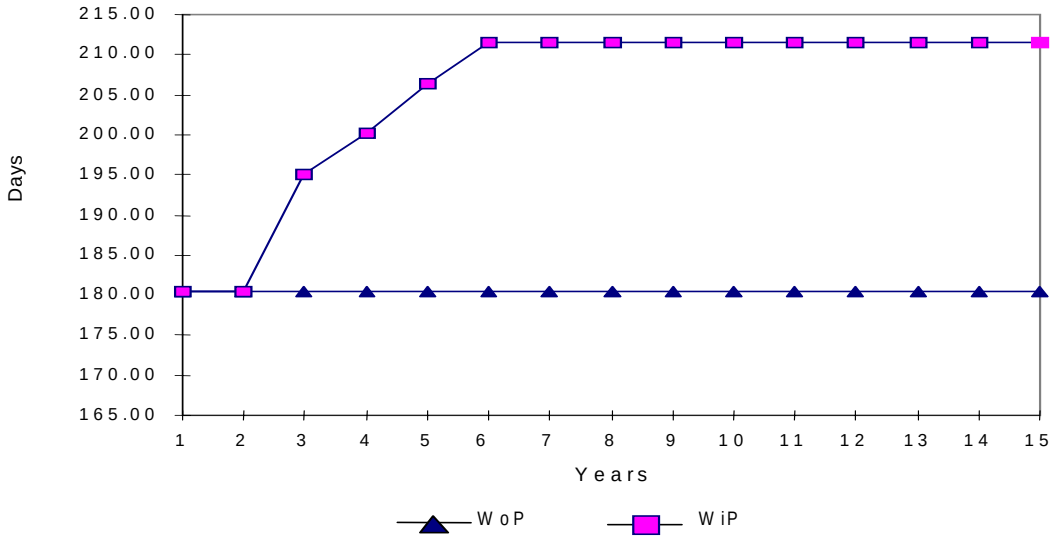

## 7.2 Answer to question (ii)

As can be seen from Table 8, (row *BULLOCKS*), the requirement for draught animals will increase by about 17 percent in six years. The WiP and WoP situations are shown in Table 11 and, graphically, in Figure 3.

**Table 11: Draught animal requirements**

| Item | Years | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 - 15 |
| WoP | 180.50 | 180.50 | 180.50 | 180.50 | 180.50 | 180.50 |
| WiP | 180.50 | 180.50 | 195.00 | 200.20 | 206.30 | 211.40 |
| Difference | 0.00 | 0.00 | 14.50 | 19.70 | 25.80 | 30.90 |
| Index WoP =100 | 100.00 | 100.00 | 108.03 | 110.91 | 114.29 | 117.12 |

**Figure 3: Draught animal requirements. Wip and Wop situations**




### 7.3 Answer to question (iii)

In addition to the variations in the inputs, which have already been considered, the other significant changes are observed in the quantities of urea and triple super phosphate (TSP), reflecting an increase of about 25 percent and 15 percent respectively in six years. Little storage difficulties are, however, envisaged due to the distribution over the two cropping seasons of these changes, therefore the formulation team foresees no particular constraints in the supply of additional quantities of these items.

As far as the outputs are concerned, the physical quantities are tabulated in Table 12, and shown graphically in Figures 4 and 5.

**Table 12: Physical outputs of the plan TRADIT**

| Output | Unit | WoP | Years | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 - 15 |
| Pad-HY | Tons | 13.86 | 13.86 | 13.86 | 14.82 | 15.01 | 16.8 | 17.01 |
| Pad-TRA | Tons | 3.3 | 3.3 | 3.3 | 3.52 | 3.41 | 3.3 | 3.19 |
| SESAME | Tons | 0.22 | 0.22 | 0.22 | 0.5 | 0.87 | 0.99 | 1.08 |
| SUNF | Tons | 0.08 | 0.08 | 0.08 | 0.16 | 0.3 | 0.42 | 0.54 |

The major change in the output is due to the high yield paddy, increasing by about four tons in six years. Some additional assessments of the available transport and marketing facilities for the farmers could be required for a further refinement of the project design. Moreover, sesame and sunflower productions show a sharp percentage increase in six years. These changes are, however, small in weight and should not lead to storage difficulties. In spite of that, due to the high value per ton of the sesame (almost twenty

times the value of paddy) the storage facilities should secure it against theft and accidental loss.

**Figure 4: Paddy production Wip and Wop situations**

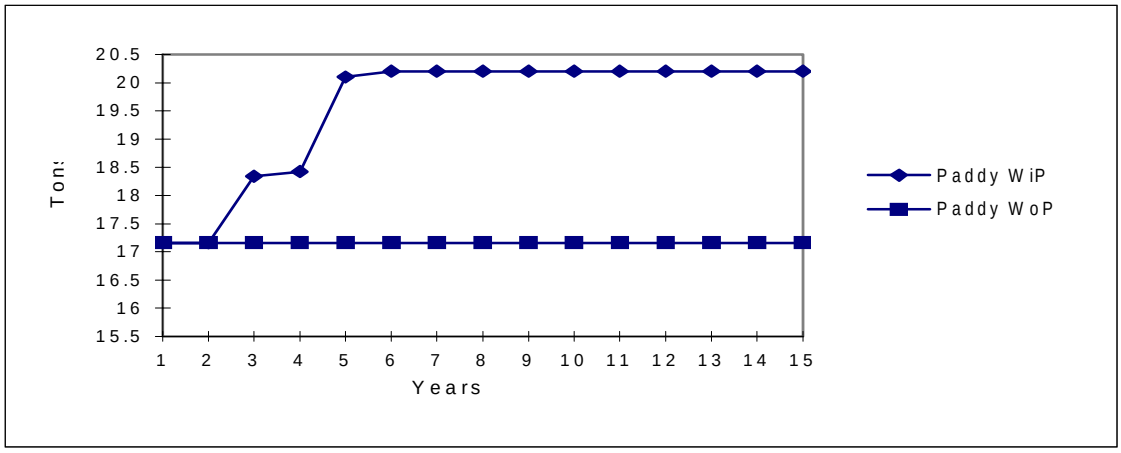
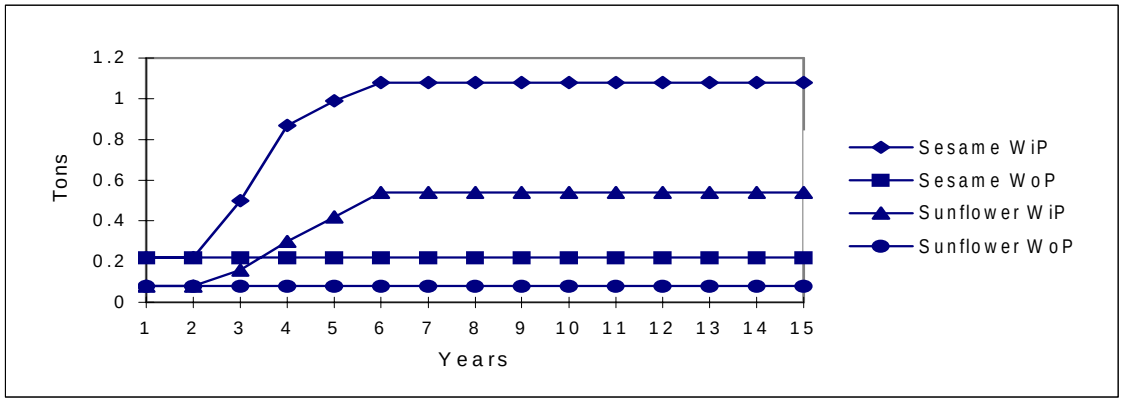



**Figure 5: Sesame and sunflower production Wip and Wop situations**




As sesame and sunflower are primarily cash crops, the feasibility (and success) of the project is very much linked to the possibility of disposing of these productions on the market.

Therefore, as a first step, the project formulation team should verify that there will be a market for the additional production generated by the project, considering also the possible price of the product (and its modifications) to the final consumers; natural changes in demand, due to population dynamics (growth, migration); possible competition with the same products from other areas of production; competition with substitutes (e.g., sunflower oil versus soybean oil) or possible synergies with complements.

Secondly, the team should verify that all the links in the commodity chains connecting producers to consumers would work properly. Notably, besides the possibilities of storage at farm level, the team will have to check the availability and suitability of

transport facilities, processing agents, wholesale market places and agents or exporters, dealers and retailers.

### 7.4 Answer to question (iv)

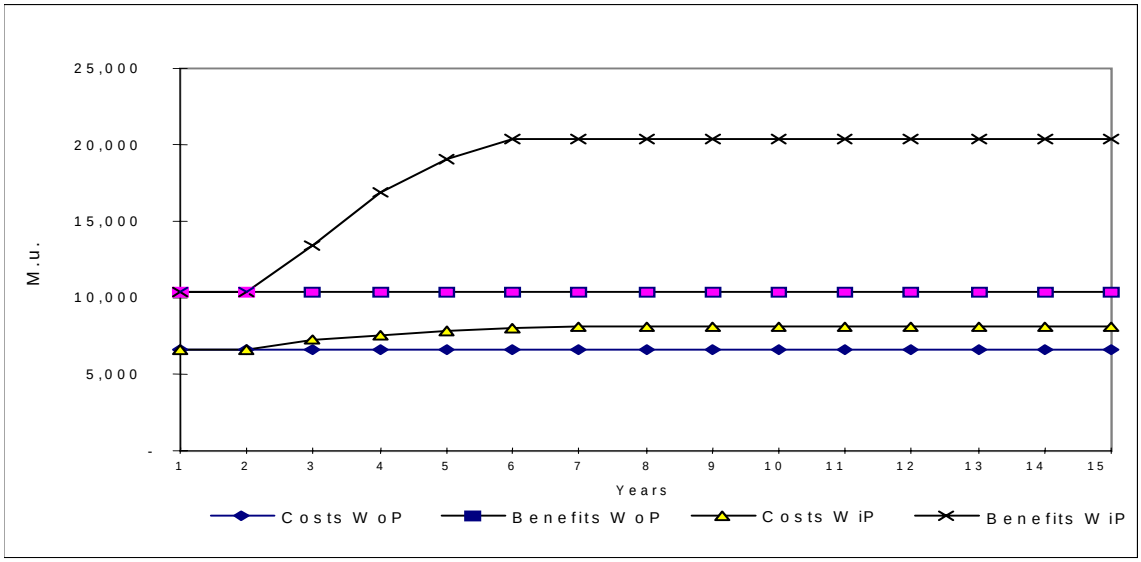
The trends in costs and benefits by value are given in Table 13. It is to be noted that the benefits almost double in six years while the costs increase only by about 20 percent in the same period. It is also to be emphasized that the monetary flows corresponding to the household labour are equal to zero, having assigned the price of zero to the household labour[4]. Thus, in Table 13, family labour is not included as a cost and, consequently, net benefits correspond to the income of the farm household.

**Table 13: Inputs and outputs of the plan TRADIT in monetary terms (Francs)**

| Item | WoP | Years | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 - 15 |
| OUTPUT | | | | | | | | |
| Pad-HY | 6,112.3 | 6,112.3 | 6,112.3 | 6,535.6 | 6,619.4 | 7,408.8 | 7,501.4 | 7,501.4 |
| Pad-TRA | 2,184.6 | 2,184.6 | 2,184.6 | 2,330.2 | 2,257.4 | 2,184.6 | 2,111.8 | 2,111.8 |
| SESAME | 1,688.3 | 1,688.3 | 1,688.3 | 3,837.0 | 6,676.4 | 7,597.3 | 8,287.9 | 8,287.9 |
| SUNF | 364.0 | 364.0 | 364.0 | 728.0 | 1,365.0 | 1,911.0 | 2,457.0 | 2,457.0 |
| Total | 10,349.1 | 10,349.1 | 10,349.1 | 13,430.9 | 16,918.2 | 19,101.7 | 20,358.1 | 20,358.1 |
| INPUTS and FACTORS | | | | | | | | |
| BULLOCKS | 5415.0 | 5415.0 | 5415.0 | 5850.0 | 6006.0 | 6189.0 | 6342.0 | 6342.0 |
| IRR-TAX | - | - | - | 110.0 | 110.0 | 110.0 | 110.0 | 110.0 |
| LABOUR | - | - | - | - | - | - | - | - |
| LAND-TAX | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 | 28.0 |
| MANURE | 82.5 | 82.5 | 82.5 | 82.5 | 82.5 | 82.5 | 82.5 | 82.5 |
| MOP | 59.7 | 59.7 | 59.7 | 62.0 | 63.5 | 65.8 | 68.0 | 68.0 |
| OTHER | 90.0 | 90.0 | 90.0 | 120.0 | 136.0 | 152.0 | 169.0 | 185.0 |
| PESTIC | 50.0 | 50.0 | 50.0 | 53.5 | 57.8 | 62.3 | 65.8 | 65.8 |
| S-PADDY | 207.2 | 207.2 | 207.2 | 208.0 | 208.7 | 209.4 | 210.1 | 210.1 |
| S-SESAME | 171.6 | 171.6 | 171.6 | 221.0 | 256.4 | 291.7 | 318.2 | 318.2 |
| S-SUNF | 6.6 | 6.6 | 6.6 | 13.2 | 16.5 | 23.1 | 29.7 | 29.7 |
| TSP | 322.4 | 322.4 | 322.4 | 341.5 | 360.7 | 383.0 | 402.2 | 402.2 |
| UREA | 196.6 | 196.6 | 196.6 | 205.2 | 213.7 | 223.7 | 232.3 | 232.3 |
| Total Inputs and factors | 6,629.6 | 6,629.6 | 6,629.6 | 7,294.9 | 7,539.7 | 7,820.5 | 8,057.8 | 8,073.8 |
| Net Benefits | 3,719.5 | 3,719.5 | 3,719.5 | 6,136.0 | 9,378.5 | 11,281.2 | 12,300.3 | 12,284.3 |
| Net Incremental Benefits | - | - | - | 2,416.5 | 5,659.0 | 7,561.7 | 8,580.8 | 8,564.8 |

[4] It is to be highlighted, however, that this item needs to be adjusted, being the required quantity of labour unavailable at household level.

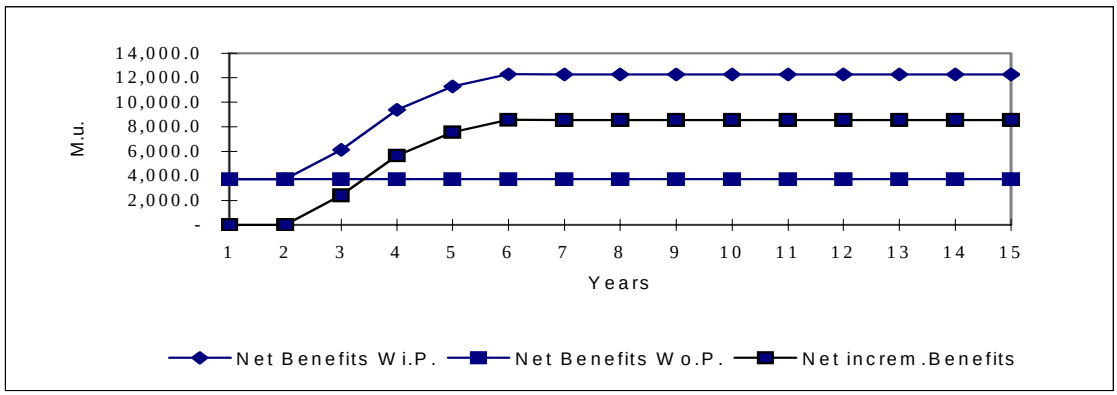
**Figure 6: Costs and Benefits in Wip and Wop situations**




The net incremental flows of benefits in the last row of Table 13 are obtained as the difference of the flow of the WiP period and the WoP flow of the same year. The WoP value is assumed to be constant across the periods and equal to the value in the first column (WoP column). It is to be noted that the net incremental flows for years one and two equate to zero, as the flows of these periods equal the WoP situation. All the other annual net incremental flows are positive. This means that, in each period, the project will bring additional benefits to the farmer with respect to the WoP situation. Accordingly, the aggregate incremental benefits across all periods will be positive as well.

Figure 6 shows the costs and benefits of WoP and WiP, while Figure 7 illustrates the trends of WoP and WiP net cash flows, and the incremental ones.

**Figure 7: Net benefits WoP and WiP, and incremental net benefits**



### 7.5 Answer to question (v)

The net benefits/household labour ratio and net benefits/land ratio in both WiP and full project development situations are calculated in Table 14. It is to be noted that the project allows an increase in the net benefits both per unit of labour and per hectare. The irrigation leads almost to triple the average productivity of labour (in terms of net benefits)[5]. The average productivity of the land is also drastically increased due to the intensification of cultivation on the same surface area.

**Table 14: Ratios net benefits/labour and net benefits/land**

| Item | WoP | WiP* |
|---|---|---|
| Net Benefits (M.u.) | 3719.5 | 12284.3 |
| Labour(man/day) | 554.3 | 671.0 |
| Land (hectares) | 5.5 | 5.5 |
| Ratio Net Benefits/Labour | 6.7 | 18.3 |
| Ratio Net Benefits/Land | 676.3 | 2233.5 |

* at full development of the project

### 7.6 Answer to question (vi)

The cash flow of the farmers without bullocks can be derived from the costs and benefit table, with some adjustments.

The cash inflows in both WiP and WoP scenarios are derived from the benefit flows after adjusting for the circa three tons of paddy that are used for household consumption.

The cash outflows can be assumed, in this case, to be equivalent to the costs.

Table 15 shows the calculations of the net benefits, net cash flows with and without project, net incremental benefits and net incremental cash flows. It is here assumed that the home-consumption intake is derived from the HY paddy (the paddy variety with the lowest market price).

In our simple case, in the WoP scenario the only difference between the net benefits and the net cash flows is due to home-consumption of part of the paddy produced on the farm[6]. The same applies in the WiP scenario (column f), leading to net incremental benefits (column g) equal to net incremental cash flows (column h)[7]

[5] It is to be highlighted, however, that the plan TRADIT uses more units of un-priced labour than those available at household level.

[6] Differences between net benefits and net cash flows could also be due to inputs both produced and consumed on the farm, such as animal traction and manure.

[7] It is to be noted that the itemization of the incremental benefits allows detection of a negative incremental benefit (a decrease in the production of paddy), to be correctly interpreted as a reduction of a benefit in the WiP context with respect to the WoP one.

**Table 15: Net benefits versus net cash flows. Wip and Wop situations**

| | Without project | | | With project* | | | Incremental | |
|---|---|---|---|---|---|---|---|---|
| | Ben & Costs | Infl.& Outfl. | B&C. - I&O | Ben.& Costs | Infl.& Outfl. | B&C. - I&O | Ben.& Costs | Infl. & Outfl. |
| | (a) | (b) | (c=a-b) | (d) | (e) | (f=d-e) | (g=d-a) | (h=e-b) |
| Benefits (inflows) Items | | | | | | | | |
| Pad-HY | 6112.3 | 4789.26 | 1323.0 | 7,501.4 | 6178.4 | 1323.0 | 1,389.2 | 1,389.2 |
| Pad-TRA | 2184.6 | 2184.6 | 0.0 | 2,111.8 | 2111.8 | 0.0 | - 72.8 | - 72.8 |
| SESAME | 1688.3 | 1688.3 | 0.0 | 8,287.9 | 8287.9 | 0.0 | 6,599.6 | 6,599.6 |
| SUNF | 364.0 | 364.0 | 0.0 | 2,457.0 | 2457.0 | 0.0 | 2,093.0 | 2,093.0 |
| TOTAL of Benefits (inflow) items | 10349.1 | 9026.1 | 1323.0 | 20,358.1 | 19035.1 | 1323.0 | 10,009.0 | 10,009.0 |
| Costs (outflows) items | | | | | | | | |
| BULLOCKS | 5415.0 | 5415.0 | 0.0 | 6,342.0 | 6342.0 | 0.0 | 927.0 | 927.0 |
| IRR-TAX | 0.0 | 0.0 | 0.0 | 110.0 | 110.0 | 0.0 | 110.0 | 110.0 |
| LAND-TAX | 28.0 | 28.0 | 0.0 | 28.0 | 28.0 | 0.0 | - | - |
| MANURE | 82.5 | 82.5 | 0.0 | 82.5 | 82.5 | 0.0 | - | - |
| MOP | 59.7 | 59.7 | 0.0 | 68.0 | 68.0 | 0.0 | 8.3 | 8.3 |
| OTHER | 90.0 | 90.0 | 0.0 | 185.0 | 185.0 | 0.0 | 95.0 | 95.0 |
| PESTIC | 50.0 | 50.0 | 0.0 | 65.8 | 65.8 | 0.0 | 15.8 | 15.8 |
| S-PADDY | 207.2 | 207.2 | 0.0 | 210.1 | 210.1 | 0.0 | 2.9 | 2.9 |
| S-SESAME | 171.6 | 171.6 | 0.0 | 318.2 | 318.2 | 0.0 | 146.6 | 146.6 |
| S-SUNF | 6.6 | 6.6 | 0.0 | 29.7 | 29.7 | 0.0 | 23.1 | 23.1 |
| TSP | 322.4 | 322.4 | 0.0 | 402.2 | 402.2 | 0.0 | 79.8 | 79.8 |
| UREA | 196.6 | 196.6 | 0.0 | 232.3 | 232.3 | 0.0 | 35.7 | 35.7 |
| TOTAL costs (outflow) items | 6629.6 | 6629.6 | 0.0 | 8,073.8 | 8073.8 | 0.0 | 1444.2 | 1444.2 |
| Net Benefits (net cash flows) | 3719.5 | 2396.5 | 1323.0 | 12,284.3 | 10961.3 | 1323.0 | 8564.8 | 8564.8 |

* at full development of the project (year 6)

The cash flow analysis is useful to assess the financial feasibility of the project.

In the WiP scenario, the farmers must be left with enough cash, after paying for the investment goods and/or the installments of the loan, to satisfy at least their basic needs and those of their households. If this happens, the project is feasible on financial grounds. This issue will be further addressed in the next steps of this exercise, especially when dealing with investment and credit.

If also the cash flows of the farmers who own bullocks were to be considered, a cash inflow for hiring out the bullocks and cash outflows for related expenses, such as veterinarian services and feeding costs, would have to be included.

## 8 READERS' NOTES

The formulation of the exercise NGAMO1 presented in this module is kept as simple as possible to allow the trainees to retain the basic elements of agricultural project analysis. If the trainer feels it necessary, some variations and further elements of discussion could be introduced.

In principle, there is no constraint associated with to the possible change of the unit of measurement of each activity, for instance by using the unit of output (tons) instead of the unit of surface area (hectare). All the inputs should, of course, be put in relation to such a unit. One additional item to be included in the analysis would be the land required to support the production of one ton of each crop. In order to check the constraints associated with the availability of land, two kinds of land should probably be considered: dry season land and humid season land.

The labour requirements could be better specified month by month to schedule the use of hired labour.

In order to run the full NGAMO1 exercise in a computer room with trainees having a weak knowledge of both the theory of project analysis and computing, a full day session, at least, should be envisaged.

When the trainees' background is weak, the trainer could deliver the questions one at a time and verify their execution step-by-step, rather than delivering the full question set at the same time.

The verification by hand of some sample calculations (notably the products of the goods per activity unit, multiplied by the quantity of each activity, multiplied by the prices) is extremely important to help the participants understand the way the software works.

## 8.1 Frequently asked questions

(i) In order to ascertain where the increased production comes from, it is important to pay particular attention to the background of the exercise, reminding trainees that NGAMO is an irrigation project which is supposed to deliver the irrigation system free of charge (except IRR-TAX).

(ii) Incremental benefits with negative values (the case of traditional paddy production) are commonly rationalized by the participants as typing errors or software bugs. They are indeed reductions in benefits in the WiP situation compared to the WoP situation.

(iii) As far as the interpretation of the "additional annual balance" is concerned, it must be emphasized that this balance is an incremental one, i.e., calculated as a difference with respect to the WoP scenario.

Some parts of this exercise, notably all the additional questions, can be skipped without hampering the flow of the exercise. Moreover, Question (vi) can be postponed, because the discussion of the relationships between net benefits and net cash flows can be addressed in the NGAMO2 exercise, when dealing with credit issues.

The use of a spreadsheet, serving as a support for verifying the results of the other calculations made by WinDASI, can be helpful.

Further discussions can compare the farmers with bullocks to the farmers without, looking at the impact of the increased needs of animal traction resulting from the project on these two categories.

## 8.2 Use of the files for the exercise NGAMO1

NGAMO1 exercise is supported by specific WinDASI files (files with a **.WDS** extension), available together with the WinDASI software[8]. The set of files available for NGAMO1 is reported in table 16.

The first file of the set contains only a small fraction of the data and each subsequent file contains additional data until the data set is complete.

**Table 16: Files for the Exercise NGAMO1**

| Step | File to be used | File content | Tasks to be accomplished in the file |
|---|---|---|---|
| 1 | Empty (default) file | Nothing | Insert the set of commodities |
| 2 | NGAMO1a.WDS | The set of commodities | Create the activities |
| 3 | NGAMO1b.WDS | The set of commodities and the traditional activities | Create the plan TRADIT |
| 4 | NGAMO1.WDS | The full NGAMO1 data set | Run all the required calculations |

The paced release of these files allows the trainer to control the data entry process as the exercise is carried out. Each consecutive file will be loaded as indicated by the trainer during the execution of the exercise, thus enabling the trainer to:

- keep all the trainees at the same level during the data entry process;
- recover partial data sets in case of computer/power failure;
- manage a step-by-step entry of the data;
- speed up the data entry process, if necessary, by skipping some steps;
- allow slow trainees in the data entry process to catch up with the rest of the class;
- run the calculations starting with a common database.

[8] WinDASI software and exercise files are available in the EASYPol Module 018: ***WinDASI: A Software for Cost-Benefit Analysis of Investment Projects. Installation Note***.

The set of files complementing NGAMO1 may be used step-by-step by the trainer as follows:

**Step 1**

After explaining the general framework of the NGAMO exercise, the trainer may start the exercise **NGAMO1**. NGAMO1 starts with the **empty (default) file**. The trainees are required to enter the commodity data.

**Step 2**

If possible, the trainer should show how to do this by means of a PC projector, and/or by directly assisting the trainees.

**Step 3**

After checking the progress of their work, the file **NGAMO1a.WDS**, which already contains the data set of the commodities, may be loaded. In this file the activities of the traditional farm are created.

**Step 4**

At this stage the file **NGAMO1b.WDS** has to be loaded. In the file NGAMO1b.WDS, the plan TRADIT is created.

The results of the data entry may be checked with the full data set file **NGAMO1.WDS**. This file may be used by all the trainees to run the required calculations.

## 8.3 EASYPol Links

This module belongs to a set of EASYPol modules which illustrate how to use the WinDASI application for financial and economic Cost Benefit Analysis of investment projects.

The user can learn how to install and handle WinDASI for Cost-Benefit Analysis of investment projects by going through the following EASYPol modules:

- EASYPol Module 018: ***WinDASI: A Software for Cost-Benefit Analysis of Investment Projects: Installation Note***
- EASYPol Module 019: ***WinDASI-A Software for Cost-Benefit Analysis of Investment Projects: Inserting and Managing Data***
- EASYPol Module 020: ***WinDASI-A Software for Cost-Benefit Analysis of Investment Projects: Calculations Performed by the Software***

The user can also follow up with NGAMO exercises using the following EASYPol modules:

- EASYPol Module 022: ***WinDASI Exercise: NGAMO2: An Irrigation Project. Impacts of Irrigation and Mechanization on Traditional Farms***
- EASYPol Module 023: ***WinDASI Exercise: NGAMO3: Economic Impacts of an Irrigation and Mechanization Project***
- EASYPol Module 024: ***WinDASI Exercise: NGAMO4: Starting a Coffee Plantation in a Phased Mode***

In addition, a case study presenting the use of WinDASI to analyze a real project is reported in the EASYPol module

- EASYPol Module 039: ***WinDASI-A Software for Cost-Benefit Analysis of Investment Projects: Case Study – Crop Intensification and Coffee Plantation***

## Module metadata

| | |
|---|---|
| **1. EASYPol module** | 021 |

| **2. Title in original language** | |
|---|---|
| **English** | WinDASI Exercise |
| **French** | |
| **Spanish** | |
| **Other language** | |

| **3. Subtitle in original language** | |
|---|---|
| **English** | NGAMO 1 - An Irrigation project: Impacts of irrigation on traditional farms |
| **French** | |
| **Spanish** | |
| **Other language** | |

**4. Summary**

This module presents NGAMO1, the first of the four practical step-by-step exercises in Cost Benefit Analysis (CBA) of investment projects, to be run with the WinDASI software (the word NGAMO comes from the name of the zone of the original project that was located in Myanmar).
The goal of this module is to analyze the technical feasibility at farm level of an irrigation project. That means processing the data set on the activities of a specific farm model for both With-Project and Without-Project (WiP and WoP) situations. The analyst addresses feasibility issues in terms of labour requirements and needs of draught animal services at farm level, whose lack is one of the main constraints identified by the project. Moreover, the analyst calculates costs, benefits, net cash flow and incremental net cash flow at farm level over the duration of the irrigation project, identifying also the main changes related to the WiP versus WoP situations.

**5. Date**

November 2005

**6. Author(s)**

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**7. Module type**

- ☐ Thematic overview
- ☐ Conceptual and technical materials
- ☒ Analytical tools
- ☐ Applied materials
- ☐ Complementary resources

**8. Topic covered by the module**

- ☐ Agriculture in the macroeconomic context
- ☐ Agricultural and sub-sectoral policies
- ☐ Agro-industry and food chain policies
- ☐ Environment and sustainability
- ☐ Institutional and organizational development
- ☒ Investment planning and policies
- ☐ Poverty and food security
- ☐ Regional integration and international trade
- ☐ Rural Development

**9. Subtopics covered by the module**

**10. Training path** Investment planning for rural development

**11. Keywords**