

**Field Guide Exercises  
for  
IPM in FRENCH BEANS  
(Part II)**

**Vietnam IPM National Programme**

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## **Introduction**

The Field Guide Exercises for IPM in Vegetables was developed through the efforts of the trainers of the Vietnam National Program, members of the National IPM Group and the FAO staff in Hanoi with contributions from the FAO Regional Programme. Some of the exercises were adapted from the Indonesian Field Guide for Rice IPM and the Palawija Exercises. Some were based on activities done in the vegetable project of the Philippine National Program.

The contents of the Field Guide are intended for use of trainers in the implementation of a Season-long Training of Trainers in Vegetables particularly on cabbages, tomatoes and french beans. Most exercises, however, can be used in Farmers' Field Schools. They can also be adapted for use in other vegetable crops. The Guide consists of two parts:

Part I: General Field Guide Exercises for Vegetables

Part II: Crop Specific Field Guide Exercises: Cabbage or Tomato or French Bean

The General Guide contains exercises along the following areas:

- Research Methods
- Field Studies
- Economic Threshold Levels
- Ecosystem
- Plant Development
- Insect Zoos
- *Bacillus Thuringiensis*
- Pesticides
- Diseases
- Weather
- Composting

The Crop Specific Field Guide contains exercises along the following areas:

- Field Studies
- Ecosystem Analysis Questions
- Plant Development

The design of the field guide has been modified considering the expansion of IPM to other vegetable crops. Therefore, sections which apply to all crops have been put together.

The guide demonstrates the capability of trainers to develop local materials. It is hoped that this output will encourage them to further experiment in the field, write up their experiences and exchange learnings with farmers as well as colleagues in the field of IPM.

# **Field Studies**

## Study 1: Effect of different management methods on bean ecosystem

### Introduction:

Vegetables are grown with high use of pesticides. Residues of pesticides can be very high, and vegetables sometimes can not be exported because of this. Consumers are becoming more aware of the effects of pesticides on their health and on the environment. Reduction of pesticides in vegetable growing is getting a lot of attention. In this study yield, disease, pest and natural enemy populations on beans under IPM (based on ecosystem analysis), under Conventional Practice and without pesticides will be monitored.

### Objectives:

- Compare the crop development, disease incidence, natural enemy and pest populations in different management systems:
  - IPM - based on weekly ecosystem analysis
  - Conventional practice - based on the management practices that farmers use in the area
  - No pesticides
- Compare economic benefits of the different management methods

### Material:

Area for study: 450 m<sup>2</sup>

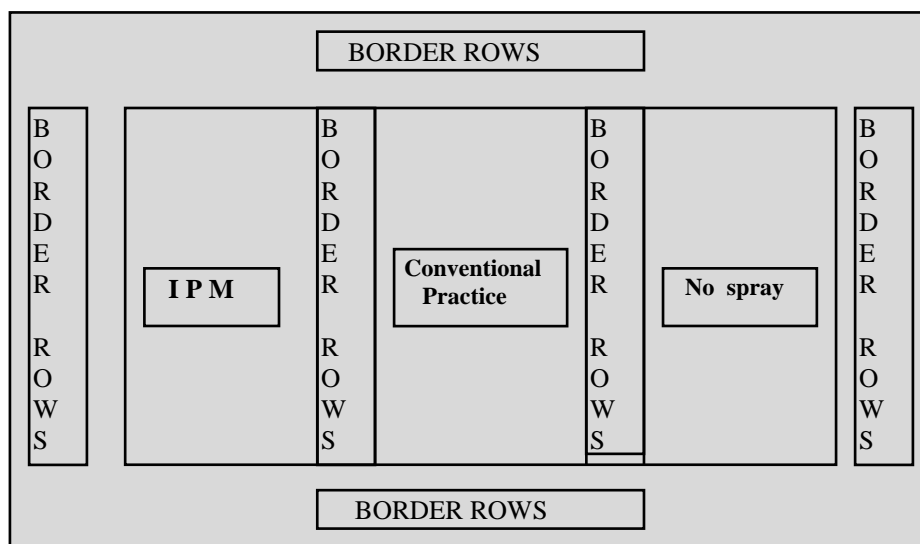
Variety: Variety most common in the the study area

Materials for study: Bean seeds, sticks to make grid shelter , insecticides, thuoc kich thich, marking sticks, basket, shovel, hoe, ruler of 1m, tape measure of 50m, scale of 10 kg.

Fertilizer: Cattle manure, nitrogen, kali, phosphate

### Method:

- \* The study is set up with 3 treatments, i.e., IPM based on ecosystem analysis, conventional practice, i.e., management as in farmer's practice, and unsprayed field. The 3 treatments will be arranged in three plots measuring 150 m<sup>2</sup> each as in the layout below.



- \* Choose the place that represents the region and where soil is uniform in fertility.
- \* The soil preparation, plant density, and water management should be suited to the selected variety, place, season and treatment.
- \* Border rows of the size of one bed will be planted between treatments and all around the entire study; the border rows shall be outside of the 150 m<sup>2</sup> per plot.
- \* Fertilizer management: For IPM plot based on ecosystem analysis and technical recommendation  
For No Spray and Conventional Practice plots based on FP in the locality

- \* Observe and analyse ecosystem weekly
- \* Every week, place and observe pitfall traps (6 traps/ treatment)

**Sampling:**

Weekly sample 10 plants in each plot for:

- ◇ Plant development: height of plant, number of leaves, number of flowers, number of fruits, record the morphological characteristics in different plant stages
- ◇ Pests and natural enemy composition, populations, weeds, disease incidence on beans
- ◇ Collect and count numbers of insects caught in pitfall traps in each plot

Measure yield at different harvesting times and collect all data for economic analysis during the season

**Results:**

1. Plot plant development (plant height, speed of leaf formation, flowering and fruit formation) for each treatment
2. Plot herbivore populations for each treatment
3. Plot natural enemy populations for each treatment
4. Plot disease incidence for each treatment
5. Plot yield for each treatment
6. Make economic analysis for each treatment
7. Summarize all management practices for each treatment

**Discussions:**

1. How did the plants grow and develop in the different treatments (plant height, speed of leaf formation, color of leaves, flowering and fruit formation)?
2. What management practices are important in growing beans (cultivation practices, fertilizer management, watering, etc)?
3. What natural enemies were there in the bean field? What is their significance? How can they be protected and also limit the damage of pests?
4. What pests occurred in the bean field? Which was the most important in each stage? How was the population density? What about the population density of natural enemies? What did you do to manage the pests? How did that influence the ecosystem?
5. How was the disease incidence in each of the treatments? How did the weather and cultivation practices influence disease development? Why?
6. How were the yields in each of the treatments?
7. Which management method was most economic? Why? Was there a difference in quality of beans in the different treatments? What about the price?
8. How many times did you spray pesticides? Was it necessary? What was the effect of pesticide use on natural enemies?
9. What were the main difficulties during the study?
10. What further studies do you recommend to better understand the ecosystem and management methods of beans?

## Study 2: Evaluation of bean varieties

### **Introduction:**

Many varieties exist with different characteristics in production. For a vegetable producer it is important to know which variety has high yield, good quality and is popular in the market. In the field, farmers often face many difficulties such as diseases, pest insects, cultivation conditions and costs of production. A good variety will be more likely to give a good yield owing to resistance. It will also make pest management easier, cut down production costs and increase economic benefits. However, varieties may differ in their suitability to locations. This study shows how to evaluate different varieties and to select suitable varieties for each region and season.

### **Objective:**

Test different varieties of beans under local growing conditions, looking at resistance against diseases, yield levels and economic efficiency using IPM methods

### **Material:**

Area for study: 600 m<sup>2</sup>

Variety: four varieties (*Note: The number of varieties for the study will depend on how many are available in the locality. A maximum of four varieties, however, is suggested.*)

Materials for study: Sticks to make shelter, bamboo sticks to mark on, hand sprayer, scale of 10 kg, baskets, hoe, shovel, wire, tape measure of 50m, ruler of 1m

Fertilizer: Cattle manure, nitrogen, kali, phosphate

### **Methods:**

- \* The study is set up with 4 treatments, i.e., 4 bean varieties, replicated 3 times. Each plot size is 50m<sup>2</sup>.
- \* Fertilizer: quantity and application methods to be based on local situation
- \* Field management: based on ecosystem analysis/IPM

### **Sampling:**

Weekly sample 10 fixed plants in each plot for:

- ◇ Plant development: Height of plant, number of leaves, number of flowers, number of fruits (Record the morphological characteristics in different plant stages.)
- ◇ Weeds, disease intensity, pests and natural enemy composition, density, degree of damage

Collect all data for economic analysis during the season and at the end of the season measure yields of the different treatments

### **Results:**

1. Plot plant development of the varieties tested.
2. Plot herbivore populations for each variety.
3. Plot natural enemy populations for each variety.
4. Plot yield of the different varieties.
5. Make economic analysis of the different varieties.
6. Summarize all management practices for each treatment (fertilizer, pesticides, etc).

### **Discussions:**

1. Was there a difference in the growth and development of the 4 varieties during the season?
2. Were there differences in herbivore populations between the varieties in different development stages of the beans?
3. How was the composition and population density of natural enemies on each variety?
4. Was there a difference in disease incidence between the varieties?
5. Was the quality of the beans for each variety the same? Was there a difference in market prices?

6. Which variety had the highest yield? Which the lowest? Which variety was most economically viable?
7. Which variety would you think would be the most suitable for this region? If you were a farmer, which variety would you choose?
8. Was variety the most important factor in bean production? What about other management practices (fertilizer, etc)?
9. What difficult and favourable conditions occurred during the experimental period ?
10. What experiment on varieties would you recommend in the future?

## Beans Study 3: Yield, pest and natural enemy, and disease response to type of fertilizer

### **Introduction:**

Fertilizer is a very important factor in bean production. In vegetable production, chemical fertilizer is often added to organic fertilizer obtain higher yields. Organic fertilizer improves the soil structure which is important in vegetable growing while also supplying some of the nutrient requirements of the crop. Producers are now paying attention to the effect, the kind and dosage of fertilizer to the yield and quality of beans. In this study we will try to find out the effect of fertilizer on plant development, yields and quality of beans. We will also evaluate the pest and natural enemy and disease response to different fertilizers, in order to find out suitable kinds of fertilizer for this locality.

### **Objectives:**

- Evaluate the effect of kinds of fertilizer on yield and quality of beans
- Observe the effect of different kinds of fertilizer on composition and density of natural enemy and pest populations and disease incidence in the bean field

### **Materials:**

Area for study: 270 m<sup>2</sup>

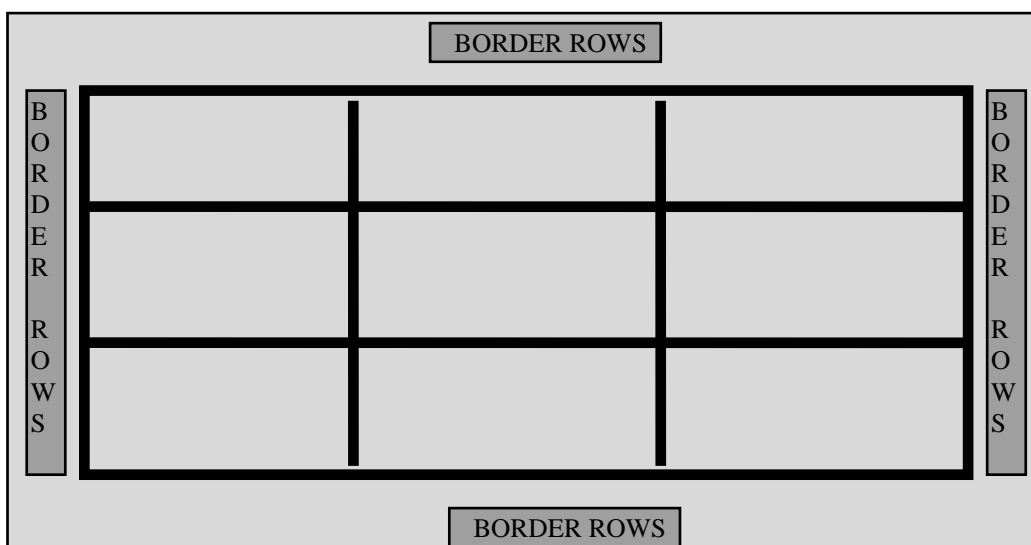
Variety: The variety used will be the one most commonly used the the study area

Materials for study: Marking sticks, bamboo sticks to make shelter, scale of 10 kg, basket, hoe, shovel, ruler of 1m, tape measure of 50 m, string

Fertilizer: Cattle manure, nitrogen, kali, phosphate

### **Method:**

- \* The study is set up with 3 treatments. The 3 treatments will be replicated 3 times in plot size of 30 m<sup>2</sup> each. Assign treatments to plots randomly.
- \* For each region the fertilizer levels have to be established after consultation with farmers to find out what kind of fertilizers and what levels are being used locally. Also indicate which level is what farmers use most in the region.
- \* Treatments:  
Treatment 1: *Chemical fertilizer*  
Treatment 2: *Organic fertilizer*  
Treatment 3: *Organic and inorganic fertilizer (following farmers' practice)*
- \* Field Management: will be based on ecosystem analysis.



**Sampling:**

Weekly sample 10 fixed plants in each plot for:

- ◇ Plant development: height of plant, number of leaves, number of flowers, number of fruits (Record the morphological characteristics in different plant stages.)
- ◇ Weeds, disease intensity, pests and natural enemy composition, density, degree of damage

Collect all data for economic analysis during the season and at the end of the season measure yields of the different treatments.

**Results:**

1. Plot plant development for each treatment
2. Plot herbivore populations for each treatment
3. Plot natural enemy populations for each treatment
4. Plot disease incidence for each treatment
5. Plot yield for each treatment
6. Make economic analysis for each treatment
7. Summarize all management practices for each treatment

**Discussions :**

1. How was the growth and development of beans in the different fertilizer treatments? What was the effect of organic fertilizer?
2. How did fertilizer affect the herbivore populations during the season?
3. Is there any difference in the composition and density of natural enemies in the different treatments?
4. How did diseases develop in the different fertilizer treatments? Why?
5. What fertilizer treatment had the highest yield and economic efficiency? Which one the lowest? How did fertilizer influence the quality of the beans?
6. What difficult and favourable conditions occurred during the experimental period?

## **Beans Study 4: Yield, pest and natural enemy, and disease response to fertilizer application method**

### ***Introduction:***

Fertilizer is a very important factor in bean production. Usually, farmers use organic fertilizer to improve the soil structure which is important in vegetable growing. Chemical fertilizer is also added to obtain higher yields. However, farmers' practices on methods of applying fertilizer vary. For example, the survey in Tay Tuu, Tu Liem, Ha Noi shows that farmers do not apply basal fertilizer. They only apply fertilizer 15-20 days after sowing. In other areas, farmers apply basal fertilizer. In this study we will try to find out the effect of application methods of fertilizer on plant development, yields and quality of beans. We will also evaluate the pest and natural enemy and disease response in order to find out suitable kinds of fertilizer application methods for this locality.

### ***Objectives:***

- Evaluate different fertilizer application methods for beans to obtain high yield and good quality
- Observe the effect of basal application of fertilizer to growth and development of beans
- Explain the effect of different fertilizer application methods on composition and density of natural enemy and pest populations, and disease incidence in the bean field

### ***Materials:***

Area for study: 180 m<sup>2</sup>

Variety: most commonly used variety in the study area

Materials for study: Marking sticks, bamboo sticks to make shelter, scale of 10 kg, basket, hoe, shovel, ruler of 1m, tape measure of 50 m, string

Fertilizer: Cattle manure, nitrogen, kali, phosphate

### ***Method:***

- \* The study is set up with 2 treatments. The 2 treatments will be replicated 3 times in plot size of 30 m<sup>2</sup> each. Assign treatments to plots randomly.
- \* For each region the fertilizer levels have to be established after consultation with farmers to find out what kind of fertilizers and what levels are being used locally. Also indicate which level is what farmers use most in the region.
- \* Treatments:  
Treatment 1: *With basal fertilizer*  
Treatment 2: *Without basal fertilizer*
- \* Field Management: based on ecosystem analysis

### ***Sampling:***

Weekly sample 10 fixed plants in each plot for:

- ◇ Plant development: height of plant, number of leaves, number of flowers, number of fruits (Record the morphological characteristics in different plant stages.)
- ◇ Weeds, disease intensity, pests and natural enemy composition, density, degree of damage

Collect all data for economic analysis during the season and at the end of the season measure yields of the different treatments.

### ***Results:***

1. Plot plant development for each treatment
2. Plot herbivore populations for each treatment
3. Plot natural enemy populations for each treatment
4. Plot disease incidence for each treatment
5. Plot yield for each treatment
6. Make economic analysis for each treatment
7. Summarize all management practices for each treatment

***Discussions :***

1. How was the growth and development of beans in the different fertilizer treatments? What was the effect of basal fertilizer?
2. How did fertilizer application method affect the herbivore populations during the season?
3. Is there any difference in the composition and density of natural enemies in the different treatments?
4. How did diseases develop in the different fertilizer treatments? Why?
5. What fertilizer treatment had the highest yield and economic efficiency? Which one the lowest? How did fertilizer application method influence the quality of the beans?
6. What difficult and favourable conditions occurred during the experimental period?
7. What are your recommendations for future studies on fertilizer application methods?

## Study 5: Compensation of plant for damage

### **Introduction:**

Consumers often do not like to buy vegetables that have some insect damage or diseases spots. This becomes a reason for farmers to use much pesticides on vegetables from the beginning of the season. Using pesticides increases production cost. It also destroys the environment as well as leaves toxic residues on products. With the government campaign for clean environment, consumers have become more conscious about the vegetables they eat. Consumers are now willing to pay a higher price for vegetables with some damage because then it is clear that pesticide use was low, and so residues are low.

To strengthen farmers' position about not using pesticides it is important to increase their confidence about the ability of a healthy crop to compensate for some damage that occurs. It is important for them to see what kind of damage can be compensated for and what kind of damage will result in quality loss of the vegetables. This study will show the ability of bean plants to compensate for defoliation.

### **Objectives:**

- Test the ability of beans to compensate for defoliation (25% and 50%) at different periods of crop development
- Evaluate the effect of defoliation on yields

### **Materials:**

Area for study: 210 m<sup>2</sup>

Variety: Variety that is used locally

Planting density: Density commonly used in the study area. However, the recommended bed width is 1.2 m. The recommended planting distance or distance between holes is 50 X 30 cm. The recommended density is 50,000 to 52,000 plants per hectare.

Materials for study: Bean seeds, marking sticks, scale of 10 kg, basket, hoe, ruler of 1m, tape measure of 50 m, string, scissors

Fertilizer: Cattle manure, nitrogen, kali, phosphate

### **Method:**

- \* The study is set up with 7 treatments. The 7 treatments will be replicated three times. The plot size for each replication is 10 m<sup>2</sup>. Assign treatments randomly to plots.
- \* Defoliation method : 10 plants per treatment; mark each plant; cut 1/4 to 1/2 of leaf area depending on the treatment
- \* Treatments:
  - Treatment 1 : Defoliate 25% of the leaf area 28 days after sowing (when the plant has two true leaves)
  - Treatment 2 : Defoliate 50% of the leaf area 28 days after sowing (when the plant has two true leaves)
  - Treatment 3 : Defoliate 25% of the leaf area at 35 days after sowing
  - Treatment 4 : Defoliate 50% of the leaf area at 35 days after sowing
  - Treatment 5 : Defoliate 25% of the leaf area at 35 days after sowing
  - Treatment 5 : Defoliate 25% of the leaf area at 50 days after sowing
  - Treatment 6 : Defoliate 5% of the leaf area at 50 days after sowing
  - Treatment 7: No defoliation (control)
- \* Field Management will be based on IPM, i.e., ecosystem observations.

### **Sampling:**

Sample weekly 10 fixed plants in each plot for:

- ◇ Plant development: height of plant, number of leaves, number of fruits (Record the morphological characteristics in different plant stages.)
- ◇ Natural enemy, pest populations, weeds, disease incidence

Measure yield at different harvesting times and collect all data for economic analysis during the season

**Results:**

1. Plot plant development for each treatment
2. Plot herbivore populations for each treatment
3. Plot natural enemy populations for each treatment
4. Plot disease incidence for each treatment
5. Plot yield for each treatment
6. Make economic analysis for each treatment
7. Summarize all management practices for each treatment

**Discussions:**

1. How is the plant development in the different treatments compared to the control?
2. How is the yield in the different treatments compared to the control?
3. Can beans compensate for defoliation in the different development stages? What is the effect on yield if bean leaves have been eaten in different development stages?
4. What is the effect of cultivation methods on the compensation of plant for damage?
5. What was the disease incidence in the different treatments? What about pest and natural enemy populations?

# **Ecosystem Analysis Questions**

## **I. 5-15 days after sowing (seedling stage)**

1. Discuss *earlier cultivation practices* and relate to plants at this stage:
  - a. What are the criteria for selecting a good variety? (Growth duration, seed form, percentage of germination, herbivore or disease resistance?)
  - b. How did you prepare the soil? ( Making a bed or row; making a planting hole; soil structure?) Why?
  - c. How did you fertilize (what kind, amount, method)? Why?
  - d. How did you plant seeds: by row or by hole? What time during the day did you plant? How did you cover the seeds? What is a suitable distance between rows and holes?
  - e. How did you water the plants? What difference does dry and wet soil make to plants?
2. *Weather*: How does weather influence the plant at this stage? What measures may be taken to protect plants against harsh weather conditions like rain, very hot sunshine, dry sunshine, hard wind...?
3. *Plant*: How many days is it after sowing? How are plants developing? What factors affect germination and plant development in this stage? Are there new leaves? How do new roots develop? Are there any changes in plant height? Are there dead or yellow leaves? Did any plants die? What percentage of plants were missing? Why so? What about pruning and replanting techniques?
4. *Pest insects and natural enemies*: What kind of herbivores did you see in the bean field? What is their density? Where did they come from? What is the role of natural enemies?
5. *Diseases*: Did you see Rhizoctonia in your field? How will you manage this?
6. *Management decisions*: Are weeds present? What should be done about them? What is the management decision for this week? What do you expect to happen in the field next week?

## II. 16 - 23 days after sowing

1. What was the effect of last week's decision? Relate this to the countryside survey results.
2. *Weather*: How is the weather affecting the plant? (sunshine, wet weather, rain, fog...)
3. *Plant*: Are there new branches? Are there new leaves? Is the plant growth and development normal? Are the plants uniform throughout the whole field? Are there some plants which could not develop? Why? What is the leaf color? How does the bottom leaf develop? How is the root development? Are there nodules? What methods can speed up the development of nodules? What is the function of nodules?
4. *Pest insects and natural enemies*: Compare natural enemies and pest populations in the CP, IPM and No Spray plots. What insect pests and natural enemies (predator, parasite) occur in the field? What are their densities? What is the change in herbivore population compared to last week? What is its significance in this stage? What are the results of insect zoo observations? Relate these to field observations. What is the role of natural enemies in the ecosystem?
5. *Diseases*: Which cultivation practices, weather conditions are affecting disease development?
6. *Management decisions*: Is the soil wet enough? Does the field need water? What method of watering should be used? What are the fertilizer requirements during this stage (nitrogen and potassium)? What do farmers do to prevent herbivores and disease from damaging the crop? Did you observe control field or farmers' field in the area? Is there any difference from your method? Why? Are there differences between cultivation practices in the area and other areas?

### III. 24 - 31 days after sowing

1. What was the effect of last week's decision? Relate this to the countryside survey results.
2. *Weather*: How is the weather (sunny, rainy, windy)? How can you protect the crop from harsh weather conditions?
3. *Plant*: How do stems and leaves of beans develop? How many leaves does the plant have? What percentage of the plants have “**tay cuon**”? What do you think about plants with no “**tay cuon**”? What method can speed up development of “**tay cuon**”? What is the stage of the plant development? What is the effect on the growth and development of the plant if 50% of the leaves are damaged? Why?
4. *Insect pests and diseases*: What kind of herbivores and diseases are present? What is the composition and density of pests in the three plots compared to last week? Which one is important? Which environmental condition will favour the increase of pests and diseases?
5. *Natural enemies*: What kind of natural enemies are present? What is the role of natural enemies? What are the results from insect zoos?
6. *Management decisions*: Compare your method with farmers' methods in the area? Did you ask farmers why they practice that? What is the management decision for this week? What do you think will happen in your fields next week?

#### **IV. 32- 39 days after sowing**

1. What was the effect of last week's decision? Relate this to the countryside survey results.
2. *Weather*: How is the weather condition (hot sunny, dry cold, wet cold, etc.)? How does it influence plant growth and development? What measures may be taken to protect plants against harsh weather conditions?
3. *Plant*: How does the plant develop (height, leaf length, number of leaves, internode length)? What percentage of plants have climbed?
4. *Insect pests and natural enemies*: What is the difference between composition and density of pests and natural enemies in the three management plots? Which of these is important? What natural enemies did you see in the field? What is the role of natural enemies in the ecosystem?
5. *Diseases*: How does weather influence disease and how can you manage this?
6. *Management decisions*: What kind of nutrient does the plant need in this stage? Which cultivation practices do you need to use: water and/or fertilize? Compare the effect of watering method by hand shower and ditch irrigation at this stage. What are those cultivation practices based on? Compare your management decision for this week with farmers' decision.

## **V. 40 - 47 days after sowing**

1. What was the effect of last week's decision? Relate this to the countryside survey results.
2. *Weather*: How is the weather influencing flowering and bean development?
3. *Plant*: How is plant growth and development (height, number of leaves, leaf length)? What percentage of plants have flowers? Are new branches developing? What is the length of stem sections of new branches? What is the significance of the length of new stem sections? What is the significance of old and yellow leaves at the bottom? Why do some farmers remove them?
4. *Insect pests and diseases*: Which are the main herbivores and diseases in this stage? Which is important? How many are there? Is there any damage?
5. *Natural enemies*: What natural enemies did you see in the field? What is the role of the natural enemies in the ecosystem? Relate this to insect zoo observations.
6. *Management decisions*: What cultivation practices are needed at this stage (fertilizer, water, etc.)? What type of fertilizer does the plant need? How much? What method of application should be employed? What is the effect of water on plant in this stage? What method of watering should be used? What are farmers in neighbouring fields doing now?

## **VI. 48 - 53 days after sowing**

1. What was the effect of last week's decision? Relate this to the countryside survey results.
2. *Weather*: What is the influence of weather on flowering and fruit development?
3. *Plant*: What percentage of plants have flowers/fruits in comparison with last week? What is the significance of old and yellow leaves at the bottom? Why are there yellow leaves? What is your management decision? Why do some farmers remove them?
4. *Insect pests and diseases*: What herbivores and diseases occurred this week? How are the densities compared to last week? Which one is important?
5. *Natural enemies*: What natural enemies are present in the field? What is their role? What are their densities compared to last week?
6. *Rodents*: Is your plot damaged by rats? What is the degree of damage?
7. *Management decisions*: Which cultivation practice do we need to do in this stage? (fertilizer, water, etc...) How do you compare your fields with farmers' fields in the area? What is the management decision for this week? What do you think will happen next week?

## **VII. 54 - 61 days after sowing**

1. What was the effect of last week's decision? Relate this to the countryside survey results.
2. *Plant:* Comment on plant development in this stage. Compare the number of flower bunches and fruits with that of last week. Did any flowers and fruits fall? What is the reason for this? What factors influence fruit development and speed of growth?
3. *Insect pests and diseases:* What herbivores and diseases are present this week? What factors will result in their increase or reduction next week? Which of them is important?
4. *Natural enemies:* What natural enemies occurred in the field? What are their densities? What is their role?
5. *Rodents:* Do rats continue to damage your plots? What is the effect of last week's management decision on rats?
6. *Management decisions:* What cultivation practice should be paid attention to now (fertilizer, water...)? What is the management decision for this week including those for herbivores and diseases? How does your management method compare with that of farmers in the area?
7. What is your comment on the ecosystems in the three management plots?

### **VIII. 62 - 69 days after sowing**

1. What was the effect of last week's decision? Relate this to the countryside survey results.
2. *Plant:* Comment on plant height and number of leaves in this stage? How many fruits form from each flower set? Is there any difference between flower sets? What is the reason for this? How is the fruit formation in this stage? What conditions are affecting fruit formation?
3. *Insect pests and diseases:* What kind of pests and diseases occur at this stage? How is the pest and disease situation compared to last week? What conditions favour their development?
4. *Natural enemies:* What natural enemies are found in the field? What is their role? What are their densities?
5. *Management decisions:* Is it necessary to fertilize and water in this stage? What about after each harvest? What are the other management decisions for this week?
6. What is your comment on the ecosystems in the three management plots?

## **IX. 70 - 77 days after sowing**

1. What was the effect of last week's decision? Relate this to the countryside survey results.
2. *Plant:* How is plant development this week (stem, leaves...)? Comment on flowering and fruit formation speed this week. What factors affect speed of flowering and fruit formation? How is fruit shape between fruit sets on plant?
3. *Insect pests and diseases:* What kind of herbivores and diseases are present in the field this week? Compare with last week. What are their densities and degree of damage?
4. *Natural enemies:* What natural enemies did you observe? What is their role? What are their densities?
5. *Management decisions:* Do you need to water or fertilize? Compare your management decision with that of farmers.
6. How many times have you harvested? How much time does it take between harvests?
7. Compare the yield per harvest between the three plots. Which plot has the highest yield? Why? Which plot has the highest economic benefits? Comment on the yield of your plot in comparison with that of farmers' plot.

# Crop Development

## 5-15 Days After Sowing

**Objectives:** Explain:

- Formation and development of root, stem and leaves of beans from sowing to 15 days
- Physiological characteristics and nutrient requirement from sowing to 15 days
- Cultivation practices necessary in this stage

**Duration:**

90 min.

**Materials:**

Plants at 5, 10 and 15 days after sowing

Paper, pen, crayons, ruler, lenses

**Method:**

- \* Observe and describe morphological characteristics, draw growth stages of bean
- \* Measure, count and describe growth criteria (height of plants, length of roots, number of leaves, etc)

**Discussions:**

1. What is a good seedling? What are the criteria for a good seedling?
2. Describe morphology of bean plant from 5 to 15 days. How many roots are there in each stage? What is their importance? How many leaves should there be in each stage? How does the stem develop in the different stages? What is the function of germination roots? Germination leaves? Older leaves? Are nodes found at this stage? What factors affect node formation?
3. Discuss the cultivation practices used in the field:
  - Soil preparation technique: preparing the bed, size of the bed...
  - Fertilizer use : Type of fertilizer, amount and fertilizing method
  - Sowing technique: Amount of seed, method of sowing
  - Watering technique: number of water applications and method of watering
  - Herbivores and natural enemies in the field
4. What cultivation methods should we apply in the field? Why?
5. Farmer's cultivation practices: From your observations and discussions with farmers, what do they do in this stage? Why?

## 20-30-40 Days after Sowing

**Objectives:** Explain

- morphological changes at stem and leaf development stages
- factors which affect plant development
- cultivation methods necessary to obtain good plant development

**Duration :**

90 min.

**Materials:**

Plants at 20-30-40 days after sowing

Large paper, crayon, pencil, ruler, etc

**Method:**

- \* Collect plants from the field
- \* Draw and describe different parts of the plants at different ages. Observe new root formation, places that roots occur, colour of roots, number of roots, length of roots, significance of root formation. Observe new leaf formation.

**Discussions:**

1. How is the plant developing (height, number of roots, number of leaves) in this stage? What is the function of nodes at this stage? What factors affect node formation?
2. Why is it important to compare the speed between root and leaf formation?
3. What is the water and nutrient requirement of plants in this stage?
4. What external factors affect plant development? How does the weather influence this stage?
5. Why is there a need to establish support for the plant? What is the effect on plant development if there is no support?
6. Are any insects or disease occurring in this stage? Natural enemies? What is their effect on the plant?

## Flower and Fruit Formation Stage

**Objectives:** Explain:

- characteristics of bean plant during flower and fruit formation stage
- methods to increase fruit setting and fruit quality

**Duration:**

90 minutes

**Materials:**

Large paper, pencil, crayons

Bean plant with flowers and fruits

**Method:**

- \* Draw the plant with flowers and fruit
- \* Observe, draw parts of flower and fruit, describe morphological characteristics of plant

**Discussions:**

1. How is the plant development in this stages (height, leaf length, number of leaves in flowering and fruit formation stages)? What is its significance?
2. What is your comment on vegetative and reproductive growth in this stage?
3. How many days after sowing does the plant have the first bunch of flowers? What is the significance of the first bunch of flowers? What is the number of flowers per bunch? Where do the flowers develop? What is the function of the flower's parts? How long does the flowering stage last? What factors influence the development of flowers?
4. What are the morphological characteristics of the flower after pollination? What factors affect pollination?
5. What is the order of flower formation? How many flower sets were there on the plant? Do all flowers become fruits? What is the percentage of fruit formation from flowers? Is this normal? How many flower sets are necessary and sufficient to obtain high yield?
6. What factors influence the development of fruits in this stage?
7. What is the role of water and fertilizer in this stage? Why?
8. How do you prune the plants? Why do you prune plants? Set up a small field study to find out.
9. When do you put support for bean plants in the field?
10. What is the farmers' recommendation for putting support in the field?
11. What are the main insect pests and diseases at this stage?
12. What are farmers' cultivation practices at this stage? Why are these done?

## Harvest stage

**Objectives:** Explain:

- characteristics of bean plant in harvest stage
- factors that affect this stage
- cultivation practices which increase yields and quality of fruit

**Duration:**

90 minutes

**Materials:**

Plant with fruits which can be harvested  
Large paper, crayons, pencils, ruler, etc

**Method:**

- \* Collect plants with fruits which can be harvested.
- \* Observe, draw, describe plant and fruit form. Also dissect fruit and draw the seed form.

**Discussions:**

1. What are the plant characteristics in this stage? How do fruits between sets in one plant develop?
2. How long does flowering to harvest stage last? What determines when we can harvest?
3. What percentage of fruits can you now harvest?
4. Is it necessary to apply cultivation methods (watering, dressing..) after each harvest while there are still fruits on the plant?
5. What factors affect the growing speed of fruits (temperature, rain, others)?
6. To what herbivores do we have to pay attention? What is the role of natural enemy in this stage?
7. What diseases occur at this stage?