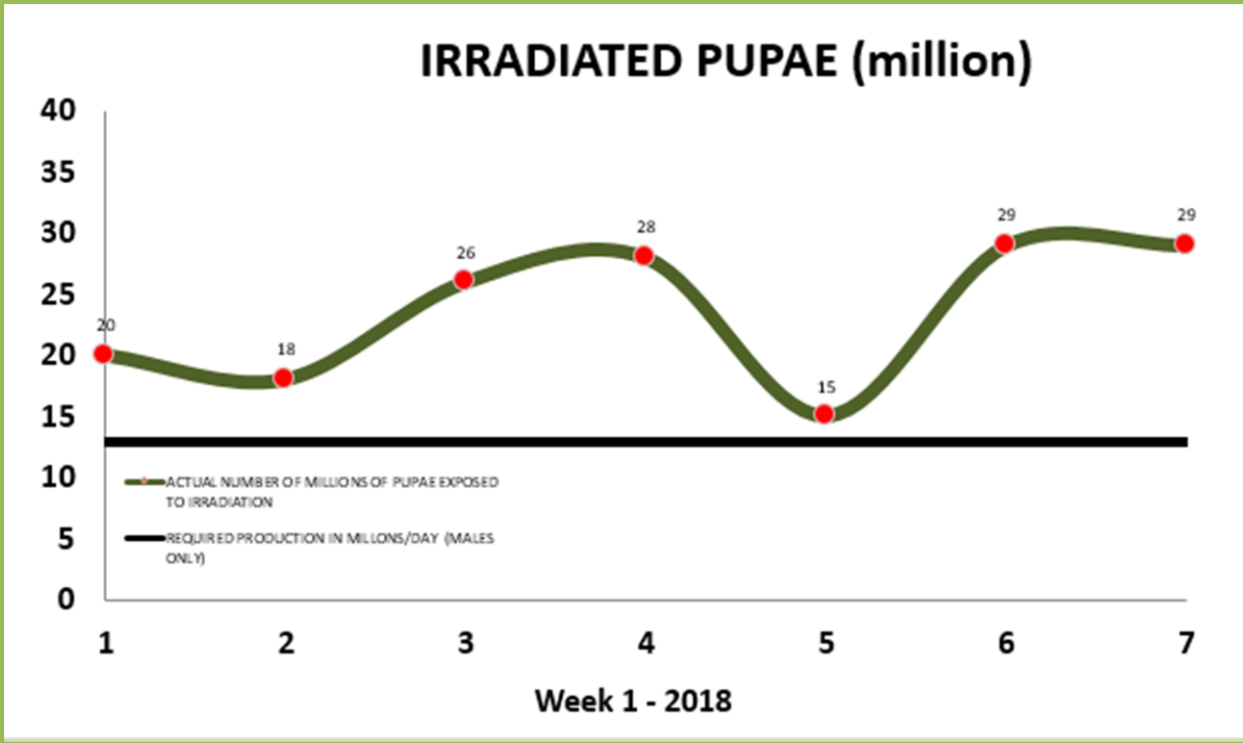
"The Dashboard" for Managers of Sterile Insect Technique Production Facilities

A Mass-Rearing Metrics and Monitoring Tool



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"The Dashboard" for Managers of Insect Production Facilities
A Mass-Rearing Metrics and Monitoring Tool

Introduction

Nowadays, large-scale rearing of insects has gained considerable interest as an environment-friendly strategy for pest control, through the production of beneficial insects, such as parasitoids, predators, pollinators, sterile insects and other beneficial organisms, as well as an alternative source of animal protein for feed and food.

Rearing operations, in general, are an intricate activity that requires a well-designed process control to ensure that the daily investment in artificial diets, supplies, personnel, operations and equipment, as well as other resources committed to the mass-production, yield the expected outcomes in terms of quantity, quality and production cost-effectiveness. In order that managers can monitor the main production components and make well-informed decisions, it is necessary that data generated during the production process be compiled and transformed into useful information that goes beyond the usual statistical analysis (averages and standard deviations), which often do not allow observing trends relevant to correcting and optimizing production processes.

Most textbooks on statistical methods, and most statistical computer programmes, pay too little attention to graphs. Graphs can have various purposes, such as: (i) to help us perceive and appreciate some broad features of the data, (ii) to let us look behind those broad features and see what other trends are there. Most kinds of statistical calculation rest on assumptions about the behaviour of the data. Those assumptions may be false, and then the calculations may be misleading. We ought always to try to check whether the assumptions are reasonably correct; and if they are wrong we ought to be able to perceive in what ways they are wrong. Graphs are very valuable for these purposes as was described by Anscombe, 1973 (http://www.sjsu.edu/faculty/gerstman/StatPrimer/anscombe1973.pdf).

The Excel spreadsheet and graphic display for this "Dashboard" has been designed as a working tool, primarily for managers and staff at mass-production facilities to facilitate monitoring insect rearing operations. It can also be used to monitor performance of small scale colonies and to carry out strain comparisons. This "Mass-Rearing Metrics and Monitoring Tool" allows managers to monitor daily production performance of their mass-rearing facility in a "Dashboard" format.

Managers and rearing technicians can be easily overwhelmed by the large volume of information generated by various production processes. Presenting production trends in an organized, dashboard-style brings much value to facility and programme managers.

By definition, a dashboard is a visual display of data collected to monitor conditions and to facilitate understanding of the process described. Dashboards are commonly used in industrial production and are suited to monitoring industrial production of insects. This Excel-based monitoring system displays Key Performance Parameters ("KPP's") showing production and quality trends in simple, easy to interpret graphs. This Excel monitoring system and graph display "dashboard" can also be used to predict or model different production scenarios and compare them to actual or proposed operations.

Monitoring operation activities helps to quickly identify production problems (Figure 1), take corrective actions, and measure their impact in improving processes. Monitoring also

strengthens process planning and implementation, use of resources, supervision in general, and invites participation by staff at all levels of the insect rearing operation, as well as all operations linked to Sterile Insect Technique (SIT) application. A stable production process, with known performance measurements, provides better control over production output, leading to reduced overall operational cost.

Thus, the aim in designing this Excel monitoring system is to facilitate managerial and technical decisions regarding the performance of insect rearing operations. The examples given and data entry are set-up for an *Anastrepha ludens* mass-production. However, initial data entry (user input in SECTIONS C and D) can be adjusted for other Tephritidae fruit flies or for non-tephritid species.

Feedback regarding potential improvements of the "Dashboard" is encouraged and greatly appreciated in order to achieve greater utility of this monitoring tool.

Key Performance Parameters (KPPs)

Key Performance Parameters (KPPs) reflect the production and quality objectives of a given production or quality unit. These production and quality goals are defined parameters that aim to address a well-studied field requirement. To consistently produce a predictable quality of insects, attention should be paid to the process that produces them (i.e. process control of the production process). To be able to monitor the production and productivity of rearing facilities, it is necessary to agree on a set of performance parameters and rearing practices, similar to what has been achieved for the quality control of the final product (http://www-naweb.iaea.org/nafa/ipc/public/QualityCo).

The mass-rearing production process showing the areas where key performance parameters and values need to be monitored for process control is shown in Figure 1.

KPP's must be measurable and represent critical success factors. Production performance and quality parameters should be monitored and maintained at an efficient level, allowing the introduction of corrections when deviations from the established performance requirement are observed. These production and quality performance parameters should be established for all of the processes that are required during the mass-rearing. Examples of KPP's include:

- Amount of eggs produced and used per time
- Larval yield in relation to the amount of diet prepared
- Overall pupal yield
- Egg to pupae conversion
- Percent of male pupae in Genetic Sexing Strains (GSS)
- Pupal weight
- Adult emergence
- Flight ability
- Adult survival under stress conditions.

Performance targets need to be set by users for each KPP (input in SECTION C and D). Over time, KPP target values can be adjusted in response to process control and production monitoring to more accurately reflect actual needs and results in terms of insect quantity and quality for each separate process.

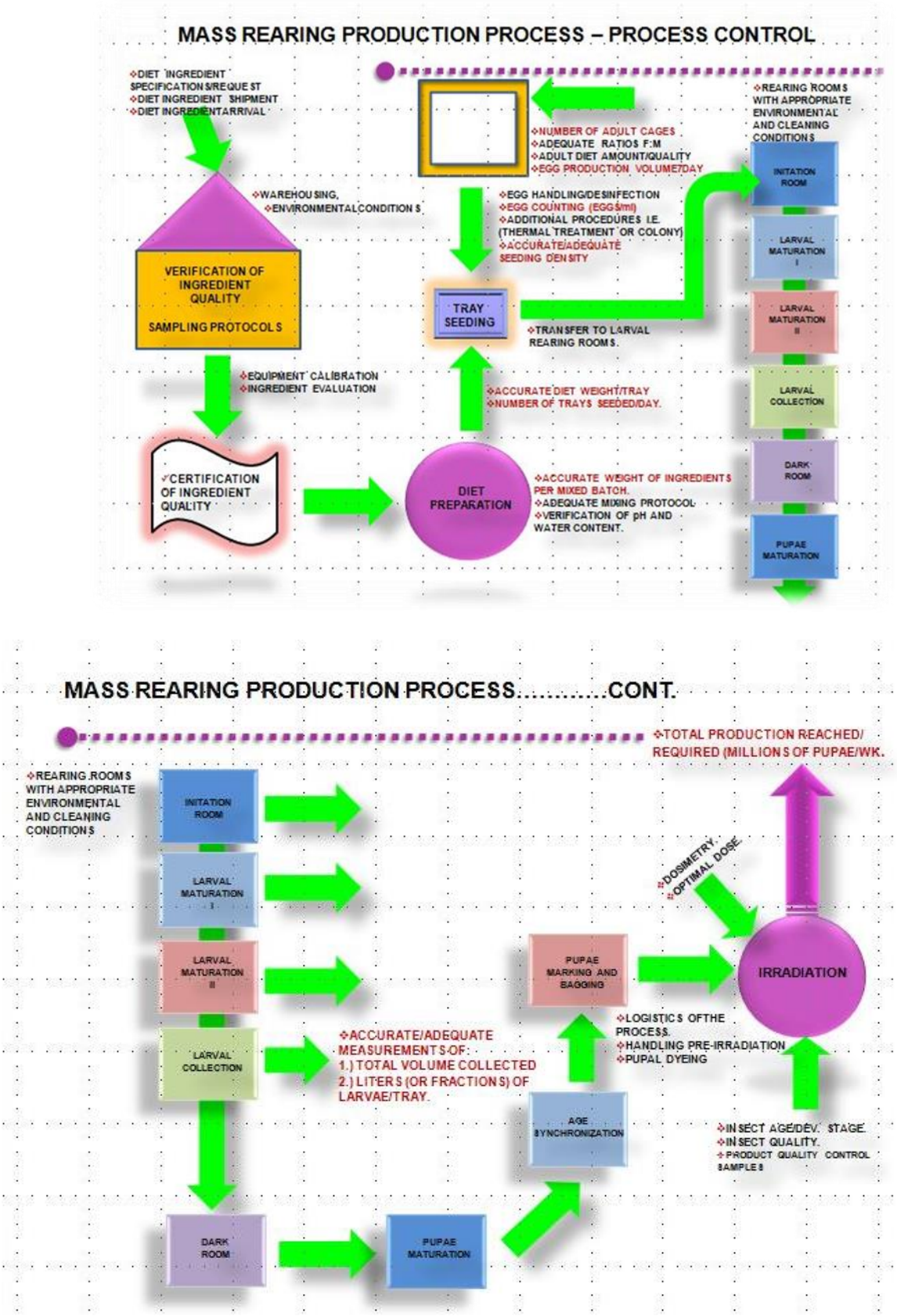


Figure 1. Mass-rearing production process showing areas (in red) where key performance parameters and values need to be collected to monitor the productivity of the production process.

Excel Spreadsheet Structure

This monitoring tool contains a set of spreadsheets which collect and process data to present two dashboards for separate target audience: 1) The "*Manager's Dashboard*" (SECTION A), which includes the weekly production target graphs, as well as the weekly quality control performance; and 2) The "*Technical Dashboard*" production graphs (SECTION B), which describes in more detail the performance of each specific rearing process.

Dashboard Menu (Sheet 1)

The main menu contains the options for accessing all the spreadsheet and display pages. It is only available when the spreadsheet view is the active window. It contains the following main options and menu items:

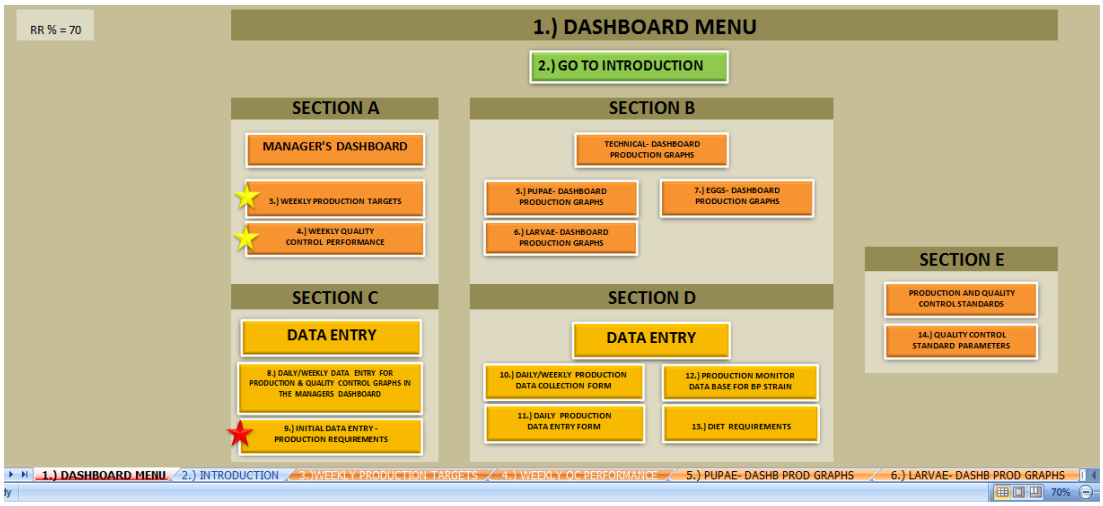


Figure 2. Dashboard menu, showing each of the sections for graphic display or data entry.

Introduction (Sheet 2)

The introduction page (GO TO INTRODUCTION) briefly describes the content and objectives of the spreadsheet. This page also shows the sponsoring organizations, as well as the staff involved in its development and this procedures manual.

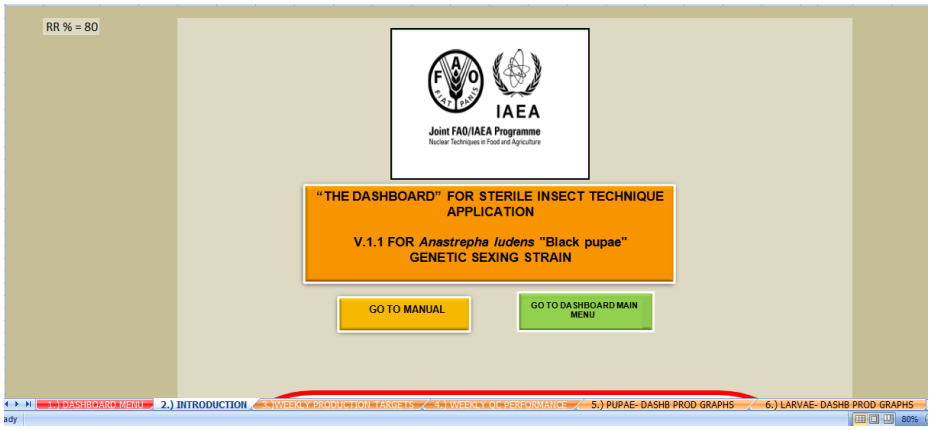


Figure 3. Introduction page (Sheet 2).

SECTION A

The Manager's Dashboard – Weekly Production Targets and Quality Control Performance (Sheets 3 and 4).

These graphs allow managers to see the actual production and quality values reached each week for specific process or development stage. The figures allow identifying gaps within the production process or problems of quality performance for the biological material that was produced or sent for field releases on that specific week (Figures 4 and 5).

Input in the data entry form (Sheet 8) automatically generates these sets of graphs:

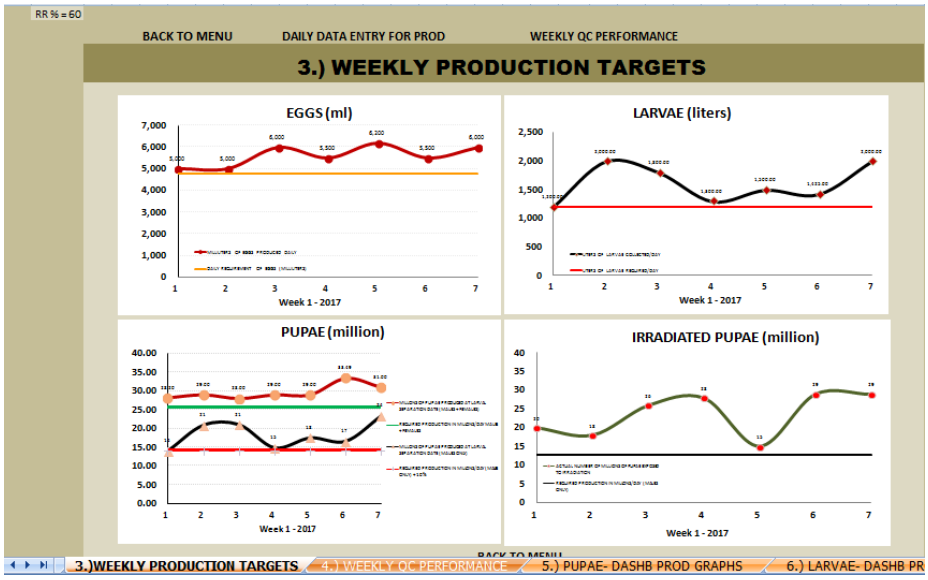


Figure 4. Example of manager's dashboard with charts of the weekly production targets (Sheet 3).

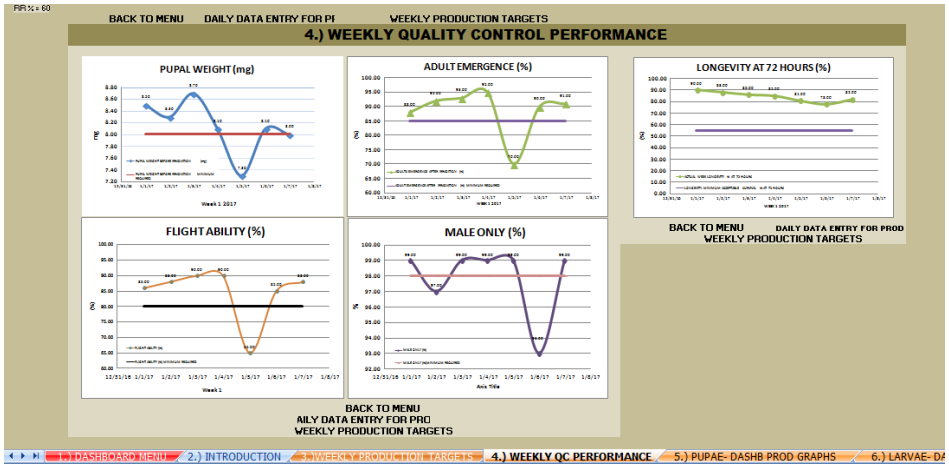


Figure 5. Example of manager's dashboard with charts of the weekly quality control performance (Sheet 4).

SECTION B

Technical - Dashboard Production Graphs (Sheets 5, 6 and 7 - See Figure 2).

The daily production data entry sheet (Sheet 11) and the related production monitor database (Sheet 12), which can be accessed in SECTION D, automatically generate a set of figures that allow users and technical personnel to analyse in more detail the performance of main production parameters for each of the insect developmental stages, such as egg, larvae and pupae, which comprise the whole production process.

To facilitate data observation and analysis, each parameter is presented in graphs that summarize the information every three months (four graphs per year); see Figure 6 as an example.

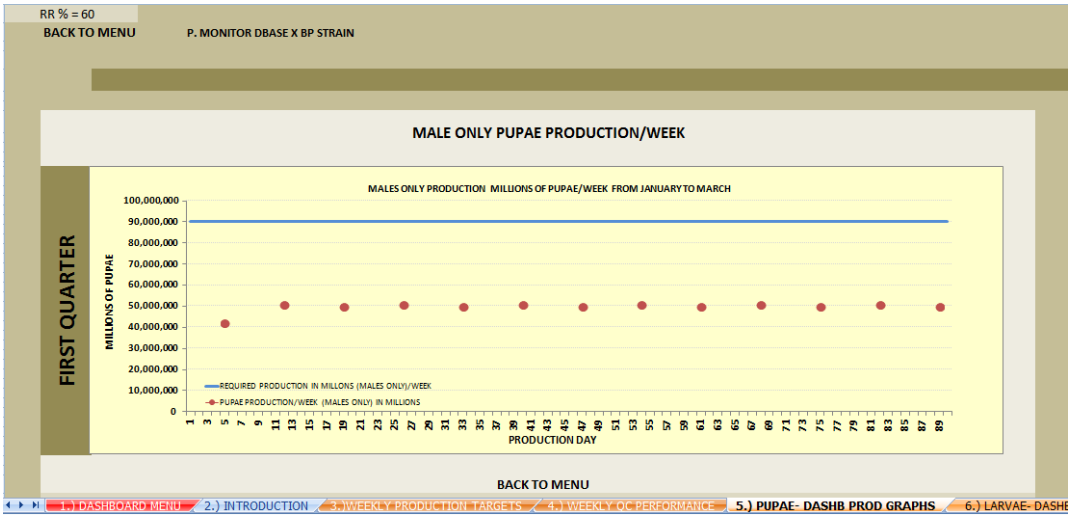


Figure 6. Example of male only pupae production per week over a three months period (Sheet 5).

There are several pages (Sheets 5, 6 and 7) that describe the rearing performance in the same dashboard format as the one observed in Figure 6 (see Figure 7). All the performance parameters and graphs can be accessed by pressing the desired tab at the menu page (SECTION B, see Figure 2).

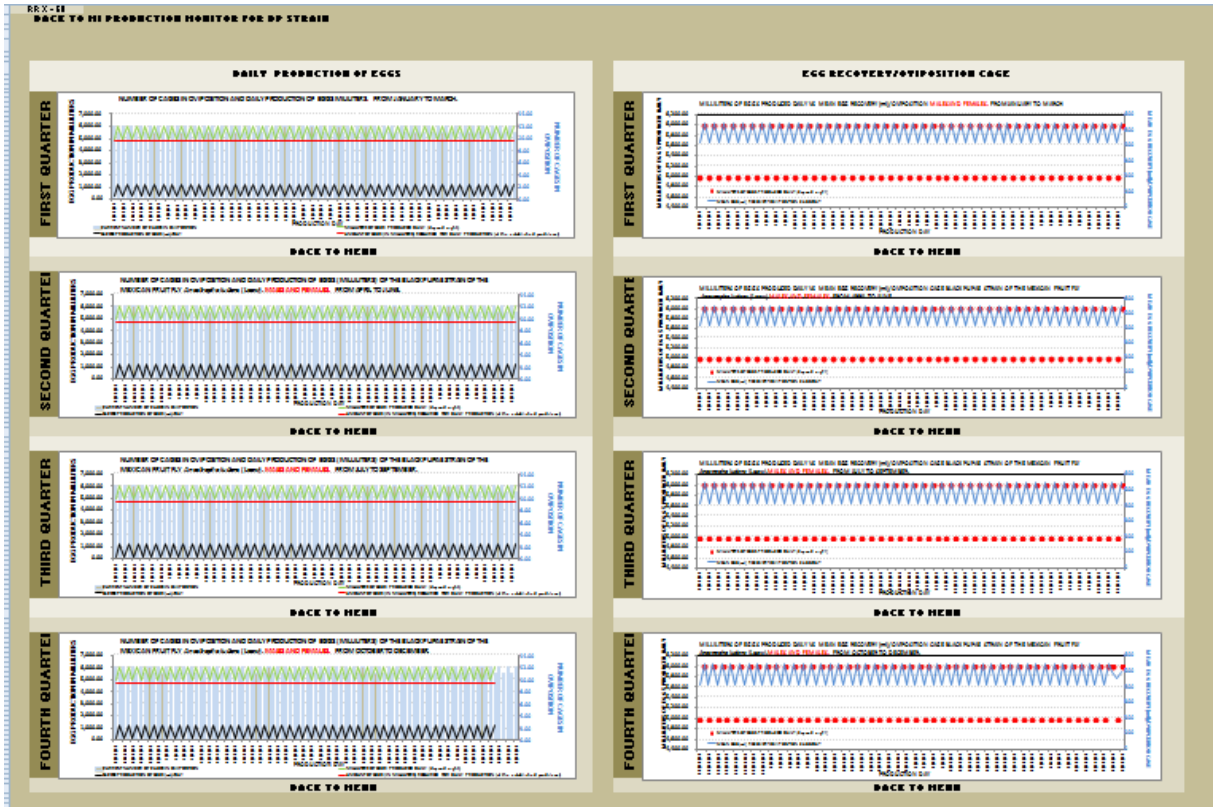


Figure 7. Daily egg production and egg recovery per oviposition cage dashboard, covering the four quarters of the year (Sheet 7).

SECTION C

Daily and Weekly Data Entry for Production and Quality Control Graphs in The Managers Dashboard (Sheet 8 – see Figure 2)

Input in this data entry sheet automatically generates a set of graphs that allow managers to see the actual production and quality values reached for a specific process or development stage.

To generate the "MANAGER'S DASHBOARD – WEEKLY PRODUCTION AND QUALITY GRAPHS" – a series of data must be entered using the form in the Sheet 8 (**DAILY DATA ENTRY X PROD & QC)**. These forms are not linked to the database, therefore data entry must be done manually every week to generate new weekly charts for the "MANAGER'S DASHBOARD - WEEKLY PRODUCTION AND QUALITY GRAPHS".

The dashboard operator should be responsible for updating the information every week based on the information generated by the production and quality control areas of the rearing facility. This information should be verified by the laboratory director or production manager. (Figure 8).

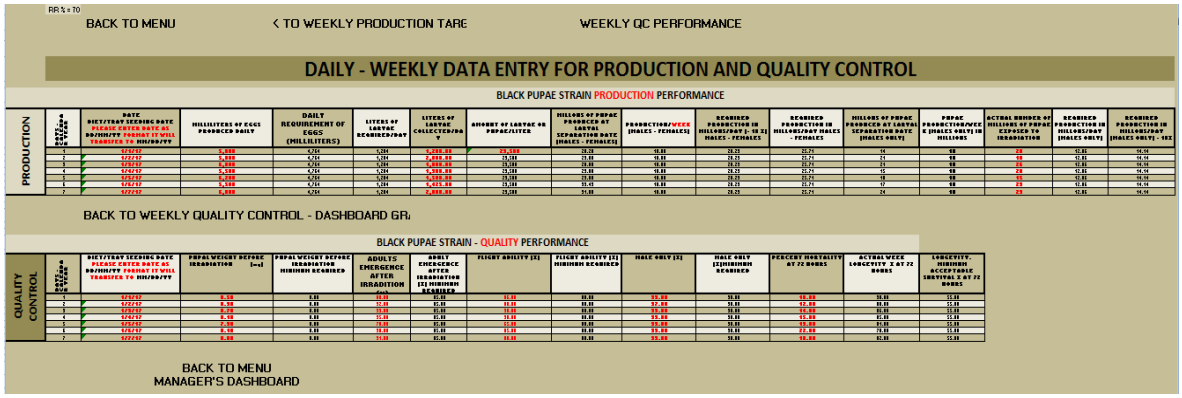


Figure 8. Daily/weekly data entry for production and quality control manager's dashboard (Sheet 8).

Initial Data Entry – Production Requirements (Sheet 9 – See Figure 2)

To generate the operational goals of the "Manager's and Technical Dashboards" (SECTIONS A and B), a series of data must be entered using this entry, located in Sheet 9 (Initial Data Entry - Production Requirements, Figure 9).

The first table, **Weekly Production Calculator** (**WPC**) that needs to be filled with production performance parameters is **WPC-A**. In this calculator, as well as in others that will be described later, the cells having red numbers are the ones that require or allow user input. All the information entered in these cells needs to be verified continuously in order to provide accurate data for the calculation and monitoring process.

In **WPC-A** the required production per week needs to be defined initially based on the number of operational days of the rearing facility. The next value that is required is the number of pupae per litter. The following important value that needs to be entered is the number of larvae (in litters) recovered per kilogram of larval diet (Appendix 1). This value is of major importance to the rearing operation since it defines the productivity of the rearing process and determines under real life rearing operations if the required production entered in the first cell of the **WPC** will be achieved**.** Finally, the amount of diet placed on a rearing tray needs to be entered. This is a variable number according to the rearing facility and species reared. This information should be verified by the laboratory director or production manager.

This initial page sets up the calculations made elsewhere within the spreadsheet. Production monitoring will be conducted based on this initial input.

The data entry points to be made by managers are shown in **Red** Colour on this page, as well as throughout the entire spreadsheet.

RR % = 80

BACK TO MENU

P. MONITOR DBASE X BP STRAIN

MASS REARING MONITORING TOOL

A	WEEKLY PRODUCTION CALCULATOR (WPC) REQUIRED PRODUCTION/WEEK	
	BLACK PUPAE STRAIN (Males and Females)	MILLIONS OF BLACK PUPAE MALES
MILLIONS REQUIRED/WEEK	180	90
NUMBER OF OPERATIONAL DAYS TO REACH THE REQ. PRODUCTION	7	7
MILLIONS/DAY	25.71	12.86
10 % ADDITIONAL *	2.571	1.29
TOTAL MILLIONS REQUIRED/DAY (+ 10%)	28.29	14.14
AMOUNT OF PUPAE/LITER **	23,500	
LITERS OF LARVAE REQUIRED/DAY	1,204	
LARVAL RECOVERY LITERS OF LARVAE/Kg DIET ***	0.1166	
KILOS OF DIET NEEDED/DAY (INCL 10% ADDITIONAL)	10,323	
KILOS OF DIET NEEDED/DAY (WITHOUT 10%)	9,384	
AMOUNT OF KILOS OF DIET/TRAY	6.5	
NUMBER OF TRAYS (6.5 Kg/EACH) + 10 %	1588	
NUMBER OF TRAYS (6.5 Kg/EACH)	1444	
MILLILITERS OF EGGS/TRAY (EGG SEEDING/INFEST)	3.0	**** Sepate seeding
TOTAL AMOUNT OF EGGS (MILLILITERS/DAY) REQUIRED + 10%	4764	density studies are
TOTAL AMOUNT OF EGGS (MILLILITERS/DAY) REQUIRED - 10%	4331	recommended/required

Figure 9. Initial data entry – production requirements – in Weekly Production Calculator (WPC) "A" (Sheet 9). Numbers in red allow users to define parameters based on their own situation and production requirements.

Initial Data Entry - Calculator for Variable Number of Trays (Sheet 9)

Below the initial data entry table for **WPC** marked "A", there is a separate calculator ("CALCULATOR FOR VARIABLE NUMBER OF TRAYS"), which allows users to quickly determine the production achieved with a variable set of conditions.

CALCULATOR FOR VARIABLE NUMBER OF TRAYS	
NUMBER OF TRAYS SEEDED/INFESTED	1450
AMOUNT OF KILOS OF DIET/TRAY	6.5
LARVAL RECOVERY LITERS OF LARVAE/KG OF DIET	0.1166
LITERS OF LARVAE PRODUCED/DAY	1098.96
NUMBER OF OPERATIONAL DAYS TO REACH THE REQ. PRODUCTION	7.00
WEEKLY PRODUCTION IN MILLIONS OF PUPAE	180.78

BACK TO MENU

Figure 10. Production calculations for a variable number of trays (Sheet 9).

Additional **Weekly Production Calculators WPC** "**B**" and "**C**" (Figure 11) are placed below the variable number of trays calculator and can be used to compare different production scenarios to compare between your production needs and performance.

These two additional calculators are not linked directly to the monitoring component of the "Dashboard".

BACK TO MENU

ADDITIONAL PRODUCTION CALCULATORS

B	WEEKLY PRODUCTION CALCULATOR (WPC)	
	REQUIRED PRODUCTION/WEEK	
	BLACK PUPAE STRAIN (Males and Females)	MILLIONS OF BLACK PUPAE MALES
MILLIONS REQUIRED/WEEK	30	15
NUMBER OF OPERATIONAL DAYS TO REACH THE REQ. PRODUCTION	7	7
MILLLIONS/DAY	4.29	2.14
10 % ADDITIONAL *	0.429	0.21
TOTAL MILLIONS REQUIRED/DAY (+ 10%)	4.71	2.36
AMOUNT OF PUPAE/LITER **	23,500	
LITERS OF LARVAE REQUIRED/DAY	201	
LARVAL RECOVERY LITERS OF LARVAE/Kg DIET ***	0.1166	
KILOS OF DIET NEEDED/DAY (INCL 10% ADDITIONAL)	1,720	
KILOS OF DIET NEEDED/DAY (WITHOUT 10%)	1,564	
AMOUNT OF KILOS OF DIET/TRAY	6.5	
NUMBER OF TRAYS (6.5 Kg/EACH) + 10 %	265	
NUMBER OF TRAYS (6.5 Kg/EACH)	241	
MILLILITERS OF EGGS/TRAY (EGG SEEDING/INFEST)	3.0	**** Sepate seeding
TOTAL AMOUNT OF EGGS (MILLILITERS/DAY) REQUIRED + 10%	794	density studies are
TOTAL AMOUNT OF EGGS (MILLILITERS/DAY) REQUIRED - 10%	722	recommended/requir

BACK TO MENU

ADDITIONAL PRODUCTION CALCULATORS

C	WEEKLY PRODUCTION CALCULATOR (WPC)	
	REQUIRED PRODUCTION/WEEK	
	BLACK PUPAE STRAIN (Males and Females)	MILLIONS OF BLACK PUPAE MALES
MILLIONS REQUIRED/WEEK	2	1
NUMBER OF OPERATIONAL DAYS TO REACH THE REQ. PRODUCTION	7	7
MILLLIONS/DAY	0.29	0.14
10 % ADDITIONAL *	0.029	0.01
TOTAL MILLIONS REQUIRED/DAY (+ 10%)	0.31	0.16
AMOUNT OF PUPAE/LITER **	23,500	
LITERS OF LARVAE REQUIRED/DAY	13	
LARVAL RECOVERY LITERS OF LARVAE/Kg DIET ***	0.1166	
KILOS OF DIET NEEDED/DAY (INCL 10% ADDITIONAL)	115	
KILOS OF DIET NEEDED/DAY (WITHOUT 10%)	104	
AMOUNT OF KILOS OF DIET/TRAY	6.5	
NUMBER OF TRAYS (6.5 Kg/EACH) + 10 %	18	
NUMBER OF TRAYS (6.5 Kg/EACH)	16	
MILLILITERS OF EGGS/TRAY (EGG SEEDING/INFEST)	3.0	**** Sepate seeding
TOTAL AMOUNT OF EGGS (MILLILITERS/DAY) REQUIRED + 10%	53	density studies are
TOTAL AMOUNT OF EGGS (MILLILITERS/DAY) REQUIRED - 10%	48	recommended/required

Figure 11. Additional weekly production calculators (WPC) "B" and "C" (Sheet 9).

SECTION D

Daily / Weekly Production Data Collection Form (Sheet 10 – Figure 2)

This page can be printed in hard copy or be used as an electronic form by the technicians or supervisors of each rearing process to collect all data that are generated daily. The collected set of data is used to fill the DAILY DATA ENTRY COLONY FORM (Sheet 11).

It is suggested that the information be entered on a daily basis. If this procedure is followed, the dashboard information will be up to date all the time with just entering six sets of data that are generated during the rearing process and collected by supervisors of each of the rearing areas (Figure 12).

RR % = 60

BACK TO MENU

DAILY/WEEKLY PRODUCTION DATA COLLECTION FORM - FOR PRINTING - PRODUCTION SUPERVISOR INPUT DATA SHEET

A	B	C	D	E	F	G	H	I	J	K	L	M	N
DAYS - CALENDAR YEAR	DATE DIET/TRAY SEEDING DATE PLEASE ENTER DATE AS DD/MM/YY FORMAT IT WILL TRANSFER TO MM/DD/YY	DAY OF THE WEEK	NUMBER OFDAYS ALLOWED FOR LARVAL DEVELOPMENT	LARVAL SEPARATION DATE	NUMBER OF CAGES IN OVIPOSITION	MILLILITERS OF EGGS PRODUCED DAILY (day and night)	ML OF EGGS COLLECTED DURING THE NIGHT SHIFT	No OF TRAYS SEEDEDANFESTED	LITERS OF LARVAE COLLECTEDDAY ACTUAL SEEDING DATE IN COLUMN B	LITERS OF PUPAE COLLECTED AFTER SIFTING	NUMBER OF PUPATION DAYS (PRIOR TO IRRADIATION)	IRRADIATION DATE	ACTUAL NUMBER OF MILLIONS OF PUPAE EXPOSED TO IRRADIATION
1													
2													
3													
4													
5													
6													
7													

DATA TO BE ENTERED DAILY BY SUPERVISORS/TECHNICIANS

Figure 12. Daily / weekly production data collection form (Sheet 10).

Daily Production Data Entry Colony Form - Data Transfer (Sheet 11)

After collecting the daily and weekly production information by technicians and supervisors, the data need to be entered in this electronic form: the-"daily data entry collection form" (Sheet 11). All relevant information typed in will be transferred to generate a daily database from which all the technical dashboard graphs are automatically prepared.

RR % = 60

BACK TO MENU

P. MONITOR DBASE X BP STRAIN

DAILY PRODUCTION DATA ENTRY FORM

A	B	C	D	E	F	G	H	I	J	K	L	M	N
DAYS - CALENDAR YEAR	DATE DIET/TRAY SEEDING DATE PLEASE ENTER DATE AS DD/MM/YY FORMAT IT WILL TRANSFER TO MM/DD/YY	DAY OF THE WEEK	NUMBER OFDAYS ALLOWED FOR LARVAL DEVELOPMENT	LARVAL SEPARATION DATE	NUMBER OF CAGES IN OVIPOSITION	MILLILITERS OF EGGS PRODUCED DAILY (day and night)	ML OF EGGS COLLECTED DURING THE NIGHT SHIFT	No OF TRAYS SEEDEDANFESTED	LITERS OF LARVAE COLLECTEDDAY ACTUAL SEEDING DATE IN COLUMN B	LITERS OF PUPAE COLLECTED AFTER SIFTING	NUMBER OF PUPATION DAYS (PRIOR TO IRRADIATION)	IRRADIATION DATE	ACTUAL NUMBER OF MILLIONS OF PUPAE EXPOSED TO IRRADIATION
1	03/22/17	TUE	10	3/23/17	12	5,000	0	687	579.10	0.000	10	4/15/17	20,000,000
2	03/23/17	WED	10	4/3/17	11	6,000	0	736	1,246.00	0.000	10	04/19/17	10,000,000
3	03/23/17	THURS	10	4/3/17	12	5,000	0	687	579.10	0.000	10	4/20/17	26,000,000
4	03/24/17	FRI	10	4/3/17	11	6,000	0	736	652.70	0.000	10	04/23/17	28,000,000
5	03/25/17	SAT	10	4/4/17	12	5,000	0	687	579.10	0.000	10	4/23/17	29,000,000
6	03/26/17	SUN	10	4/5/17	11	6,000	0	736	652.70	0.000	10	04/23/17	29,000,000
7	03/27/17	MON	10	4/6/17	12	5,000	0	736	579.10	0.000	10	4/24/17	29,000,000
8	03/28/17	TUE	10	4/7/17	11	6,000	0	687	652.70	0.000	10	04/25/17	29,000,000
9	03/29/17	WED	10	4/8/17	12	5,000	0	736	579.10	0.000	10	4/26/17	29,000,000
10	03/30/17	THURS	10	4/9/17	11	6,000	0	687	652.70	0.000	10	04/27/17	29,000,000
11	03/31/17	FRI	10	4/10/17	12	5,000	0	687	579.10	0.000	10	4/28/17	29,000,000
12	04/01/17	SAT	10	4/11/17	11	6,000	0	736	652.70	0.000	10	04/29/17	29,000,000
13	04/02/17	SUN	10	4/12/17	12	5,000	0	687	579.10	0.000	10	4/30/17	29,000,000
14	04/03/17	MON	10	4/13/17	11	6,000	0	736	652.70	0.000	10	05/01/17	29,000,000
15	04/04/17	TUE	10	4/14/17	12	5,000	0	687	579.10	0.000	10	5/2/17	29,000,000
16	04/05/17	WED	10	4/15/17	11	6,000	0	687	652.70	0.000	10	05/03/17	29,000,000
17	04/06/17	THURS	10	4/16/17	12	5,000	0	736	579.10	0.000	10	5/4/17	29,000,000
18	04/07/17	FRI	10	4/17/17	11	6,000	0	687	652.70	0.000	10	05/05/17	29,000,000
19	04/08/17	SAT	10	4/18/17	12	5,000	0	736	579.10	0.000	10	5/6/17	29,000,000
20	04/09/17	SUN	10	4/19/17	11	6,000	0	687	652.70	0.000	10	05/07/17	29,000,000
21	04/10/17	MON	10	4/20/17	12	5,000	0	687	579.10	0.000	10	5/8/17	29,000,000
22	04/11/17	TUE	10	4/21/17	11	6,000	0	736	652.70	0.000	10	05/09/17	29,000,000
23	04/12/17	WED	10	4/22/17	12	5,000	0	687	579.10	0.000	10	5/10/17	29,000,000
24	04/13/17	THURS	10	4/23/17	11	6,000	0	736	652.70	0.000	10	05/11/17	29,000,000
25	04/14/17	FRI	10	4/24/17	12	5,000	0	687	579.10	0.000	10	5/12/17	29,000,000
26	04/15/17	SAT	10	4/25/17	11	6,000	0	687	652.70	0.000	10	05/13/17	29,000,000
27	04/16/17	SUN	10	4/26/17	12	5,000	0	736	579.10	0.000	10	5/14/17	29,000,000
28	04/17/17	MON	10	4/27/17	11	6,000	0	687	652.70	0.000	10	05/15/17	29,000,000
29	04/18/17	TUE	10	4/28/17	12	5,000	0	736	579.10	0.000	10	5/16/17	29,000,000
30	04/19/17	WED	10	4/29/17	11	6,000	0	687	652.70	0.000	10	05/17/17	29,000,000
31	04/20/17	THURS	10	4/30/17	12	5,000	0	687	579.10	0.000	10	5/18/17	29,000,000
32	04/21/17	FRI	10	5/1/17	11	6,000	0	736	652.70	0.000	10	05/19/17	29,000,000

Figure 13. Production monitoring pages receive information to proceed to generate a graphic representation of the production process (Sheet 11).

Production Monitor Database for Black Pupae Strain (Sheet 12)

Structure of the Database

Origin of the data:

Placed on the upper left-hand side of Sheet 12 (the "PRODUCTION MONITOR DATA") there is a small table explaining the origin of the data placed on this database (Figure 14).

ORIGIN OF THE DATA ON THIS TABLE	11.) DAILY DATA ENTRY COL FORM	MANUAL ENTRY IN THIS SPREADSHEET (ME)
	9.) INITIAL DATA ENTRY - PROD. REQ	SPREADSHEET CALCULATION

Figure 14. Origin of the data on this table, showing that manual entry (ME) of statistics will be required in four columns of the database (Sheet 12).

Most of the table is self-explanatory; however, there are few sets of data, mostly the result of running basic statistical analysis of the actual production process, that need to be filled manually on this database. This requirement is identified as “Manual Entry in this Spreadsheet (ME)”.

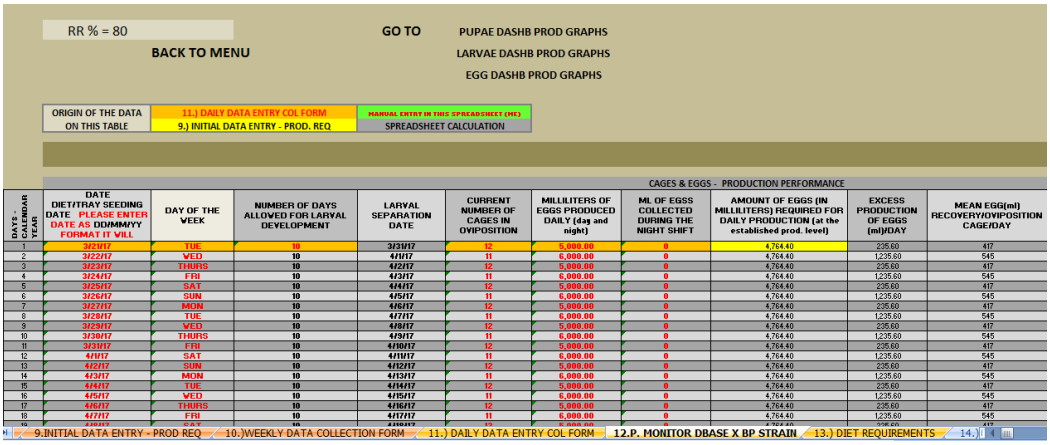
The few instances when this entry is required will be shown as:

- Five times in the first cell in grey of the column that requires filling,
- two times for DIET & TRAYS, and
- three times for LARVAL PRODUCTION PERFORMANCE.

To process the full set of information, this spreadsheet “dashboard” collects and compiles information in five distinctive rearing and production areas, as follows:

1.) Cages & Eggs Production Performance

This area of Sheet 12 collects the information on the number of cages in oviposition, amount of eggs produced daily, as well as the required amount of eggs to reach the requested production level (Figure 15).



RR % = 80

BACK TO MENU

GO TO PUPAE DASHB PROD GRAPHS
LARVAE DASHB PROD GRAPHS
EGG DASHB PROD GRAPHS

ORIGIN OF THE DATA ON THIS TABLE	11.) DAILY DATA ENTRY COL FORM	MANUAL ENTRY IN THIS SPREADSHEET (ME)
	9.) INITIAL DATA ENTRY - PROD. REQ	SPREADSHEET CALCULATION

CAGES & EGGS - PRODUCTION PERFORMANCE

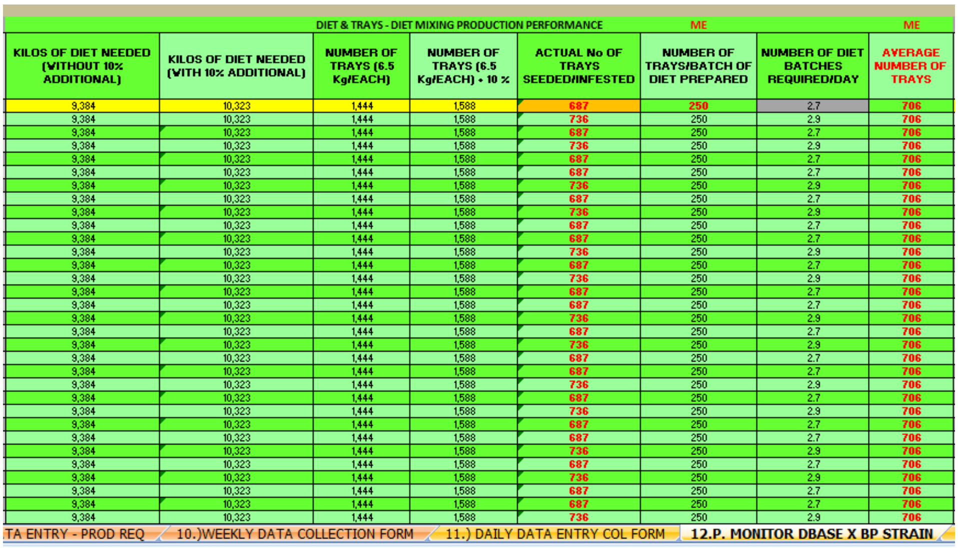
DAYS - YEARS	DATE DIET/TRAY SEEDING DATE PLEASE ENTER DATE AS DD/MM/YY FORMAT IT WILL	DAY OF THE WEEK	NUMBER OF DAYS ALLOWED FOR LARVAL DEVELOPMENT	LARVAL SEPARATION DATE	CURRENT NUMBER OF CAGES IN OVIPOSITION	MILLILITERS OF EGGS PRODUCED DAILY (day and night)	ML OF EGGS COLLECTED DURING THE NIGHT SHIFT	AMOUNT OF EGGS (IN MILLILITERS) REQUIRED FOR DAILY PRODUCTION (at the established prod. level)	EXCESS PRODUCTION OF EGGS (ml)/DAY	MEAN EGG(ml) RECOVERY/OVIPOSITION CAGE/DAY
1	3/21/17	TUE	10	3/31/17	12	5,000.00	0	4,764.40	235.60	417
2	3/22/17	WED	10	4/1/17	11	6,000.00	0	4,764.40	1,235.60	545
3	3/23/17	THURS	10	4/2/17	12	5,000.00	0	4,764.40	235.60	417
4	3/24/17	FRI	10	4/3/17	11	6,000.00	0	4,764.40	1,235.60	545
5	3/25/17	SAT	10	4/4/17	12	5,000.00	0	4,764.40	235.60	417
6	3/26/17	SUN	10	4/5/17	11	6,000.00	0	4,764.40	1,235.60	545
7	3/27/17	MON	10	4/6/17	12	5,000.00	0	4,764.40	235.60	417
8	3/28/17	TUE	10	4/7/17	11	6,000.00	0	4,764.40	1,235.60	545
9	3/29/17	WED	10	4/8/17	12	5,000.00	0	4,764.40	235.60	417
10	3/30/17	THURS	10	4/9/17	11	6,000.00	0	4,764.40	1,235.60	545
11	3/31/17	FRI	10	4/10/17	12	5,000.00	0	4,764.40	235.60	417
12	4/1/17	SAT	10	4/11/17	11	6,000.00	0	4,764.40	1,235.60	545
13	4/2/17	SUN	10	4/12/17	12	5,000.00	0	4,764.40	235.60	417
14	4/3/17	MON	10	4/13/17	11	6,000.00	0	4,764.40	1,235.60	545
15	4/4/17	TUE	10	4/14/17	12	5,000.00	0	4,764.40	235.60	417
16	4/5/17	WED	10	4/15/17	11	6,000.00	0	4,764.40	1,235.60	545
17	4/6/17	THURS	10	4/16/17	12	5,000.00	0	4,764.40	235.60	417
18	4/7/17	FRI	10	4/17/17	11	6,000.00	0	4,764.40	1,235.60	545

9.INITIAL DATA ENTRY - PROD REQ | 10.)WEEKLY DATA COLLECTION FORM | 11.) DAILY DATA ENTRY COL FORM | 12.P. MONITOR DBASE X BP STRAIN | 13.) DIET REQUIREMENTS | 14.)

Figure 15. Cages & eggs – production performance (Sheet 12).

2.) Diet & Trays – Diet Mixing Production Performance

This area of Sheet 12 collects the information relevant to the amounts of larval diet and numbers of trays required to reach the required production goals (Figure 16).

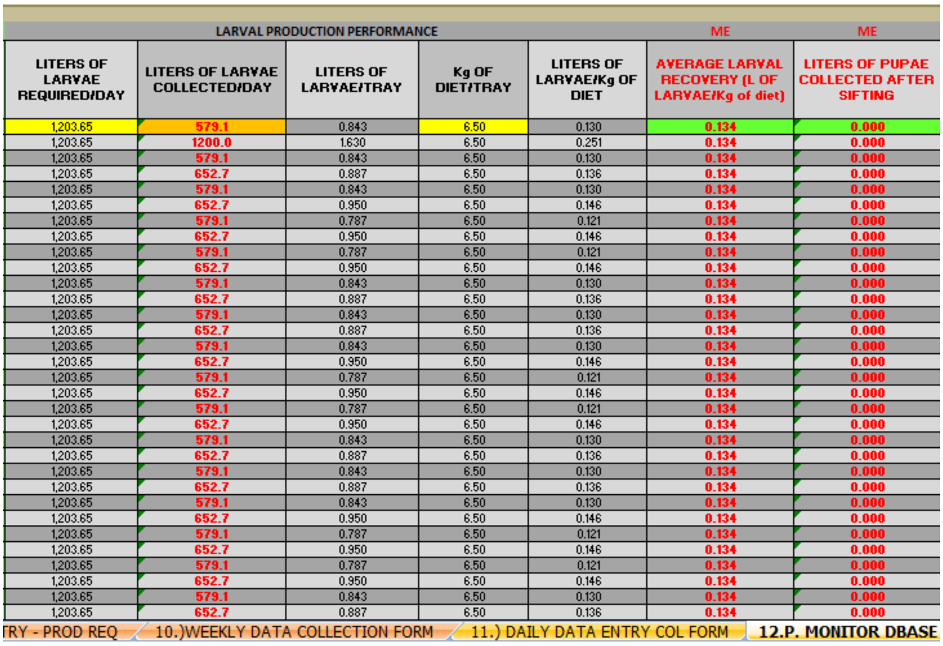


DIET & TRAYS - DIET MIXING PRODUCTION PERFORMANCE					ME		ME
KILOS OF DIET NEEDED (WITHOUT 10% ADDITIONAL)	KILOS OF DIET NEEDED (WITH 10% ADDITIONAL)	NUMBER OF TRAYS (6.5 Kg/EACH)	NUMBER OF TRAYS (6.5 Kg/EACH) + 10 %	ACTUAL No OF TRAYS SEEDED/INFESTED	NUMBER OF TRAYS/BATCH OF DIET PREPARED	NUMBER OF DIET BATCHES REQUIRED/DAY	AVERAGE NUMBER OF TRAYS
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	687	250	2.7	706
9,384	10,323	1,444	1,588	736	250	2.9	706

Figure 16. Diet and trays – diet mixing production performance database (Sheet 12).

3.) *Larval Production Performance*

This area of Sheet 12 collects all the information related to the production achieved with the larval diet, i.e. liters of larvae collected per tray and its productivity per kilogram (liters of larvae per kilogram of diet). It also gives indications of the required amount of larvae per day to reach the initially established production requirement (Figure 17).



LARVAL PRODUCTION PERFORMANCE					ME	ME
LITERS OF LARVAE REQUIRED/DAY	LITERS OF LARVAE COLLECTED/DAY	LITERS OF LARVAE/TRAY	Kg OF DIET/TRAY	LITERS OF LARVAE/Kg OF DIET	AVERAGE LARVAL RECOVERY (L OF LARVAE/Kg of diet)	LITERS OF PUPAE COLLECTED AFTER SIFTING
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	1200.0	1.630	6.50	0.251	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.887	6.50	0.136	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.787	6.50	0.121	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.787	6.50	0.121	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.887	6.50	0.136	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.887	6.50	0.136	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.787	6.50	0.121	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.787	6.50	0.121	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.887	6.50	0.136	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.887	6.50	0.136	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.787	6.50	0.121	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.787	6.50	0.121	0.134	0.000
1,203.65	652.7	0.950	6.50	0.146	0.134	0.000
1,203.65	579.1	0.843	6.50	0.130	0.134	0.000
1,203.65	652.7	0.887	6.50	0.136	0.134	0.000

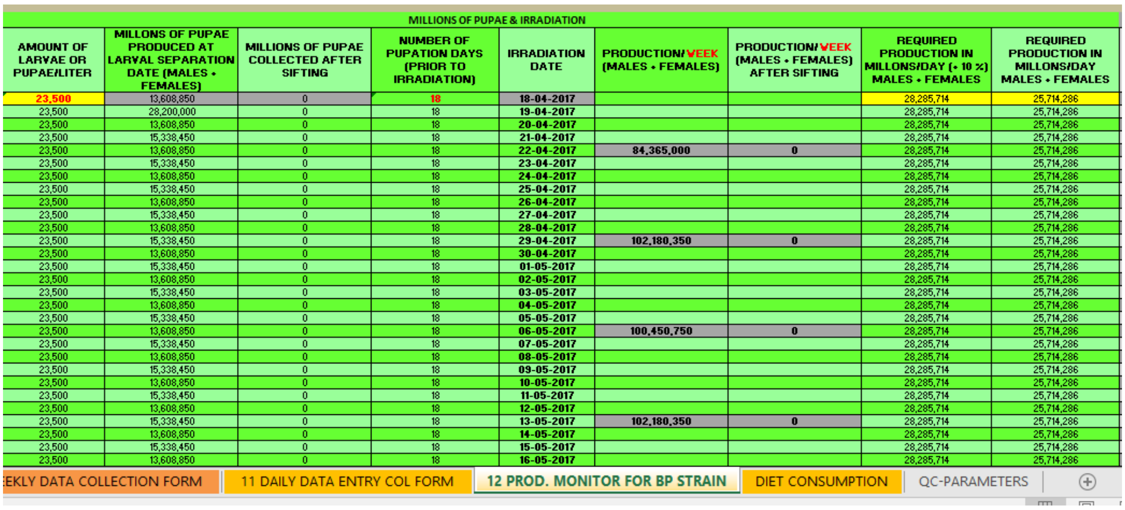
Figure 17. Larval production performance (Sheet 12).

4.) *Millions of Pupae & Irradiation*

This area of Sheet 12 starts by establishing the amount of pupae per litter (this value needs to be verified periodically because, this count is affected the pupae size). In this page, the

programme software calculates the millions of pupae produced at larval separation. In a following column, a variable number of pupation days needs to be entered by the user. Based on this an approximate irradiation date is proposed (Figure 18).

From the following four columns the only number that needs to be added by the user is the actual number of millions of pupae that is exposed to irradiation. The following columns are numbers that were calculated in the Initial Data Entry (Figure 9 – Sheet 9).



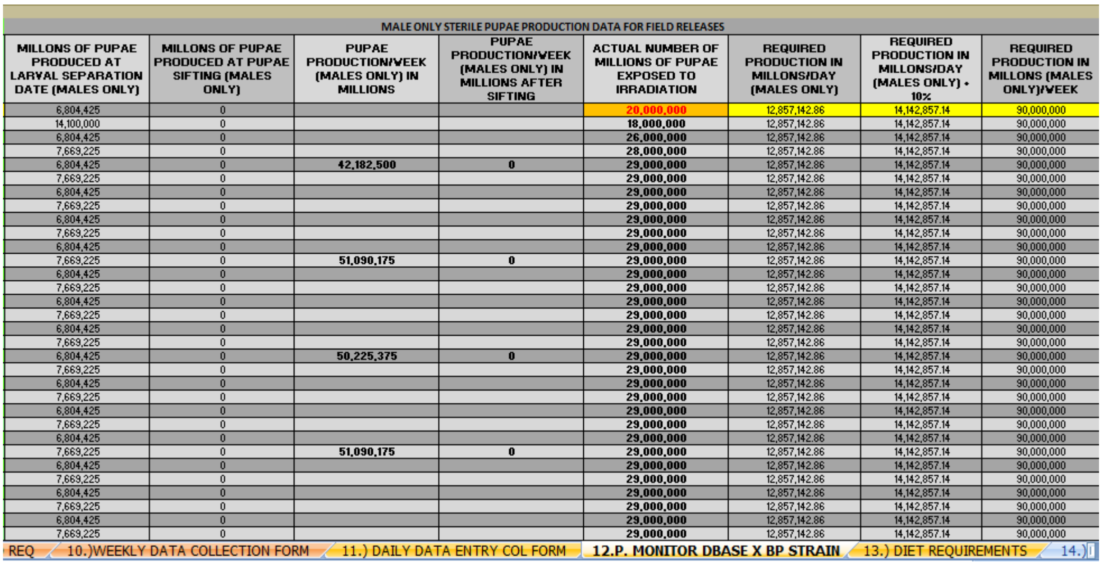
MILLIONS OF PUPAE & IRRADIATION

AMOUNT OF LARVAE OR PUPAE/LITER	MILLONS OF PUPAE PRODUCED AT LARVAL SEPARATION DATE (MALES + FEMALES)	MILLIONS OF PUPAE COLLECTED AFTER SIFTING	NUMBER OF PUPATION DAYS (PRIOR TO IRRADIATION)	IRRADIATION DATE	PRODUCTION/ WEEK (MALES + FEMALES)	PRODUCTION/ WEEK (MALES + FEMALES) AFTER SIFTING	REQUIRED PRODUCTION IN MILLONS/DAY (+ 10 %) MALES + FEMALES	REQUIRED PRODUCTION IN MILLONS/DAY MALES + FEMALES
23,500	13,608,850	0	18	18-04-2017			28,285,714	25,714,286
23,500	28,200,000	0	18	19-04-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	20-04-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	21-04-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	22-04-2017	84,365,000	0	28,285,714	25,714,286
23,500	15,338,450	0	18	23-04-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	24-04-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	25-04-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	26-04-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	27-04-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	28-04-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	29-04-2017	102,180,350	0	28,285,714	25,714,286
23,500	13,608,850	0	18	30-04-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	01-05-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	02-05-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	03-05-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	04-05-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	05-05-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	06-05-2017	100,450,750	0	28,285,714	25,714,286
23,500	15,338,450	0	18	07-05-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	08-05-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	09-05-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	10-05-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	11-05-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	12-05-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	13-05-2017	102,180,350	0	28,285,714	25,714,286
23,500	13,608,850	0	18	14-05-2017			28,285,714	25,714,286
23,500	15,338,450	0	18	15-05-2017			28,285,714	25,714,286
23,500	13,608,850	0	18	16-05-2017			28,285,714	25,714,286

Figure 18. Millions of pupae produced and their respective irradiation information (Sheet 12).

5.) Male Only Sterile Pupae Production Data for Field Releases

All information presented in this area of the Sheet 12 is generated automatically. The main information is the number of millions of insects irradiated per day compared against the required number either daily or weekly (Figure 19).



MALE ONLY STERILE PUPAE PRODUCTION DATA FOR FIELD RELEASES

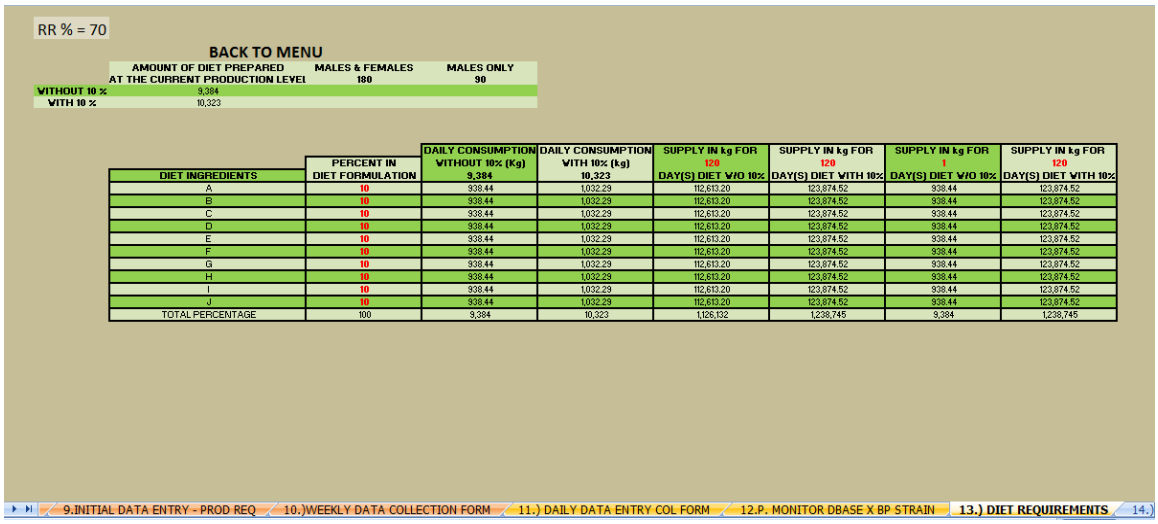
MILLONS OF PUPAE PRODUCED AT LARVAL SEPARATION DATE (MALES ONLY)	MILLONS OF PUPAE PRODUCED AT PUPAE SIFTING (MALES ONLY)	PUPAE PRODUCTION/WEEK (MALES ONLY) IN MILLIONS	PUPAE PRODUCTION/WEEK (MALES ONLY) IN MILLIONS AFTER SIFTING	ACTUAL NUMBER OF MILLIONS OF PUPAE EXPOSED TO IRRADIATION	REQUIRED PRODUCTION IN MILLONS/DAY (MALES ONLY)	REQUIRED PRODUCTION IN MILLONS/DAY (MALES ONLY) + 10%	REQUIRED PRODUCTION IN MILLONS (MALES ONLY)/WEEK
6,804,425	0			20,000,000	12,857,142.86	14,142,857.14	90,000,000
14,100,000	0			18,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			26,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			28,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0	42,182,500	0	29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0	51,090,175	0	29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0	50,225,375	0	29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0	51,090,175	0	29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
6,804,425	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000
7,669,225	0			29,000,000	12,857,142.86	14,142,857.14	90,000,000

Figure 19. Male only sterile pupae production for field release (Sheet 12).

Diet Requirements (Sheet 13)

This sheet allows manual entry of the diet ingredients and their respective percentages that are used at each rearing facility.

The calculations of the amounts of diet required to run the rearing operation are based on the initial data entry for the desired production level. This section of the spreadsheet allows to calculate automatically the consumption of those ingredients at the desired number of days, information which can be useful for instance for provisioning, storage and daily diet preparation (Figure 20).



RR % = 70

BACK TO MENU

AMOUNT OF DIET PREPARED AT THE CURRENT PRODUCTION LEVEL	MALES & FEMALES 180	MALES ONLY 90
WITHOUT 10 %	9,384	
WITH 10 %	10,323	

DIET INGREDIENTS	PERCENT IN DIET FORMULATION	DAILY CONSUMPTION WITHOUT 10% (Kg) 9,384	DAILY CONSUMPTION WITH 10% (kg) 10,323	SUPPLY IN kg FOR 120 DAY(S) DIET W/O 10%	SUPPLY IN kg FOR 120 DAY(S) DIET WITH 10%	SUPPLY IN kg FOR 1 DAY(S) DIET W/O 10%	SUPPLY IN kg FOR 120 DAY(S) DIET WITH 10%
A	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
B	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
C	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
D	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
E	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
F	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
G	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
H	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
I	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
J	10	938.44	1,032.29	112,613.20	123,874.52	938.44	123,874.52
TOTAL PERCENTAGE	100	9,384	10,323	1,126,132	1,238,745	9,384	1,238,745

9.INITIAL DATA ENTRY - PROD REQ | 10.)WEEKLY DATA COLLECTION FORM | 11.) DAILY DATA ENTRY COL FORM | 12.P. MONITOR DBASE X BP STRAIN | 13.) DIET REQUIREMENTS | 14.)

Figure 20: Diet requirements and consumption

SECTION E – Production and Quality Control Standard

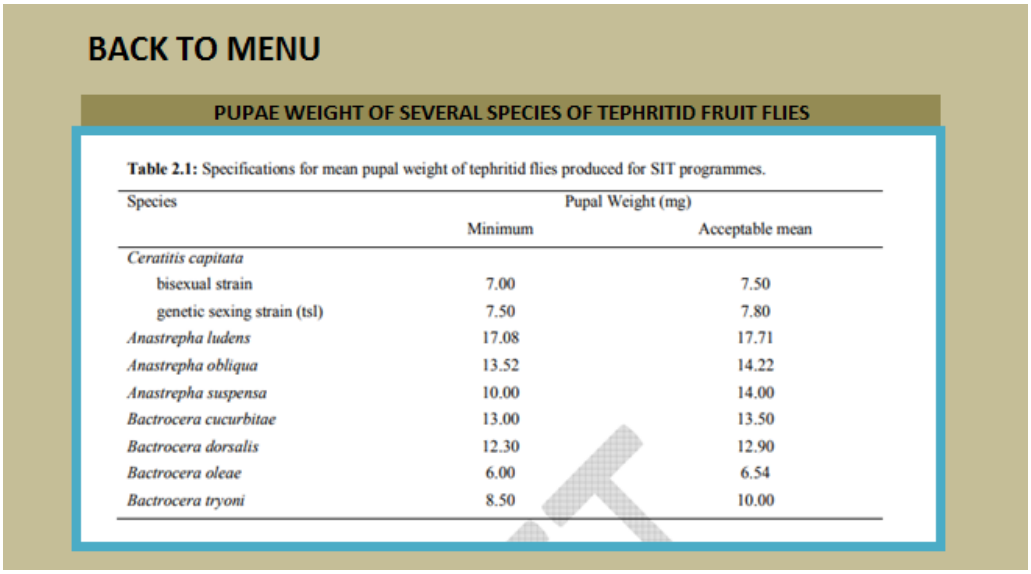
This section on production and quality control standards of the dashboard spreadsheet includes as a reference the values of each of the parameters that measure the quality and the production of mass-produced tephritid fruit flies.

Quality Control Standard Parameters (Sheet 14)

This section is divided into two units:

1.) Three quality control standards tables (2.1, 2.2, and 2.3) that are based on the latest version of the Quality Control Manual for sterile insects, which serves as reference of what is considered an acceptable insect product for tephritid fruit flies (http://www-naweb.iaea.org/nafa/ipc/public/QualityControl.pdf).

- Pupae weight of several species of tephritid fruit flies
- Percent emergence and flight ability
- Percent survival and longevity.



BACK TO MENU

PUPAE WEIGHT OF SEVERAL SPECIES OF TEPHRITID FRUIT FLIES

Table 2.1: Specifications for mean pupal weight of tephritid flies produced for SIT programmes.

Species	Pupal Weight (mg)	
	Minimum	Acceptable mean
Ceratitis capitata		
bisexual strain	7.00	7.50
genetic sexing strain (tsl)	7.50	7.80
Anastrepha ludens	17.08	17.71
Anastrepha obliqua	13.52	14.22
Anastrepha suspensa	10.00	14.00
Bactrocera cucurbitae	13.00	13.50
Bactrocera dorsalis	12.30	12.90
Bactrocera oleae	6.00	6.54
Bactrocera tryoni	8.50	10.00

Figure 21: Example of the Quality control standards tables that will be displayed.

2.) Main standard production measurements that are used to determine and establish the values of the performance of the production process, both the number of pupae per liter and number of liters of larva recover per kilogram of diet are the key parameters used to assess the production performance (these procedures are described in Appendix 1 of this manual).

3.) Other link of interest

User also can be interested on the utilization of "The FAO/IAEA Spreadsheet for Designing and Operation of Insect Mass Rearing Facilities (http://www-naweb.iaea.org/nafa/ipc/public/Spreadsheet-insect-mass-rearing.pdf)

Saving the Spreadsheet

This spreadsheet should be saved as an Excel 97-2003 workbook (*.xls). This format will allow wider access by all users, including those with newer versions of the software.

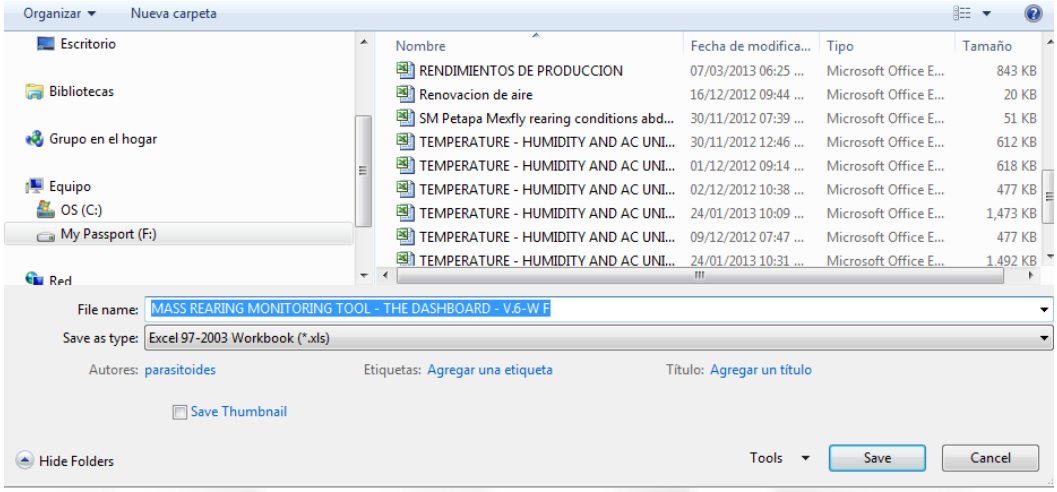


Figure 22: Spreadsheet saving step A.

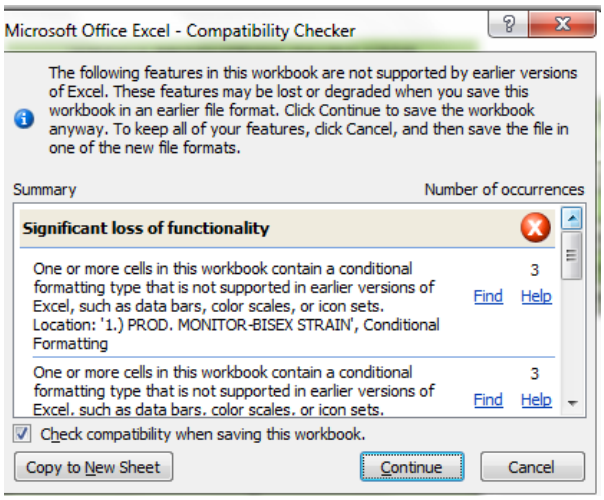


Figure 23: Spreadsheet saving step B.

When saving the file, in Excel 97-2003 workbook (*.xls) a message will show up on your computer screen stating that some features will be lost if the file is saved in an earlier file format. Please maintain the same format and press “Continue” to save the file in the same format in which it was originally designed.

The spreadsheet can also be saved in newer versions of the software for personal use, but it may require some verification that the transfer of data and formulas are operating as originally intended.

APPENDIX 1

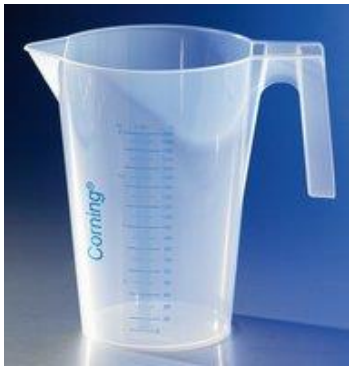
Number of Pupae Per Liter

This value needs to be determined periodically because it is relevant for the final calculation of the total amount of insects produced (normally measured in millions of pupae). The count of pupae per liter is obviously affected by the pupal size, and pupal size is affected by the larval yield per tray.

Number of Larvae (in Liters) Recovered per Kilogram of Larval Diet

Liters of larvae are determined by collecting and measuring the total volume of larvae collected during the operational day. (Optionally it could be established by measuring the volume of pupae, as for some species measuring larvae may be cumbersome). Most of the time, this measurement is also carried out by separating the volumes by batch of diet during the work day. This allows assessing the efficiency of the larval diet preparation and other changes in the process (i.e. different diet, different diet ingredients, etc).

The amount of larvae is measured (hopefully without any foreign material that could increase the volume established) using a graduated plastic beaker, usually of about 2.0 liters. For Tephritidae, this volume is about the correct amount for placement in pupation trays (later the volume could also be verified with the same tray using pupae).



*** TO CALCULATE LITERS OF LARVAE/KG OF DIET	
AMOUNT OF KILOS/TRAY	6.50
LITERS OF LARVAE RECOVERED	0.8860
LITERS OF LARVAE/KG OF DIET (l of L/kg) =	0.1363
FOR ADDED ACCURRACY OF L/Kg DIET CALCULATE A	
MEAN VALUE OVER TIME USING THE GREEN TABS	
1.) PROD. MONITOR-BISEX STRAIN	
2.) PROD. MONITOR-BP STRAIN	