# Crop Pedigree Recording (CPR) Excel Macro: $F_1$ Crosses & $F_{n+1}$ Selection

*Excel Macro Add-In to Generate $F_1$ Crosses and $F_{n+1}$ Selection Pedigree Names (version 4.6.4) K. El-Shamaa[1] and W. Tadesse[2]*

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Symbolic presentation of pedigrees, cross identification numbers, and selection histories are important tasks of any breeding program. Although it may be possible to undertake such processes manually in breeding programs where the number of crosses and subsequent generations on an annual basis are small, in large breeding programs it is cumbersome and erroneous to write pedigrees of F1 crosses manually. In response, ICARDA has developed a free and user- friendly customized Excel macro which automatically generates pedigree descriptors, Breeders Cross ID (BCID), and selection history.

## Pedigree Recording System

A standardized pedigree recording system is used for all crosses types (i.e. simple, double, top and back crosses). Pedigrees provide the parentage or the sequence through which a cultivar was obtained.

In breeding programs, pedigree information for each genotype is generally entered into field books, crossing files, and plot tags.

This Excel macro follows the United States Department of Agriculture (USDA) system of designating pedigrees, which applies standard rules.

As a rule, the female parent is written first, followed by a single slash "/" in the first cross and double slashes "//" in the second cross, followed by the male parent. Thus, if A is the female parent and B is the male parent, the simple cross is represented as A/B.

In the case of a top cross, if a female parent F1 (A/B) is pollinated with a male parent C, the cross is designated as A/B//C. Subsequent crosses with parental materials D, E, F and G are used sequentially, as males are indicated using a number recording the cross order in the following fashion (see columns A & B in Screen Shot 1): A/B//C/3/D/4/E/5/F/6/G
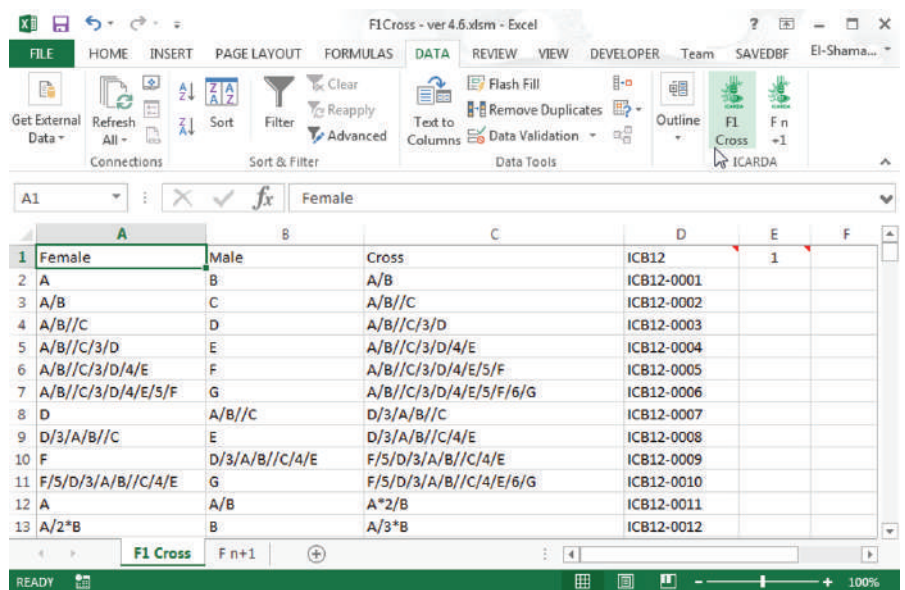
However, subsequent parents D, E, F and G can be crossed alternately as female and then as male, rather than always as a male. As in the first example, the cross would be indicated as follows:

F/5/D/3/A/B//C/4/E/6/G

Backcrosses are designated with an asterisk * and a number indicating the dosage of the recurrent parent. The asterisk and the number are placed next to the crossing symbol that refers to the recurrent and donor parents.

The following examples show pedigree formats with backcrosses:

- A is the recurrent parent: A*2/B
- B is the recurrent parent: A/3*B
- A/B is the recurrent parent: A/B*4//C/D
- C/D is the recurrent parent: A/B//5*C/D



*Screen Shot 1 (CPR macro)*

## How does it work?

List your female parents n the first column "A" starting from the cell "A2" (cell "A1" left for column title) without leaving any blank cell. The first blank cell will refer to the end of the list. Associated male parents should be listed in the next column "B" starting from cell "B2" in the same way.

Once you insert female and male parents' names in the required format, go to the "Data" Ribbon, where you will find the "F1 Cross" button in the new "ICARDA" group at the end of that Ribbon. Click on that button to run the associated VBA macro which will apply the rules of the standardized pedigree naming style for crosses record by record. The resulting cross name will be written in the next column (i.e. column "C" in the current active sheet).

The next column (i.e. column "D") will use the prefix you set in the header cell "D1" (which usually refers to the location, crop, and year. For example the prefix "ICB12" refers to ICARDA, Barely crop, and year 2012). This prefix will concatenate an increment four digits number to the cross ID and a separator "-".

In some cases you may need to start an entry number for a cross ID using a different number, rather than 0001 (e.g. sometimes in back cross/top cross cases you may prefer to start from 20001 for example just to differentiate it from the normal crosses). Therefore users are able to choose the starting entry number for the very first cross in the "E1" cell.

## $F_{n+1}$ Segregating from an $F_n$ List

This functionality is used to generate a $F_{n+1}$ list for segregating populations from the $F_n$ list. You have to list your own data in the "$F_{n+1}$" sheet where the first column (A) has "Selection History (F n)" information gathered during the $F_n$ growing season for each segregating population. All the information will automatically be carried forward into the $F_{n+1}$.

The second column "B" contains the "Location" code which used to identify where and possibly when the selections were made, such as AP12 for Aleppo 2012, for example. The default location code is AP; you have to add the location code only once at the first selection record. The rest of the records will automatically use that location code until you insert a new location code explicitly in any given record. In this case, the new location code will then be used for successive records.
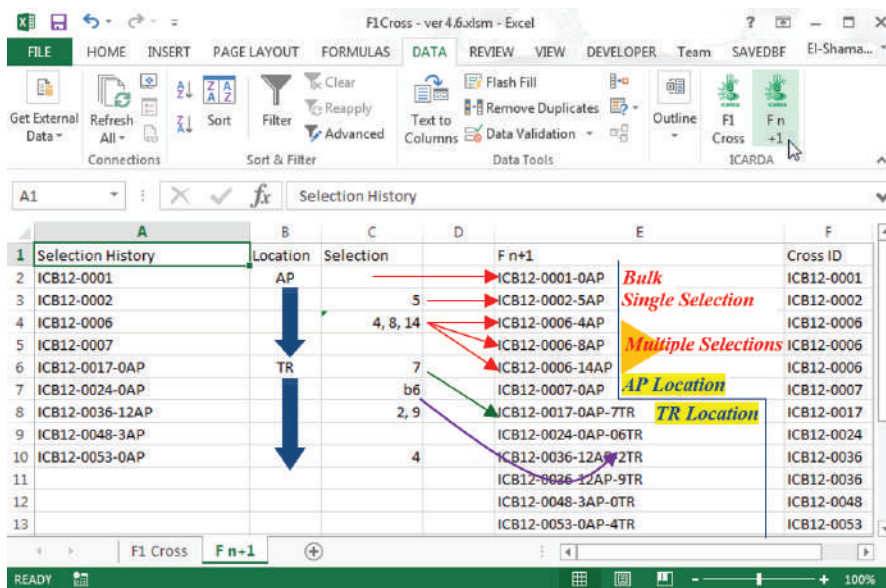


*Screen Shot 2 (CPR macro)*

The "Selection" information should be listed in the third column "C." This will be used to define selection indicators. If the associated selection indicator cell is blank then it refers to a bulk selection, which will be coded by 0. Alternatively, it could also refer to the selected plant number in the pedigree method (you can list a set of numbers using a comma as a separator).

In the case of a selected bulk method, you have to list in the associated selection cell a value like "b6" for example, which indicates that 6 plants were selected and harvested in bulk.

This is important to distinguish it from the pedigree method (in that case the associated selection cell value can be, for example, "6" to indicate that plant number 6 was selected and harvested separately).

Once you insert the required information, go to the "Data" Ribbon, and click on the "F n+1" button in the "ICARDA" group to run the associated VBA macro, which will concatenate the pedigrees in the Fn list (column A), the selection number and the location code. The resulting Fn+1 list will be written in the next column (i.e. column "E") and the "Cross ID" will be extracted and listed in the next column "F".

This macro will also search for the "Cross ID" in the column "D" at the previous "F1 Cross" sheet. If a match is found, then it will copy the associated pedigree listed in column "C" (i.e. "Cross" column at the "F1 Cross" sheet) next to the "Cross ID" column on the "F n+1" sheet. This lookup works fine even if you just copy the associated map of pedigree and Cross ID manually to the "F1 Cross" sheet.

## Notice – Security Warning!

You will need Microsoft Excel 2007 or a later version to run this macro. This Excel macro enabled workbook file (*.xlsm) contains macros written in Visual Basic for Applications (VBA), so that when you open it you will see a security warning for enabling macros. In the case of this spreadsheet, you must select "Enable Macros" or it will not work. If you are not offered this choice, then you must have your security level in Microsoft Excel set at "Medium".
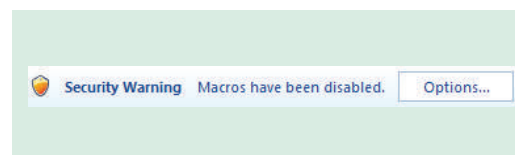
References:
*W. Tadesse, M. Nachit, O. Abdalla and S. Rajaram (2016). Wheat Breeding at ICARDA: Achievements and Prospects in the CWANA Region. In Alain Bonjean, Bill Angus and Maarten van Ginkel (eds).The World Wheat Book Volume 3. A History of Wheat Breeding. Lavoiseier, Paris. ISBN: 9978-2-7430-2091-0.*

*Van Ginkel, M., R. M. Trethowan, K. Ammar, J. Wang, and M. Lillemo (2002). Guide to bread wheat breeding at CIMMYT. Wheat Special Report No. 5. (Revised edition Mexixo, D.F.) CIMMYT.*