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PROCEEDING

THE 3RD INTERNATIONAL CONFERENCE ON MATHEMATICS AND STATISTICS

BOGOR, 5 – 6 AUGUST 2008

Mathematics and Statistics: bridge for academia, business, and government in the entrepreneurial era

3rd ICOMS 2008

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Mathematics and Statistics: bridge for academia, business, and government in the entrepreneurial era

organized by

MSMSSEA (Moslems Statisticians and Mathematicians Society in South East Asia)

Department of Statistics
Department of Mathematics
Institut Pertanian Bogor

Department of Mathematics
Universiti Malaysia Terengganu,
Malaysia

PREFACE

Assalaamu'alaikum warahmatullaahi wabarakaatuh

Welcome all participants of ICoMS 2008 to Bogor – Indonesia. This event is organized by MSMSSEA in collaboration with Institut Pertanian Bogor (Indonesia) and Universiti Malaysia Terenganu (Malaysia).

We, the organizing committee, are very glad having this international conference due to many reasons.

1. ICoMS is a good avenue for mathematicians, statisticians, and other scientist to communicate.
2. ICoMS 2008 has a theme related to entrepreneurial era which is very important for mathematicians and statisticians, and scientist in general.
3. The event is important venue for business group, government, and academia to communicate and share knowledge as well.
4. Bogor is beautiful place in Indonesia surrounded by many research centers, IPB, Botanical garden, an other point of interest related to research institution.

We are also happy that the Vice President of Republic of Indonesia, Ministry of National Education, Ministry of Energy and Mineral Resources, and Ministry of Communication and Information Technology are supporting to the ICoMS 2008.

This event held on two days, August 5-6, and consist of several parts. We invite 17 outstanding professors to share and discuss topics in mathematics and statistics, including application. As many as 170 paper and 30 posters presented during this two-day conference. We appreciate to all of contributor from various countries who are motivated to participate in this event.

High appreciation is also awarded to companies and agencies which facilitate so that the even could run well.

We really hope all participants can benefit many things from this international event. May God bless you.

Wa'alaikumsalam warahmatullaahi wabarakaatuh.

The Committee of ICoMS 2008

CONTENTS

SESSION C

POSTER

Speech of Director General of Higher Education at ICoMS 2008
At Novotel Corralia, Bogor, 5 August 2008

Dr. Fasli Jalal
The Director General of Higher Education
Ministry of National Education, Republic of Indonesia

Bismillahirrahmanirrahim
Assalamu'alaikum Warrahmatullahiwabaraktuh

Good morning ladies and gentlemen
It is a great honor for me to provide a speech in this important scientific event, the Third International Conference on Mathematics and Statistics of MSMSSEA (Muslim Statistician and Mathematician Society in South East Asia). I can see from here that the audiences are of from various countries. So, let me welcome you to Indonesia, a country of great diversity in unity. I think it likes mathematics and statistics that we always find diversities and similarities. As far as I know that these two terms that make science and technology develop rapidly.

Someday a Germany great scientist, who found the Normal Distribution, Carl Fredric Gauss (1777-1855), had mentioned that mathematics, is the queen and servant of science. It is very reasonable statement, becuase mathematics plays an important role in developing science and technology and in the same time it must be reconed in all aspects of science production, preservation and dissemination. Hence, it is a servant of science. In the other hand, all scientists, irrespective their domains have to understand mathematics (including statistics) in order to analyze the problems properly. Thus, it is a queen of science. With its two functions, mathematics with its derivatives has narrowed the gap between the so called hard science and soft science. Hence, there is no exact distinctin between soft and hard sciences. Whatever the sciences, they need mathematics and statistics in order to clarify and simplify the issues. In mathematics and statistics, simplicity is the clarity of mind. However, mathematics and statistics can analyze complex issues. The modelling itself is the simplication of complicated real world.

Ladies and gentlemen
Let me talk about about sscience, mathematics and technology which are well-known as the tripod in an unknown area. All scientists who have achieved high standing positions in science reputation always have strong mathematical background. Hence, they can see the things that the other people can't see, also they can predict that the other people can't predict. Their deductive as well as inductive thinking are both adequate. These two ways of thinking are essential in research and science development. Deductive reasoning is considered mathematical way of thinking, while inductive is statistical way of thinking. Both type of reasoning are the key factors of scientific circle, without them the science development is stagnant. The Kuhnian model of scientific revolution occures when the deductive and inductive thinking are accomodated well in a society. Hence, education has to provide great room for student to flourish their reasoning. Their brain for deductive and inductive thinking can develop if the school gives enough space for student creativity. Hence, they can think freely and try to find facts, which are called data in the statistical term, to proof their ideas. A great Indonesian statistician, Prof. Nasoetion (1932-2002), someday mentioned 'In God we trust, all other bring data'.

The challenges are to find the ways in order to facilitate the students to love science and mathematics. After they love and understand the important of science and mathematics as well as stimulated by realities, finally they can develop technologies. Hence, the three point of the tripod are interconnected and progess well in a conducive ecosystem. Many technological problems influence the mathematical and science development, and at the end have made the society developed and their income increased. However, the conducive academic atmospehere is needed in order the tripod of science, mathematics, and technologies can develop well. For example, the problems of communication and information have made topology, number theory, and graph theory which are needed in developing information technology. This phenomenon has created big market for the mathematicians and statisticians. Finally, without strong mathematics (including statistics) the technologies as well as the economy are stuck. In other word, there is no great economy without great mathematics and science. Hence the economic development is termed as knowledge-based economy or K-economy. There is no K-economy in society with poor knowledge. In other words, K-economy can only develop well in the society, who understand knowledge. This society is called knowledge-based society or K-society. I am sure that all scientists in this room agree with me that the developing countries have to be the K-society in order to lead the world. Otherwise, we are only the followers.

Ladies and gentlemen.
I understand that one of the clusters in theis conference is 'mathematics in education processes. I believe this is very important for scientist and professors of higher education to pay enough attention to the basic and secondary education, especially in cultivating the important of mathematics and science for emerging technologies. Students with poor comprehension of mathematics can be predicted will have difficulties in facing complex subjects. Therefore, the universities have obligations to make the basic and secondary education understand well the fundamental principles of mathematics including their mathematical skills. Since the pupils are the main sources of the future scientists and technologists, their foundation in basic science and mathematics is greatly important. Hence, interesting method of subject delivery is key factor for the pupils to comprehend mathematics. So, one of important services of higher education to society is to train the teacher of lower education in order to follow new frontier of science. They need to be up dated. This service has direct and indirect positive effect to the universities. The direct effect is to obtain high quality of student intake, while the indirect one is to share knowledge to the society.

I fully agree with the theme of the third ICoMS "mathematics and statistics as a bridge for academia, government and business in the entrepreneurial era". This theme implies some consequences, such as: mathematics and statistics are not just passive subject to be learned or memorized, they must be considered as active materials to be understand creatively and hence finally the scientists can produce mathematics and statistics. In other words, students have to learn mathematics and statistics actively including the basic theory and their application. It is understood that inside the airplane there exist complex mathematics and statistics. Without strong mathematics and statistics, the airplane cannot fly appropriately. This example can be extended into many areas of life and technologies, including medicine, social sciences, economy, business, politics, public health, biotechnology, manufacturing, civil engineering, energy, and so on. However, to produce mathematics and statistics needs entrepreneurial soul. Hence collaboration among stakeholder from various institutions is needed in approaching the complex issues in the entrepreneurial era.

For our fellows from the private sectors, one easy way to help mathematicians and statisticians is to provide education programs on CSR (Corporate Social Responsibily). For example we can build a

mathematics fellowship program, mathematics and statistics entrepreneurial award, entrepreneurial rsearch competition, and many other thins. For implementing these ideas, we are more than happy to collaborate with the private sectors.

Ladies and gentlemen
At the present time, almost all countries are shifting their concept of development from centralism to decentralism. The paradigm shift is also recognized by international bodies, like The World Bank. Hence, the role of scientists including mathematicians and statisticians are getting crucial. Why? Because regional development without strong human resource is difficult. The local governments certainly need knowledge for their regional planning. Mathematicians and statisticians can collaborate with the local government in creating and measuring some tangible indicators for government strategic planning and road mapping. Otherwise, the plan is too normative and uneasy to measure. As a result, the progress of development cannot be evaluated objectively. Number is not everything in lives, but lives without number is nothing. Hence, cooperative action among academia, government and business is 'a must'.

To optimize the opportunity, let me provide you some assignment to formulate what is the role of mathematicians and statisticians in the economic holistic development. While you are presenting your research papers, maximize your present here to have such discussion on mathematics related to regional development, entrepeneruship, environment, food and energy resources including the process of education and research. It looks simple but needs a well trained mathematicians and statistician like you all. I believe you can produce innovative approaches which are useful for the Indonesian government, universities, research centers, private sectors, and other community. Your thought is surely needed by other participants coming from various countries.

Finally, I envoy my deep gratitude while hoping you enjoy this conference and other activities organized by MSMSSEA. I hope you are always fresh and health with full enthusiasm in participating the important event.

Selamat berkonferensi dan terima kasih.

Billahittaufiq wal hidayah
Wassalamu'alaikum warahmatullahi wabarakatuh
Dr. Fasli Jalal

PBSTAT: A WEB-BASED STATISTICAL ANALYSIS SOFTWARE FOR PARTICIPATORY PLANT BREEDING

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Abstract. *Indonesian agriculture areas were dominated by variation in agro-ecological and socio-economic conditions implies that formal plant breeding (FPB) programs less effective compare to parcipatory plant breeding (PPB). However to improve genetic gain in PPB, should be supported by simple statistical program. PBSTAT was developed in order to meet the needs of simple statistical software for selection and trials in participatory breeding approach. This software is programmed using PHP scripting language, therefore can be utilized on web platform, and provides easy access for its users to do the statistical analysis. The user can use common spreadsheet software for data entry and web browser to run the analysis. The main feature of PBSTAT is analysis of variance (ANOVA) for analyzing variety trials in one location (using one factor RCBD), multi-locations, and multi-seasons-locations (combined analysis of several RCBD trials across seasons and locations). Mean differences can be compared using Tukey's HSD method. Other important feature of PBSTAT is stability analysis using Finlay-Wilkinson method. This feature is very useful for the breeder conducting several participatory trials to elucidate which genotypes are stable across environments, and which one are environment-specific.*

Keywords*: statistical software, combined ANOVA, broad-sense heritability, stability analysis*

1. Introduction

Indonesian agriculture areas were dominated by variation in agro-ecological and socio-economic conditions implies that formal plant breeding (FPB) programs less effective compare to parcipatory plant breeding (PPB). PPB is defined as plant breeding program that involving researchers, farmers, and other stakeholders such as consumers, vendors, industries, extension and farmer groups (Sperling *et al.*, 2001).

One of the most important thing to consider in PPB trials is interaction of genotype and environment. The effect of the environment is therefore a distraction in the genetical analysis, and our aim will thus be to isolate it and set it on one side in the analysis rather than to make it subject of analysis in its own right, except of course where genotype and environment interact in producing their effects (Mather and Jinks, 1982). Genotypic main effects (i.e. differences in mean yield between genotypes) provide the only relevant information when genotype x environment (GE) interaction effects are absent or ignored (Annicchiarico, 2002).

In the data analysis point of view, there is many statistical analysis software existed to meet the needs of combined analysis. However to improve genetic gain in PPB, should be supported by simple statistical program. PBSTAT was developed in order to meet the needs of simple statistical software for selection and trials in participatory breeding approach. Utilizing the web technology, this software provides easy access to do PPB's combined analysis.

2. Software features

2.1 The platform

PBSTAT is using web platform. The reason is because we want this software to be available widely over the internet. It will make its users, especially plant breeders, can use it easily. They don't need to install this software in their PC. They just require a web browser to run PBSTAT. We have tested it with Microsoft® Internet Explorer 6 and Mozilla Firefox 3 web browser. Using web browser, just point to http://web.ipb.ac.id/~agrohort/pbstat to access this software.

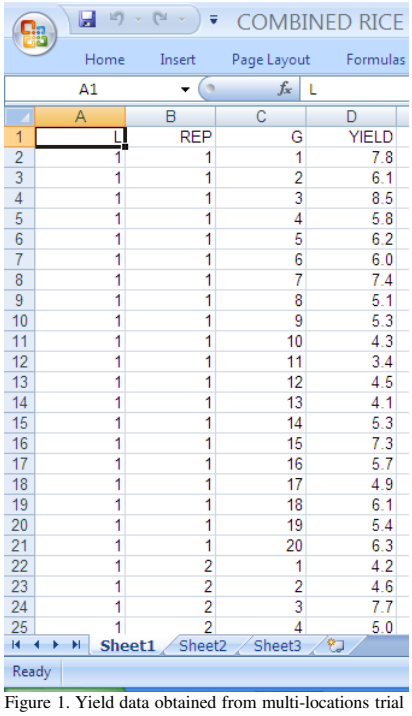
We are using PHP: Hypertext Preprocessor, a famous web programming language to develop this software. The scripts are processed server-side, and the outputs are sent as HTML page. The software can be hosted over the internet, or distributed in CD using a packaged web server software embedded with PHP, such as Server2Go (Haberkern, 2008).

2.2 The data file

Here we use a sample data set from rice yield evaluation trials conducted in four locations (Aswidinnoor *et al.* 2007, with one location added). In each location, 20 genotypes are arranged in Randomized Complete Block Design (RCBD) with three replications. Yield observed at each experimental plot and then converted to ton/ha at 14% moisture content.

Field-collected data inputted in a Microsoft® Excel worksheet (Figure 1). The first row is used only for the name of factors or variables, and the following rows could be contain either labels or observation data. The name of factors or variable must be all in lowercase or uppercase, and without spacing. Note that PBSTAT is using some reserved letters or word to define the session, location, replication, and genotype factors, which is Y, L, REP, and G respectively. If we want to add another character, such as plant height and 100 g seed weight, simply input the data in the right column after YIELD.

The data file has to be saved in Microsoft® Excel 2000/XP/2003 format, with the "xls" extension. In this example, name of data file is "COMBINED RICE 4 LOC.xls". The Excel data file can be directly imported by PBSTAT. Note that data file must be closed before imported.



	A	B	C	D
1	L	REP	G	YIELD
2	1	1	1	7.8
3	1	1	2	6.1
4	1	1	3	8.5
5	1	1	4	5.8
6	1	1	5	6.2
7	1	1	6	6.0
8	1	1	7	7.4
9	1	1	8	5.1
10	1	1	9	5.3
11	1	1	10	4.3
12	1	1	11	3.4
13	1	1	12	4.5
14	1	1	13	4.1
15	1	1	14	5.3
16	1	1	15	7.3
17	1	1	16	5.7
18	1	1	17	4.9
19	1	1	18	6.1
20	1	1	19	5.4
21	1	1	20	6.3
22	1	2	1	4.2
23	1	2	2	4.6
24	1	2	3	7.7
25	1	2	4	5.0

Figure 1. Yield data obtained from multi-locations trial

2.3 The interface

Because of its specialized feature, the first screen of PBSTAT 1.0 software directly shows an query form for PPB's data analysis (Figure 2). In this form, we have to browse data file (in Microsoft® Excel format), choose type of trial, and define response variable(s) according to the data file's column name(s). Those form elements are mandatory. Moreover, we can select further data analysis, those are estimation of broad sense heritability (h^2_{bs}) and Finlay-Wilkinson stability analysis. Finally, a click on "Show" button will run the program and outputs the result.

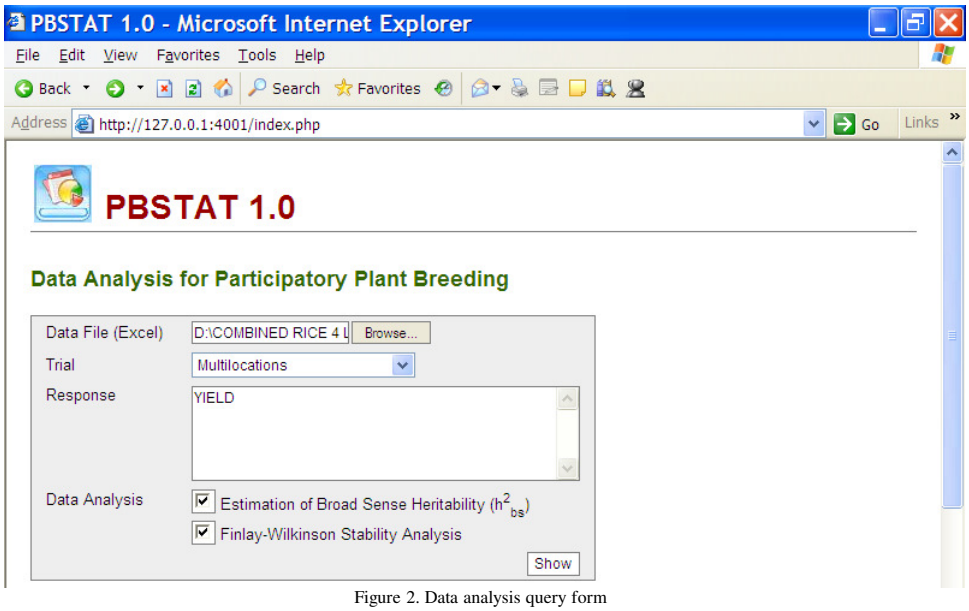


Figure 2. Data analysis query form

2.4 The output

Output of ANOVA presented in Figure 3. In this example, the dependent variable is YIELD. To make a "common" heritability estimation by using the Expected Mean Squares in combined analysis (Comstock and Moll, 1963; Darrah and Mukuru, 1977), G and L here are assummed as random factors. Therefore, G is tested to G*L and G*L is tested to Error (Annicchiarico, 2002). In SAS program, we have to do this way using "test h = … e = …" statement after MODEL in PROC ANOVA (SAS Institute, Inc., 2003). The summary of ANOVA table presented after the series of ANOVA tables. If there is more than one variable analyzed, the summary table will contains ANOVA's summary of all variables.

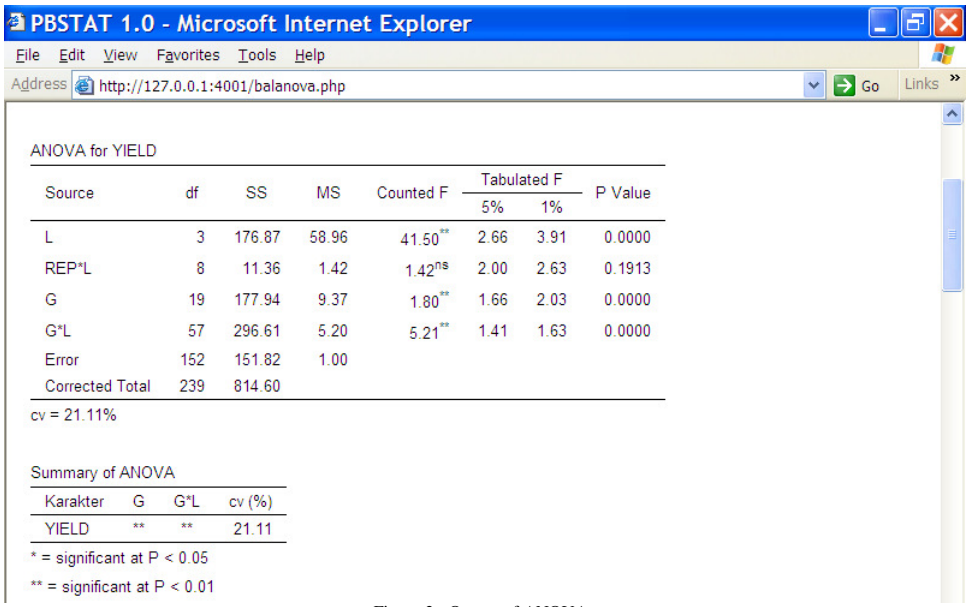
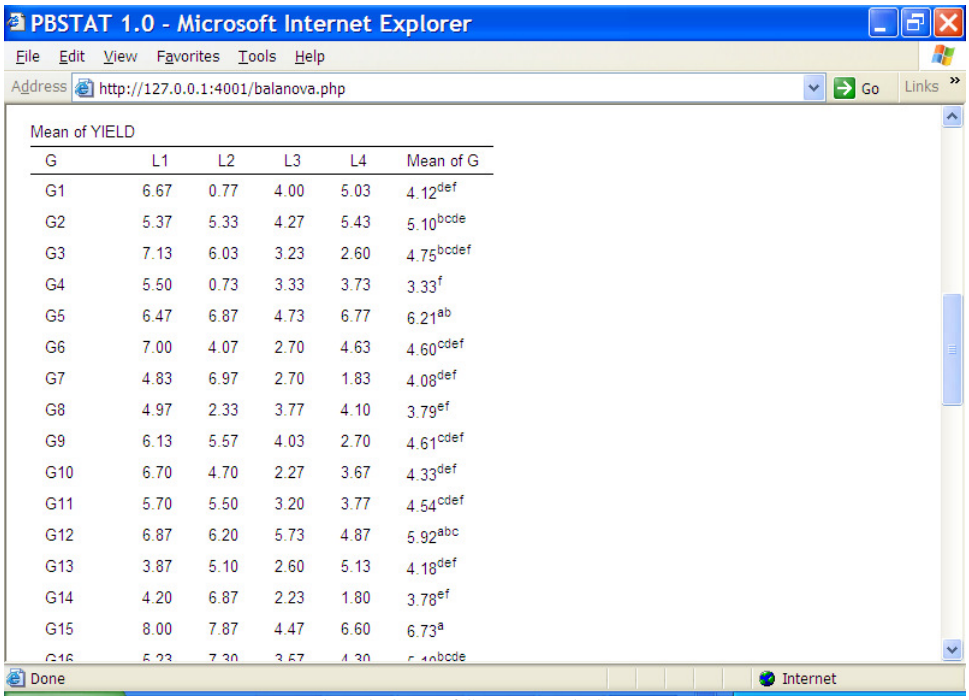


Figure 3. Output of ANOVA

However, for precise result of combined analysis, it's suggested to do the ANOVA for each locations first, and then check the homogeneity of variance among locations using chi-square test. If the variances are homogene, we can use the pooled error mean square in combined analysis. (Gomez and Gomez, 1984; Koopmans, 1987). Unfortunately, the "automatic" ANOVA for each location using combined data set, as using "BY" statement in SAS's PROC ANOVA (SAS Institute, Inc., 2008), has not supported by PBSTAT yet.

Below the summary of ANOVA, PBSTAT also outputs GxL means (Figure 4). The means presented in two-way tables, with the mean of each G and L showed on the right and bottom, respectively. If there is a significant effect of G, L, or GxL factor the mean number is followed by HSD letter to show the differences between means. We limit the HSD comparisons to 20 sample means, which is the same as the maximum number of treatment means in q table (May *in* Steel and Torrie, 1980). Therefore, the letters doesn't appear in this example's GxL means (Figure 4).



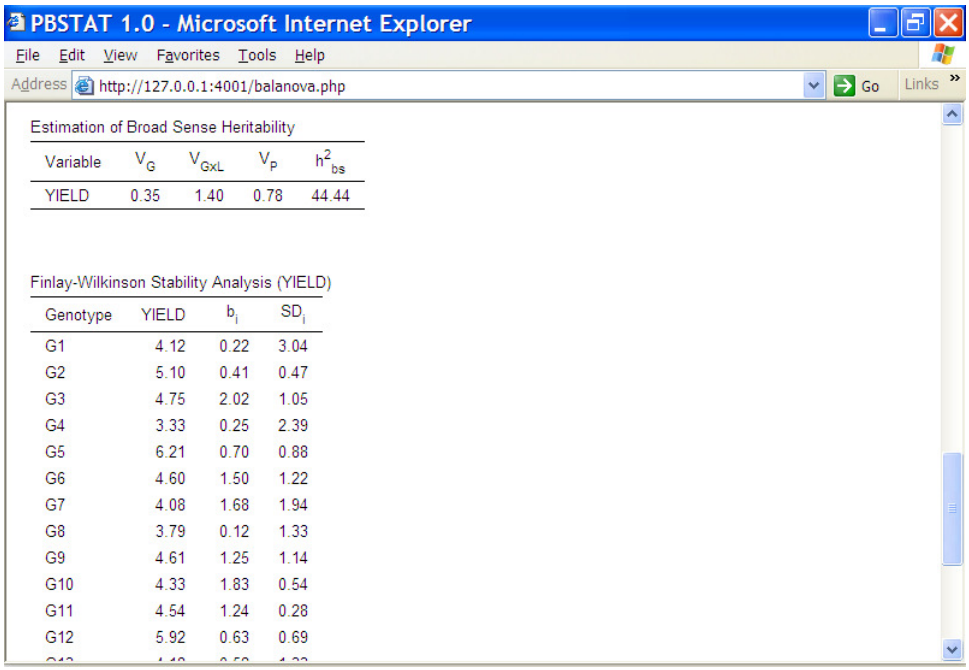
Mean of YIELD

G	L1	L2	L3	L4	Mean of G
G1	6.67	0.77	4.00	5.03	4.12^{def}
G2	5.37	5.33	4.27	5.43	5.10^{bcde}
G3	7.13	6.03	3.23	2.60	4.75^{bcdef}
G4	5.50	0.73	3.33	3.73	3.33^{f}
G5	6.47	6.87	4.73	6.77	6.21^{ab}
G6	7.00	4.07	2.70	4.63	4.60^{cdef}
G7	4.83	6.97	2.70	1.83	4.08^{def}
G8	4.97	2.33	3.77	4.10	3.79^{ef}
G9	6.13	5.57	4.03	2.70	4.61^{cdef}
G10	6.70	4.70	2.27	3.67	4.33^{def}
G11	5.70	5.50	3.20	3.77	4.54^{cdef}
G12	6.87	6.20	5.73	4.87	5.92^{abc}
G13	3.87	5.10	2.60	5.13	4.18^{def}
G14	4.20	6.87	2.23	1.80	3.78^{ef}
G15	8.00	7.87	4.47	6.60	6.73^{a}
G16	5.23	7.30	3.57	4.30	5.10^{bcde}

Figure 4. Output of GxL means and HSD test

The estimation of broad sense heritability is presented below the GxL tables, followed by the Finlay-Wilkinson stability analysis (Figure 5). The estimation of broad sense heritability showed genetic variance (V_G), interaction between genetic and location variance (V_{GxL}), phenotypic variance (V_P), and the broad sense heritability (h^2_{bs}) which is the ratio of V_G and V_P in percent (Darrah and Mukuru, 1977). For advanced breeding lines, the higher h^2_{bs} showed the better repeatability across environments.

The Finlay-Wilkinson stability analysis presented the genotype number, followed by its yield, bi, and SDi. Finlay-Wilkinson proposed the regression coefficient for each genotype, b_i, as a stability parameter. The observed value are regressed on environmental indices defined as the difference between the marginal mean of the environments and oer all mean. A genotype considered to be stable if its response to environment is parallel to the mean response of all genotypes in the trial (Lin *et al*., 1985). Genotype has bi = 1.0 considered dynamically stable. The b_i value greater than 1.0 expect the genotype is suitable for more favorable environments, otherwise the b_i value less than 1.0 expect the genotype is suitable for less favorable environments.



Estimation of Broad Sense Heritability

Variable	V_G	V_{GxL}	V_P	h^2_{bs}
YIELD	0.35	1.40	0.78	44.44

Finlay-Wilkinson Stability Analysis (YIELD)

Genotype	YIELD	b_i	SD_i
G1	4.12	0.22	3.04
G2	5.10	0.41	0.47
G3	4.75	2.02	1.05
G4	3.33	0.25	2.39
G5	6.21	0.70	0.88
G6	4.60	1.50	1.22
G7	4.08	1.68	1.94
G8	3.79	0.12	1.33
G9	4.61	1.25	1.14
G10	4.33	1.83	0.54
G11	4.54	1.24	0.28
G12	5.92	0.63	0.69

Figure 5. Output of Estimation of Broad Sense Heritability and Finlay-Wilkinson's Stability Analysis

3. PHP functions

3.1 Data reading and statistical tables

Excel data file are imported using PHP-ExcelReader utility (Tkachenko *et al.*, 2008). The F table and P-value are provided by PDL Library (Meagher *et al.*, 2008). The qtukey alogarithm (Trujillo-Ortiz and Hernandez-Walls, 2003) is used to estimate the q studentized range critical value for HSD test.

PHP functions mostly used to store, read, and manipulate data are the array functions. For example, *foreach* statement is frequently used to do some calculation on array keys or values (Bakken *et al.*, 2008; Schwendiman, 2001).

3.2 Estimating broad sense heritability

PHP functions to estimate broad sense heritability for multi-locations trial is presented in Figure 6. We named it heritability2, where the heritability1 and heritability3 function will estimate heritability for single and multi-seasons-locations, respectively. The heritability2 function simply required the number of replication and location, as well as G, G*L, and Error mean square. It will calculate the genetic variance ($var_G), interaction between genetic and location variance ($var_GL), phenotypic variance ($var_P), and the broad sense heritability ($h_bs). Finally, it will return those three values in one-dimensional array. We can access the array's values and present it in tabluar format like Figure 5 above.

```
function heritability2($r, $l, $ms_G, $ms_GL, $ms_E)
{
   $M1 = $ms_E; $M2 = $ms_GL; $M3 = $ms_G;
   $var_E = $M1; $var_G = ($M3-$M2)/($r*$l);
   $var_GL = ($M2-$M1)/$r;
   $var_P = $var_G + ($var_GL/$l) + ($var_E/($r*$l));
   $h_bs = ($var_G / $var_P) * 100;
   $ret = array($var_G, $var_GL, $var_P, $h_bs); return $ret;
}
```

Figure 6. PHP function for estimating broad sense heritability in multi-locations trial

3.3 Finlay-Wilkinson's stability analysis

We create PHP function fw_stability to do the Finlay-Wilkinson's stability analysis (Figure 7), based on its formula (Lin *et al.*, 1986) . The function will require two parameters, $G_value and $L_value. Both of them are two-dimensional array. In $G_value array, [G1][L1] is the yield mean of Genotype 1 in Location 1. This value will be paired with the same element ([G1][L1]) in $L_value array, which contains the Location 1 mean over all genotypes. The fw_stability function will outputs $fw_parameter, which is an one-dimensional array. The array contains three values: genotype mean ($G_mean), b value ($b), and SDbi value ($se). Same as heritability functions, we can output those values in tabular format like Figure 5 above.

```
function fw_stability($G_value, $L_value)
{
   foreach($G_value as $key => $value)
   {
      $n = count($value);
      $G_mean[$key] = array_sum($value) / count($value);
   }

   foreach($L_value as $key => $value)
   {
      $L_mean[$key] = array_sum($value) / count($value);
   }

   foreach($G_value as $key => $value)
   {
      foreach ($value as $key2 => $value2)
      {
         $ypow[$key] += pow($value2 - $G_mean[$key], 2);
         $xpow[$key] += pow($L_value[$key][$key2] - $L_mean[$key], 2);
         $xy[$key] += ($value2 - $G_mean[$key]) * ($L_value[$key][$key2] -
         $L_mean[$key]);
      }

      $b[$key] = $xy[$key] / $xpow[$key];
      $se[$key] = sqrt((1/($n-2)) * ($ypow[$key]-(pow($xy[$key],2)/$xpow[$key])));
   }

   $fw_parameter = array($G_mean, $b, $se);
   return $fw_parameter;
}
```

Figure 7. PHP function for Finlay-Wilkinson's stability analysis

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