Reduce Expenses by Reusing Consumables for the DNA Extraction Department

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Abstract *— The genotyping lab has been spending an excessive amount of the budget on E-Z 96 DNA plate (plastic plates for storing samples). The plates contain the samples trough the sample collecting process in the field and the DNA extraction process. Through both process the sample plates are expose to high stress. Even though the stress which they are expose; most of the plates are being dispose in new like conditions. The plates, after a visual inspection show that have the potential of being reuse in the process. The possibility of reusing theses consumables in the laboratory could decrease the expresses approximately 80%. An experiment was executed which statistics results determine than enabling the reuse of the sample plates has no negative impact in the data produce by the genotyping laboratory and will generate savings in expenses cutting the purchase of 40,000 plates to an amount of 7,000.*

Key Terms *— Budget, Genetics, Savings, Statistical Analysis.*

PROJECT STATEMENT

Yearly, the genotyping lab of the company purchases 40,000 E-Z 96 DNA plate. The plates are fabricated to hold several samples and solutions one being Plant DNA, it may hold a quantity of 1 mL of solution [1] which are used in the sample collection process which takes place in the field, then it's proceed with the DNA extraction or insulation process to generate the plants genotype and to delivered the data to our customers. The DNA extraction consists in several chemicals and physicals techniques. During the process lyses of the leaf cells will occurs for the buffer dispensed in the E-Z 96 DNA wells may react in the purification molecule. Once the process of DNA Extraction amplification and genotyping analysis is concluded plates are disposed. After a visual inspection, it was notice that plates are being disposed and they appear to be in almost the same conditions as they were purchase. Then the big questions were raised, are the plates reusable? Reusing plates could have impact in the data generated? If reusing plates is possible, how many times they could be reused? How much the company would save if the plates are reused? This questions lead to an experiment to enable the possibility of reusing the sample plates; which will lead to net savings.

RESEARCH DESCRIPTION

On DNA Extraction department, once their process is completed the team will dispose the buffer and DNA waste and will recycle the plastic plates. Recycling plastic generates no income for the company; it is performed to reduce the solid waste and comply with environmental stewardship. Each plate sample cost $3.50 which represent $168,000 yearly expenses after processing 40,000 *E-Z 96* plates on a year. Even though recycling plates is a great initiative, it is not the most efficient use of recourses; meaning that $168,000 is an excessive amount for sample containers. Reusing these consumables will enable a great amount of savings and will have a more significant impact to the environment, do to reusing an item is more convenient to the environment than to recycle it.

RESEARCH OBJECTIVE

The main objectives of the project are:

- To determine if the plates are reusable without the presence of contamination of prior samples nor cross contamination.

- Developing an efficient cleaning procedure that eliminates possible residues from samples and buffer waste.
- Determining the number of time a plate can be reuse
- Establishing net savings in expenses for the company.
- Implementing a reusing process of consumables, which has a grater positive impact in the environment than recycling the raw material.

RESEARCH CONTRIBUTIONS

Enabling the reuse of consumables will decrease drastically the unnecessary excusive amount in yearly expenses in E-Z 96 DNA plate. The possibility of being able to reuse plates more than once will result in regain the project investment in a short period of time. Being able to reuse plastic consumables will continue to decrease the waste that will be in need of recycling continuing to comply with the environmental stewardship responsibility of the company.

LITERATURE REVIEW

In the agriculture business breathing to achieve desirable characteristic could be extremely complicated. Breathing according to the phenotype of the plants could end up in a product very far to the one targeted. If you take in consideration the genomic information of the plants when breathing, the breather will have all the information needed for the right decisions. In the DNA Research and Genotyping Lab, plant leaf tissues are the main targets in the studies. Plants with different genotypes are plated in the field, which DNA will be analyze to identify desire genes that will express different characteristics in the plats. The DNA is a molecule present in every living organism that contains the genetic instructions for the development of each organism. This molecule is compose by 4 main amino acid; Adenine (A), Thymine (T), Cytosine (C) and Guanine (G). Specific genes will codify for a specific characteristic of the organism as shown by Dr. Rob Brooker, Dr. Eric Widmaier, Dr. Linda Graham, and Dr. Peter Stiling [2].

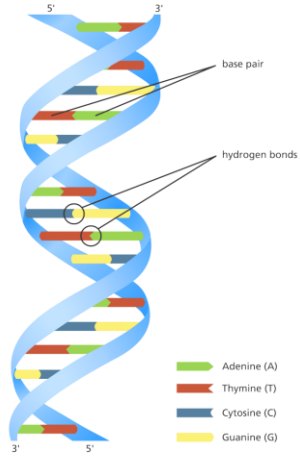

Figure 1
DNA Molecule: Cytosine, Guanine, Adenine and Thymine Bonds (Image credit: Genome Research Limited)

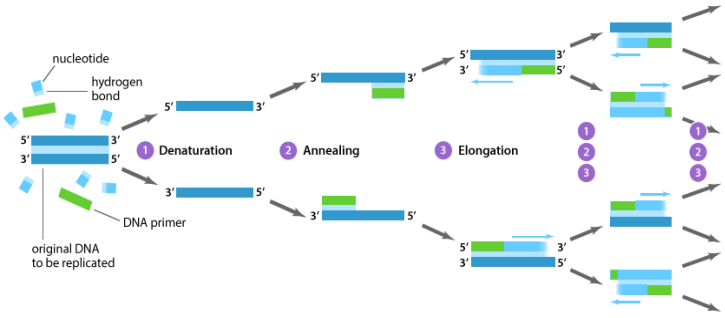

Figure 2
Polymerase Chain Reaction
(Figure from *2016 ABM Inc.*)

After performing polymerase chain reaction (PCR) where a single or a several copies of a DNA molecule can be amplify by several thermal cycling reaction as explain by Alan G. Atherly, Jack R. Girton, John F. McDonald [3] to perform genotype analysis it that will determine which plant will express which characteristic; the undesirable plant and candidate crops for the costumers.

E-Z 96 DNA plate (plastic plates for storing samples) will be used to collect leaf sample for each plat that is desire to analyze. These plates contain 96 wells; the sample will be introduce in a plastic tube that will be located in the correct well of the plate.

After gathering all 96 samples in each plate, they will be delivered to the research lab. Yearly an amount of 40,000 plates can be analyze. Once in the lab, the first department that works on their analysis is the DNA Extraction; then it goes through the PCR reaction where the DNA is amplify and the end process would be the DNA Analysis.

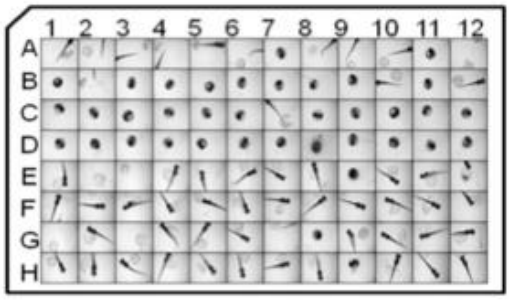

Figure 3
E-Z 96 DNA Plate

For the DNA extraction each plate will go through an automated process well each well that contains a sample will received two steel BBs (steel ball bearings) that will serve their function in the grinding process where the cell lyses will occurred and an X amount of buffer will be dispensed for the extraction part of the process. After dispensing both, the BBs and the buffer the plates will be sealed for the grinding. After the lyses of the tissue, each plate will be incubated at high temperatures which prevent the DNA degradation by enzymes such as Desoxyribonuclease (DNas). Before the DNA analysis the next step will be the polymerase chain reaction or PCR. In this process an amplification of a single or few copies of the DNA strand will occur by a thermo cycle chain in the presence of DNA Primers.

Processing over 40,000 E-Z 96 DNA at a cost of $4.20 per plate, represent a cost of $168,000. After carefully studying the process it was notice that at the end, the E-Z 96 DNA plates were almost intact and very much useful. The plates at this point are being recycled. The target of the project is to reuse the plates that are in good conditions and determine the amount of time they are reusable. To prevent the cross contamination within samples; the tubes containing residues from the previews sample, need to be extracted from the plate to insert new tubes with new samples before the moment they are reuse.

METHODOLOGY

The purpose of the project is to prove that reusing the E-Z 96 DNA plates have a positive financial impact for the company. The investments in equipment and salary for the operators to reuse the 40,000 field plate, will not surpass $168,000 in expenses; which will result in net savings for the company. For the project to be a success several metrics has to be documented such as time of use of each plate, percentage of usable plates after each use and cost of cleaning process.

The project will consist of 100 test E-Z 96 DNA plate that will be incorporates simulating the production process. After each round of process there will be a count of how many plates are reusable. During the production process some plates will crack or the skirts will break, causing them to be unusable in production. In each run of production there will be a percentage of plate that will be lost, the first step will be to determine and average of plates that is lost in each run. While the experiment is taking place to determine if plates are reusable, establishing the amount of time each plate can be reuse will determine the total savings. In theory there is a maximum amount of times each

plate can go through the stress production will cause. Both metrics documented in this first tow part will determine the net savings reusing plates may represent. The experiment will take place while plates are still available or to reuse plates up to 5 times representing 5 cycles per year.

Each cycle will be dived into 3 main steps: Tissue Sampling where operators will visit the fields and collect leaf samples from the plants; DNA Extraction where in the laboratory operators will dispense buffers, grind tissue and incubate plates to conclude with the extraction process; and finally to enable plates to be reincorporated into the process an operator will clean plates off from buffer and tissue waste. Each of the steps per cycle will have duration of one day. The experiment will have duration of 15 labor days but to conclude the experiment will take 19 calendar days.

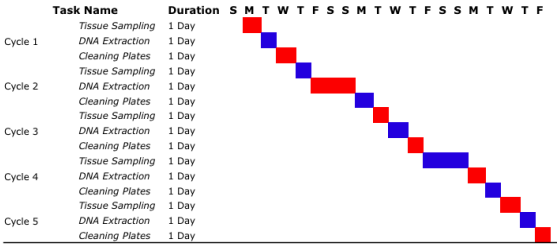

Figure 4

Gantt Chart: Reusing E-Z 96 DNA Plate

To determine the final savings, the metrics of the cost on reusing plates will be studied. This cost are represented on every task of making each plate reusable again, which is basically cleaning them from previews samples, removing the tubes containing old samples and discarding any plates that did not met the production specifications. This also will include the salary of the operators performing the task. Once all the metrics are documented; with the contrast of both saving and costs will determine the viability of the project.

Enabling the process, if the results are profitable the procedure will consist in seven main steps, which are suggested that will provide savings for the company. As mention before, the process will consist in the collection of the samples, which are desire to analyze in the lab. Once the samples are placed in the plates' wells, the samples will go through the DNA extraction process. Once the genomic information has been analyzed, the buffer waste will be disposed. The plates will be inspected and the damage plates will be separated to be recycled with the rest of the plastic waste. The acceptable plates will be cleaned off from any residue of the samples and buffer. Plates will be packed and shipped and then be incorporated back into the process. At this point it is suggested that the company will star to see savings in the process.

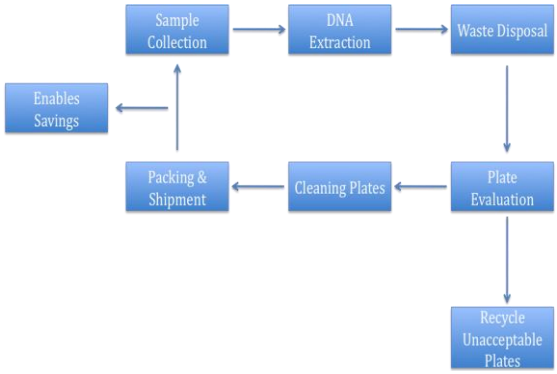

Figure 5

Flow Chart for the Reuse of E-Z 96 DNA Plate

RESULTS AND DISCUSSION

One hundred test plates went through the process of collecting samples in the field. The plates were delivered to the research lab to proceed with the production process. Every plate was exposed to the automated equipment use for the processes such as buffer dispensing, grinding of the tissue and high temperature incubation; which are standard steps performed for the DNA extraction. The plates received high stress since the moment they are in they are in the filed until the end of the DNA extraction process.

The test plates purpose, is to show that the plates are fabricated strong enough to be expose to the field and lab stressed conditions; and the plates conclude the production process in conditions more than acceptable to be re-expose to the process several times.

When the initial cycle was concluded, the plates were inspected and it was notice that two

plates were crack. This damage could end up in sample cross contamination or even sample loss if they are reused. Crack plates will be determined as not acceptable or not reusable. After the inspection it was determine that 98% of the plates were reusable at this moment.

Proceeding with the second stage of the experiment, the 98% of the reusable plates were reincorporated in the process. The reusable plates were delivered back to the field where they will be reuse and new samples will be collected in the plates used; then plates took part in the DNA extraction process once again. The cycle was repeated a total of five time, from the sample collection in the field until the end of DNA extraction.

After the five cycles the experiment was concluded and the metrics showed that the stress caused by the process damaged an average of 1.65*%* plates per cycle. The unusable plates showed damages such as cracks, bends debilitating the sample containers, broken edges; in the end any, indication that could end up in cross contamination in any sample or sample loss. Each cycle is broken down in the following chart.

Plates Available		Plates Damage	Percentage of plates damage per Cycle
Cycle 1	100	2	2.00%
Cycle 2	98	1	1.02%
Cycle 3	97	3	3.09%
Cycle 4	94	1	1.06%
Cycle 5	93	1	1.08%

Figure 6
Reuse Plates per Cycle

After reusing plates trough 5 cycles, the experiment determines that 92% of the plates were reusable up to six cycles. Eight plate lost through the process per cycles showed that, an average of 1.65% of the plates are lost every time plates are reuse. Plates will be replaced yearly; there for they will be used a maximum of 6 times.

	Plates To Purchase	*Expenses*
Initial Purchase	6,667	$ 28,001.40
Damage plate Replacements	660	$ 2,772.00
Total	7,327	$ 30,773.40

Figure 7
Expenses after Deployment

Taking in consideration the lost plate percentage, the initial purchase will increase 660 plates; concluding with an initial investment of 7,327. This change would reduce the expenses in plates by 81.68%.

For the plates to be reused, the buffer with the samples needs to be disposed and the plates need to be clean from any tissue left in the wells. A temporary employee or an intern will hired to perform this task; the salary pay by the company to an employee performing this task will be $9.00 per hour.

The task will consist on preparing the area with the appropriate containers to collect the buffer waste and another for the steel BBs. Once the area is set up, the employee will dispose the buffers and BBs in the container; it will have wringer were the buffer waste will drain through it and the BBs will be contained. Once the waste from every plate is disposed, the employee will rinse every plate with distilled water to eliminate every residue that might been left behind. Once the plates have been dried, the acceptable plates will be packed to shipped back to the field group for the plates to be incorporated back into the process. The unacceptable plated will be place with the plastic to be recycle. The steel BBs will be recycle as well, and the buffer due to its pH will be collected by a company that treats the solution for it to be disposed properly.

	Plates Available	Metrics (hrs)	Metric per plate (min)
Cycle 1	98	3.593333333	2.20
Cycle 2	97	3.718333333	2.30
Cycle 3	94	3.055	1.95
Cycle 4	93	3.255	2.10

Figure 8
Metrics to Enabling Plates for Reuse

For plates to be reuse five times, four cleaning cycles will need to be performed. In the chart above the metrics for the cleaning cycles are brake down showing that per cycle the operator will dedicate an average of 2.14 minutes per plates to make each plate reusable for the process. This metric cleaning 6,667 plates will represent an increase of the expenses by $2140.11 on an employee only dedicated on the task of cleaning plates.

CONCLUSION

According to the data collected sample plates have the capacity of being reuse multiple times. Through five cycles it was observed how plates where used over and over and the majority was in nearly new conditions enabling them to be used up to 6 time with only a small lost plate percentage of 1.65% average. For a year bases, it's suggested to reuse plates 6 times which will end up in net savings in plate expenses. Implementing the reuse of sample plates, plate purchased will be reduce up from 40,000 down to 7,327 plates. The total expenses will be $30,773.40, which represents 81.68% in saving when compared to the expenses prior the reuse of plates. Implementing the process of reusing plates will required a temporary employee whose salary will increase the expenses $2140.11. The total expenses after the enabling the process is $32,913.51 representing a total of 80.41% in savings every year including the salary of the temporary employee.

The reuse of the sample plates has a significant impact in the expenses reduction without any negative impact to the quality of the product. With the data collected it is determined that reusing sample plates should be implemented for the beginning of next year.

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[3] A. G. Atherly, J. R. Girton and J. F. McDonald, *Science of Genetics*, Diane Pub Co., August 30, 1999.