

## **QUALITY CONTROL OF HYBRID CORN SEED PRODUCTION USING SIX SIGMA METHODE**

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**Abstract:** PT. Advanta Seeds Indonesia is a company engaged in sustainable agriculture with a production focus on hybrid corn seeds. In the processing of corn seeds, PT. Advanta seeds Indonesia experiences a high average product defect 10% of the total production. Therefore, the purpose of this research is to analyze the quality control od hybrid corn seeds using the six sigma method and seek continuous improvement actions. In this research using step define, measure, analyze, improve, and control. Data collection in April – May 2023 and September – November 2023 by production recapitulation. The results showed that the company’s sigma level was 3,40, meaning that in the production process improvement was still. There are three types of defect in corn seeds production : non-conforming corn cobs, seeds that do not match the size and damage seed. Non-conforming cobs are the most dominant type of defect caused by human, environment, and raw material factor. The continuous improvement action such as conducting stricter supervision during male flower detaseling activities, providing training when there are new hybrid of varieties. After taking corrective action there is an increase in the capability of the production process ( $Cpk > 1,00$ ) so that it can be said to be capable

**Keywords:** *Capability process, hybrid corn seeds, quality control, six sigma.*

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### **1. Introduction**

Corn is one of the food crops that human need, corn can be used as food an animal feed (Wahyudin et al., 2016). The development of corn crop productivity contonues to increase with an average prodyctivity growth of 2,21% in the period 2015 – 2019 with a harvest area of 1.930.000 Ha in the java island. The increase in productivity is due to the use of hybrid corn seed, which is of higher quality than composite corn (Kementarian Pertanian, 2020). Increased corn production can be achieved through post-harvest processing of hybrid corn crops (Mujiadi et al., 2023). According to the view (Asmadi et al., 2021), to ensure the post harvest processing of hybrid corn seeds, some agroindustry have standardize the processing process. According to (Yuanitasari & Muchtar, 2018) standardization is the process of defining planning, implementing, and monitoring undertaken by the company to ensure product quality and to serve as a benchmark in determining product characteristics and specifications. To ensure that the quality of hybrid corn seed produced is maintained until the hand of consumers (farmers), quality control measures are needed. In theory Heizer and Render (2013) in (Fadhlirobbi et al., 2022) quality control is an integrated action taken by the company to maintain the quality of product to remain in accordance with companuy standards. Quality control can be useful for

increasing productivity by tackling factors that cause product defect and reducing the number of product defect.

PT. Advanta Seeds Indonesia is a company that focuses on developing and promoting sustainable agriculture, especially in food crops with hybrid corn commodities. The company produces hybrid corn seed of sweet corn and tropical corn varieties with several trademarks such as adv bejo, adv ruby, adv joss, adv montok and adv madu-59. Based on the results of observations and findings in the field, the production process of hybrid corn seed at PT. Advanta Seeds Indonesia still found a product defect of 10% in the period April – May 2023, thus affecting the quality of hybrid corn seed produced.

**Table 1 Product Defect in Period April – May 2023**

Weeks	Total Defect Product (kg)			Total defect	Percentages (%)
	Non-standard corn cobs	Corn seeds that do not march size	Damaged corn seeds		
1	2.995	1.208	2.120	6.323	11%
2	3.735	1.437	2.000	7.172	12%
3	3.590	1.466	1.980	7.036	12%
4	4.765	1.168	1.200	7.133	12%
5	3.755	1.033	1.000	5.788	9%
6	4.190	1.076	750	6.016	9%
7	2.340	951	850	4.141	6%
8	2.145	853	1.000	3.998	6%
<b>Total</b>	<b>27.515</b>	<b>9.192</b>	<b>10.900</b>	<b>47.607</b>	
<b>Average</b>	<b>3.439</b>	<b>1.149</b>	<b>1.363</b>	<b>5.951</b>	<b>10%</b>

In the production process, PT. Advanta Seeds experiences very high product damage so corrective actions are needed to avoid waste production costs and reduce the quantity of defect product. One method that can be used is the six sigma method. Six sigma can be defined as a business improvement methodology that aims to find and reduce factor that cause defect and error product, reduce operating cost, and meet customer needs. Six sigma can be achieved by DMAIC (Define, Measure, Analyze, Improvement and Control). From a six sigma measurement perspective represents a quality level where faults amount to at most 3,4 defect per-millions opportunities (DPMO). The concept has its roots in design specifications in manufacturing as well the ability of processes to achieve product specifications (Evan & Lindsay, 2007). One the relevant studies is research belonging to (Shabrina, 2018) in improving the quality of pipil corn with the six sigma method using DMAIC stage where the tools used are operation process maps, input process diagram, pareto diagrams, and fishbone diagram. So that purpose of this research is to analyze the quality control of hybrid corn seed using the six sigma method and seek improvement action.

## 2. Research Method

This research method takes place in several stages as follows :

### a. Collection of data

At this stage, interviews and observations are carried out. Interviews are data collection by asking questions directly with related divisions such as plant and quality control divisions. While observation activities are the stage of data collections based on literature studies and recapitulation of production data and defect in hybrid corn the period April – May 2023 and compared with production data in September – November 2023 as many 100 sample.

### b. Data Processing

The stage used in data processing is DMAIC, it is as follows :

- (1) Define : activities to identify problems and customer needs using tools SIPOC diagrams, potential CTQ (Critical to Quality) and pareto diagrams.
- (2) Measure : focuses on how to measure the production process using tools individual moving range charts, capability process, defect per-millions opportunities (DPMO) and sigma level calculation.
- (3) Analyze : focuses on the causes of product defects, error and excessive variation using fishbone diagram.
- (4) Improvement : continuous improvement activities for the resolution of product failure issues with tools 5W + 1H (What, Why, When, Where, Who, How)
- (5) Control : focus on keeping improvements going with tools comparison capability process.

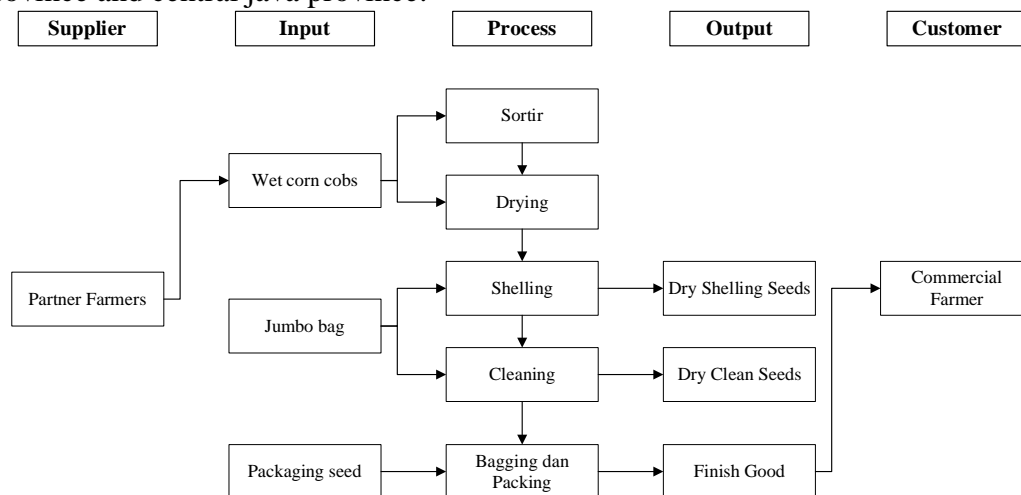
## 3. Results and Discussion

Quality control of hybrid corn seed at PT. Advanta Seeds Indonesia can be done with the DMAIC stage with the following steps:

### Define

#### 1) SIPOC Diagram

SIPOC diagram is a diagram used to present a glimpse of the work flow that the company. Data taken based on interview with the head of the plant division and explains that PT. Advanta Seeds Indonesia get raw materials from partner farmers in the regions of east java province and central java province.



**Figure 1. SIPOC Diagram**

2) CTQ Potential

Types of defects in the post harvest processing of hybrid corn seed that affect the quality characteristics of the seeds include :

a. Non standard corn cobs

This type of product defect is found at the sortir stage with the category of wet corn that must be discarded, namely male corn cobs, corn cobs offtype, rotten and infested cobs, young corn cobs.

b. Seeds that do not fit the size

This type of product defect is found at the seed cleaning stage. This category of damage is generally in the form of broken and small seed, broken cobs that are still attached to the seeds

c. Damage seeds

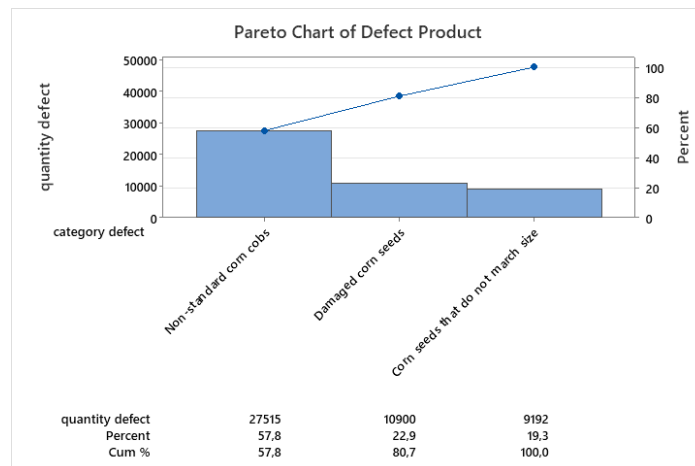
This the type of product defect is found in the seed separation machine based on color. This category of damage can be in the form of seeds that have red, yellow, and black color due to contamination by pests and diseases.

3) Pareto Diagram

Pareto diagram is a histogram of data that sorts from the largest total frequency to the smallest total frequency to determine which opportunities are most potential (Sulaeman, 2020)

$$\text{Presentase defect} = \frac{\text{Types of defect}}{\text{Total defect}} \times 100\% = \frac{27.515}{47.607} \times 100\% = 57,8\%$$

$$\text{Presentase defect kumulatif} = \text{presentase defect } i + \text{presentase defect kumulatif } i-1 = 57,8\%$$

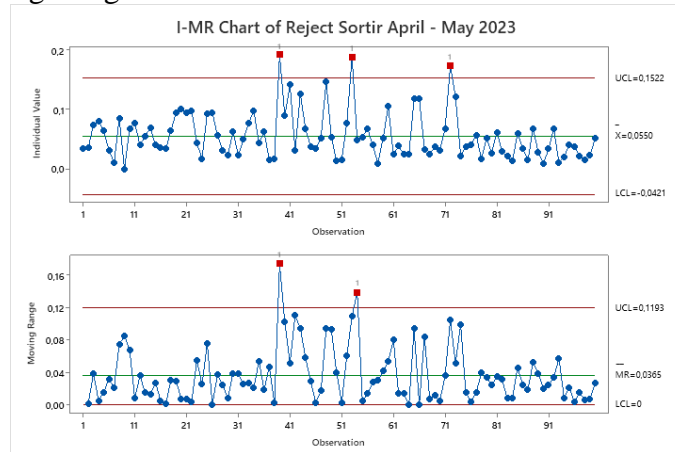


**Figure 2. Pareto Defect Product Period April – May 2023**

Based on figure 2, the highest product CTQ in the hybrid corn seed production process is corn cobs that are not up to standard with a percentae of 57,8%.

**Measure**

1) Individual Moving Range Chart



**Figure 3. Individual Moving range Period April – May 2023**

Based on figure 3, individual and moving range control chart based on the CTQ potential is stage sortir in April – May 2023 as many 100 sample, the moving range chart shows a central line value of 0,1822, a lower control limit of 0 and upper control limit of 0,5952. While the individual chart show the central line value of 0,275, lower control limit (LCL) of 0,209, upper control limit of 4,068. In the moving range graph there is data that is out of control according to the theory this high enough MR value makes the data condition out of control so that an improvement process is needed at the sortir stage to reduce the amount of corn cobs damage or waste or raw materials for hybrid corn seed production.

2) Capability Process

PT. Advanta Seeds Indonesia has determined the upper limit and lower limit of product specifications produced at USL 0,04 with a target of 0,02.

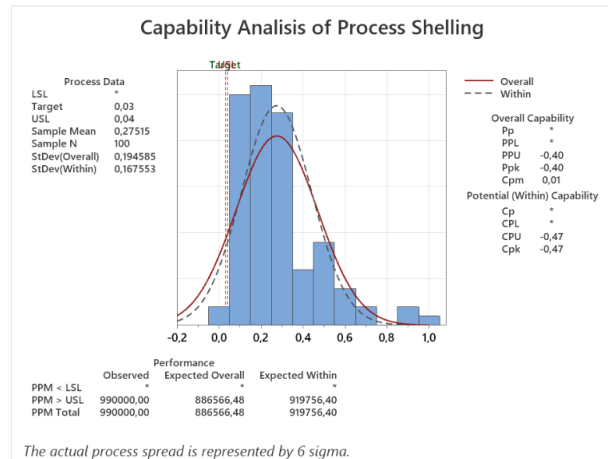
a. Measure Cp

$$Cp = \frac{USL - LSL}{6\sigma} = \frac{0,04 - 0}{6 \times 0,167} = 0,039$$

b. Measure Cpk

$$Cpk = \min \left( \frac{USL - mean}{3\sigma} ; \frac{mean - LSL}{3\sigma} \right) = \min \left( \frac{0,04 - 0,27515}{3 \times 0,167} ; \frac{2,371 - 0,02}{3 \times 0,543} \right) = \min (-0,47 ; -0,55) = -0,47$$

In figure, the results of the process capability calculation of the wet corn cob sortir stage show that the Cp value is 0,039 and the Cpk value is -0,47. The Cp value at the sortir stage < 1,00. This proves that the sorting process is not capable or a lot of production raw material are wasted / reject so that improvement is needed to achieve targets that are in accordance with the company predetermined sortir reject specification limit of 4% and the Cpk value at the sortir stage is negative so the avarage raw material sortir process is outside the specification limit.



**Figure 4. Capability Analysis Defect Product Periode April – May 2023**

3) Defect Per-Millions Opportunities and Sigma Level

a. Measure DPO (Defect Per Opportunity)

$$\frac{\text{Defect Product}}{\text{total production} \times \text{CTQ product}} = \frac{294}{5.000 \times 3} = 0,0196$$

b. Measure DPMO

$$\text{DPO} \times 1.000.000 = 0,0916 \times 1.000.000 = 19.600$$

c. Measure nilai sigma

$$\text{Sigma level} = \text{normsiv} \left( \frac{1.000.000 - \text{DPMO}}{1.000.000} \right) + 1,5 = \text{normsiv} \left( \frac{1.000.000 - 19600}{1.000.000} \right) + 1,5 = 3,56$$

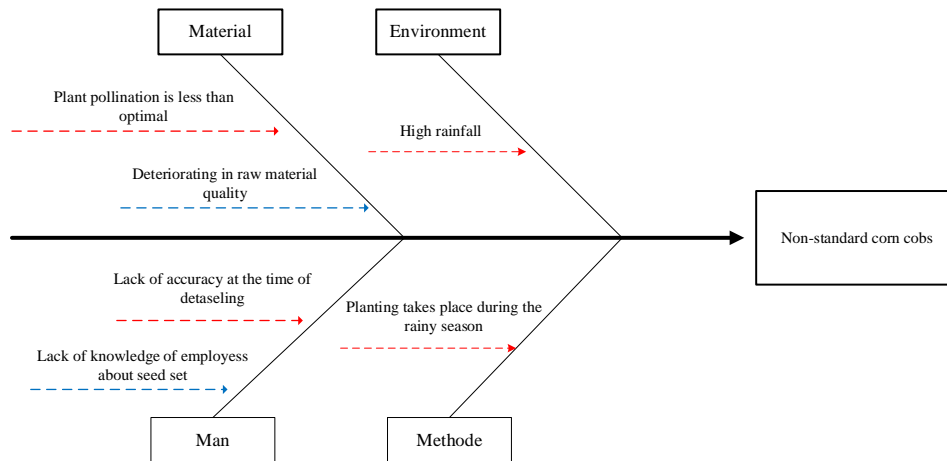
**Table 2. DPMO and Level Sigma**

Period	Production (Kg)	Total Defect	DPO	DPMO	Level Sigma
1	5.000	294	0,0196	19600	3,56
2	5.000	560	0,037333	37333,33	3,28
3	5.000	592	0,039467	39466,67	3,26
-	-	-	-	-	-
100	5.000	349	0,023267	23266,67	3,49
<b>Average</b>				<b>31738,00</b>	<b>3,40</b>

The DPO (Defect Per Opportunity), DPMO (Defect Per Millions Opportunity) and sigma level values can be calculated to determine how many product defect opportunities in each hybrid corn seed processing proces at PT. Advanta Seeds Indonesia in April – May 2023. Where the sigma level achieved by PT. Advanta Seeds Indonesia is 3,40 and is still far from the 6 sigma level. Therefore, corrective action is needed to reduce the number of product defect.

**Analyze**

The next stage is the analyze stage which is a step to analyze the results of the measurements that have been taken in the previous stage and also determine the root causes of hybrid corn seed product defects using a fishbone diagram (cause - effect).



**Figure 5. Analyze**

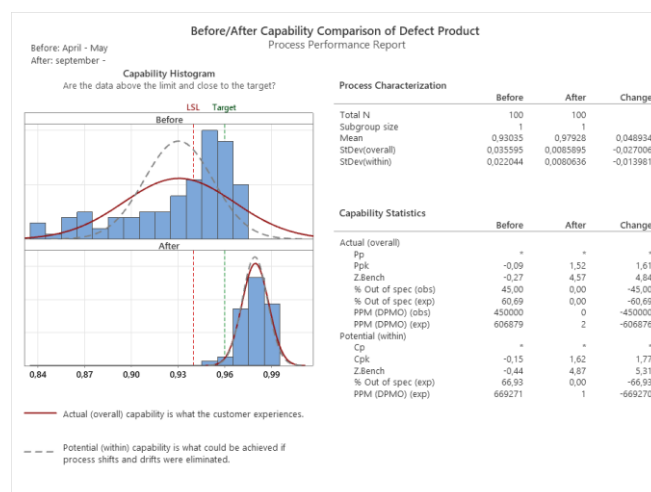
**Improvement**

<b>Factor</b>	<b>Man</b>
What	<ol style="list-style-type: none"> <li>1. There is a high quantity of male corn cobs</li> <li>2. Lock of knowledge of employess about seed set and characteristics hybrid</li> </ol>
Why	<ol style="list-style-type: none"> <li>1. To reduce male corn cobs reject</li> <li>2. To reduce good corn cobs</li> </ol>
Where	<ol style="list-style-type: none"> <li>1. Planting parent seed on partner farmer field</li> <li>2. Employe sortir</li> </ol>
When	<ol style="list-style-type: none"> <li>1. At the time detaseling male flower seed</li> <li>2. Before change shift</li> </ol>
Who	<ol style="list-style-type: none"> <li>1. Field Assistance</li> <li>2. Quality control sortir</li> </ol>
How	<ol style="list-style-type: none"> <li>1. Field assistant conduct stricter monitoring when detaseling male flower</li> <li>2. Conduct breafing during shift change</li> </ol>
<b>Factor</b>	<b>Material</b>
What	<ol style="list-style-type: none"> <li>1. High quantity of corn cobs that are unfilled</li> <li>2. Reject sortir over</li> </ol>
Why	<ol style="list-style-type: none"> <li>1. Improve input wet cob in bin drying</li> <li>2. Minimize quality degradation when receiving raw materials</li> </ol>
Where	<ol style="list-style-type: none"> <li>1. Corn planting in the field</li> <li>2. Receiving material</li> </ol>
When	<ol style="list-style-type: none"> <li>1. At planting time to reduce drought</li> <li>2. At the time of variety delivery and document submission</li> </ol>
Who	<ol style="list-style-type: none"> <li>1. Plant division, especially agronomists from the company</li> <li>2. Employee QC</li> </ol>
How	<ol style="list-style-type: none"> <li>1. Agronom in the field educating farmers sbout the condition of the seed crop</li> <li>2. The raw material receipt supervisor checks the suitability of the HDD</li> </ol>
<b>Factor</b>	<b>Environment</b>
What	<ol style="list-style-type: none"> <li>1. Many diseased corn cobs</li> </ol>
Why	<ol style="list-style-type: none"> <li>1. Avoid shortage of raw material supply and damage to raw material</li> </ol>
Where	<ol style="list-style-type: none"> <li>1. Planting field</li> </ol>



- When 1. At the time of parent seed selection  
 Who 1. *Departement techonology development* PT. Advanta Seeds Indonesia  
 How 1. The company prepares parent seeds that are resistant to pests and diseases

## Control



Based on Figure 5, it can be seen that after the corrective actions taken by PT Advanta Seeds Indonesia, it can produce finish good seeds that are in accordance with specifications through maintenance actions on production machines and regulate the length of time for seed storage to avoid damage to the seeds. This can be proven by the increase in the Cpk value before and after the corrective action of 1.77, meaning that the corrective actions taken by PT Advanta Seeds Indonesia have succeeded in optimizing the performance of production machines. The average process of processing hybrid corn seeds in September - November 2023 is considered very capable because the Cpk value after corrective action  $> 1.00$

## 4. Conclusion

The production process of hybrid corn seeds of PT Advanta Seeds Indonesia has 3 types of defects or product failures in the form of cobs that do not meet the standards, seeds that do not match the size, and damaged seeds. The damage to corn seed products produced by the company in the period April - May 2023 amounted to 31,780 kg in one million production opportunities with a sigma value of 3.40 and each production stage is considered not capable because the Cpk value is  $< 1.00$  so that corrective actions are needed in quality control in the form of conducting stricter supervision when detaching male flowers, providing training when there are hybrids or new varieties, etc. After taking corrective action, there is an increase in the capability of the production process ( $Cpk > 1.00$ ) so that it can be said to be capable. Recommendations for further research are to develop and provide deeper insights into the influence of production quality and marketing volume levels as well as commercial farmers' interest in using hybrid corn seeds owned by PT Advanta Seeds Indonesia

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