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Agricultural Management by new Diagnostic of Selling Sulfur Organic Granular Fertilizer

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ABSTRACT

The low percentage of organic matters in the soil and their alkaline status (high PH), especially in Khorasan of Iran provinces is a good reason for the production and distribution of non-chemical fertilizers along with suitable add-ons for the enrichment of farms and gardens. This motivation has led to the implementation of an explanatory plan entitled "The production of granular sulfur organic fertilizer from compost" in 2004 commissioned by the Mashhad Municipality's Waste Management Organization in Khorasan-e-Razavi Ministry of Agricultural Jihad High Education Center. The main feature of this scheme is the production of fertilizer granules in the form of rods (pellets) and the addition of sulfur to decrease the soil PH. After the start of operation by the private sector, the production rate reached a maximum of 800-1,000 tons per month which based on the design needs mush be about 1,800-2,000 tons per month or 20,000 tons per year. During three consecutive years, the company's sales were declining and eventually led to the closure of the factory in 2012. This research is performed based on the general approach of diagnostic projects and the implementation of factor sensitivity analysis procedures. After a short familiarization with various kinds of fertilizers and the advantages of granular organic fertilizers with a neutral view, what is obtained based on observations and studies during the project will be criticized. After that the diagnostic methods will be separately discussed and the methodology of the project will be selected and justified. Next the selected method is implemented and the results are presented along with real practical solutions.

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INTRODUCTION

The ever-increasing need of the country to foods that is mainly the result of the increased population and the changing consumption pattern, necessitates more production. According to the increased under-cultivation area in recent years, the importance attempting to increase the performance in the surface unit is limited. Over the last 50 years, the country's total agricultural production has increased to about seven times and during the same period, the under-cultivation area has increased to approximately 0.5 times. The optimum plant feeding and the maximum pickup is only possible when during the growth season, each nutrient is given to the plant sufficiently and in a balanced manner. The balanced use of fertilizers not only maintains and enhances the soil fertility, but also may increase the product quality, protect the bio-environment and reduce the erosion.

On the other hand, the optimum fertilizer consumption is one of the most important factors in increasing the efficiency of fertilizers, improving the quality of agricultural products and the promotion of the community health level. According to the Global Food and Agriculture Organization, between 40 to 60% (minimum 33%) of the increase in the global agricultural production in the past three decades has been due to the consumption of different fertilizers [12]. In Iran, about 14 million hectares of lands are in a way under cultivation of which about 7 million hectares are in the form of irrigated cultivation. Fertilizers are the most common and most important institutions that increase the yield per unit area in today Iranian agriculture [9].

The soils of arid and semi-arid regions of our country – that constitute more than eighty percent of agricultural lands- are lean of organic materials. Various fertilizers are used to help with this situation. Any material that increases the crop efficiency both in qualitative and quantitative terms to reinforce the soil and

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increase its fertility is called fertilizer. Fertilizers generally fall into three categories, which include chemical fertilizers, organic fertilizers and biological fertilizers.

Using a combination of bio-fertilizers not only reduces the production costs and helps maintain the bio-environment, but also can maintain the performance level of the agricultural products. The bio-organic fertilizers have the power of providing 40 percent of the country's need for fertilizer production and the production capacity of 600,000-700,000 tons per year. A 110 ml-bottle of bio-fertilizer per hectare of agricultural lands is enough, but in case of using chemical fertilizers, two 50 kg-sacks should be used In this study, the following general procedure was used for diagnosing the sulfur granular organic fertilizer sale.

1 - Explaining the evidences and signs of trouble
2 – Presenting the scientific hypotheses concerning the causes of the problem and their examination
3 - Finding the causes and origins of problem change and their interpretation and conclusion
4 – Providing a problem-solving strategy based on a strong and viable foundation. Indeed the works and achievements of diagnostic projects may be observed after removing the root causes (that have led to the problems).

1 - Organic fertilizer consumption and the necessity of its consumption in the country:

Any organic matter that is decomposable by microbes can be used as an organic fertilizer. But in terms of quality, durability in the soil and price, organic fertilizers are very different. It should be noted that the provision of plant nutrients by adding organic materials to the soil is expensive. The main value of organic fertilizers is due to the physical changes they make in the soil. Based on the available statistic, the soil organic carbon content was less than one percent on more than 60 percent of the country's agricultural lands in 2011. While the optimal level of the soil's organic carbon to achieve sustainable production should be 2-3 percent, according to the Vision Document, the Ministry of Agricultural Jihad is bound to a 1% increase in the soil organic matter content and perform the necessary programming. 10% of the world's agricultural lands are faced with major soil fertility problems whose main reason is the lack of organic matters in these lands. The soil organic matters content has a direct relationship with the plant's performance such that with increasing the soil's organic carbon content as much as 1%, the amount of increased production in developing countries may reach 30-50 million tons per year. The status of the soil's organic matter in most agricultural lands is critical and so the attention to this issue may increase the production potential of agricultural lands. Organic fertilizers can be divided into three groups, animal manure, green manure and compost. Since compost is used as the raw material in the product considered in the present research, it is necessary to know it well enough.

Compost is a type of fertilizer obtained from recycling organic materials (waste materials remains from plants and animals). Compost is used in gardening and agriculture as the soil reinforcing agent. It is one of the best herbal fertilizers and natural soil reinforcements that may be a good alternative to commercial fertilizers. The most advantage of this fertilizer is its low price. When compost is added to the soil, it increases the water retention in the soil as much as 3-6 times and prevents its continuous evaporation. This compensates the items that are low in the soil for the plant reinforcement and naturally helps the plant growth.

Compost improves the soil fertility and helps the plant to grow healthy roots [3]. The organic matters in compost are indeed the microorganisms' foodstuff that maintains the soil in a healthy balanced position. Nitrogen, potassium and phosphorus are the materials produced by the microorganisms' nutrition of organic materials and therefore there remains only a small percentage of nutrients that should be added to the soil. All organic wastes in the nature are converted into compost after a sufficient amount of time. Of course not all wastes are suitable for home composting. In most home composting systems, the system does not reach the suitable temperature for killing the disease-making factors and therefore the type of raw materials used for composting should be carefully considered. After composting by reprocessing and the addition of the necessary soil elements such as sulfur, the organic fertilizer with required characteristics may be produced.

2 - Advantages of sulfur granular organic fertilizer:

After nitrogen, phosphorus and potash, the fourth essential element for plants is sulfur, except that the plants need to this element is even more than phosphorus. Sulfur is mainly involved in the production of amino acids and proteins and its deficiency reduces the quantitative and qualitative efficiency of the crop. Most of the country's soils, especially the soils of the Iranian plateau are alkaline and calcareous, and also the lack of organic matters and the bicarbonate manner of most of the irrigation water limit the solubility of macronutrients and micronutrients, and therefore the uptake of these elements is practically slow. So sulfur feeding in plants and its consumption is very important.

The pH of most lands in the country is higher than 7.8 and the lime percent (TNV %) is generally higher than 20 (the mean TNV and pH of Khorasan's lands is 7.91 and 22, respectively), the Iranian soils mainly have a high pH, low organic matters and a relatively high rate of limestone. In these conditions, the solubility of certain nutrients such as phosphorus, iron, zinc, copper and manganese in the plants' growth medium is very low. As a result, the use of sulfur fertilizers as soil amendments and the required elements required by plants is

necessary. In the investigations performed in this field, the effect of sulfur on the modification of the lime soil's pH has been very advantages [1]. By consuming 1-2 kg sulfur ever three years for trees along with animal manure as buried for 5 years, the tree soil's pH decreased from 8.2 to 7.8 (for every 0.1 unit of decreased pH, the elements' absorption by plants increases up to 20 times). The various trials conducted indicate that the increase in the sulfur level increases the phosphorus absorbency in the soil. The overall benefits of sulfur consumption in lands for farming and gardening are as follows:

Increased nutrients' solubility, especially "phosphorus, iron, zinc, manganese and decreased consumption in phosphate fertilizers and micronutrients as well as the qualitative improvement of the irrigation water

Solution of the deficiency of the plant's required sulfur and increased yield per plant

- Correction of alkaline and calcareous soils' pH
- Reduction of the nitrate accumulation in crops
- Gradual sterilization of the soil and contribute to the health of the bio-environment and reduction in chemical pesticides consumption

It should be noted that the various common sulfur fertilizers used in our country are as follows:

- Organic sulfur granular fertilizer containing 40% sulfur, 40% organic matters and 20% bentonite
- Bentonite-containing sulfur granular fertilizer containing 85% sulfur and 15% bentonite. It is a granular fertilizer (particle size of 2-4 mm) that becomes powder after exposure to moisture with the help of bentonite.
- Powder sulfur fertilizer (Surrey fertilizer) or agricultural sulfur fertilizer containing at least 95% sulfur

Thiobacillus bentonite-containing granular sulfur fertilizer containing 85% sulfur and 15% bentonite with thiobacillus bacteria. By the way, the impure sulfur extracted in agglomerated form from mine is not very suitable for agriculture.

Meanwhile, the granular organic fertilizer is a kind of fertilizer produced based on waste compost and other additives such as sulfur, beetroot molasses, helps the plant's bed growth by increasing high and low-consumption nutrients in the soil and also increases the product performance. The benefits of granular organic fertilizer include:

1 – Reduction of the use of chemical fertilizers
2 - Increasing the amount of the land's nutrients, especially organic materials
3 - Preventing soil and agricultural land erosion
4 - Nutrients uptake by plants is easily done in the presence of this fertilizer.
5 - Sulfur reduces the soil pH and makes it balanced.

Fig. 1: An example of the sulfur granular organic fertilizer.

3- Investigation of sales diagnosis:

Toloo Barsava Fertilizer Manufacturing Industries Co., the trustee of Mashhad sulfur granular organic fertilizer factory is located on the 5th km of the old Neyshabour road. This private-owned company cooperates with the Waste Management Organization of Mashhad Municipality [2]. The basic characteristics of the production plan are as below:

Operation year: 2008
Production capacity: 4 tons per hour
Machinery costs: 12.7 billion R.
Construction cost: 10 billion R.
Total area: 3,000 square meters
Employment rate: 14 people

After the start of production by the company, the production rate reached a maximum of 800-1,000 tons per month which should be about 1,800-2,000 tons per month or 20,000 tons per year based on the design needs. The company's sales in the years 2009-2011 were 320, 4,000 and 2,000 tons, respectively. The company's

products sales in the same period were 320, 4000 and 2000 tons whose declining trend is evident. In addition, between 89 and 90, of the total product, 334 and 2568 t has been sold, respectively. The continuation of this general declining trend from, 2009 to, 2012, eventually led to the closure of the factory.

As observed in Figures 2-5 are, the fertilizers and other products sales chart of the Waste Management subsidiary factories in compost and vermin-compost has been relatively smooth. However, the relative changes of granular fertilizers have high sales and its sales were done in the cross-sectional form at some periods.

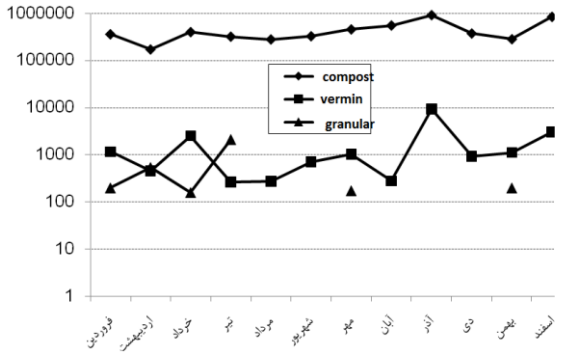

Fig. 2: Sales of various types of fertilizers manufactured by the subsidiary factories of the Waste Management Organization of Mashhad Municipality in 2010.

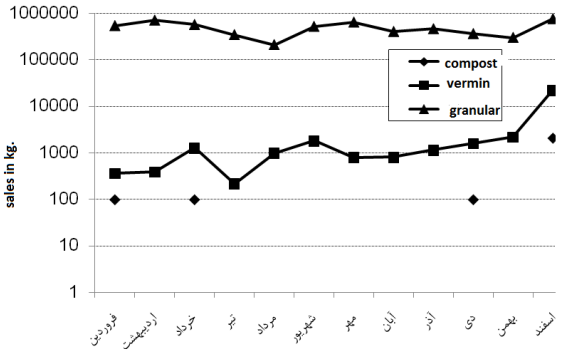

Fig. 3: Sales of various types of fertilizers manufactured by the subsidiary factories of the Waste Management Organization of Mashhad Municipality in 2011.

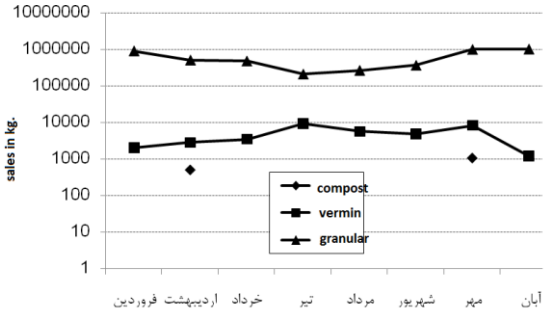

Fig. 4: Sales of various types of fertilizers manufactured by the subsidiary factories of the Waste Management Organization of Mashhad Municipality in 2012.

The above charts show that the difficulty of selling the granular organic fertilizer is unique to this product and this factory and is not observed in other products. Its secondary result is that the sale issue in this factory is neither common nor affected by external factors. According to the studies conducted in general, the reduced or stopped product sale can be the result of the following two main factors as further described below.

1 - External factors

2 - Internal Factors: a) buyer/ consumer's dissatisfaction

b) Salesperson/ producer's inability

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4 - Diagnostic methods and research methodology:

Various approaches have been introduced to identify the effective factors on the appearance of a problem or issue, some of which such as cause and effect analysis are more well-known that others by using fish bone or Ishii Kava diagram. On the other hand, in most quantitative and qualitative studies, finding the most important factors has been one of the concerns of the scholars whose reason is the more complex relationships between the variables and the phenomena under investigation. In this regard, the dependant variable is not only under the influence of a single independent variable, but there are many known and unknown variables influencing the dependant variable. They may also be influenced by a set of other variables. So the determination of which variable can have a greater impact on the dependent variable can be challenging. According to the qualitative or quantitative analysis of the relationships between the variables, there are many analytical methods each of which offers an acceptable solution according to the demands of the research question and the relationship between the variables. Methods such as regression analysis, structural equations (path analysis), neural networks, scenario analysis and Monte Carlo simulation can be useful in this regard [8,10].

The rest of the research sought a method for the effective analysis of methods that would lead us to the optimum solution according to the possible constraints of the problem. Therefore, we studied numerous articles published in related fields with keywords such as Sensitivity analysis, Impact assessment, Contribution analysis, Importance of variable and Partitioning of variance. However, the investigation of the core reasons analysis literature had noticeable results. One of the core reasons analysis-based methods published in Dassau and Lewin‘s article [7] is a systematic method for increasing the performance combining the 6σ concepts with design and control to improve the estimated performances in the process design steps. After identifying the variables "critical to quality" and "critical to productivity", the key step involves the process measurement analysis which leads to the detection of the low performance or quality core factors. In this study, the method implementation (Mixed Integer Nonlinear Programming) is not possible due to the lack of sufficient data. In addition, designing new experiments and the utilization of factor analysis methods is not possible due to stopped the production line. However, it seemed the implementation of simpler procedures, such as local differential analysis, despite the lack of high degree of accuracy, is more suitable for this purpose. This method is performed by calculating the output functions’ partial derivatives relative to the input variables. In order to calculate these derivatives, the values of the input parameters are changed in small intervals. Using a Taylor expansion for the output function around the parameters’ baseline values and by using the variance spreading technique, the uncertainty in the output function is estimated based on the mean values and the standard deviations. In fact, the Taylor series expansion is necessary for the determination of the importance of each parameter. The failure of this method lies where the linearity assumption is not true for the output function [11]. In order to perform the local differential method, large searches in terms of sales information and the affecting factors such as the quality of raw materials were carried out. Due to the closure of the factory and the lack of the accountability of those involved, it was initially thought that maybe the required information was available, but difficult to access. However it was determined after extensive follow-ups and repeated referrals that due to the lack of the attention of the experts of the time, the information record was not done clearly and the available information was not accountable for the needs of each simple statistical method. Finally after extensive investigations, data gathering from the customers, sales agents, experts, specialists, officials and employees of the factory, presenting questionnaires and using mean statistical methods, the result was determined and its clarification was performed based on the information and documents. In this study, data were collected from relevant people with the help of questionnaires. In this questionnaire, the diagnosis-related problems were classified in three sections, i.e. quality, sales and other categories. In the next step, the classification of the effective factors and the representation of the relationships between them were done by using relationships graphs and each factor was validated by presenting adequate documentation. In addition, the factors’ effects were classified and the main factors were identified by eliminating the incorrect data and using simple averaged methods.

Research results:

The data collected from the questionnaires, are Quality Problems, sales and other factors weighted and prioritized, respectively, which is presented in the following tables:

Conclusions and recommendations:

In this research, the sale diagnosis procedure is based on the determination of the contribution percentage of each of the effective factors on the diagnosis appearance. So far, several mathematical methods have been developed for the sensitivity analysis of a cause to its factors. Among them is the partial differential method that uses the partial derivatives of each factor to detect its influence. The procedure described in this paper was initially considered, but then it was decided to collect data through the related experts, consumers and experts due to the unavailability of sufficient data (during the production period, the data and statistics were not recorded/maintained properly). The factors knowledge procedure and its influence were declared in the present

paper. By collecting more than 30 questionnaires from various people and organizations and the solutions' analysis, prioritized factors and their influence, it was determined that in summary:

- Factors affecting the quality of products (raw materials, technology, etc.) 47%
- Factors affecting the product sales (advertising, marketing, etc.) 35%
- External factors (inflation, etc.) 18%

Table 1: prioritization of qualitative factors.

weight	priority	Effective factors on qualitative problems
0.1562	1	Technological problems
0.1478	2	Improper raw materials
0.1414	3	Poor production management
0.1051	4	insufficient expertise knowledge
0.0893	5	Lack of commitment to qualitative limits and standards
0.0865	6	Improper packaging
0.0828	7	Non-skilful production human force
0.071	8	Few qualitative trials
0.0651	9	Low production capacity
0.0549	10	Improper carriage

Table 2: Prioritization of the sales problems.

weight	priority	Effective factors on sales problems
0.2012	1	Improper marketing
0.1875	2	Improper offer
0.1788	3	Low demands
0.1788	3	Poor non-production management
0.1587	4	Sales procedure
0.095	5	Lack of on-time delivery

Table 3: Prioritization of other factors.

Weight	priority	Effective factors on other problems
0.3868	1	Lack of support of organizations/organs
0.3236	2	Inflation and out-of-organization economical factors
0.2895	3	Low cash

In general, the main factors may be prioritized in the form of table 4.

Table 4: Prioritization of general factors.

overall means of each criterion	weight	priority	General criteria
316.27	0.4703	1	Qualitative problems
235.29	0.3499	2	Sale problems
120.88	0.1798	3	Other problems
Total means			
672.44			

Were important. Therefore, based on the priorities obtained, the plant quality problems should be examined first. Among the factors affecting the quality, the following three factors are known to be more effective: than others

- Inappropriate raw materials (presence of glass, etc.) 16%
- Technological problems (mold erosion, grain size, etc.) 15%
- Poor production management 14%

The solutions may be found by the identification and prioritization of the effective factors in the diagnosis. The short-term solutions may be classified into the following three categories:

- Improvement of the quality of the input materials
- Repairing the machines and modification of the production
- Improvement of the sales status

Some of the executive solutions are:

- Improving the input compost quality (glass separation on the origin or the purchasing and installation of the glass sorting system at the beginning of the line)
- Technology overview (reducing the friction coefficient of the input materials, anti-friction coating for molds and rollers, etc.)
- Launching the Product Research section (production of customized fertilizer for various agricultural products, customized packaging according to the customer's needs, etc.)
- Advertising and farmers training (free shipping examples and demo)
- Discounts on purchases (including discount tables per purchase, installment sales, etc.)

- Guaranteed shopping of granular fertilizer for a short-term produced by the municipality until the end of the crisis

Also there are general guidelines that require more time, including:

- Ceding the company to the private sector (due to the different business approach in the private sector, etc.)
- Revision of the excusive plan (due to the lack of the complete supply and demand review and the lack of balance of the production line in the initial design, etc.)

Also, some of the major strategies were major ones not in the authority scope of the project partners, but in case of the long run, they will work on the project, including:

- Giving the required subsidies to farmers to buy fertilizer through the public sector (in some countries, farmers are given free fertilizers)
- Reviewing the cultivation pattern and the assignment of appropriate fields on the various types of permitted fertilizers for different products and their authorized percentages

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