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Elvin Hasman has Presented a paper titled Prototype, Performance Test and Simulation of Organic Fertilizer Disseminator Machine at The 2n1 International Conference on Security in Food, Renewable Resources and Natural Medicines 2018 (SFRN 2018) Held between 25-26 October 2018, at the Convention Hall, Universitas Andalas, Padang West Sumatra, Indonesia

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Prototype, Performance Test and Simulation of Organic Fertilizer Disseminator Machine
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E-mail: elfinhasmarqyahoo.co.id ih.siraci— This study is conducted to create a prototype of an organic fertilizer disseminator machine and perform the performance test to optimize the crop_production by using SRI. The purpose of this prototype is to support the farmers' incomes since it can optimize the crop production.

Furthermore, the fertilization cost also can be suppressed. Additionally, the farmers' welfares will be increased by reducing the production cost since the machine can replace the labours on cultivation phase. The main components are standing frames, disseminator, speed reduction gear motor, mover and moved-pulley.

The specifications are length, width and height by 240 cm, 124 cm and 110 cm, respectively. It finishes with 4 paths points of fertilization. The performance test shows that it releases noise level by 94.48 dB. The effective capacity is 90.137 hectares per hour. The engine power that is used is 7HP with 4 hours of durability. As well as the economic analysis, the main cost is Rp184.990,88 per hectare with BEP 72.7 per year.

The B/C ratio is 1.34 and NPV is 7.139,779. All in all, this research is expected to support the average crop production to 10 tons per hectare so that Indonesia will have its prosperous rice self-sufficiency. Keywords—organic fertilizer disseminator machine; performance test; mathematical model; economic analysis

1.

INTRODUCTION The imported rice can be eliminated by increasing the production from 4.75 [4] to 7.0 tons per hectare as the expected potential production can be reached 10 tons per hectare. Nowadays, System of Rice Intensification (SRI) has been performed in several areas in Indonesia and shows a significant increment of productivity.

Several districts in West Sumatera which have applied SRI and gained the average outcome of 7.8 tons per hectare [9]. Meanwhile, SRI implementation in several areas in West Java have reached 8.5 tons per hectare 18]. Nonetheless, not all the trial result has been utterly successful while the method is directly applied to the local rice fields or farmers.

'I he problem is with the current technology to support rice field's productivity is still poor. The application of cultivation technology such as superior varieties, fertilization, plant balance, _harvest and post-harvest which is followed by prime counselling, yet it has not provided the optimal results. The superior's productivity is still far below the potential target at 10 tons per hectare.

The national rice production growth rate is not sufficient enough to balance its domestic demands. All matters need to be updated. SRI application admittedly gives a better result than the non-optimized method. At the first segment of the study, a mechanical handling machine is made to subdue the weeds on the rice field by using SRI.

Next, rice plant is fertilized with precise, efficient and appropriate dosage in order to achieve an optimal production. SR1's fruitfulness is defined by implanting one perforated seed by aged 7-10 days with planting distance and the number of productive paddy's saplings are able to reach 60 stems per clump [11]. In addition, as the plant density in the rice field is soaring, it makes the manual fertilization will be ineffective and uneven.

Since it spreads unevenly per clump, plenty of fertilizers does not reach the ground and it mostly stuck on the leaves. Therefore, the evaporations process will be disturbed. The results from field observation have found that the conventional cultivated area and has been planted with SRI method, the plants have grown disproportionately.

It is a consequence of the fertilization process that have been done by hands and uneven spreading. Therefore, while harvest time. grains will not ripe and have uneven grain size. Thus, harvested productions will not going optimal since many the grains have not been fully filled out earlier. On the rice field that use SRI method, it gets more difficult to fertilize due to plant density and denser soil.

Then, it needs more labours to do fertilizing and it creates the ineffective attempt since it is not given close to the base of plant. Hence, SRI has not been optimal without being supported by proper and effective fertilization process on plants. Nonetheless, agriculture labour depreciation rate continues and tends to increase.

While at the same time, it requires a large number of labour for executing a proper and spot on fertilization. As the result, the fertilization cost will increase. Therefore, the main issue is, fertilization needs to be done by the right time, accurate dosage per plant and a proper way in order to achieve the optimal results. To overcome this issue, the mechanical fertilizer machine has been designed in order to optimize the crop production by using SRI method.

It is expected to achieve the target of 10 ton per hectare 11* as the average production. Thus, Indonesia will
accomplish its own rice self-sufficiency. The application of SRI method provides various privileges compared to the conventional cropping pattern. Nevertheless, the paddy's saplings growth on the rice field is escalating which in one clump consists of 60 productive saplings.

A large amount of productive tillers conformed by the extended leaves parts on the rice field will shade its surface. Some of the productive tillers on the rice field are being shaded by the other leaves parts and it covers the surface of the rice field. Therefore, it needs more fertilizers than normal.

While it is being fertilized, it has to be done by a precise dosage and has a proper spacing among the plants, _so that it will be fertilized on the base of the plants. Furthermore, the shaded rice field will make the fend liation becomes ineffective and the plants receive it futilely. In addition, the limited number of labours to do the fertilization when the number of labours in agriculture area is having its drawback.

As a result, the fertilization costs more for the labours' wages. Regarding this issue, a solution is a need as a way to overcome the problem of the fertilization on the rice fields either using SRI or conventional method. This study is aimed to construct a prototype of organic fertilizer disseminator machine for paddy and can be used for other horticultural plants.

This machine can be adjusted to array planting spacing, dosing the fertilizer, multi-function, efficient and high capacity, according to the farmers' necessities. Therefore, the fertilization can be precisely done on the plants by place and dosage. Moreover, it wraps up the problem with the limited number of labours for fertilizing. Besides, it helps ease the works and the operational cost so that the fertilization process will not be an issue for the farmers.

Next, this study is expected to support the farmers' welfare, particularly since the production outcome will become optimal whereas the cost of fertilization can be suppressed. This organic fertilizer disseminator machine is able to save the production cost by replacing the number of labours' during each growing season. Hereinafter, this prototype is expected to be able to create new agriculture machinery workshops that will produce appliance and machinery.

Thus, it will create new job vacancies in Limapuluh Kota district and eventually in West Sumatera. Another prototype's advantage is, it potentials to be a multi-function equipment which can be modified and improved into an upgraded machine by attaching other implementations on the specific parts of it.

Further, it can be converted into planting equipment, fertilizer tool and harvesting tool by replacing or attaching the specific attachment on this machine. Moreover, it can be multi-tasked by mounting several parts at the same time. For instance, this machine can also fertilize while harvesting some plants. Hence, this study will also support and encourage the agricultural workshop of Politeknik

Pertanian Negeri Payakumbuh to become the community to be used.

The flow chart is illustrated leading in agricultural equipment and machineries. in Figure 2.

2. THE MATERIAL AND METHOD This study starts with identifying the existing problem on the SRI method. Next, determining the design criteria, e.g. the design has to be simple but efficient, high capacity, use the local material and a multi-tasking machinery (e.g. as fertilizer tool, harvesters). 2.1.

Mechanical Loop Causal The use of mechanical fertilizer machine will suppress the conventional needs of fertilizer, suppress the fertilization cost and increase the farmer's income. Likewise, it will create new employments for instance operators, maintenance handyman, fertilizer machine rental business and breed new agriculture workshops.

The causal loop is seen in Figure I. It depicts that by increasing the use of mechanical fertilizer then, Rice production will increase as well as the farmers' incomes. The number of labors in manual fertilizing will decrease as well as the fertilization cost to be paid, therefore the farmers' incomes will escalate. It creates new employments namely, operators, fertilizer machine rental business, new workshops for producing and maintenance.

- - 44echsnical (paddy production \ Machine ,' + ----- (+1 New employment (Operator. rental,
machine maintenance Labor for manual fere luation (+) +& workshop Manual fertilization waim Figure I. Mechanical Loop Causal Diagram Next, draft the concept by considering the functions and structural matters that need by the machine.

Further, performance test and evaluation whether the machine meets the requirements. If it is yes, the machine can be forwarded to the _(Sheri ilkTf II ..r Jeri all rat am pr. tillevn Acterrn Irma m cif design criteria. Simple. I- ffremni.
Multi 11ukiu.n . tealgh c apse ny . local me+er.al Jr_ • i.rro u rnr-e I•iincinen dik n SC/ lone Mt Rare t.rtiere Ds.-sign cvul mat ion / C STOP) Figure 2. Flow Chart 2.2.

PROGRAM SIMULATION Generally, the simulation is defined by imitating a system or activity without presenting the actual matters. This technique turns out to be a choice while the other analysis technique is impossible to be done. Many combinations and alternatives can be obtained through a simulation before it executes on the field.

It will diminish errors that will incur large costs in its implementation. The simulation is an activity that allows the reviewer to draw conclusions about system behaviours by studying a balanced behaviour model, the causal connection which is similar or behaves like the actual system.

The simulation can be interpreted as a system that is used to solve real-life problems filled with uncertainties by using a specilicmodel or method and more emphasis on the use of computer to get the solution [7]. Some of the advantages that can be obtained by simulating the simulation are: (a) saving time, (b) being able to monitor varied sources, (c) correcting calculation errors, (d) can be stopped and re-run, and (e) easy reproduced [8].

2.3. Mathematical Model of Fertilizer Machine Mathematically.

the ability; that can he achieved by this mechanical fertilizer machine is a function of engine power. RPM. work width, work speed and wceddensity onthe field. Me machine capacity to fertilize can he calculated in the following ways: n1 fot2 i I) nl KKOWtx) n2 area covered by weed (m') total path area of fen dilation (m') 1) here, kl,:c I :nginc v4orting capacity (m2 sec).

fertiliration work width (m): the wonting speed of the machine (m sec); n 2 ; Weed density; coefficient (no units) The relationship between machine work capacity and weed density, mathematically can be seen as follows: Mathematical models that work on each component of the fertilization machine are as follows 1101: Power to drive the wheels of the fertilizer machine P--Cr*W*V/75 (4) Fertilizing power of machine: P=Tssd*L•RPM*2K / (75x60) ....

(5) RPM (rev / min) on the speed reducer: RPM1=NI/N2*RPM2 (6) Spinning power (watt) on gear box: P = cr*2•xeRPM / 60 (7) _ _The Block Diagram is showed in Figure 3. _HP - Engine power - Torque N = Comparison of number of teeth Nc = Number of pairs of gears Number of fertilizer units (Work width = L) d - fertilization depth Ts = Torque specific soil (kg.m

/ cm2) W = Total machine weight Cr = Coefficient of roller resistance V = Speed of fertilization S = Distance of the track D = Wheel diameter 2.3.1. Data analysis Effective capacity of machine The effective capacity of fertilization can he calculated by comparing the area of fertilized fieldwith the time required for the fertilization. Kef--A/T (8) Theoretical Capacity The theoretical capacity is obtained by multiplying the width of the works by the speed of the machine.

KTe=W*V*0.36 (9) Working speed (V) can be calculated by the following formula: v=srr (10) Field Efficiency Field efficiency can be calculated by comparing the machine's effective capacity with its theoretical capacity with the following equation: Eff=KetT/ TK Tex 100% (I I) _ _ 2.3.2.EcoNomic ANALYSIS OF FERTILIZER MACHINE The economic analysis can be calculated by using fixed variable cost, fixed cost and number of working hours per year and the elfective surfing capacity. The fertilization cost can he calculated by the following equation: BP --(11'1'/1'+1111)1 Is el (I _ _

1. 4 1.

1 isure 3, Okla Diagram oil kganie I cnilimr Machine Where; _I. lireak-Fven Point Wreak I \ cot Point- Itl P) UT aims to know the minimum production volume so that the income w ill cover the total cost of production. IlFP can be calculated using the following equation:

SEP =BT/(h1xliP)- (51T / KP) (13) Power Operator Thc povker of the operator is measured by heart rate, the operator's heart rate is measured before performing the operation and shortly after performing the machine operation in the field.

llsed Motor Pmscr Thc power used in the operation of this fertilizer machine can be found using the formula: Mechanical Power = Chemical power x gasoline (14) Fuel used x p gasoline x Heat value of gasoline s 4./ (15) Chemical Power=3600•735 Engine Noise Level By knowing the noise level, it is measured by sound detector that is sound level meter.

The data is then matched to a standard of noise that is still safe for humans and performs the comparisons with existing research conducted by experts who take into account the noise level of the device with the length of operation of the device. 3. Results and Discussion 3.1. Machine description Thc mayor components are standing frame, disseminator, speed reduction gear motor, mover and moved pulley.

Engine specifications; Length 240 cm, width 124 cm, height 110 cm and number of fertilization path is 4. The machine works smoothly during testing without frequent jamming. The result that is obtained from the tests shows that the disseminator effectively distributesthe organic fertilizer. _/ 1 'Doe ; I cmlustim result 3.2.

Machine Performance Olmervatio• Results. Based on the observation data of fertilization on the field, here is obtained recapitulation result of fertilization performance as seen in Table 5. TABLE 5 RECAPITULATION OF MECHANICAL FERTTI I/ER PF/IPOIIMANCE N o _Performances parameter _Quantity 1 _ _1 _Actual speed (m/s) _0.568 _ _2 _Effective capacity (ha/hour) _0.137 _ _3 _Working width (m) _0.75 _ _4 _Theoretical Capacity (ha/hour) _0.426 _ _5 _Field efficiency (%) _32.13 _ _6 _Basic cost (Rp/ha) _184.990.88 _ _7 _Break even point — BEP (Ha year) _72,7 _ _8 _B/C Ratio _1,093 _ _9 _NPV (Rp) _7.139.779 _ _10 _Operator (Watt) _47.96 _ _11 _Used motor power (HP) _2.52 _ _12 _Available motor power (HP) _7 _ _13 _Engine Noise level (dB) _94.48 _ _14 _Durability of operator (hour) _4 _ _Machine specification _ _ _I _Weight (kg) _124 _ _2 _Total width (cm) _100 _ _3 _Length of the machine tem) _240 _ _4 _Height of the machinet cm) _I If) _ _5 _Number of feni hiation path (row) _4 _ _ TABLE 6 I MANI- IO CA ARNO% ngine _1Power' IIBM _RPM _Jiimneter f Polies _Gear
hos _ _Robin _7 I g,i_Nolene _2400 _3 inch _ _ _(It 2 s 31 IA111.1, 7 l it AR la).\ I iigine _i'Ltile.i input _R I'M of iiipui _PINI lt.'

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SPI ID Kt Ill tiK it) Jr FIR III I/UK Si Veil reducer _RPM out put _Poky our put _Pulley input _Rpm of
fertilizer _ _ _27 _6 inch _3 inch _54 _ _ 3.3.

Engine transmission to wheel drive The radius (R) of the wheels is desired = 50 cm The circumference of the wheel circle =7r D = 314 cm The desired linear velocity is 5 km / h (walking speed) = 5000m / 60 minutes = 83 m / min Rpm required wheel = 83 m / 3.14 m x Rpm / min = 26.43 Rpm wheel = 26 rpm / min Transmission gearbox with composition gear M3 x 18 and M3 x 44 Ratio rpm = 18/44 x 18/44 x 18/44 x 18/44 = 0.028 = 0.03 or 3: 100 Rpm top shaft = 100/3 x 26 = 866,67 rpm ti 900 rpm Pulley gearbox = (Rpm engine / Rpm shaft) x pulley engine = (2400/900) x 3 inches = 7.9

inches 8 inches 3.4. Fertilizer Machine Simulation Program The application program that has been generated in this research is effortlessly to use. The design of the application program can be seen in the following Figure 6, while the program lists afterwards. _While listing the program from the simulation of the fertilizer machine using Visual Basic programming languages are as follows; Private Sub Command I_Click() Dim NG As Single Dim A As Single Dim Wt As Single Dim V As Single Dim Cr As Single Dim W As Single Dim Ts As Single Dim d As Single Dim RPM As Single Dim NI As Single Dim N2 As Single Dim RPM2 As Single Dim T As Single Dim RPMGear As Single NG = Val(Textl.Text) A = Val(Text2.Text) Wt = Val(Text4.Text) V = Val(Text5.Text) Cr = VaI(Text7.Text) W = Val(Text8.Text) Ts = Val(Text IO.Text) d = Val(Text11.Text) RPM = Val(Text I 2.Text) NI = V al(Text14.Text) N2 = Val(Text15.Text) RPM2 = Val(Textl6.Text) T Val(Text18.Text) RPMGear = Val(Text 19. Text) Koef = NG / A Text3.Text = Str(Koef) Ka = (Wt • V) / Koef Text6.Text = Str(Ka) P = (Cr • W • V)/ 75 Text9.Text = Str(P) Ps = Ts d • WI * RPM • ((2 • 3.14) / (75 • 60)) Text 13.Text = St n Ps) RPM! = (N I / N2) ' RPM2 Text17.1'ext = Str(RPM I) P0ear T • (2 • 314) • (RPMGear / 60)

.fext20.Text Str(Riear) i 'nd Sub Private Sub Conitand2 1 "Text 1 .Text = " Text2.Text "" Text3.Text "" Text4.Text "" Text.5.Text "" Textb..text • "" Text7.Text "" texts. text = "" Text9.Text n "" Text 1 0. Text "" Text1 I Text = "" Text 1 2.Text = "" Text13.Text = "" Text 1 4.Text = "" Text 1 5.Text = "" "rext16.Text = "" Text17.Text = "" Text18.Text = "" Text19.Text = "" Text20.Text = "" End Sub Private Sub Command3Slick() End End Sub The results of data analysis in the relationship between the capacity of the fertilizer engine with the existing weed density in the test field can be seen in the graph below. Fertilizer machine capacity and weed density relationship _ _ _ _ _ _ _ _ _y - 0 0523.e .'" _ _ _Rz = 0.8898 _ _ _ _ _ _ _ _ _ _. . _ _ _:.:. .. C,5 :,i Weed Density _: C _ _ I igure 7.

Graph of the relationship between the work capacity and the weed density in the field. 3.5. nil OM WORKS Based on the performance test,it is recommended to: a. 'the weight of the machine needs to be reduced so it will not be problematic and complicatedwhilc being operated onthe field, especially in wetland. _ _ _h. It needs simplification of fertilizer transmission system fin. fertilizer dosage dropped, so it will he more controllable.

It is important to have further socialization to the community fitr planting distance and alignment in order to achieve optimal performance of the machine. It needs to be Iiillowed bya simulation of engine program to get a simulation program dimensions, power and weight of the machine. Conclusion All in all, a prototype of organic fertilizer disseminator machine is designed, constructedand tested for spreading the organic fertilizer.

The machine is adequately humble for local fabrication, operation repair and maintenance. The performance test is showed that this machine generates noise level 94.48 dB. Engine specifications; Length 240 cm, width 124 cm, height 110 cm and number of fertilization path is 4. From economic analysis is obtained that Basic cost = Rp184.990,88 / ha; BEP = 72.7 ha/year; B / C ratio = 1.34 and NVP =7.139.779.

While the effective capacity 90,137 hectares per hour; Power of motor used was 7 HP and durability of the operator is 4 hours. This research is expected to support the realization of achieving an average production of 10 tons/ha so that Indonesia will have itsprosperous rice self-sufficiency. ACKNOWLEDGMENT The author would like to thank Ministry of Research, technology and Higher Education of Indonesia who has funded this research through the Superior Research Scheme of Higher Education. REFERENCES Admin. Proses Produksi Pembuatan Pupuk Organik dart Sampah Pasar. Yayasan Danamon Peduli, 2010. Sragen.Basuki.

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NOMENCLATURE KKe Engine working capacity m2/sec Wt fertilization work width The working speed of the machine m/sec Cr Coefficient of roller crane motor resistance W total weight of fertilizer machine Speed of the fertilizer machine Ts Torque specific soil Depth / height falling fertilizer fertilization work width K ef Effective capacity of tool A Area of cultivated land T Time for fertilization W Theoretical work width 0.36 Conversion rate Path length T Travel time Eff Field Efficiency (%) BP Cost of Goods BT Fixed cost T Working hours BTT Non-fixed cost K ef Effective capacity K Te Theoretical working capacity BEP Break-even point BT Fixed cost BP Cost of goods BTT Non-fixed cost Kp Capacity hi Coefficient indicating the price rent is to get a profit of 10% of the cost of

goods RPM Speed Rotation NI Number of teeth in gear at output N2 Number of teeth in gear at input Mechanical power = In unit (HP) Chemical power = In units (HP) Unused fuel = In units (liters / hour) a gasoline = thermal efficiency of gasoline fuel = 0.195 p gasoline = 0.725 (kg / It) The calorific value of gasoline = 10,000,000 (cal / kg) 4.2 = conversion number, 1 cal = 4.2

Joule 3600 = Unit Conversion, 1 hour = 3600 seconds 735 = Unit Conversion, I HP = 735 watts ir 2 Weed density coefficient E Torque N.m

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