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_ _Development of Mechanical Organic Fertilizer Machine: Simulation, Implementation, and Performance Test Elvin Hasmana, Naswira, Irwan Ag, Jarnaludtlin''

Agricnitnrol Enxineering, PayaliktulnA Stole Polytechnic of Agrk-J,h.re. Judrur Payee Negara Km 7, Tortih.etfir.
Ltindesauh Kaki It'esi Suntatra.26271, Inclonelio alflethasoinnrbethoo. Co. id ilibantro—
Ito objective of the.

research am in dr, elop lechnolue mechanical fertiliner machine was designed i• order la optimize Its beennet to Ita arhurvecl b!. wring SRI. Tar Laraci In !se achielett in (riva the regatta a this swoty r tI he enpreted to nuppurt The annalmitins of increasing tit ks el of farmers erneusiny• especially because the achieved production cos he a-tare optimid, On the other two& die case to be paid for feriainition ;lc. can he vat pprr.scil.

!he ability of a enechanicai krliklar ;dine Iv Le al./r lu rri la.c
dm es at labor during each grriaing season will save :lir cosi yr production so it hill be able to imp rine the welfare !Ail:rot era. Tr design the machine, mathematical model and simelstion were devekmed. Thr perfortnence test Showed that this wiuchinc ginadmIrs naive levet 94413 dH.

Engine specircanam; Length 240 era, width 124 cm. height 110 ca, and number or ferillitation pith 6 a aro. nr.metn.m- is nI nt 1 that itsimic cool = Ilai..9941,161 = 72,7 lithoyear; R C ratty = 1....14 and NVP
-./-L91/.771. N hik Ise effectirs capacity M,137 herrares per boar; Power of smear used was 7 HP and durability of the operator is -1 limprially.

ibis renearelt can support the target of achieving an average production of 10 tons:tut cam he midi:rid so that sodeom.. recta, schirve5 oelf-salTk kik-, in eke-learmeeile---fertiliter machine, kridtcalion and totecianical organic feetigeee.

I. INTIIOOICttoll Tic ,rte of rice production from 4.75 tootha (BPS. .211188 is 7.0

wrap in ti-der in eliminate rice import can he aulional bemire rice production potential can reach 10 lames howadays, the system of Rice Intensification (SRI) due ton hevn tried in several places in Indonesia shwa hike productivity. fn some districts in West Sumatra 2111110111 SRI reached an average yield of 7.8 tons I ha Arialsolk 2004}. Meanwhile, the results of SRI ameintmemation in some places in We Java showed the mmiltmalmme of 8.5 tons / ha (Irrigation Center. 20061.

But gesaks of this trial has not been su successful when wied arca]," to the rice fields of the community or %men roblcni is with the technology applied the undoesoipity of paddy field "is will v cry- tow. The application macron tedincloKy such as superior varieties, foliolla. plant balance, harycsi and post-hervesi which is antamgmies1 by the advantages of counseling and pmileam has not provided optimal rszwilis.

The superior _level of productivity is still far below the production potential of 10 Loris per hectare. The national rice productitm growth rate is not vnoagh to keep pace with domestic demand. All of these things need to he updated. Application of SRI Method [Paddy Intensification System) indeed givcs a bettor result than nut yet optimal.

In the first phase of the research, Worts were made to overcome the problem of weeding weeds in rice paddy arca with SRI system by creating mechanical handling machine. next stage that needs to be dune it by
providing fertilizer in rice plantz with a precise. efficient and appropriate dosage in order to obtain optimal pmduction tt.ul la.

The sueccns of SR1 is the planting of one seed of perforation and is June at the age of seed 7 - 10 days and the distance of planting. the number of productive tilkrs of paddy rice can reach 60 stems per clump. Plant densiiy and density in rice fields is very high. This rxanJltimnt makes manual fertilization ineffective and uneven.

Pecause it cwt not be spread evenly per clump, many of these fertilizers arc not reach derive to the ground like because ii will be muck on leaf midrib, will waste because of evaporation

Field ubsc-rvation resin's found in the conventional rice area and planted with wet 1 system, the fertilization process is done manually by hand, uneven spread of fiztilizer, consequently the growth of rice plants is not the same.

So at the time of harvest, the maturity of the grain is not the same or uneven pine-grain, consequently, the Nue/coed result% are not optimal because many gains of rice are not pithy. earlier. In the rice field area SRI system is more difficult to do fertilization because the density of plante and soil oamitions detect so that increase more labor to spread fertilizer and it is not effective because it is not given near the base of the plat So SRI has not been optimal without being supported by proper and effective koilization process in plants. On the other hand, the depreciation of farm labor continues to occur and lend to increase.

While at the same time required a large eno-ugh amount of manpower to pecker= proper and correct fertilization. As a result wages kw fertilization to be larger. the bast of this problem, the ifixtirization process should be done with appropriate time, anoareee dosage per plant and proper way in order to achieve opaal prodoetion to overcome this problem, mechanical fertilioce machine was &mimed in order to optimize the harvest to be achieved by osolg SRI method above.

Hopefully the target of achkeririg an m erage production of 10 tons/ha can be ittaftendw that Indonesia really achieves self-surliclency in H. FORMULA DUN OF Tilt PRO 1311141 Appireacia of SRI system rice pattern (the System of Igor aoasilication) provides many advantages compared smational cropping pattern_ However, the growth of ingiings 1 the rice field area is very fast, in one clump Q via CIO reads 64) productive saplings. .A

large number of panimaive tillers accompanied by the canopy of the planumiat in the rice fields will close the surface of rice fehla. Su need to be given more knilization than usual. tepeatitsias of fenitizer in this rice find must he appropriate naw ad spacing fix proper targeting of Fertilizer at the ins dile plant.

Rice fields are quite dense by the canopy er plan resulting in fertilizer given to the plant manually elkaively accepted by the plant. In addition, the limited =maw sf tiarckiwo- In fertilize the field, while the ariliffily of labor in agriculture is limited. So, for isilimion cos big for labor wage Based on this problem.

Derr skald he a way out to overcome the problem of crop lodillmalfma in the rice field either using SRI system or ormainIkina Tic papaw of this research is to create a prototype of stra1 kaki= spreader machine for paddy rice and also coo be mall for other horticultural plants, can be arranged wag ail dose of fertilizer. multi-function. efficient. high accordance w ith the needs of farmers so that fenituer cap' tsc given to place and proper dose on the plant.

lha a ompox,rint the problem of labor limitations to In addition.. it helps to alleviate the work and kmmtme sperational costs so that the tenni:ration process is INIf whim for farmers. _The target to be achieved is from the results of this study will be expected to support the acceleration of increasing the level of farmers economy, especially because the achieved preelection can he more optimal. On the other hard, the. cost to be paid for fertilization wages can be suppixosi.-d.

The ability of a mechanical fertilizer machine to be able to replace the use of labor during each growing season will owe the COSI of production so it will he able In improve the welfare of farmers. Besides, it is hoped that the creation of a prototype of this machine will encourage the growth of workshops of agricultural machinery which will produce appliance and agricultural machinery applied so that it will open new job field in Lima Puruh Kota and West Nurnatera generally. In addition to the above.

other advantages of this machine are the machine has the potential to be multi-fun Linn equipment that can be modified antiobr upgraded to other types of machines by adding other implementations on the machine. Further, this machine oat be converted into planting tools. fertilizer tool and also the harvesting tool by replacing or adding crarrpnrims of the moil above on this marhine.

It could even be some tool components mounted on this machine so that one machine can do several jobs at once such as acing. a fenilieer tool on the machine so that the engine does the fertilization in each uperatinn. This research will also encourage the workshop of Political Affairs Payakornhuh become the workshop of engineering toots and agricultural machinery especially tools and agricultural machinery / 441 ernplovnen Cl+tr.v, mu; (*) femur +wows rw,e+.-, ;•• 1.1 fenshrmen wage, Figure I. Mechanical Causal Diagram of mechanical loop.

MOOR AM SIMULATION In general, the simulation is defined as imitating a system or activity without having so display it in real terms. The imulation technique becomes an option when other means of analysis arc impossible or nut purformed. Various enrthirtations and alternatives can be teamed through simulations prior to their implementation in the field.

Phis IN id' ti -lucr dm occurrence of errors that result in enomeitis eons in its implementation. Simulation is an activity that enables the reviewer to draw conclusions about the behavior of a s!...SIern, through the r study of a harmonized behavior model, the causal relationship being similar to or as it is in the actual system.

Aoxirding to Kidney (2f104), the simulation can be interpreted as a system used in solve real-life problems filled with uncertainty by using a particular model or method and more emphasis on the use of computers to get the solution_ Some of the advantages that can be obtained by simulating the simulation are:. (a) saving Unite, (b) being abbe to monitor varied sources, (c) correcting calculation errors, (d) can be stopped and re-run, and (e) easy reproduced. iv.

METHOD The research process begins with identifying problems drat exed in the SRI system. Next determine the design criteria is the design should be simple but efficient, high Gawky, using locally available materials as well as the egpeClid multi-purpose machine that implemen mild be replaced by other implemen (fertilirer, harvesiersi.

Ile ma stage is to draft the concept by taking into stecnint the necessary ihnclions and structures of the meline_ After this toll the engine performance and eunlawkan of whether the machine In accordance with the langaiwal. If yes can be followed by the stage of applying the awhile lo the community. The flow chart of this stage can beam* it Figure 2. / Ferializabor isnl / 1...___Feeu III rairon engine Nolocligm r.-rfrrrreltr.*

IDunign evaluation Met-1 Me wed Illgs 2 PI= Me of Resenach Phase Eng wooing of Fonliszet Machtne _Mathematical Model of Fertilizer Machine Matherrutically, the ability that can be achieved by this mechanical fertilizer machine is a function of engine power, RPM, work width, work speed and weed density in the field. The capacity of the machine lo fertilize can be calculated in the lapwing ways: xl= f (a2 (I) x1 Me I x V)._...._........_......_......._._..........(2) x2 = area covered by weed (m2) 1 tutal path area of fertilization Kra, .(3) l'he relationship between machine work capacity and weed density, mathematically can be scum as follows.;

Mathematical models that work un each curnpAent of the fed i tieal ion machine are as follows: I. Pinin.7 to drive the wheels of the fertilizer machine P=CrxWaV075 (41 Fertiliding power of machine: P = Ts adxLs RPM 21 (7500) ...... (5) RPM (rev / min) on the speed reducer: RPM) =NI /N2 x RPM 2 (6) TAME I ENrorw TO (1555 .505 Engine _INw.tr HP) _E18M _11.11M _Name= of Pulley _ _Robin' _1 _gmetene _2400 _3 inch _ _ _ _ _ _(B2s3 _ _ TABLE 2 0 EAR DON Engine _PON, MO _RPM of input _Palley opiiii _Gearbox carpet _ _ _S inch _900 _3 inch _900 _ _ TADIY.

3 OFJULIDOX TO SPEED rine CEJt Speed
Reducer

(type) _Rama _' Pulley hap" _RPM input _RPM out put _Padke output _rend i
zur
unit _ _P A _1 - XI _5 mean t a 241 _540 a _27 _6 incl. _ _ _ TABLE 4 SPEED RetxrrImmPam
rr FFATILIZER Spred
redraw _RPM out put _Niel: oar Put _Palley input _Rpm of
Fertilizer _ _ _27 _6 inch _3 inth _54 _ _

rir Engine tram mission to wheel drive 1 The radius (R) of the wheels is desired - SO cm The circumference of the wheel circle = x D = 314 cm 2.

The desired linear velocity is 5 km 1 h (walking speed) = 5000m ! 60 minutes = /13 m / min 3.. Rpm required wheel = 83 m / 3,14 rn x Rpm / min • 2.6.43 Rpm wheel 26 rpm/min 4_ 4. Traismismon gearbox with composii ion. gear M3 I11andM3 x44 Ratio rpm • IR/44 x 1 /1144 x 18144 x 18/44 - 0,028 = 0.03 ar 3. 100 5. Rpm top shaft • 100/3 X 26 - 866,157 rpm 900 rpm Pulley gearbox = (Rpm engine / Rpm shaft) x pulley engine = (2400/900) s 3 inches .• 7.9 inches = B inches 4. Spinnins.

power (watt) on gear box; P= or 2 xxx RPM 60 „ (7) Bleck Diagram of Fertilizer Machine 'nit Fertilizer Block diagram in Figure 3. IMP • Engine power - Tempe Ile - Belson ul number of teeth Ttk - %ober of pairs of gears = ltleaekcr of fatlizer units (Work width - 1 4." litaiTerwitan depth Ts • Tempe specific soil (kg.m! em2,1 111 - Tod tanchirie weight 4121rm Creilicient oil roller resistance Or fertiliation of the track Mad diameter _Data analysis The parameters observed in this study arc: Effective capacity of tools The effective capacity of fertilizatiun can he by comparing the area of fertiliixd land with the time required for the fertilization.

K of = A / ------ ----- (B) Theoretical Capacity The theoretical capacity is obtained by multiplying the width of the work by the speed of the machine KTe=WxVx016 ...._..............._..(9) working speed (V) can he calculated by the formula: V = S t.. 110) Field Efficiency Field efficiency can be calculated by comparing the machine's effective capacity with its theoretical (aped)) with the following equation: bit K e TK Te 100% ....(II) V. ECONOMIC ANALYSIS OF FERIll HER MACHINE a.

Page Layout The economical analysis of the machine can be calculaied using fixed variable cost fixed cost and numbw of working hours per yew and the effective working capacity of the machine, so that we can calculate the cost of fertilization by machine using the equation-. BP = (BT / T +131-111 K ef....._._ .... (12) b Break-Even Point (Break Event Point- REP) BEP aims to know the minimum production vtilutive so that the income will cover the total cost of production_ RF.P

can be calculated using the equation: BFP =BT/(h1 x BPI -03T1 .... (13) Power Operator The power of the operetta is measured by heart rate, the operator's heart rate is measured before performing the operation and shortly atter performing the machine operation in the field.

Used Motor Prover The power used in the nperation of this fertile/et rrewhinv can be found using the formula: Mechanical Power = Chemical power x gasoline..-...(14) Fuel used x p gasoline x Heal value of gasoline x t2. (15) Chemical Power - 3600 x 735 (In)

7. Engine Noise Level To know the level of noise, the Doke kvet is measured by sound detector that k sound level meter.

The data is then rrialched to a standard of noise that is &LAI safe for humans and P4ITSWIII5 CIINTIpar ISMS with Perdeardl conducted by pert5 who take into account the noise level of the Lk -Am with the hength of operation or the LILY-PM. Machine Perfnrmance Obseri.ation Re-sults. BMW(' on the resott of observation data of fertilization in the ricid. hcncc obtained rmapilulalion null of ferciliratton performance ds in Table 3.

FABLES RWANtutAnON MWo.recu.FEutnIF. Potropy.lApici, Pi lin a• _1 Performailm pa'arnekr • _Meehan/4 ferniiration _ _ _Ackial spar) (inirs-) -1 _0161 _ _ _EfFectitv aped ly (hahourt _0.137 _ _ _Working width tm) _0.73 _ _ _Theorevcal Capacity I haibeur) _0.426 _ _ _rick) efficiency 11') _32.13 _ _ _Basic a= (1.pika) _1114.991).811 _ _ _Break ere" peon -REP ithe'.v....0

_32,7 _ _11 _Bit Ratio _093 _ _ _MN IRO _7. /14.779 _ _Li _Ogoraaor (Watt) _47,46 _ _II _Liked motor pinver{1-1P} _.) 32 7 _ _Ili _Available motor pow= 111P1 _ _ _ _Naas level [dB) _SWAM _ _44 _Dashili ty or Ter-41r (Om) _4 _ _lamdtiot -mina _ _ _specific _ _ _I _*1+ {kBt _524 _ _2 _Tidal width tan) _14Q _ _ _LiLearls of the nhlichine km) _240 _ _IM _Height afar rriaeh inc(cm I.

_ILO _ _ _t4lier of fertilization path {row} _4 _ _ _ _ _ __/ Fertilizer Machine Simulation Prosram 1k appLicution program generated in Ii05 research is 'my cmy to me. The design of the resulting application pregy-ain in the followieg Figure. while die program lasting in the ric4/ mo. Maw/ ILIAfremalis Me*. Ptaaltiar Pupal two? Andatia,. ter IA0 ./....laraPI . . Pimlarr ? _ Nat.I.ma 1111•91. Moan IdbrIamts 1ml. oyim pada. kw*. _ . lamli Obi afe gm 1m ••••rm. 9.14 i1EIn sm. Para.. ...41:bminim I- quit 6 S,Muitban

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NG • Val(rext I .Text) A = VahlexL2.Text) Val(Text4.Teru -V = Vid(Text5.Text) Cr Val(Tert7.Ter1) W • Val(TesciS.Text) Ts • Va1(Tex110.Text) d = Val(Teatt 1.Texi) RPM = Valaext12 Text) NI - Valif est 14:Text) N2 - V attTerI15-Text} RPM2 Val(Textle.Text) T = Vall(Tort/8.Text) RPMGear Val(Text19.Tex1) Kriel.. NG A Tula. fest = Slr(Knef) Ka= (Wt• V)/ Knef Toni Text.. Sot Ka) P=(Cr•W•V)I75 Tear?.

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FL cat WORK Rased on the above perkintutoce tot is recommended; I. Weight machine to be rialoced so as riot to be too problematic in the tick) operaliCe, especially in wetland, and does root complicate the operator in operating the machine. Nccd simplification or fertilizer transmission system for fertilizer dosage dropped more manageable. 3.

Need socialization to the community fur planting distance and lineage alignment is important in order to achieve optimal performance of the machine. 4_ Need to be pursued simulation engine program to get simulation program dimensions. power and weight of the machine NOmENc IATIJRE Klee:Engine working capacity f'S.X

Wt fertilization work width The working weed of the machine mm see Cr Coefficient of roller crane motor rcsiAance total weight of fertilizer machine kg Speed of the fertilizer machine m r set Ts Torque specific soil ktr...m(cm* Depth / height falling fertilizer cm I. fertilization work width K cf Effective capacity of tool ha ; hour A Area of cultivated land I la T Time for fertilization hours Theoretical work width 036 Conversion rate S Path length 'travel Lime :Leeds
Eff Field Erlickney (%) BP Cost of Goods Kp / by }3T Fixed oast Rp year T Working hours hour/year HTT Non-fixed cost Hp 1 hour
K of Effective capacityha / hour K Te Theoretical working capacity lie th ha / year FIEF Break-even point

HT Fixed cost Rp (year BP Ca et of goods Rp FITT Non-fixed cost Rp I hour Kp Capacity ha (hour hi Coefficient indicating the price of equipment rent is to get a profit of 10% of the cost of goods RPM Speed Rotation N1 Number of teeth in gear at output.

N2 Number of teeth in gear at input Mechanical power = In unit 0-IP) Chemical power • In units (HP) Unused fuel = In units (liters-, hour, 0 gasoline therm& efficiency of gasoline fuel = 0.195 ppsoline = 0325 (kg / It) The caltnific value of gasoline = 11)900,004 (cal 1 kg)
conversion number, I cal = 4_2 Joule 3600 • Unit Corrozsion, I hour = 3600 seconds 735 = Unit Conversion, I HP-. 735 wati,. Weed density coefficient 2: I cirque Si_rn
AC14NOWLE.121011NT The author would like thank to Ministry of Research asehreplou and Higher Educatifm of Intharsia who has funded this research through the Superior Resean.th Scheme a Higher Fox:Nilo° TIFFERECII; LS Mem 2010 Prose. Par.(l:3i Peinbutuan Pupuk Orgarnk slan 5sweis Passe Yavas:.n [summon Peds,13. Sown Sasaki.

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