Integration tillage mechanism on design of seed planter for small farming

I D G A T Putra[1], I M Suarta[1], N Sugiartha[1], I M Sugina[1], W Suirya[1]

[1] Department of Mechanical Engineering, Politeknik Negeri Bali, Kampus Bukit Jimbaran, Bali, Indonesia

E-mail: dewagedeagustriputra@pnb.ac.id

Abstract. Seed metering devices with drive mechanically currently perform their function efficiently and are a good solution to the problem of Balinese farming. Seed planter was developed for small farming that has been mechanically driven with manual operation. Volume based control of seed utilized on drive shaft coupled wheel drive with ground contact for sowing seed on farmland. Tillage mechanism integrated on this seed planter and used gasoline motor for drive of rotary blade tiller. Tiller drive shaft have been rotated speed about 60-90 rpm by speed reducer of gearbox type. This design has tested their performance for sowing seed of sweat corn. Due to the individual volumes of metering roller systems each holding more than one seed, seed drills provide random seed distribution. A surveillance camera system for evaluating seed spacing uniformity and velocity of manual drive seed planter system is described. The sowing uniformity of seed drill as investigated was affected by the speed of the metering rollers. Coefficient of variation of seed spacing increased as speed of metering rollers by manual drive operation on farm field. Integration of tillage mechanism also reduced seed spacing accuracy of seed planter.

1. Introduction

Seed planter has been widely developed by various vendors in agricultural technology industry. Many seed metering device was developed in others country that have many differences of farming methods (e.g. seasons, farmland, social culture and etc). Bali is small island that was basically agro economy society with their small farming area. Wet farming type and terrace farm field is main objective their agricultural development. Since recently, almost all of Balinese farmers have been worked by conventional methods on farming and seed have been planted by hand to a drill seed. Seed planter with drive mechanically will be perform their function efficiently and it will be one good solution to the problem of metering rates as seed. The methods for placement seed in row planting are accomplished with a variety of mechanically driven equipment, typically driven by a wheel in contact with the ground. Providing mechanical power to drive seed planter through these methods will be gain a cost effective and reliable solution [1-3]. Balinese farmers commonly, make groups of farmers working for planting of seed on farm field. This working management method has more time, inefficiency of number of seeds, and reduced their capacity to extensification farming area.

We have 3 main considerations to developed new model for precision planting, portable design, simple and mechanically. Small farming area and terrace contour farm field make big design of planter difficult to implemented. Balinese farmer is low index in education and capital. Simple technology

will robust diffusion novel planter design on their farming equipment. Electrical control technology also needs good understanding to operate on their farmland.

Tillage mechanism is equipment that is used by farmers to precondition of soil to planted area of farming. Integration of this mechanism to seed planter influenced precision of planter. Spacing uniformity and singulation of seed will be investigated on monitoring seed planter design when it's working on the farming area.

2. Literature review

Since development of design on mechanical planter technologies in the late 1800s, seed metering singulation have been driven on ground contact drive wheels. This design of seed planters was one of mechanical planters that served as an effective seed planter. This technology was an accomplished providing a varying row unit seed that react real-time to speed based changes during field operation [1]. Singulation of seed metering device have two inputs to regulate seed planting: application rate (plant population) and seed planter travel speed. Studies have exposed the importance of uniform seed metering and seed drill depth control to maximize seeding inputs and the interception of sunlight for energy to optimization of growing seed [2].

Since mechanically ground contact wheels to drive planters become popular as an effective planting technology at traditional planter, rise speed on operations has been responsibility on slip of rotational wheels and vibrations from typical drive design can impact lower accuracy of planting, especially at higher planting speeds [2, 4]. In addition, typically ground contact wheels controlled to singulation of seed metering at least two or more row units and in most cases control all row units across the whole planter tool bar. As a result, each row units' planting speed is the same across the planter or driven planter section which in turn fail to account for angular speed differences across the planter bar when planting on contours. Consequently, seed spacing error occur when planting on contours as the planter's inside row spacing is reduced while the outside row spacing is beyond the recommended increment. Planting errors such as over- and under-applied seed rates have been shown to increase with larger planter size and planter speed. Furthermore, as planters in bigger design and higher speeds to operate, unexpected farm field create concerns because of the chance accuracy of this technology. It also meets inputs to contribute rise in production costs [1-4].

In recent years many studies have been conducted into the performance of high precision seed planter. These, mostly experimental, studies have revealed information on how the seeders perform in laboratory or field. Commonly, electric drive systems on seed metering become chosen technology for crop seed planter to accommodate increased machine size and operational speeds and also allow control for individual row unit that specific planting for small areas and contour farming. Seed singulation is one of testing parameters, it become critical requirement when operating on high speed planting.

Seed selection on the mechanism planter had been established three categories of design, flute roller, cup feed mechanism and internal double-run [1], [4-6]. This model implemented on manual drive system of seed planter. 4-unit row of showing seed increased effectiveness of this applicable mechanism on manual drive power. Precision of this mechanism is unexpected be compared to recently technology

3. Materials and methods

Seed spacing uniformity is an important criterion on field testing of seed planter performance. A Distribution of seeds provides rate of distance for each plant and increases yields of farm field due to the reduction of intra-specific competition among growing plant. Also, weeds are easily removable due to the preventive of misses. This effect is important and proportional to the size of the required seed selection mechanism, which is the reason tillage mechanism been developed for crops like corn and also reduced their precision of planting. Tillage mechanism are needed higher power of engine and suitable only for large row spacings. Corn seedling are therefore usually sown by conventional

seeder drills that provide a random distribution of the seeds due to the volumetric metering by handling manual [8].

The motion obtained from ground wheel in precision planters is changed by way of shafts as mechanical drive components and drive by farmer in farmland. Thus, the speed of the seed roller is adjusted for reaching seed spacing by user manual drive (walking). These type machines are frequently used by farmer and even though they are accepted to have the sufficient performance, it still has many shortcomings. The transfer of rotational speed from the ground wheel to the seed metering unit at high speeds can be injured errors as spinning and slipping on ground wheel, and vibration on shaft drive systems [7, 8].

3.1. Seed

Corn seed of 45.4 g/1000 seeds. Seed dimensions were measured by using a Vernier calliper with a sensitivity of 0.01 mm. Means and standard errors of the seed dimensions are given: length: 6.5±0.18 mm; thickness: 2.3±0.04 mm and width: 3.3±0.07 mm. Recently, sweat corn becomes popular plant among Balinese farmer because of tourism development in Bali. Planting of sweat corn give them beneficial as animal feed (cow) by agricultural waste and easy to farm if it compared with others horticultural plant.

3.2. Seed planter design

There are several seed planter that was built by various agricultural machinery company. Unfortunately, there is no design that can be applied effectively on farmland in Bali. Balinese farmer needs portable agricultural technology for mobility equipment on their terrace farm field. Model of seed planter applied wheel for ground contact (alumina alloy) and coupled on shaft to drive roller type seed selection. This seed planter drives manually by farmer on planting field. Number of rows planting is two rows with 40 cm spacing between two rows. 80 cm spacing is given every two-row planting. Farmer drive this planter to produce two rows of planting back and forth on the farm field. Currently the methods of metering and seed singulation are only controlled by volume of the roller (Figure 1). Speed of manual drive of seed planter indicated to the rate of seed placement on the ground.

Tillage mechanism is a rotary type of tiller. It's coupled with gearbox speed reducer (WPA 40 ratio 1:60) and v-belt type A1 330 for coupled two pulleys (2 inch). A gasoline engine (53 cc) has been utilized as power to drive tillage mechanism. Integration tillage mechanism would be led up to lose farm field and created seed placement on rows of planting seed. Reduction of rotary speed will be increased torque of drive rotary tiller. Wet farming type on the tropical could be give lower torque to tillage on farmland [9, 10].

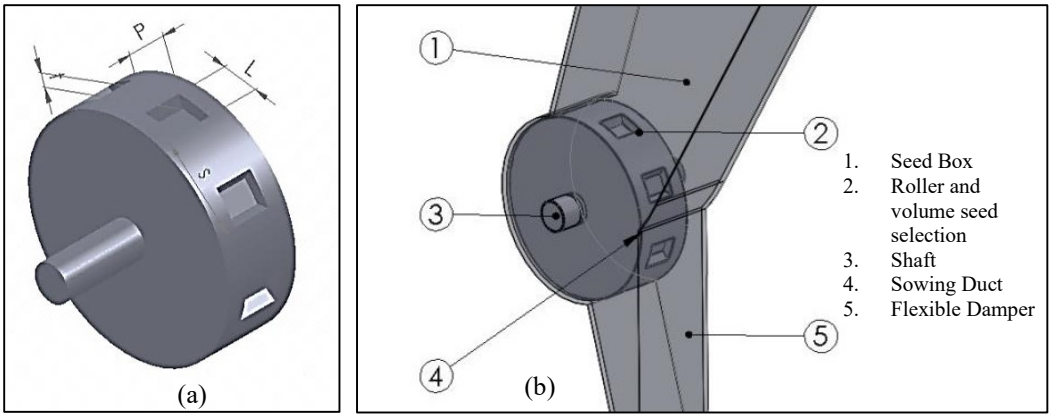

Figure 1. Singulation seed metering device (a) Roller design (b) Sowing seeds mechanism.

3.3. Measurement procedure and data monitoring

We utilised surveillance 5MP infrared camera to monitor seed spacing uniformity. Two 5 watts infrared LED as light inspection on sowing seed give more clearly view of 720p 60 fps video monitoring. Raspberry Pi 3 B+ has been compatible processor to saved video recording when it's observations and monitoring this seed planter. Raspberry Pi is operating system to installation of Raspberry 3b+ and their surveillance camera. Video recording file could be edited on windows movie maker as free software to direct analyst and observations on seed singulation of this seed planter.

The velocity of seed fall was determined by taking the difference of locations of falling seed between successive images when the seed just leaves roller outlet. The accuracy of the longitudinal seed distribution and velocity of fall of seeds were indicated by the coefficient of variation (CV). Coefficient of variation influenced by vibration of gasoline motor on tillage mechanism on the seed planter [11-14]. Velocity of fall of seed also indicated by variations of singulation seeds falling to the ground on frame every image in monitoring with video recording. Every seconds of monitoring was generated frames of image monitoring as setting video on 60 fps.

3.4. Testing of seed planter

Seed planter have been monitored on farming area for testing of variations seed metering. Surveillance camera utilized to monitoring on drive manually of the seed planter. On the farmer's area, seedling corn sowed by this planter when growing season. Area of planted was determined on every two rows of planting ± 10 m back and forth. Video recording on planter monitoring have been observed to analysis coefficient of variations seed singulation as variations seed falling to ground. A regression analysis was used to compare these seed spacings by analysed every frame of image on the video recording.

Data of video has been acquired from the micro SD card on the raspberry and we observed about 1.2 Giga byte of video. Testing was conducted on 3 variations of manual speed drive by different farmer i.e.: 0.5 m/s, 1 m/s and 1.5 m/s. After distance steps about 10 m, we saved video recording on SD card storage. Number of seed spacing was configured by the number of volume seed selection of roller design. Ground wheel is diameter 5 inch and wheel's shaft assembled with two rollers for two row of planting corn seed. If we have divided this roller by 4 number of volume of seed selection, then seed spacing of planter becomes 19.9 cm. It's meets spacing requirement for corn planting. The seed metering roller is designed based on recommended seed spacing and agronomic requirements of corn.

4. Results and discussion

After several testing and measurement has been conducted and investigated coefficient of variations of seed metering that was indicated by frame time of image on the video capturing. Coefficient of variants (CV) for seed spacing have a strong correlation to volume of seed selection on roller (Figure 1a) and it's also influenced by index of miss seed or seed singulation accuracy (%) that it was recognized. Operational parameter has been indicated by manual drive on working of seed planter and characterization of farmer. This project was studied integration tillage mechanism on seed planter that have been conducted by farmer on several farm field.

Coefficient of variants for seed spacing have been determinated by the number miss of seed on frame time of video recording. It's also indicated seed metering uniformity, if this field testing ignored pile up soil because of tillage mechanism. Others, irrigation on the farm field by farmer also can be change seed metering uniformity.

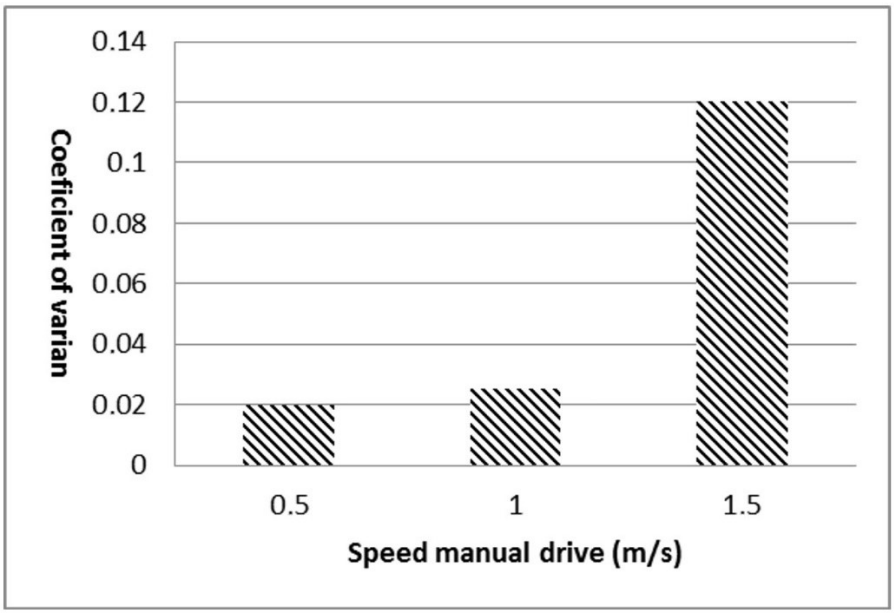

Figure 2. Coefficient of variant on testing variations manual speed drive.

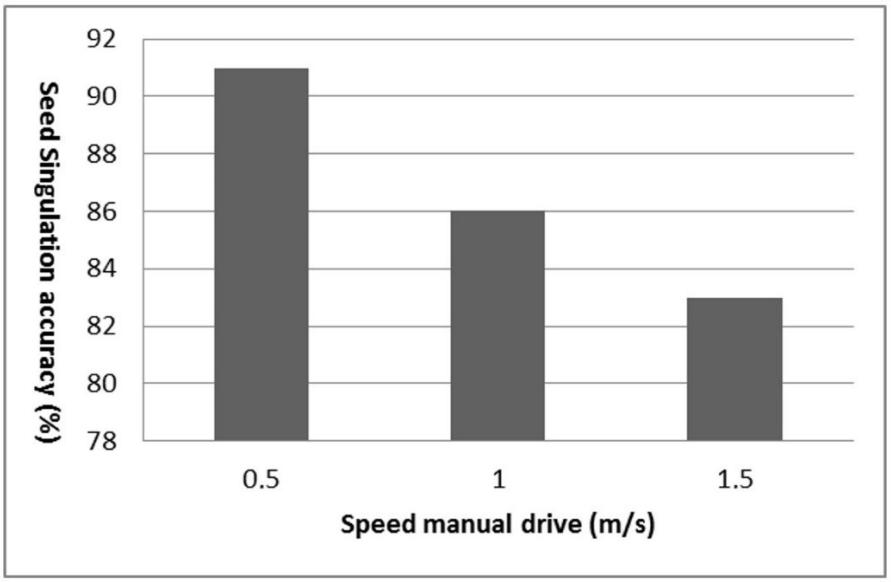

Figure 3. Planter Accuracy on testing variations manual speed drive.

Coefficient of variant had been increased as speed manual drive by farmers. Vibration of roller's shaft also increased significant when this seed planter had been driving on 1.5 m/s. It's made farmers to be running conditions when they drive this seed planter. Thought it would be increased the number of planting area, but it's causes of human error enhancement and rise up failure of seed planter.

Observations on seed singulation accuracy has been known which is design parameter of roller as volumetric selection of seed and existing of flexible damper. Seed singulation accuracy inversely proportional to rise up drive manually of seed planter. The thrust speed of on drive manually affects roller rotation and causes errors in the single seed selection and also the failure of the flexible damper on the seed planter mechanism. Flexible damper is an important part for stabilizer on seed singulation and metering.

5. Conclusions

Integrations of the tillage mechanism on the seed planter was investigated for testing of seed planter performance and accuracy. Seed planter accuracy was risen up inversely proportional to drive manually of seed planter and also their coefficient of variant was increased as speed manual drive by farmers. Even though, integrated tillage mechanism will be reduced time of over all farming processes and also it increased the quality of soil for agronomic planting (sweat corn).

6. References

[1] Yeon J and Shaw N 2004 *ASABE Annual International Meeting Ottawa Ontario*
[2] Stout B 1999 *CIGR Handbook of Agricultural Engineering* **3** 217-240
[3] Lacomi C and Popescu O 2015 *Agriculture and Agricultural Science Procedia* **6** 38-43
[4] Yang L, Xiantao H, Dongwing Z, Song S, Zhang R and Mantao W 2015 *International Journal Agricultural and Biological Engineering* **8** 1-9
[5] Bassett J H 1997 *Mechanism for Planting Agricultural Seed* (USA: United States Patent)
[6] Crabb R J et al 2000 *Seed Planter Apparatus and Method* (USA: United States Patent)
[7] An X, Wang S, Duan H, Yang C and Yu Y 2017 *Procedia Engineering* **174** 353-359
[8] Velandia M, Buschermohle M, Larson J, Thompson N and Jernigan B 2013 *Computers and Electronics in Agriculture* **95** 1-10
[9] Koller A, Taylor K, Weckler P, Buser M and Raun W 2013 *ASABE Annual International Meeting Kansas City Missouri*
[10] Hunt D 2001 *Farm power and machinery management* (Ames: Iowa State University Press)
[11] Kamgar S, Noei F, Khodabadi and Shafaei M. 2015 *Information Processing in Agriculture,* 169-76
[12] Mangus D, Engelhardt A, Sharda A, Flippo D, Strasser R and Terry G 2017 *Computers and Electronics in Agriculture* **142** 314-325
[13] Bansal R 1989 *Journal of Agricultural Engineering Research* **43** 23-31
[14] Halderson J 1982 *ASAE Paper* 281-306

Acknowledgments

This research was supported by Research and Community Service Centre Bali State Polytechnic, and funded by Minister of Research, Technology and Higher Education of Republic Indonesia (No: SP Dipa-042.01.2.401006/2019, date 5 December 2018.