

**DESIGN, DEVELOPMENT AND EVALUTAION OF A MANUALLY  
OPERATED SINGLE ROW SEED CUM FERTILIZER DRILL  
(MOSIR-SF DRILL)**

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## ABSTRACT

Machinery is a modern agriculture practices in which most of the labours are replaced with machines to yield higher productivity, lower labour cost, and reduce drudgery. Seed-cum-fertilizer drill is one of these machines applied in the field to make seed sowing faster, easier and more efficient compared to traditional methods, viz. broadcasting. It opens up furrows, dropped seeds and fertilizers at a desirable rate and covers them with soils. Most of the seed drills in the local market are designed to be operated as an implement to the tractors, motor-powered or drawn by animal where each of these design requires higher cost and sophisticated technology. Whereas, a manually operated single row seed-cum-fertilizer drill is simple and low cost to be fabricated. Thus, to practice this technology, a manually-operated single-row seed-cum-fertilizer drill, or simply named as MoSiR-SF drill will be designed, developed and evaluated. MoSiR-SF drill was designed to sow small-seeded vegetables. It consisted of several major components, which were the metering mechanism, furrow opener, seed and fertilizer hoppers, and the frame. The fabrication of the machine was generally accomplished in line with the design specification. However, fertilizer pellet with sticky nature was found to be incompatible with the hole-type metering mechanism. Evaluation for the performance of the prototype MoSiR-SF drill had been carried out in laboratory and actual field condition with choy sum seeds. In the result, prototype was delivering satisfactory performance with sowing efficiency measured up to 95% under actual field condition.

# **PEREKAAN, PEMBINAAN DAN PENGUJIAN MESIN PENANAM BIJI-BIJIAN BERSAMA BAJA (MOSIR-SF DRILL)**

## **ABSTRAK**

Mekanisasi adalah satu pengamalan pertanian yang moden di mana pekerja buruh akan digantikan oleh mesin untuk mendapatkan daya produksi yang tinggi, kos buruh yang rendah dan mengurangkan kepenatan pekerja. Mesin penanam biji-bijian bersama baja adalah salah satu mesin yang digunakan dalam ladang untuk mempercepatkan, mempermudah dan memperkesakan proses pembenihan berbanding dengan cara tradisi seperti cara penaburan. Ia dapat membuka alur, menjatuhkan biji benih dan baja di dalam alur itu pada kadar yang diinginkan dan menutupinya dengan tanah. Hampir semua mesin penanam biji-bijian dalam pasaran adalah direkakan untuk dijadikan peralatan kepada traktor, dikuasakan oleh motor atau ditarik oleh binatang. Rekaan tersebut memerlukan kos yang lebih tinggi dan teknologi yang lebih rumit. Manakala, mesin penanam biji-bijian yang boleh dioperasikan oleh manusia adalah senang dan murah dibuat. Oleh itu, untuk mempraktikkan teknologi ini, satu mesin penanam biji-bijian bersama baja telah direka, diperbuat dan diuji. Mesin MoSiR-SF ini akan direkakan untuk menanam sayur-sayuran yang berbiji kecil. Ia terdiri daripada beberapa bahagian, iaitu mekanisasi pengukuran, pembuka tanah, kotak benih dan baja, dan bingkai mesin. Pembuatan mesin ini telah siap dan berjaya diperbuat mengikut spesifikasi rekaan yang ditetapkan. Pengujian MoSiR-SF ini telah dijalankan dalam makmal dan atas tanah dengan menggunakan bijih sayur choy sum. Dalam pengujian, prototaip MoSiR-SF drill telah menunjukkan prestasi yang memuaskan dengan keberkesanan penaburan setinggi 95% direkodkan dalam keadaan pengujian atas tanah.

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## LIST OF SYMBOLS, UNITS, AND ABBREVIATIONS

ca.	circa
CAD	Computer Aided Design
D	diameter
GDP	Gross Domestic Product
HR	hardened rubber
MoSiR-SF	Manually Operated Single Row Seed cum Fertilizer
MS	mild steel
PE	polyethylene
PVC	polyvinyl chloride
s.d.	standard deviation
SE	sowing efficiency
SSA	School of Sustainable Agriculture

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## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

Planting distance is crucial for the development of healthy and productive crops. If they are planted too near, competition for nutrients, sunlight and water would occur, resulting in a poor establishment of the crops; while too far apart, the lands will be wasted and subjected to weed growth which will give rise to pest and disease problems. To keep this in mind, in order to achieve maximum yield, crops should be planted at optimum distance depending on the planting design, crop types and soil attributes. Achieving optimum and uniform planting distance is not easy and therefore, seed sowing technique plays a major role in distributing seeds uniformly at optimum planting distance.

Seed sowing techniques differ from farm to farm depending on the planting design, crop types, diffusion of technology, and availability of resources. Among the smallholders especially for the developing country like Malaysia, most farmers still practice the traditional methods of sowing seeds, viz. broadcasting method. Seeds are broadcasted over the soil and left without coverage. Besides being wasteful, this method, neglecting the planting distance between crops, is very imprecise and often led to a poor distribution of seeds, results in low productivity of the crops. To counter this problem, farmers need to adopt a better technology, which is the line sowing method.

Devnani (1989) had reported that line sowing is the most efficient means of sowing the crops and most ideal for crop management. Line sowing not only saves seed but also allows post-sowing operations conveniently and efficiently. Moreover, it



helps control of weeds through use of mechanical weeders and encourages maximum tillering as well as better sunlight penetration. To practice this line sowing technique extensively, mechanization of the sowing operation is necessary and thus seed drill is introduced.

A seed drill is a sowing device that precisely positions seeds in the soil in line. This is a technology necessary to be adopted for smallholders in order to allow the diffusion of mechanization as seed drill can give ways to other machinery such as tiller, weeder and harvester. Farm mechanization in developed countries is well established while in developing countries like Malaysia, mechanization level is still relatively low. In particular, Sabah, as a main agricultural state of Malaysia which contributes 30% of the state Gross Domestic Product (GDP) (Bernama, 2011), has a very low level of mechanization in respect of farming system. Further adoption is necessary to achieve agriculture modernization as mechanization of farm can improve productivity by producing more products with consistent quality using lesser time. Besides, it can reduce the dependency on labour and increase the competitiveness by reducing cost and time.

According to Laura (2010), seed drill has popularly regarded as the invention of an eighteenth-century British gentleman farmer Jethro Tull during 1674 to 1741. This invention gives farmers much greater control over the planting depth of the seed and the ability to cover the seeds without back-tracking whilst planting crops in lines. This greater control means that seeds germinate consistently in the good soil, resulting in an increased rate of germination and a much-improved crop yield. Furthermore, seed drill can reduce drudgery of the operations, save labour power and reduce the timeliness cost.

Implementation of seed drill in the field had always subjectively associated with large scale farming. However, this is not true because seed drill can be and should be deployed for smallholder farming system (Pandey, 2002). Seed drills are often designed to operate as an implement to the tractor, motor-powered, or drawn by animal. These implements are costly for smallholders as they are capital intensive. Not all smallholder farmers can afford to buy tractors with seed drill implement. With low acreage, smallholders can hardly utilize the sophisticated seed drill to maximum extent and causing loss in the investment. For smallholders, primary consideration will be on

the profitability of the adoption. To be profitable, the seed drill introduced should have a low ownership and operation cost, while producing sufficient accuracy for the sowing operation. In other words, the investment on the seed drill should have a short payback period. In view of this, a small, cheap and easy-operated seed drill will be considered relatively suitable for the smallholders.

A well-designed seed drill can meter seeds of different sizes and shapes; place the seeds in the acceptable pattern of distribution in the field; place the seeds accurately and uniformly at the desired depth in the soil; and cover the seed and compact the soil around it to enhance germination and emergence. After sowing seeds on the field, timely application of fertilizer is essential. This separate operation can be combined and therefore reducing labour works by introducing a seed-cum-fertilizer drill. The combination of seed sowing and fertilizer application has conferred greater survivability and quick establishment of the seedlings.

Thus, a manually-operated single-row seed-cum-fertilizer drill or simply named as MoSiR-SF drill was designed and developed. MoSiR-SF drill had five main functions. First, it put the seeds in the soil at a planned soil depth every time. The user can measure and control the outlet of seeds for the right spacing between seeds. Thirdly, it can plant the right amount of seeds without wasting seeds; while applying fertilizers near to the dropped seeds to enhance the survivability of seeds. Lastly, MoSiR-SF drill presses soil around the seed to mildly compact the soil around it to get a good seed-to-soil contact. MoSiR-SF drill was equipped with a roller metering system which enabled it to sow small seeds, chiefly leafy vegetables crops like mustard, spinach and swiss chard in a continuous stream.

Drafting of the MoSiR-SF drill was carried out using computer-aided-design software, Autodesk Inventor Professional 2012. Design specification will focus on the low costing and easy-operating properties, which will be further discussed in methodology section. Laboratory and field test was carried out to evaluate the performance of the prototype of MoSiR-SF drill.



## **1.2 Justification**

In this project, a MoSiR-SF drill was designed to be manually operated by single man and to sow single row of seeds. This characteristic can grant high manoeuvrability to the machine especially for the smallholders to sow seeds on hilly land and uneven terrain. Albeit the low field capacity, MoSiR-SF drill can be very efficient in the seed sowing of small area of land in order to fully utilize the existing lands. Apart from that, MoSiR-SF was developed as an attempt to create awareness for the adoption of mechanization among smallholders in Sabah, Malaysia to initiate the diffusion of technology and modernization in agriculture.

## **1.3 Objectives**

This project was set to accomplish the following objectives:

- a. To design and develop a Manually-Operated Single-Row Seed-cum-Fertilizer Drill (MoSiR-SF drill)
- b. To evaluate the performance of the MoSiR-SF drill

## **1.4 Scopes of Works**

In order to meet the project objectives, the following scope of works were covered:

- a. To review existing manual seed-cum-fertilizer drill in the market
- b. To design a low cost manual seed-cum-fertilizer drill based on local vegetable farm condition using basic calculations and computer-aided-design (CAD) software
- c. To design a performance evaluation experiment for the seed-cum-fertilizer
- d. To evaluate the performance of the MoSiR-SF drill in a laboratory set up and on local farm condition

## **1.5 Project Procedures**

This project was accomplished using the following procedures, as pictured in Figure 1.1.

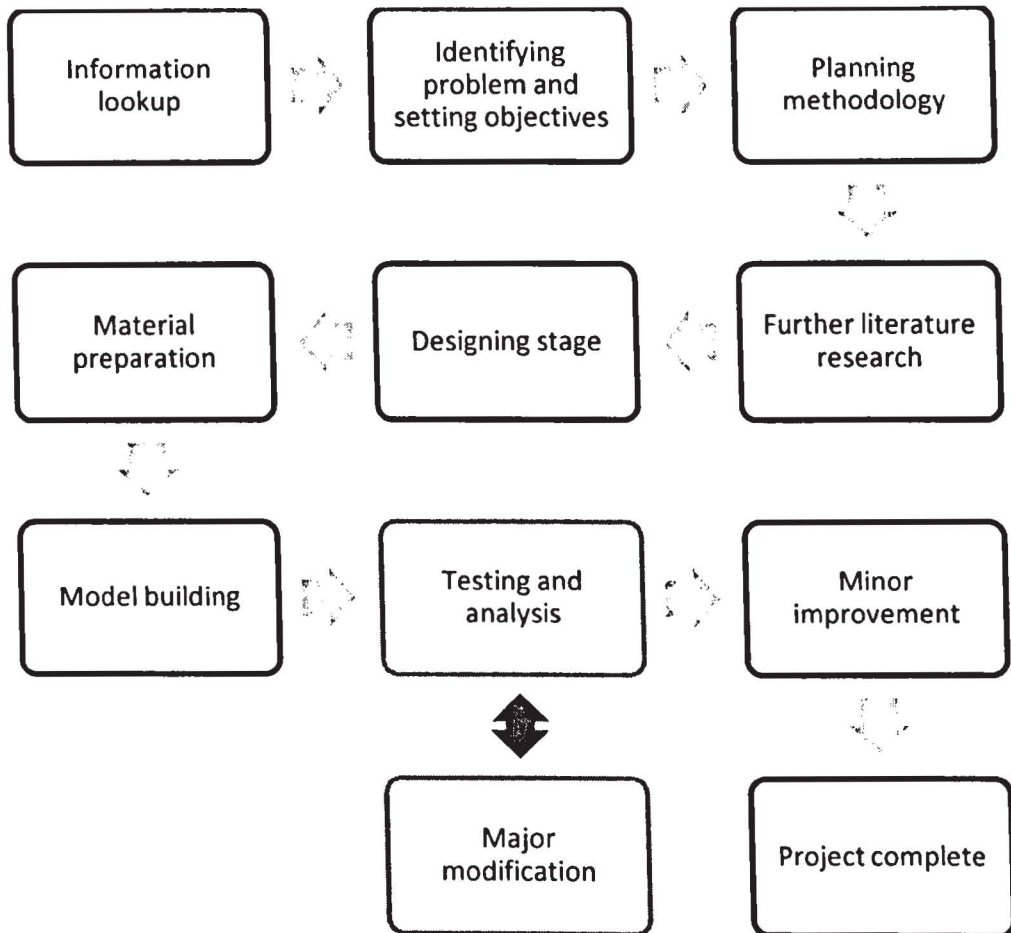


Figure 1.1 Steps of completing the project

## 1.6 Thesis Organization

The Chapter 1 in the thesis is the Introduction. In this chapter, there are several subtopics such as Background, Justification, Objectives, Scope of Work, Project Procedures, and Thesis Organization. Background includes simple overview of the title of this project. Justification emphasized on the importance of the project. Objectives state the aims to be achieved in this project; Scope of Work describes the objectives in a more specific scope. Procedures show how the project is planned to be carried out. Thesis Organization is a section where the outline of the whole thesis is briefly described.

Chapter 2 is the Literature Review. This chapter mainly contains all the facts, current issues, and theories about the project title. All these information are obtained from previous researches, journals, books, articles, and some other reliable sources.

Chapter 3 is the Methodology. The first part of this chapter described the design specification of the model and its components, relevant calculations and computer-aided drawings of the model. The latter part showed the methodology of the performance evaluation of prototype which comprises of laboratory test and actual field test.

Chapter 4 is the Results and Discussion. In this chapter, result of the test taken on the prototype was reviewed and discussed. Apart from that, differences between the conceptualization of the model and the prototype was compared and discussed. Limitation of the model was, likewise, briefly discussed.

The final chapter of the thesis, Chapter 5 is the Conclusion and Recommendations. This chapter summarizes and concludes the whole thesis. At the last part, suggestions and improvement that can be done in the future were stated.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Smallholders Vegetable Farming

Small holder agriculture can be defined as that conducted by farmers using predominantly family labour in the farm to achieve main source of income and livelihood. Small holder farm size is considered to be that less than three ha, even though fields farmed by a household may be dispersed around a village. Small holder farmers are also subsistence farmers, in that they use few if any purchased inputs, the main output of their farming activities is consumed directly, and only a minor proportion of their farm output is marketed (Johansen *et al.*, 2011).

Vegetable comprises about 15% of the daily food intake of the Malaysian population (Ding *et al.*, 1981). About eighty percent (80%) of the sample vegetable farmers, on the average, cultivate two acres of vegetable farms (Arshad *et al.*, 1991). Junius (2001) had reported that, in Sabah most of the vegetable farms are operated in two farming systems, i.e. small-scale farm system and the larger commercial-scale system. Both are highly dependent on manual labour. Commercial vegetable farms are usually much larger in size than the small-scale farm and is complemented with small machinery. These data implies that the vegetable farming is a potential industry in Malaysia but it has a limited development partly due to the low mechanization level in the farming system. Vegetable farmers in Sabah are mainly occupied with small farms in which most of them can hardly adopt expensive and heavy machinery like tractors. Tractor implemented seed drill is not appropriate for most vegetable farmers in Sabah due to the low adoption level but small machinery like manually operated seed drill is suitable for both small-scale farm system and commercial-scale system in Sabah.



## 2.2 Existing Seed cum Fertilizer Drills

In India, Pandey (2002) had reported many types of seed cum fertilizer drill that had been developed as farm equipment to use in the sowing operation. These are basically divided into 2 groups, viz. animal drawn and tractor drawn/motor-powered.

For animal drawn seed cum fertilizer, there are ANGRAU Animal Drawn Seed-cum-Fertilizer Drill, Camel Operated Seed-cum-Fertilizer Drill, HAU Animal Drawn Seed-cum-Fertilizer Drill and Animal drawn Seed/Fertilizer Drill. These seed drills have been adopted as they have a moderate field capacity and low unit cost. Nevertheless, these seed cum fertilizer drills require skilled operator to regulate the seed rate accurately.

On the other hand, Power Tiller Operated Seed-cum-Fertilizer Drill, Tractor Drawn Seed-cum-Fertilizer Drill, Tractor Operated Seed-cum-Fertilizer Drill cum Planter and CIAE 2-row Rapeseed-mustard Seed-cum-Fertilizer Drill are among the developed seed cum fertilizer drill that work as an implement to the tractor or motor-powered. These seed cum fertilizer drills conferred higher field capacity and higher efficiency in the sowing operation. However, these are not applicable to smallholders economically as the smallholders don't have enough acreage to cover the high operation cost of the tractors.

At this state, there are still limited developments of manually operated seed cum fertilizer drill that can sow seeds and apply fertilizer at the same time. Further study and development is thus required.

## 2.3 Criteria of a Good Seed cum Fertilizer Drill

Over the years seed drills have become more advanced and sophisticated but the technology has remained substantially the same. There is no best seed drill design available, but the most suitable and adaptable design can be achieved by suiting the design to the local community as well as to the desired crop. In this case, targeted community/group of this design is the smallholders in Sabah and the targeted crops are small-seeded vegetables like mustard, pak choy and choy sum.

Improved seed-cum-fertilizer drills are equipped with seed and fertilizer boxes, metering mechanism, furrow openers, covering devices, frame, ground drive system and controls for variation of seed and fertilizer rates. The type of seed and fertilizer metering and furrow openers will determine the designs of the seed drills. Therefore, it is important to select the machine with a metering unit and furrow opener suitable for the crop and soil conditions.

### **2.3.1 Seed Metering Devices**

Metering mechanism is the essential core of the sowing machine and its function is to distribute seeds uniformly at the desired application rates. A good seed metering unit can control the seed spacing in a row precisely. A seed drill may be required to drop the seeds at rates varying across wide range. Common types of metering devices used in seed drill are the adjustable orifice with agitator, fluted roller (standard), fluted roller (small flutes), vertical rotor/roller with cells, plate with cells and lastly the cup feed type.

In adjustable orifice with agitator, seed flow is regulated by changing the size of opening provided at hopper bottom. An agitator fixed above seed opening helps in continuous flow of seeds. However, this does not give precise control over the seed rate and uniformity of distribution in rows. Many designs of conventional animal and tractor operated machines have adopted this mechanism on account of its simplicity and low cost.

Fluted roller metering mechanism is a more positive metering device. Axial or helical flutes are machined or cast on an aluminium, cast iron or plastic roller. Rotation of fluted roller in a housing, filled with seeds, causes the seeds to flow out from roller housing in a continuous stream. Seed rate is controlled by changing exposed length of fluted roller in contact with seeds and fairly accurate seed rate can be achieved for a variety of medium size seeds like wheat, soybean, sunflower and safflower etc. Standard fluted roller is also suitable for medium seeds such as wheat, soybean, safflower and linseed. However, metering of small seeds like mustard and sesame at 2 to 5 kg/ha seed rate is not accurate with normal size flutes, designed for seed rates of 20 to 120 kg/ha. Therefore, fluted rollers with smaller size flutes were developed.

For sowing of small seeds like rapeseed-mustard and sesame, fluted roller with small flutes has been developed. These can be fitted by replacing the standard fluted rollers on the seed cum fertilizer drill. The roller is provided with 10 small flutes of 2x2 mm size. Low seed rates of 3 to 5 kg/ha can be achieved with this metering roller. Besides, it is mostly appropriate for the sowing of small-seeded crops like vegetables (e.g. mustard, spinach).

Vertical rotors with cells are suitable for metering individual or hill of seeds. The rotor with grooves or cells on its periphery is fixed in the hopper. The size and number of cells on the rotor are according to the size of seed and desired seed rate. A cut-off device is provided above the rotor for regulating the flow of seed to cells. By changing the rotor, it can be used for sowing of small to medium seed crops at controlled seed rates.

Horizontal, inclined or vertical plate with cell type metering mechanism picks and drops individual seed or a hill of seeds depending on design of cell on the plate. Spacing between seeds/hills is controlled by drive ratio and number of cells on plate. Separate plates are required for sowing different crops.

Seed picking cups or spoons are provided on periphery of a vertical plate. When the plate rotates, cups pick seeds from seed hopper and drop them in seed funnel. Size of cups depends on size and number of seeds per hill. This type of metering is used for seeds, which are easily damaged by mechanical devices. For bold seeds like groundnut and castor, cup feed type of metering system are recommended.

### **2.3.2 Furrow Openers**

The design of furrow openers of seed drills varies to suit the soil conditions of particular region. Most of the seed cum fertilizer drills are provided with pointed tool to form a narrow slit in the soil for seed deposition. There are many types of furrow openers had been developed around the world and the common types are the double end pointed shovel type, pointed bar type, shoe type and runner or sword type.

Double end pointed shovel type furrow openers of 100 to 200 mm size are used on seed drills in light to medium soils for medium to deep placement of seeds. For

trashy, stony and light to medium soils, the depth of seed placement from 50 to 100 mm can be achieved with these openers.

Pointed bar type (diamond shaped) furrow openers are used for forming narrow slit under heavy soils for placement of seeds at medium depths. Shoe type openers are used in black soil regions. Seeds are dropped through a tube connected to boot at rear of opener for placement at shallow to medium depths. When used on seed cum fertilizer drills a special narrow boot is designed to place seed and fertilizer in soil at same depth but separated by a small distance. Shoe type openers with single or twin boots are used for sowing in heavy and medium soils for seed placement at 20 to 70mm depth. While small shoe type furrow opener is suitable for shallow (20 to 50 mm deep) placement of seeds in dry farming areas.

Runner or sword type openers are used on seed drill for shallow sowing. Soil over seed flows back in furrow during operation and seeds are covered with a levelling bar, press wheel, chain or by operating a wooden plank behind the drill. Runner type opener is widely used for placement of seeds at shallow depth where soil disturbance required is minimal. Soil cover over seed is also minimal.

## **2.4 Material Selection**

The material selection should not be solely based on cost. A systematic approach to material selection process is necessary in order to select the best material for any application. The proper material selection technique involves carefully defining the application requirement in terms of mechanical, thermal, environmental, electrical and chemical properties. (Vishu, 2006)

Material selection process starts with carefully defining the requirements and narrowing down the choices by the process of elimination. Designer must identify application requirements including mechanical, thermal, environmental and chemical. All special needs such as outdoor UV exposure, light transmission, fatigue, creep, stress relaxation, and regulatory requirements must be considered. Processing techniques and assembly methods play a key role in selecting appropriate material and should be given consideration.



## REFERENCES

- Ajay, K. V. and Dewangan, M. L. 2007. Design, Development and Evaluation of Seed cum Fertilizer Drill. *Agricultural Mechanization in Asia, Africa, and Latin America* **38(2)**: 33-37
- Ajay, K. V., Dewangan, M. L., Singh, V. V. and Das, V. 2007. Mechanical Consideration for Design and Development of Furrow Openers for Seed cum Fertilizer Drill. *Agricultural Mechanization in Asia, Africa, and Latin America* **38(2)**: 74-78
- Arshad, H., Jipanin, J., Lee, S.H. and Michalik, S. 1991. Factors Influencing the Pesticides Use Pattern of Vegetable Farmers in Sabah, East Malaysia: An Exploratory Baseline Survey, MGPP- DOA Sabah.
- Bernama. 2011. Sabah, private sector team up to boost agriculture. *The Edge Financial Daily*, 11 Oct, 7
- Darbie, M. G., Terry, K. and George, B. 2008. Seeding Rates for Vegetable Crops Buletin 1128, The University of Georgia, Cooperative Extension
- Das, N. R. 2008. Types and Methods of Tillage. *Tillage and Crop Production*. West Bengal: Scientific Publishers (India)
- Devnani, R. S. 1989. Design Manual for Sowing Equipment RNAM Regional office Philippines. pp 4-9
- Ding, T. H., Vimala, P., and Yusof Salleh. 1981. An Agroeconomic Survey of Vegetable Farming in Peninsula Malaysia. MARDI, Selangor, Malaysia.
- Henry, G. T. 2009. Planting a home vegetable garden. <http://www.extension.iastate.edu/Publications/PM819.pdf>. Access on 29 November 2012. Verified on 2 December 2012
- Jayan, P. R. and Kumar, V. J. F. 2004. Planter Design in Relation to the Physical Properties of Seeds. *Journal of Tropical Agriculture* **42(1-2)**: 69-71
- Jinius, J., Alinah, A. R., Jackson, R. J. and Phua, P.K. 2001. Management Of Pesticide Use On Vegetable Production: Role Of Department Of Agriculture Sabah. *6th SITE Research Seminar*
- Johansen, C., Haque, M. E., Bell, R. W., Thierfelder, C. and Esdaile R. J. 2011. Conservation Agriculture for Small Holder Rainfed Farming: Opportunities and Constraints of New Mechanized Seeding Systems. *Field Crops Res.*
- Matt, H. 2002. Guide to No-Till Seeding. Exapta Solutions Inc. [http://www.exapta.com/knowledge/guide\\_seeding.html#](http://www.exapta.com/knowledge/guide_seeding.html#). Access on 5 May 2012. Verified on 15 May 2012

- Laura, B. S. 2010. The Pre-history of Soil Science: Jethro Tull, the Invention of the Seed Drill, and the Foundations of Modern Agriculture. *Physics and Chemistry of the Earth* **35**: 851–859
- Pandey, M. M. 2002. Present Status and Future Requirement of Farm Equipment for Crop Production
- Sankaranarayanan, M. and Nzamwitakuze, A. 2012. Development of a Push Type Seed Drill for Sowing Maize in Rwanda
- Sheridan, J. C. and Clara, O. 2011. SPSS version 18.0 for Windows, Analysis without Anguish.
- Vishu, S. 2006. Material Selection. *Handbook of Plastics Testing and Failure Analysis, Third Edition*. Pomona: John Wiley & Sons, Inc