



Research paper

Evaluation of Two Types of Mowers for Windrowing of Faba Bean (*Vicia faba*) in River Nile State, Sudan

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ABSTRACT

In northern Sudan, where farm holdings range between 0.5-2 ha, the small size of farms makes the manual traditional practices still prevailing for crops production. The faba bean is one of the major food legumes crops grown in the region. This evaluation carried out at Hudaiba Research Station, to test two types of fodder mower to cut faba bean to face the problem of unavailability of labor at harvest time and high cost of wage during the last three years. The two mowers reduce the cost of cutting by 69% compared to manual cutting. The evaluation presented some technical specifications and recommendation when using the mowers for cutting faba bean to reduce losses.

Keywords: faba bean, sickle mower, disc, mechanical cutting, losses

تقييم استخدام نوعين من قاطعات الاعلاف في القطع المنتظم لمحصول الفول المصري بولاية نهر النيل، السودان

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الحيازات الصغيرة تجعل من خدمة المحاصيل يدويا تظل هي الممارسة السائدة في شمال السودان حيث المساحات لا تتجاوز نصف الي 2 هكتار. يمثل محصول الفول المصري واحد من المحاصيل المهمة المزروعة في هذا الاقليم. اجريت هذه الدراسة في محطة بحوث الحديدية لتقييم اداء اثنين من انواع قاطعات الاعلاف لحصاد محصول الفول المصري، لحل مشكلة ندرة العمالة في وقت الحصاد وارتفاع التكاليف الملموس خلال الثلاث سنوات الاخيرة. تكلفة الحصاد بقاطعات الاعلاف كانت ادني بنسبة 69 % مقارنة بتكلفة الحصاد اليدوي. اجمل تقييم هذه الحاصدات عدد من الملاحظات الفنية والتوصيات التي يجب مراعاتها عند استخدام هذا النوع منها لحصاد الفول المصري.

كلمات مفتاحية: الفول المصري، قاطعة اعلاف منجلية، قرص، القطع الميكانيكي، الفقد

Introduction

Faba bean (*Vicia faba*) is one of the major food legume crops, it is used as human food in developing countries and as a common breakfast food in the Middle East, Mediterranean region, China and Ethiopia, it can be used as a vegetable, green or dried, fresh or canned (Gasim and Link, 2007), and used as animal feed in industrialized countries (Singh *et al.*, 2012). The annual production in sub-Sahara Africa in 1999 to 2003 was estimated at 510,000 tones, almost entirely about 405,000 tons produced in Ethiopia and about 100,000 in Sudan (Anil, 2013).

Faba bean crop is one of the most important cool-season food legumes produced in the Sudan, the faba bean provide a major part of the daily diet, particularly among the poorest sections of the population and it is also cash crop for farmers. The Northern region of the country (Northern and River Nile states) is the main production area for the crop, where about 27% of the North Africa area planted in the Northern region of Sudan (MOA, 2014), because of its favorable climatic conditions, particularly the relatively cooler winter. The crop grown under surface irrigation system, and irrigated agriculture extends along the River Nile banks which stretch over 678 km of the narrow strip of cultivable land along the Nile with the farm holding ranges between 0.5-2 hectares. There is a decline in the area cultivated and average yield per hectare from season 2007 to 2013 (MOA, 2014) (Fig.1) due to traditional manual cultural practices still prevailing in the northern region including manual harvesting of the crop, which is expensive and time consuming. Several surveys conducted by Nile Valley Project in the Sudan, recorded that harvesting faba bean (including cutting; transport; threshing and cleaning) accounted for between 32-47% of the total production cost of the crop (Salkini *et al.*, 1983a,b), where concerning work rate a four-labor required about 23.8 working hour to cut, bind and to collect on heaps one hectare (Awad Alla *et al.*, 2014), given that food legume production is often held back by a lack of technology and the limited application of new innovations (Haddad *et al.*,1988).

Legume crops in some developed and European countries are successfully harvested mechanically, fully mechanized by direct harvest or by mowing and bandaging followed by combining. However, the systems used might not be suitable for farmers in the Sudan, as farmers in the northern region have small-holdings, they plant legume crops using traditional methods to

grow the faba bean crop under surface irrigation, in addition, socioeconomic factor in the region consider the crop residue as an important animal feed. Therefore, harvest mechanization may well demand different approaches.

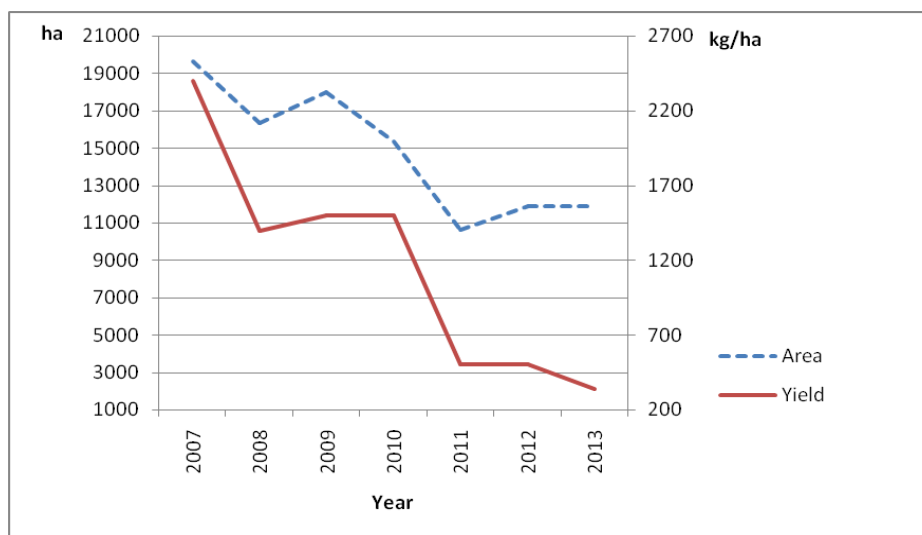


Fig. 1: Area of faba bean and yield during 2007-2013 in River Nile State

In the northern region of Sudan, two stages of harvesting is still practiced for the crop, which is manual cutting at physiological maturity for drying, and binding and collecting the crop on heaps then feeding to stationary threshers. In recent years the high cost of labor wage and unavailability at proper time, has challenge the continuity of the crop production in the region. For sustainability of crops produced with traditional practices, the application of mechanical technology in agriculture enhance the productivity of human labour up to 500 times in comparison to traditional agriculture (Mazoyer, 2001), also for analysis of data in India from 1950-1997, shows that the yield is positively related to power available in both time and space (Singh, 2001). In northern region of Sudan, introduction of direct harvesting is very difficult, because of small holdings; different crops grown; ridges and inter canals for surface irrigation and the needs of crop residue as animal fodder.

Solving faba bean harvesting problem is crucial to encourage farmers to grow more area of faba bean. Intensive efforts by national agricultural engineering research program are now being made to overcome this important constraint, as introduce of simple available technology to substitute labor at harvest cutting operation, that a simple and inexpensive tractor mounted

mower or windrower equipment could be a potential solution, as windrowing is becoming more popular in faba bean. Therefore, the objective of this demonstration is to evaluate the available prevailing fodder mower in the the northern region for mechanical windrowing of faba bean in terms of pods and seeds losses, uncut stems, work rate and harvest cost.

Materials and Methods

The mechanical cutting of faba bean executed using two types of tractor rear mounted mower, single effect sickle bar mower model Gaspardo (Fig. 1, Photo1) and disc mower model Agromaster TOB 1350 (Fig.1, Photo2). Some technical specifications for the two mowers are presented in Table 1, the main difference is that the drum speed is unadjustable in the Agromaster type. The demonstration executed during seasons 2012/13 to 2015/16. According to indeterminate growth habit of faba bean, the pods ripen sequentially; therefore, windrowing needs to be done at the appropriate stage, to minimize losses due to shattering. The mechanical cutting carried out at two different intervals in the first season only and at maturity stage in the second two seasons.

The two mowers compared with manual cutting using hand held sickle, normally the work team contain three workers with seven work hours per day. Area of 1.2 hectare in Hudeiba Research Station farm sown by faba bean variety Hudeiba 93, divided to three sections equally, a twenty-one stems at W track were tagged by sticker to determine stem height and count number of pods and seeds before and after cutting. This replicated three times along each section, to determine loss as a percentage of pods and seeds; uncut stem and length of cut stems, also data on work rate were collected for each section. In a preliminary test the cut crops did not arrange in line to ease the operation of crop collection which appear with the two mowers. To overcome the problem, wings were fixed at rear of each mower. Each section was cut by one of the three methods mentioned, the time of cutting at daylight to able collecting tagged stems.

Results and Discussion

From the results shown in Table 2, generally, the losses increased when delay cutting by the two types of the mower tested, it was more in case of the disc mower, from shattering action to dry

Pods, which attributed to high peripheral disc speed, than with sickle mower. The more uncut stem percent with sickle mower refer to that, single effect mower bar making one cut by stroke. The distance of cut from the soil surface appears under the height of pods setting in three methods. For the work rate, one team require at least two days for one hectare working most hours at daylight. Harvest of legumes is critical, because delays can result in significant yield losses due to lodging, shattering and pod loss, as faba beans are very prone to pod splitting and pod drop after once the plant has dried down, yield losses of up to 30% have been recorded (GRDC, 2017). Therefore, considering the unavailability of labor to cut the crop at the optimum time, which will result in increased pre-harvest loss, using the mower with the reduction of cost by 69%, can become the farmer decision.

Conclusion

The results from the demonstration, explain some technical specifications to be in the mower for mechanical cut of faba bean in River Nile State, that double action sickle bar mower to reduce uncut stem, and variable pulley speed system for disc type to reduce losses, and adjustable rear wings for swathe purpose. In the mean time the available mower can be used with seeds moisture content of 45% (NSWA, 1999) in the morning or night to reduce losses.

Table (1): Some technical specifications for Sickle bar and drum mowers.

Item	Sickle bar mower	Drum mower
Working width (cm)	130	135
No. of blades	18 teeth	2 drum each has 6 blades
Rpm	Tractor rpm 540	Tractor rpm 540, Drum rpm 1920
Motion drive	V belt	V belt

Table (2): Parameters to evaluate mechanical cutting of faba bean at HRS

Method	PH (cm)	PSSS (cm)	SLAC (cm)	Losses on pods on grain (%)		Uncut stem (%)	Work rate (hr/ha)	Cost (SDG/ha)
Cutting date 13/2/2013								
Sickle bar mower	67	30	12	5	11	7.7	2.7	
Disc mower	72	28	11	6.3	16.5	4.8	2.9	
Manual cut	81	24	4	1.8	5.2	3.2	34	
Cutting date 17/2/2013								
Sickle bar mower	71	23	11	8.3	20	7.7		
Disc mower	84	37	19	39	60	0		
Season 2014/2015								
Sickle bar mower	97	33	20	5.3	13.7	9	3.7	
Disc mower	93	26	13	2.5	5.3	5	2.4	
Manual cut	94	24	5	1.6	2.4	3.2	57	
Season 2015/2016								
Sickle bar mower	83	32	22	5.4	12	8.1	3.4	400
Disc mower	97	40	15	8	12	5	4	400
Manual cut	101	39	12	2.1	3.1	3	32	1300
Mean								
Sickle bar mower	82	32	18	5.2	12.2	8.3	3.3	
Disc mower	87	31	13	5.6	11.3	4.9	3.1	
Manual cut	92	42	7	1.8	3.6	3.1	41	

PH: plant height, PSSS: pods setting height from soil surface, SLAC: remain stem length on soil after cutting.

SDG= Sudanese pound (1 US\$= 16 SDG)

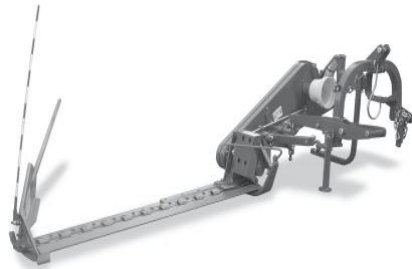


Photo 1.



Photo 2.

Fig. 1: Single effect sickle bar mower model Gaspardo (Photo1) and disc mower model Agromaster TOB 1350 (Photo2).

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