RESEARCH ARTICLE Legume Research- An International Journal, Volume 47 Issue 7: 1151-1157 (July 2024)

Harvesting and Threshing Methods on Seed Quality of Dhaincha (*Sesbania aculeata*)

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10.18805/LR-4642

ABSTRACT

Background: The present investigation is an attempt to study the effect of different harvesting and threshing methods on germination and seedling vigour of dhaincha. The use of a combine harvester to harvest dhaincha will be an effective alternative method that has not been widely tried. However, work on different methods of harvesting and threshing of dhaincha is limited. Hence, a study was conducted to evaluate the impact of various harvesting and threshing methods on germination and seedling vigour of dhaincha.

Methods: This study was conducted at Anbil Dharmalingam Agricultural College and Research Institute, TNAU, Tiruchirappalli, Tamil Nadu. The dhaincha crop was harvested and threshed using four different methods *viz*., manual harvesting and manual threshing, manual harvesting and threshing by tractor treading, manual harvesting and mechanical threshing and harvesting and threshing by combine harvester. The resultant seeds were tested for mechanical damage and germination potential. The experiment was laid in completely randomized block design. Germination was tested by roll towel method using 100 seeds in four replications. Germination percentage, root and shoot length were measured in seven days after sowing from ten randomly selected seedlings in each replication. For the estimation of dry matter production, ten seedlings were selected at random and kept in a hot air oven maintained at 85°C for 24 hours after measuring their root and shoot length and vigour index was calculated. Mechanical damage to seeds was observed by ferric chloride test. Seed recovery per cent was calculated based on the 100 kgs of dhaincha seeds were cleaned and graded treatment wise using cleaner cum grader and the seeds retained on the bottom sieve were weighed and expressed as per cent of total quantity of seed.

Result: The results revealed that the significant difference was found among the different harvesting and threshing methods. The seeds harvested and threshed by manual method recorded 85 per cent germination followed by seeds harvested manually and threshed by mechanical threshing (84 per cent) and seeds harvested manually and threshed by tractor treading (80.5 per cent). The lowest germination of 80.0 per cent was recorded by combine harvesting. From this study, it could be inferred that combine harvester is a modern method for harvesting of dhaincha that saves time and labour when compared to all other methods.

Key words: Germination, Harvesting and threshing methods, Mechanical damage, Seedling vigour, *Sesbania aculeata.*

INTRODUCTION

Dhaincha (*Sesbania aculeata*) is a leguminous green manure crop. It is mainly cultivated in Asia and Africa. It is one of the most important green manure crops with multiple uses, *viz*. green manure, mulch for moisture conservation, weed suppression, ground cover, firewood, fuel, fibre and bioenergy sources, providing live support fencing wood, raw materials for industrial uses and in traditional agroforestry systems, animal feed, fodder and medicinal importance (Palaniappan and Budhar, 1994; Chanda *et al*., 2019). It can grow well in poor and salt affected soils. It is mainly used as green manure to fixes atmospheric nitrogen in the soil through Legume-Rhizobium symbiosis. After 40-60 days of sowing the crop is buried in soil to add 80-86 kg of N/ha (Sharma and Ghosh, 2000). The genus *Sesbania* showed a luxuriant growth in soil with a high electrical conductivity up to 10 mS cm^{-1} and have been recommended for reclamation of saline and sodic soils (Chavan and Karadge, 1986). As there is an emerging demand for dhaincha seeds, efficient agronomical interventions are required to ensure the seed quality and storage. Few researchers have attempted to study the effect of spacing, fertilizer level and different nutrient management practices on seed yield of dhaincha (Rajesh *et al*., 2017 and Gopal *et al*., 2016). But Among the different seed production practices, harvesting and threshing are very much important operations as it has many impacts on post-harvest seed quality and viability. Dhaincha is indeterminate crop, pods are produced continuously. Pod maturity is identified by brown colour and mature pods are found at the base of plants. Selvaraj and Ramaswamy (1984) stated that the seeds of *Sesbania*

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How to cite this article: Masilamani, P.,Eevera, T., Ramesh, T. and Venkatesan, S. (2024). Harvesting and Threshing Methods on Seed Quality of Dhaincha (*Sesbania aculeata*). Legume Research. 47(7): 1151-1157. doi: 10.18805/LR-4642.

Submitted: 21-04-2021 **Accepted:** 21-06-2021 **Online:** 28-07-2021

aculeata attained physiological and harvestable maturity around 40th and 60th days after anthesis respectively. Beyond this stage, the pods started to dehisce and resulted in shattering of seeds in the field itself. Harvesting of the crop at 75% pod maturity stage gave higher yield and quality (Radha, 1991) and further delay affected both yield and quality. Mature pods are strongly attached to the crop and pulling them or twisting them for pod collection is not easy (Arul, 2014). Further the tip of the pod has needle like projection, that causes injury to the person involved in pod collection.

Various studies have been conducted to evaluate the effect of different methods of harvesting and threshing on seed quality, threshing efficiency, seed germination and labour requirement in crops like rice (Masilamani and Tajuddin, 2012; Govindaraj *et al*., 2017ab) and sunn hemp (Masilamani *et al*., 2017). In general, the dhaincha plants are harvested manually and separation of seeds were done by beating the plants with pliable sticks which is laborious and time-consuming. In manual method of harvesting, the harvested crop bundled and transported from field to threshing floor and heaped for 3-4 days and threshed manually with plaiable stick (or) heaped plants are dried over threshing floor and then threshed using tractor which moves in circle over a threshing floor. Mechanical damage to pods can be reduced if the plants were spread in a layer with 2' thickness (Masilamani and Sivasubramaniam, 2016). In all the above post-harvest handling operation, spillage of seed is the major problem. Harvesting and threshing losses are the first phase of post-harvest losses which aids in further storage and quality loss (Benazeer *et al*., 2018). As a result, an efficient method for harvesting the dhaincha is required. Increasing labour scarcity, labour wages and more post-harvest losses leads to cultivation and manual harvesting and threshing of dhaincha is a laborious and costly process. Hence, it is necessary to find an alternative and cost-effective method for harvesting and threshing of dhaincha. The use of combine in harvesting of paddy and sun hemp made major breakthrough and minimize time, labour and loss of seeds during harvest and post-harvest operation. Before use of combine in rice harvesting and threshing is considered to be labourites and costly affair. However, work on different methods of harvesting and threshing on dhaincha is limited. Hence, a study was conducted to evaluate the impact of various harvesting and threshing methods including combine on seed and seedling quality parameters of dhaincha.

MATERIALS AND METHODS

The dhaincha crop raised over an area of 4 ha during summer 2020 at the Anbil Dharmalingam Agricultural College and Research Institute, TNAU, Thiruchiraplli, Tamil Nadu was harvested and threshed at 17 per cent moisture using four different methods *viz.,* manual harvesting and manual threshing with pliable stick (T_1), manual harvesting and threshing by tractor treading (T_2), manual harvesting and mechanical threshing by multipurpose thresher (T_3) and harvesting and threshing by paddy combine harvester (T_4) (Fig 1). The threshed seeds were sun dried to reduce the moisture content to 12 per cent. Seed recovery per cent was calculated based on the 100 kgs of dhaincha seeds were cleaned and graded treatment wise using cleaner cum grader and the seeds retained on the bottom sieve were weighed and expressed as per cent of total quantity of seed. Mechanical damage to seeds was observed by ferric chloride test (Agrawal, 1995). For this, 20% ferric chloride ($FeCl_3$) solution was prepared by adding four parts of water to one-part $FeCl_3$. Five replications of 100 seeds of each treatment were soaked in 20% solution of $FeCl_3$ for fifteen minutes. Enough $FeCl_3$ solution was poured to immerse the seeds in the solution. Separation of black stained seeds was started within fifteen minutes after soaking by counting the number of black stained seeds and mechanical damage percentage was recorded.

Germination was tested by roll towel method using 100 seeds in four replications in seed germination room maintained at temperature of 25±2°C and Relative Humidity of 95±2% (ISTA, 1985) The experiment was laid in completely randomized block design. Seven days after sowing, per cent germination was computed. Ten seedlings from each replication were randomly taken and root and shoot lengths were measured. For the estimation of dry matter production, ten seedlings were selected at random and kept in a hot air oven maintained at 85°C for 24 hours. The vigour index I was derived from the following formula (Abdul Baki and Anderson, 1973).

VI=Per cent germination × Total seedling length (cm)

The vigour index II was calculated based on the dry matter production of the seeds multiplied with germination percentage. The results were subjected to analysis of variance and tested (t-test) for significant difference (p=0.05) as suggested by Panse and Sukhatme, (1995). Percentage values were transformed into arc sine values prior to statistical analysis.

RESULTS AND DISCUSSION

The results revealed that the significant difference was found among the different harvesting and threshing methods. The highest seed recovery was recorded in manual harvesting and manual threshing (78 per cent) followed by harvesting and threshed by combine harvester (77.8 per cent) and the lowest seed recovery was obtained in manual harvesting and mechanical threshing (70 per cent) (Table 1).

The different method of harvesting and threshing had significant effect on hard seed characters. The highest hard seed percentage was recorded in seeds harvested and threshed by tractor treading (72 per cent) followed by seeds harvested and threshed by manually (67 per cent). Seeds harvested and threshed by combine had 28 per cent hard seed and the lowest hard seed (19 per cent) was recorded in seeds harvested by manual and threshed by thresher. The mechanical harvesting and threshing methods recorded minimum number of hard seeds. The above may be due to

rubbing action of the rotating roller leads to softening of seed coat during separation of seeds by mechanical mode. So, mechanically threshed seeds were scarified and devoid of seed coat dormancy and ready to germinate with good seedling vigour (Masilamani *et al*., 2017) (Table 2).

Seeds harvested and threshed by manual method recorded the highest germination of 85 per cent followed by seeds harvested manually and threshed by thresher (84 per cent) and seeds harvested manually and threshed by tractor treading (80.5 per cent). The lowest germination of 80.0 per cent recorded in seeds harvested and threshed by combine. The highest mechanical damage of 20 per cent was recorded in seed harvested manually and threshed by thresher followed by harvesting and threshed by combine 15 per cent and manual threshing and manual harvesting 8 per cent. The lowest mechanical damage of 5 per cent was recorded in seeds harvested manually and threshed by tractor treading. The highest root length of 10.27 cm was recorded in seeds harvested manually and threshed by thresher followed by seeds harvested manually and threshed by tractor (9.43 cm) and seeds harvested and threshed by combine harvester (9.18 cm). The lowest root length of 7.6 cm was recorded in seeds harvested and threshed by manual method. The highest shoot length of 7.37 cm was recorded in harvesting and threshing by combine harvester followed by seeds harvested manually and threshed by tractor (7.35 cm), seeds harvested manually and threshed by mechanical thresher (6.97 cm) and the lowest shoot length was recorded in seeds harvested and threshed by manual (5.28 cm). Significantly higher dry matter production was recorded (0.094 g/10 seedlings) in harvesting and threshing by combine harvester followed by seeds harvested

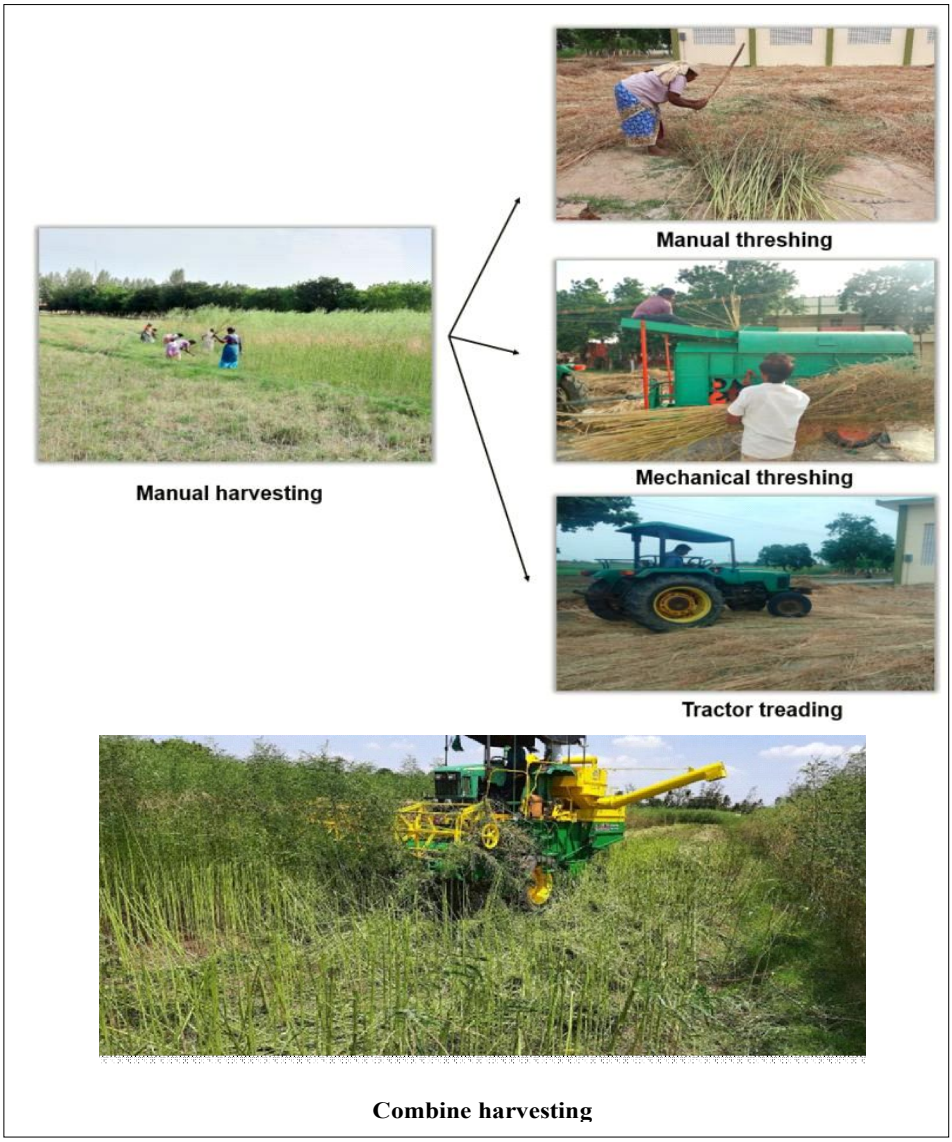

Fig 1: Different methods of harvesting and threshing.

and threshed by manual and mechanical thresher (0.089g/ 10 seedlings) and the lowest dry matter production was recorded in seeds harvested and threshed by tractor treading. The highest vigour index I was recorded in seeds harvested manually and threshed by mechanical thresher (1448) followed by seeds harvested and threshed by tractor treading (1350) and harvesting and threshing by combine (1315). The lowest vigour index I was recorded in seeds harvested and threshed by manual (1094). The highest vigour index II was recorded in seeds harvested and threshed by manual (7.56) followed by mechanical thresher (7.47) and combine harvester and the lowest vigour index II was recorded in seeds harvested and threshed by tractor treading (6.68) (Table 3, Fig 2-3).

Table 1: Effect of harvesting and threshing methods on seed recovery (%) using cleaner cum grader.

Treatments	Seed recovery (%)
T1- Manual harvesting and manual threshing with pliable stick	78.0 (62.02)
T2- Manual harvesting and mechanical threshing with multipurpose thresher	70.0 (56.79)
T3- Manual harvesting and threshing by tractor treading	71.3 (57.41)
T4- Harvesting and threshing by combine	77.8 (61.34)
Mean	74.2 (59.34)
SEd	0.751
CD (P=0.05)	1.637

(Figures in parentheses indicate arc sine values).

Table 2: Effect of harvesting and threshing methods on hard seed (%) of dhaincha.

Treatments	Hard seed (%)
T1- Manual harvesting and manual threshing with pliable stick	67 (54.940)
T2- Manual harvesting and mechanical threshing with multipurpose thresher	19 (25.842)
T3- Manual harvesting and threshing by tractor treading	72 (58.053)
T4- Harvesting and threshing by combine	28 (31.949)
Mean	46.5 (42.706)
SEd	0.210
CD (P=0.05)	0.459

(Figures in parentheses indicate arc sine values).

Seeds harvested and threshed by manual method had higher germination when compared to all other methods, whereas higher vigour index was associated with manual harvesting and mechanical threshing. Manual harvesting and threshing may not be economical since it is labouries, seed loss (spillage) during harvesting, bundling and transporting from field to threshing floor, more time consuming and lower threshing efficiency. Combine harvesting and threshing is a time saving in a single operation both harvesting and separation of seeds completed. Which reduces the manual effort and ultimately the land can be put into sowing of next crop in a very short duration. In addition to above advantages, field subjected to seed harvesting by combine, incorporated with the plant debris in the same field itself without any wastage of plant debris like that of other method followed in this experiment. Seeds harvested by combine initially found to be green in colour with more moisture content (17%) and a week after shade drying the colour was changed from green to brown with reduction in moisture content (12.0%) (Fig 4). Due to indeterminate type of maturity except combine harvester process, in the other method followed in these plants were harvested, bundled and stacked for 2-3 days at threshing floor. This stacking facilitated to ensure immature pod to attain maturity. During stacking lot of chances are derived for development mold and loss of seed quality. In combine harvester aided harvesting, the mature and immature seeds also harvested and threshed without any loss of seeds. After harvesting, seeds were dried under shade condition. During drying the immature seed colour also become green to brown and moisture content reached the level of 12%. During processing in the cleaner cum grader all the immature and insect infected seeds were discarded. Green *et al*. (1996) stated that the soyabean seeds harvested by combine at lower rpm significantly improves germination and also

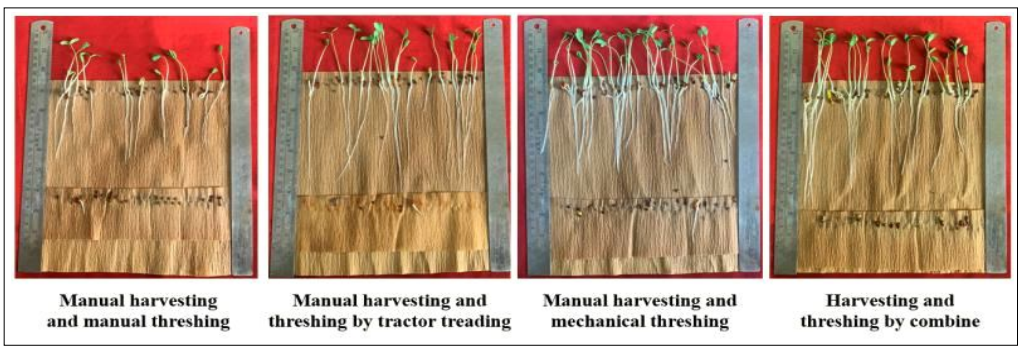

Fig 2: Effect of harvesting and threshing methods on germination (%) of dhaincha.

feeding rate is an important factor with respect to seed losses (Andrews *et al*., 1993). Masilamani *et al*. (2017) reported that combine harvester is best suited for harvesting sunn hemp at 21.5 per cent moisture content without impairing germination and seedling vigour.

In manual harvesting/manual threshing and manual harvesting/mechanical threshing, harvested crops were bundled and transported to a threshing location, by employing++ huge labour. During transportation matured pods that are available in the harvested plants get dehisced and seed get lossed. Combines provide an enclosed system which greatly reduces the loss of seeds and also provided a sophisticated cleaning system. Threshing and cleaning operations are complex but combine harvester operates on

Table 3: Effect of harvesting and threshing methods on mechanical damage (%), germination (%) and initial seedling vigour of daincha.

Treatments	Mechanical damage (%)	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (g/ 10 seedlings)	Vigour index I	Vigour index II
T1- Manual harvesting and manual threshing with pliable stick	8 (16.43)	85.0 (67.21)	7.6	5.28	0.089	1094	7.56
T2- Manual harvesting and mechanical threshing with multipurpose thresher	20 (26.56)	80.5 (63.43)	9.43	7.35	0.083	1350	6.68
T3- Manual harvesting and threshing by tractor treading	5 (12.92)	84.0 (66.42)	10.27	6.97	0.089	1448	7.47
T4- Harvesting and threshing by combine	15 (22.78)	80.0 (62.72)	9.18	7.37	0.094	1315	7.47
Mean	12.0 (20.26)	82.25 (64.89)	9.12	6.7425	0.088	1302	7.29
SEd	0.111	0.787	0.119	0.072	0.001	9.198	0.104
CD (P= 0.05)	0.243	1.716	0.259	0.157	0.003	20.042	0.227

(Figures in parentheses indicate arc sine values).

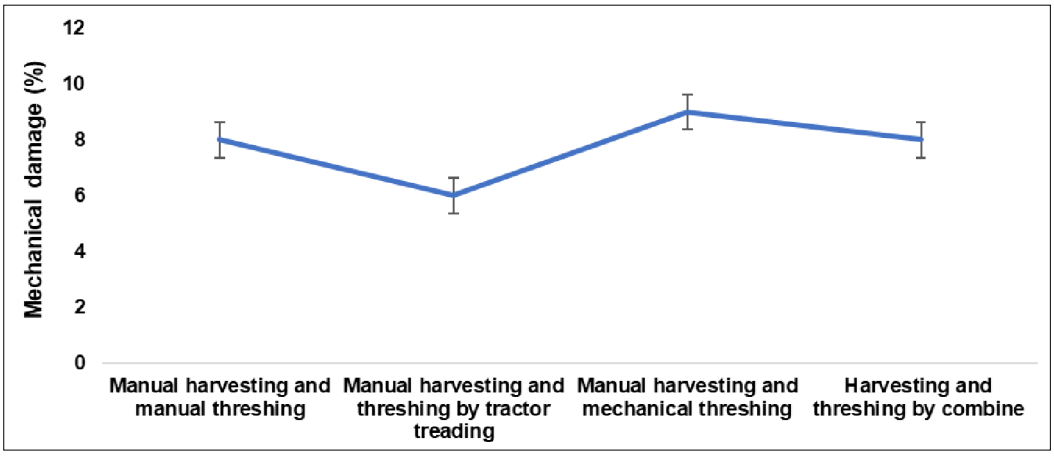

Fig 3: Effect of harvesting and threshing methods on mechanical damage (%) of dhaincha.



Fig 4: Harvested seeds by combine.

proven physical principles using impact, acceleration and gravity to thresh, separate and clean seeds. During threshing, separation and cleaning of the seeds by combine recorded extremely low level of seed loss. If the operator drives slow enough to not slug feed the cylinder/rotor, losses will be very low (Paulsen *et al*., 2015). Since combine harvester is designed for paddy *etc*, necessary adjustments have to be made to increase the efficiency. When thresher or combine is used, care must be taken to thoroughly check the machinery for previous crop remnants to avoid seeds admixture. The mechanical damage estimated by the ferric chloride test shows minimum damage irrespective of the treatments tried (6 to 9%) and it has hard seed coat, it escapes from mechanical impact and damage under different harvesting and threshing methods adopted in this experiment. Lowest damage (6%) was recorded in the crop harvested and threshed by mechanically and the highest (9%) was in the manual harvest and threshed by tractor treading. Presence of hard seed coat in dhaincha is an added advantage in the perspective of mechanical harvesting and threshing. Any seed coat softens that were occurred during mechanical harvesting and threshing reduces the seed coat dormancy and enhanced the germination and seedling growth.

Seed moisture play an important role in harvesting of the seed crop through combine. If crop moisture increases, combine requires higher peripheral threshing velocity to thresh. As crops dry, crop material is easier to thresh and peripheral velocity should be reduced. When the seeds have higher moisture content, outer hull, pericarp and seed coat of seed is usually soft, so that peripheral threshing velocity will be determining to quality of threshed seeds (Alizadeh and Khodabakhshipour, 2010). Rate of feeding of crop into the combine need to regulates, if faster rate of feeding leads to loss of fully matured seeds in the field itself during harvesting (Paulsen *et al*., 2014). Andrews *et al*. (1993) studied the effects of combine harvesting in rice on crop quality and losses. In this study, they endorsed be negative effect of rate of feeding on seed loss during harvesting.

CONCLUSION

From this study, it could be concluded that combine harvesting of dhaincha seed crop is a feasible method to obtain good quality seeds with maximum threshing efficiency and seed recovery for large scale seed production. This study clearly indicated that the dhaincha crop harvested at 17 per cent moisture content by combine satisfy the seed standards of dhaincha as specified by IMSCS (Indian Minimum Seed Certification Standards) 75 per cent germination.

ACKNOWLEDGEMENT

The authors are thankful to Tamil Nadu Agricultural University Coimbatore for providing facilities and funding for the research work.

Conflict of interest

All authors declared that there is no conflict of interest.

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