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Case Study

Grass Seed Harvesting – Methods, Machines and Aspects

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Abstract

Grass seed collection is tedious and intensive labour consuming operation, which is carried out by detaching the grass seed from standing plant or by beating the seed head in standing crop or by cutting, drying and threshing. Selection of machines for these operations in different continents depends upon the climatic conditions, topography, type of grass, its physiological properties etc. Different methods and machines used for grass seed collection are therefore reviewed and presented. The grass seed collection tools and machines available according to the method of harvesting and collection are manually operated fork, handheld engine powered seed stripper, brush type harvesters operated by hydraulic or mechanical power, pull type seed harvester, utility vehicle mounted grass seed harvester, trough and beater harvesters, vacuum harvesters, wide vacuum harvesters and offset suction harvesters. However, direct combine harvesting and collection of grass seed with modification of header unit also prevails in some of the countries. The aspects that are of prime importance for successful mechanical harvesting such as equipment reliability, climatic effects and storage of grass seed are also discussed.

***Key words*:** Brushing, Grass Seed Harvester, Seed collection, Vacuum harvesting

Grasslands, including sown pasture and rangeland, are among the largest ecosystems in the world and contribute to the livelihoods of more than 800 million people. They are a source of goods and services such as food and forage, energy and wildlife habitat, and also provide carbon and water storage and watershed protection for many major river systems [1]. Grasslands are important for *in situ* conservation of genetic resources. Of a total of 10,000 known species, only 100 to 150 forage species have been cultivated, but many more hold potential for sustainable agriculture and grassland development. Globally grasslands area is estimated at 52.5 million square kilometers, or 40.5 percent of the terrestrial area excluding Greenland and Antarctica [2]. World Resources Institute). India exhibits great diversity in climate, topography, flora, fauna and land use. The total area of permanent pastures and grasslands is about 12.4 m ha or 3.9% of the country`s geographical area. The area cultivated for fodder amounts to 4% of the total cultivable area.

Forage crops in general and range grasses and legumes in particular are shy seed producers. Seed availability of forage crops is just 15-20% of national requirement at low level of demand under unorganized seed market where nucleus and breeder seed form major bottleneck in the supply chain [3]. One of the stumbling blocks for low fodder availability is lack of sufficient quantity of quality seed. In forages, availability of quality seed is only 25-30% in cultivated fodder and <10% in range grasses and legumes (Technical bulletin, 06/2014, IGFRI). Prices paid for seeds of native plants vary from Rs.3000 to 4500 per kg for some grass species.

Grass seed harvesting is an intensive labour consuming operation. It involves many methods to detach grass seed from the plant that include brushing from the standing crop, beating the seed head in standing crop, cutting, drying and threshing etc. Different kinds of grass seeds take different forces and efforts to detach from the plant. The period of maturity in most of the grass seeds continues for longer duration that allows multiple picking of seed from a standing crop. Multiple picking also increases the time and labour involvement linearly thus making operation cumbersome and costlier. The availability of seed is limited by the labour availability to gather them. Therefore, large grass production farms and fallow lands require a machine that is suitable for harvesting grass seeds. Methods and machines used in harvesting and collection of grass seeds in different agro-climatic conditions, type of crop, its maturity status is discussed here to make a user choose suitable tool and technique as per the requirement. These are described as following.

A. *Methods and machines used in grass seed harvesting*

1. *Manual seed collection*

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This involves picking of grass seed manually. Hand picking is full of drudgery and seed yield are low in this method. A 'U' shape fork type device is used to detach the grass seed from the plant and a bag hanging with the neck of worker is used for storing detached seed while working in the field. Using this manual device, an area of 0.05-0.08 ha/h can be covered for collection of grass seeds. It is feasible method of seed collection when a plant is rare with limited local occurrence or plant is in an inaccessible area. Seed heads is individually cut off or seed is stripped from the inflorescence by running a hand upward from the base of the inflorescence (Fig 1). In some cases (e.g., *T. triandra*), seed are harvested by cutting the entire stem, and allowing the seed to mature in the head and shed at its own over the time.

Fig 1 'U' shape manual fork used in manual grass seed collection

2. *Hand-held engine powered seed stripper*

Seeds from some native shrubs and grasses are available only by hand stripping from plants in wild land stands. Handheld engine powered brush or flail strippers are useful machine practical for harvesting some grass and forb species. Collection mechanism for hand held engine powered seed stripper include bags, baskets, cans, tubs, and numerous homemade devices [4]. Light weight collector bags made from canvas cloth and plastic tubing plus a padded shoulder strap are versatile and popular in use as collection of harvested seed with this machine (Fig 2). Hand held bags are suitable for small and large patches. An experienced operator can be effectively harvest and collect grass seed using this device. They are used also in wetlands and other environmentally sensitive areas. This machine is to be swapped on the grass heads while walking in the grass field.

Fig 2 Hand-held powered seed stripper

3. *Brush type harvesters*

Grass seed harvester using brush as seed detaching element were developed to harvest light, difficult-to-handle, chaffy seed. A brush that rotated upward at the leading edge strikes the matured seeds, detaches it from the plant and the air flow produced by the shroud-covered brush gathers seed heads into the flailing brush and carry the stripped seed to the seed hopper [5]. A metal shroud over the brush creates a cross flow fan action that generates sufficient air velocity to gather seed heads into the flailing brush (Fig 3). This is a non-destructive harvesting technique that allows for multiple harvests of a stand of grass. In this way it overcomes some of the difficulties by removing ripe seed only resulting in increased yields of viable seed [6]. These have become the standard machines for harvesting numerous grass species in the United States, Australia, and other countries. Brushing units attached to the front-end loader frame on a tractor have width of 1.2 to 3.6 m. These are well suited for use on commercial grass-seed farms as well as small farms and research plots because they are simple and cost effective. They are not suited for rocky or rugged terrain [7].

Fig 3 Grass seed harvester mounted on tractor front-end loader frame

4. *Pull type seed harvester*

Pull type machines are attached behind tractor/ utility vehicle for operation in the field. The rotating mechanism is operated by the power given by hydraulic circuit. One such harvester uses nylon brushes of varying coarseness to brush the seed off the stems as they ripen [8]. The detached seed is then carried into a hopper via the airflow generated by the brush. At the time of harvesting, machine is swung out to the side of the vehicle to facilitate harvesting operation from the area where it has not run previously. This is particularly important when harvesting species of grass whose ripe seed require only minimal disturbance to be removed from the seed head like *Dianthonia* spp. Raising and lowering of the brush height is carried out either manually or via hydraulic rams which can be fitted optionally, and are operated remotely from within the cabin of the vehicle.

5. *Utility vehicle mounted grass seed harvester*

This harvester was been developed by the DLWC company in conjunction with the Barney's Reef Landcare Group and Rosevale Engineering, and has been named as "Rosevale Reaper". In this harvester, the harvesting head employs either brush or solid steel beaters of approximately 200 mm diameter and a partial vacuum generated by a large air blower picks up the seed. The power source and hoppers of this harvester type mount onto the rear of a 4-wheel drive utility vehicle and harvesting mechanism is attached to the front of the vehicle. The beaters are driven with 12 Volt electric motor (Fig 4). As the vehicle travels forward through the standing grass, the seed or panicles are removed from the plant and transported through large flexi-hoses to the hoppers. A large fan at the rear of the vehicle provides the suction. Gauges are installed in this

device to measure beater speed and fan speed to control the parameters of operation [9].

Fig 4 the 'Rosevale Reaper'

6. *Trough, beater harvesters*

The light, chaffy nature of grass seed lends itself to beater, and is collected by vacuum or wind flow in particular direction. Trough and later beater harvesters were developed in Queensland to collect seed from *Heteropogon contortus* (black spear grass) and *Cenchrus ciliaris* (buffel grass). In their simplest form, trough harvesters are simply a trough fixed on the front of the vehicle at an appropriate height. As the vehicle is driven through the crop, ripe seeds fall into the trough while immature seeds remain on the plant to be harvested later. Troughs are not effective for species with light and fluffy dispersal units as they tend to blow out of the trough.

7. *Combined harvesting*

Conventional grain combines are also widely used, alone or after swathing (harvesting and leaving the crop in filed at its place). Combining is a once-over treatment and is conducted when the greatest number of seeds are mature and remain on the plants. Conventional grain combines are useful for harvesting large-scale seed fields. These self-propelled combines are designed for major grain crops but can be adjusted to handle many types of grass seed. A combine consists of a header assembly, threshing mechanism, separating and cleaning unit, storage bin, power-train, and a cab with all the controls. The header assembly consists of a reel, cutter bar, and an auger. Grass stems are severed just below the seed heads by the cutter bar, and the seed heads are fed into the thresher by an auger. Seed is separated from the seed heads and transported into the storage bin, while stems and trash are blown out the rear of the combine. Some grass species are cut first with a swather to aid in field drying. A pick-up mechanism mounted on the combine's header is then used to gather the crop into the combine.

A specialized stripping header assembly that replaces the standard header has been used effectively by commercial grass seed growers. The seed heads are stripped rather than cut before entering the threshing section of the combine. Harvesting efficiencies, i.e., seed harvested compared with that available, range between 28% to 73% [10].

8. *Research plot combines*

Research plot combines are designed for organizations that harvest hundreds of small plots. These combines have the same features as the large grain combines except they are very narrow in width. They usually have special instrumented weighing systems to accurately record grain weight for each plot. They are designed for level cropland and should not be operated on rocky, rough, or sloping land.

9. *Windrowing and threshing*

Some grasses (*Austrodanthonia* spp.) have high degree of seed retention but are unsuited to direct brushing or beating operation due to high seed shattering tendency and light fluffy nature of their seed. In such cases, windrowing followed by threshing the dry crop is used with limited success to harvest seed.

10. *Vacuum harvesting*

The dispersal units of some grasses (e.g., *M. stipoides*) are very easily removed from the inflorescences, even when they are in the early stages of development. Hand-held commercial outdoor vacuum cleaners can be used to harvest this type of seed and tend to remove only mature seed. Vacuum cleaners are only suitable for harvesting small areas because the intake is quite small (say 12 cm × 8 cm).

The success of these hand-held machines stimulated inventive groups of farmers to develop small vacuum harvesters with a wider intake (about 1 m wide) for harvesting larger areas of native grass seed. These vacuum type harvesters are fitted in front of a tractor or utility vehicle. Another type of vacuum harvester have seed harvesting mechanism in rear of the vehicle and operating in the side so that it can move over the grasses where previously collection mechanism has not run over.

A. *Grass seed harvesting aspects*

Successful harvesting of grass seed needs to stand well prepared during the season. Such preparation requires beyond simply locating and managing crop stands. The following points may be taken in due care for a successful grass seed harvesting.

i) *Equipment reliability*

All equipment to be used must be checked to be free of faults before harvesting begins. For a harvester to break down, even for a couple of days at a crucial time could mean that an opportunity to harvest a particular species is lost. With this in mind, it is essential that the operators familiarize themselves with the equipment so that if minor breakdowns occur, they can be fixed immediately. It is wise to carry spare parts whilst in the field. The vehicle with which machine is attached should also be in maintained condition with clean air filters, radiators etc. that clog quickly with seed and other matter.

ii) *Time of harvesting*

Most of the grasses are non-synchronous in maturity. Seed ripening begins at the panicle tip and moves downward. The recommended stage of harvest is at the medium to hard dough stage. This is the stage where moderate to hard pressure with a thumbnail will make a mark on the seed. There often needs to be a compromise between maturity and shattering losses when making the decision to harvest to maximize yield. It is the unique seeding characteristics of grasses that make seed harvesting difficult using conventional direct harvesting methods. In a non-synchronous maturing crop stand, the available machines may be operated three to four times to get maximum seed yield.

i) *Climatic effects*

Every season has peculiar characteristics generating different responses from plant communities that may not be same as per expected routine observation. This means that not every species desired may be available to be harvested every

year. In grass seed harvesting, a planner needs to be little opportunistic. If an opportunity arises to harvest a species that may not be of high importance now, but may be useful later, it should be seized immediately**.**

Storage of grass seed

When good seasons do occur, it is wise to harvest a certain amount of seed in excess of what the immediate requirements are and store it for the period to come. Having appropriate storage facilities for the warehousing of seed is critical. Storage places need to be dry and vermin proof or the seed has to be stored in vermin proof containers at relatively stable temperature, neither becoming too hot or too cold. Storage drums which have been found to be useful include large, 200-litre plastic drums, or for smaller samples, 20 litre paint drums. Containers need to be clean and dry, although not necessarily sterilized.

ii) *Seed drying*

The harvested seed needs to be dried immediately, particularly during the warmer months. Seed left unattended in bags quickly begins composting, thus effectively destroying most of the seed. Ideal drying conditions will consist of a large area which is protected from weather, some airflow without being excessively draughty to prevent seed being scattered and vermin proof. Under ideal conditions, depending on the original moisture content of the seed, drying takes about one week.

iii) *Labeling*

All seed must be labeled immediately upon collection. Labels must also accompany seed as it is being dried, and once again during storage. Accurate record keeping ensures that seed lines do not become mixed.

CONCLUSION

Grass seed being an important commodity in forage production, needs collection from the standing crop with higher efficiency and effectiveness. Grass seed harvesting has always been a tedious and intensive labor consuming operation. Due to shortage of human power in agriculture, more mechanization in grass seed harvesting has become important and is need of current period to fulfill the scarcity of grass seeds in the country. This paper described various methods and machines used in grass seed harvesting that gives user a choice to select suitable machine according to the requirement.

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