

# Combine Harvesters and Fleet Management

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## Summary

A combine harvester is a type of modern agricultural machinery that performs multiple harvesting operations, i.e., reaping, threshing, gathering, and winnowing, in a single process. Combine harvesters are available in a broad range of sizes, going from small units that can handle several hectares per day to very large units for major operations that can handle several hectares per hour. The harvesters can be used for various crops such as wheat, maize, rice, soybean, barley, sunflower, amongst others, which allows it serve different types of farms in the same region and makes them more economical as their cost can be shared. Careful selection and efficient management of combine harvesters is key to optimize performance and minimize costs and it is possible to design a fleet by considering the technical and technological parameters of the machines. Tools exist that allow to identify the best makeup of a combine harvester fleet based on the field dimensions, crop portfolio, harvesting times, material costs and working time. Combine harvesters substantially reduce grain losses during harvest and costs of labour which is key for a field crop like wheat, and also make it possible to expand production in areas where there is a shortage of workers.

## Technical Description

Wheat crops are gathered by the header with a slowly rotating reel and cutter at the front of combine harvesters while driving over the field. The cut parts are carried up the feeder throat by a conveyor and flight elevator that feed into the threshing drum consisting of grooved rasp bars and a concave grate. By friction the rasp bars pull the crop through concaved grates that separate the grain heads from the straw. Long pieces of straw cannot pass through the grate and float over it onto the straw walkers that lead to a chopper at the back of the combine where it is spurted down on the field. In most modern combines, the grain head is transported by a set of 2, 3, or 4 augers to the shoe which contains the chaffer, sieves and fan that separate out the chaff and grain. The lightweight chaff is carried away by air passing over the shoe and ejected from the back of the combine. An auger at the bottom of the sieves moves the clean grain into the tank from which it can be transferred to carts pulled by tractors that drive alongside the combine. The capacity of combine harvesters depends on their size, configuration and threshing speed.

## Uses

Combine harvesters can be deployed in all wheat growing areas of Sub-Saharan Africa as it is possible to select the right size, configuration and performance for farms with different sizes, planting density and micro-topography. Large units with a cutting width of 4 m or more have a harvested weight performance of 15 to 25 ton per hour, and harvested area performance of 4 - 5.5 hectare per hour. Small “mini” combine units with a cutting width of 1.2m have a harvested area performance of 3 to 6 hectare per day. The high horsepower engines on combine harvesters allow using the machinery in lowland and highland areas with varying types of soil and atmospheric conditions. Hydraulic hillside leveling system are fitted on some combine harvesters allowing the machine to be operated on croplands with a steep slope without large amounts of grain falling on the ground. Fleet management systems are available as mobile and web application, and have extended offline capability for the various modules that can operate in remote rural areas. The digital tools for service contracting and performance tracking can be used anywhere since they have the ability to roam different telecom networks, and achieves a GPS accuracy of up to 2 meters.

### **Composition**

The header on combine harvesters can be changed according to the required performance and crop type. Rigid headers are used for all kinds of cereals only whereas flexible headers that move over contours and ridges can be used for grains and soybeans. When moving between fields the header is removed and towed behind the harvester lengthwise so it can fit down narrow lanes. Tyre sets fitted on most combines can operate on a broad range of terrains whereas some have rubber tracks that put less pressure on the soil and can easily move over wet fields in lowland areas. Besides a combine harvester there is need for separate carts and tractors or trucks to carry grain to the storage facility or processor factory. Fleet management systems embed sensor technology for collecting intelligence on the internal workings and performance of combine harvesters. Multiple telematics solutions are integrated for optimizing the deployment of combine harvester fleets such as GPS tracking, fuel management, driver management, maintenance and servicing, fraud prevention and customer booking; which are operated via a dashboard available via smart phone.

### **Means of application**

Combine harvesters can be operated by a single person who is trained on the workings of electronic control panels and the mechanical parts inside the machine so to ensure that it is used in good order without breaking down. The height of crops, land slope and other features of a field have to be surveyed in consultation with farmers for determining the best approach to avoid grain losses, excessive fuel use, poor manoeuvrability and damage to irrigation furrows. Via a mechanized contracting platform owners of combine harvesters can offer services directly to farmers, or may work through booking agents that aggregate demand within their community, or a mixture of the two. Farmers who seek contract mechanization services must request, schedule and prepay for them via the SMS messaging or mobile applications that places them in touch with equipment owners or booking agents. Once a job is completed the balance of payment is settled through the digital system. Equipment owners and investors get detailed reports about

the user and cost-effectiveness which allows them to improve business models and access financing for new equipment.

<b>Agroecologies</b>	Dryland area, Highlands, Moist savanna.
<b>Regions</b>	Africa South of Sahara.
<b>Developed in Countries</b>	Ethiopia, Kenya, Nigeria, Tanzania, Zambia, Zimbabwe.
<b>Available in</b>	Ethiopia, Kenya, Nigeria, Tanzania, Zambia, Zimbabwe.
<b>Solution Forms</b>	Equipment.
<b>Solution Applications</b>	Mechanized Farming.
<b>Agricultural Commodities</b>	Maize, Rice, Wheat, Soybean.
<b>Target Beneficiaries</b>	Small-scale farmers, Commercial farmers, Agro-dealers.

## Commercialization

### Commercialization Category

Commercially available

### Startup Requirements

The following steps have to be taken for expanding the use of combine harvesters and fleet management tools in wheat growing areas of Africa: 1) Raise awareness with farmers about the benefits of using mechanized equipment on harvesting efficiency and costs, 2) Provide financial support for purchasing combine harvester and installing smart devices for tracking equipment, 3) Get equipment owners to upload specifications, trained operators and booking agents onto contracting platform, and 4) Track movement and performance of harvesters, operators and booking agents to optimize machine parks, maximize profits and reduce fraud.

### Production Costs

The investment for combine harvesters varies according to size, configuration and performance. Small units that have a header width of 1.1 meter and no grain tank are more affordable with prices starting from US \$12,000 without shipment and import

taxes. For a New Holland CX 8080 with a cutting width of 3.3m the total harvesting unit cost are US \$ 56 - 63 per hectare. Large units with a cutting width of 10 meters and a grain tank of 5,000 liter have a new price of US \$300,000 to 500,000. Taking into account the performance, the total harvesting cost for this unit comes to US \$ 25 - 33 per hectare, or US \$ 4.7 - 9.2 per ton of grain. Digital applications that help manage contracted use of agricultural power equipment can be downloaded for free. Owners must also invest in smart telemetric devices and their installation by accredited technicians.

### **Customer Segmentation**

There is a diverse market for modern combine harvesters in wheat growing areas of Sub-Saharan Africa. Larger and smaller sized units are fit for agricultural service companies and commercial wheat farmers who operate on holdings of hundred hectares or more. Smaller units can be bought collectively by associations of farmers who each own a few hectares.

### **Potential Profitability**

Costs and losses of harvest are substantially reduced by the single automated process, and a much cleaner grain is collected by better separation of weeds. The greater work rate and saving in labour make it possible to cultivate larger areas of land with wheat, and prepare fields in a shorter time for the next crops. In general it is found that the net harvested income strongly depends on the ratio of grain to stover, the market price for grain, the in-field yield, the harvesting day length, and the timeliness of harvesting. The use of fleet management tools and optimization models allows to minimize running costs and increases efficiencies which is crucial for large capital-intensive equipment like a combine harvester. Use of advanced financial analytics alleviates risks of inappropriate deployment and breakage of power equipment which increases confidence in further investment in mechanization.

### **Licensing Requirements**

The intellectual property of combine harvesters is owned by manufacturers, whereas digital applications for management and contracting of a fleet, such as Hello Tractor, are free of commercial licenses and royalties.

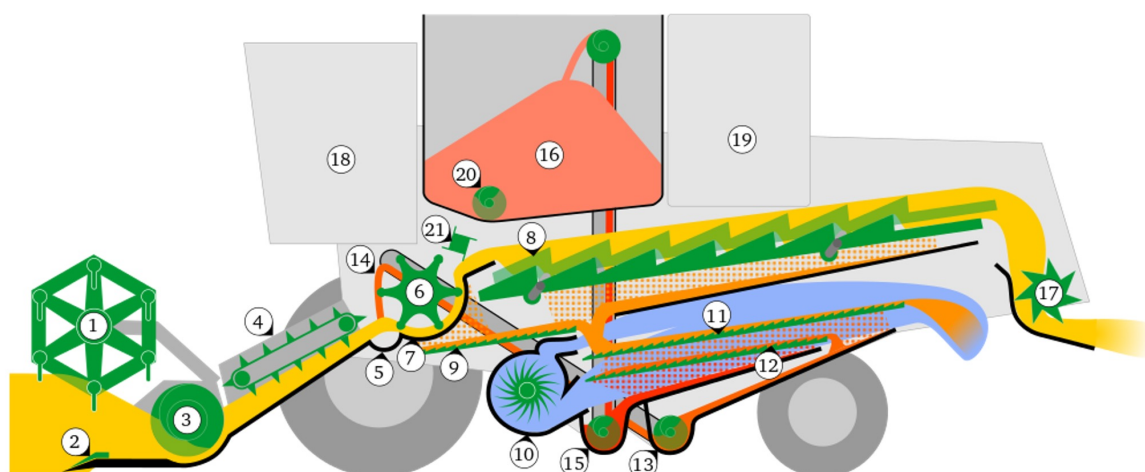
### **Innovation as Public Good**

Models from selecting the appropriate units for particular holdings and landscapes are developed as a Public Good, and warrants replication throughout Africa.

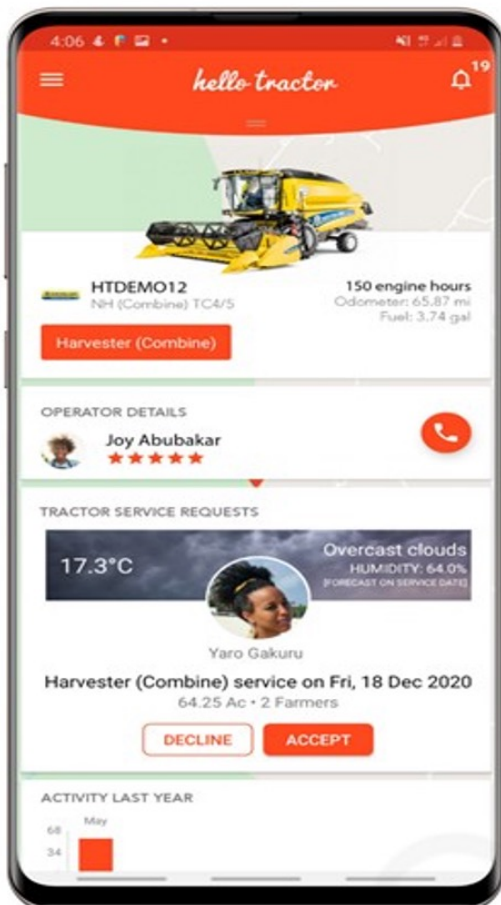
## Solution Images



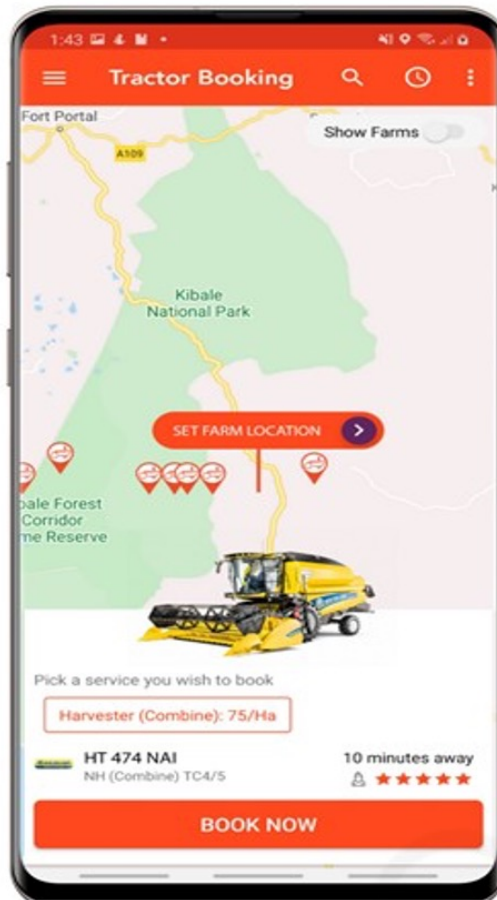
*Combine harvester operating in Sudan*



*Schematic overview of a combine harvester: 1) reel, 2) cutter, 3) header auger, 4) grain conveyor, 5) stone trap, 6) threshing drum, 7) concave grate, 8) straw walker, 9) grain pan, 10) fan, 11) top sieve, 12) bottom sieve, 13) tailings conveyor, 14) re-threshing of tailings, 15) grain auger, 16) grain tank, 17) straw chopper, 18) driver's cabin, 19) engine, 20) unloading auger, and 21) impeller*



**Contractor App**



**Booking App**

*Digital applications for fleet management and contract services by Hello Tractor*

## **Institutions**

