CHAPTER 1

INTRODUCTION
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1.1 Conceptual Framework

India, is a country where 70% of its population lives in villages in rural areas, and 90% of the rural population is concentrated in villages where a population is less than 2000 with farming being the main business in all these villages.

"Madhya Pradesh" state is situated at the heartland of India where main livelihood for over 60% population is dependent on Agriculture Farm produce only. With the division of land and increase of population it is the utmost need of the state to explore possibility of increased farm fertility, for each crop cultivated in the state and also explore high yield crops suitable to land strata of the state.

Malwa: A historic province of India, which has given its name to one of the political agencies into which Central India is divided. Strictly, the name is confined to the hilly table land, bounded South by the Vindhya range, which drains North into the river Chambal, but it has been extended to include the Narmada valley farther south. Its derivation is from the ancient tribe of Malwa’s about who is very little known, except that they founded the Vikrama Samvat, an era dating from 57 B.C., which is popularly associated with the king Vikramaditya. The earliest name of the tract seems to have been Avanti, from its capital the modern Ujjain. Within Madhya Pradesh Malwa is a region, comprising 14 Districts of MP State, having Chambal as Main River flowing thru the region and Narmada flows side ways to Malwa.
1.1.1 Global Positioning of India in Farm Sector
India is the largest manufacturer of Farm Tractors in the world. Despite the fact that India is the largest number of tractor manufacturer country in the world, the average yield per hectare is among the lowest in the world. The low productivity contributes to low farm incomes and wages, lower on farm employment generation and relatively higher food prices for all Indians. Study shows, average yields from tomato cultivation comparable to India from other countries is, 76% higher in Mexico and 400% higher in USA, while on Seed cotton, 400% higher in Mexico, and 300% higher in USA.

On global mapping on the Cereal crops yield (kg/ha) India, falling in the lower intensity side, i.e. the Yield is on the lower side in comparison to the other major agriculture countries.

1.1.2 Scope of Farm Tractors in Agricultural Growth
Existing population of Farm Tractors and their various expanded usages have given a lot more boost to farm growth and farmers have started looking at multi cropping and high value high yield crops and multi fold increase in farm utilization has been witnessed at various districts of the state.

Poverty, Illiteracy and poor cash in hand position of Farmers lead to compromise on buying decision of Farm Machineries v/s farm specific, need specific requirements of Farm Mechanization machines like Farm Tractors.
Indian agriculture has come a long way ever since green revolution, however still we as country is lagging behind in mark to application equipments as well farm tractors.

Very recently Indian tractor industry has shown a remarkable change in their thought process and leader M&M and Escorts Limited have already started mark to application products ranges after detailed study in market places. The face of Indian Agriculture has changed in the past 5-7 years. Mechanized solutions are fast replacing the traditional bullock cart approach and labour intensive solutions are disappearing.

Farm mechanisation – adopting power based solutions for agriculture has made headways, with the sale of farm tractors rising over the years of these the mid range HP tractors are the most popular.

Implements that are attached to these tractors are currently made by local players with a few players having a national presence. A farmer buys a tractor and implements as a separate purchase, needing both for a solution to emerge as winning farmer.

All the farm tractor manufacturing companies are keen to get a perspective on the current reality of Indian agriculture, to offer a comprehensive solution on mechanization, even government has been in swift action on these front and state government of MP, UP, Bihar ,AP and Karnataka have created a pool of tractors with high end implements and these units are being deployed at block level to allow access of high end agriculture -implements on hire to marginal farmers as well, this will facilitate sowing of deep root variety crops and right oxidation of land which results is high fertility and yield.
It is being thrust upon by government to truly understand the life of an Indian farmer, beyond the profession of farming, and to understand how mechanization can offer a solution within the canvas of a farmer's life.

1.1.3 Major Agriculture & Horticultural Crops in MP

Agriculture is one of the most important sectors of Indian economy. It contributes around 24% to the GDP and employs 65% of the working population in the country. Agriculture is fundamental to the India’s social, political and industrial stability.

Study shows that MP is the second largest State in the Country by its geographical area, with an estimated population of about 60 million. Agriculture is predominant sector in the State with 75% of rural population largely dependent on it.

The State has 5 crop zones, 11 agro climatic regions and 4 soil types, which add to the biodiversity in the State and acts favorable for the production of various agriculture and horticulture crops. Madhya Pradesh is the largest producer of pulses and oilseeds in the country. The State also shares a major share of the national agriculture production. About 25% of pulses and 40% of grams are grown in the State. The State is the largest producer of “Soyabean” and gram and the second largest producer of “Jowar” and “Masoor” in the Country. Contributing almost one third to the State GSDP, the sector forms the Chilies, Garlic, Coriander, Ginger, Turmeric, Mango, Guava, Orange, Papaya, Banana, Green Peas, Cauliflower, Okra, Tomato, Onion, Potato Gram, Pigeon Pea (Tur), Lentil (Masoor) Soybean, Mustard, Linseed Wheat, Sorghum (Jowar), Maize, Paddy, cotton & Garlic.
“Malwa” Madhya Pradesh is one of the leading agro climatic zone which has all major crops grown in the area Soyabean and cotton being traditional crop now farmers have advanced to Potato, Onion, Ginger, Turmeric, as well, an average 10000 number of farm tractors are being sold every year in Malwa alone.

1.1.4 Focus and Thrust by Planning Commission, Government of India, for Agricultural Growth

Recent thrust by Prime Minister, to and Agriculture sector growth drivers to Agri GDP growth will lead to new era of rural development, & farm tractors can be the major growth engine for overall rural development of country , Malwa being largest producer of Soyabean, Gram, Total oil seed, Linseed, pulse in the Country will have an added advantages. Improved literacy linked with better media coverage has generated immense awareness in rural young farmers towards new products and practices, farmers have started looking at High Potential Sectors, such as Commercial Agriculture, Agro-Industry & Agri-Business.

Introduction of advanced crop technology will reduce production costs and expand the market for important commercial crops. There is enormous scope for accelerating growth in Agriculture, through improved Soil nutrition, diversification into higher value added crops, expansion and efficient use of irrigation potential and infrastructure development of agro processing industries.

Farmer’s buying behavior is changing from their traditional Farm Land development methods towards mechanization, mainly due to high yield short duration varieties with traditionally rain fed terrain. Most farmers
are now ploughing their land by use of farm tractors as pressure on utilization of every piece of land is very high.

1.1.5 Farm-Tractor Evaluation and History
A tractor is a vehicle specifically designed to deliver high traction effort (or torque) at slow speeds, for the purposes of hauling a trailer or machinery used in agriculture or construction. Most commonly the term is used to describe a farm vehicle that provides the power and traction to mechanise agricultural tasks originally tillage but nowadays a great variety of tasks.

Agricultural implements may be towed behind or mounted on the tractor, and the tractor may also provide a source of power if the implement is mechanised. Another common use of the term, "tractor unit", describes the power unit of a semi-trailer truck (articulated lorry).

The word tractor was taken from Latin, being the agent noun of trahere "to pull". The first recorded use of the word meaning "an engine or vehicle for pulling wagons or ploughs" occurred in 1901, displacing the earlier term traction engine (1859).

In Britain, Ireland, Australia, India, Spain, Argentina, and Germany the word "tractor" usually means "farm tractor", and the use of the word "tractor" to mean other types of vehicles is familiar to the vehicle trade but unfamiliar to much of the general public. In Canada and the US the word may also refer to the road tractor portion of a tractor trailer truck.

1.1.6 History
1882 The first powered farm implements in the early 19th century were portable engines – steam engines on wheels that could be used to drive mechanical farm machinery by way of a flexible belt. Around 1850, the first traction engines were developed from these, and were widely adopted for agricultural use. The first tractors were steam-powered ploughing engines. They were used in pairs, placed on either side of a field to haul a plough back and forth between them using a wire cable. In United States where soil conditions permitted steam tractors were used to direct-haul ploughs, but in the UK and elsewhere plough engines were used for cable-hauled ploughing instead. Steam-powered agricultural engines remained in use well into the 20th century until reliable internal combustion engines had been developed.

In 1892, John Froelich invented and built the first gasoline/petrol-powered tractor in Clayton County, Iowa, USA. After receiving a patent Froelich started up the Waterloo Gasoline Engine Company, investing all of his assets which by the year 1895, become a failure.

After graduating from the University of Wisconsin, Charles W. Hart and Charles H. Parr developed a two-cylinder gasoline engine and set up their business in Charles City, Iowa. In 1903 the firm built fifteen "tractors", The 14,000 pound is the oldest surviving internal combustion engine tractor in the United States and is on display at the Smithsonian National Museum of American History in Washington D.C. The two-cylinder engine has a unique hit-and-miss firing cycle that produced 30 horsepower at the belt and 18 at the drawbar.

In Britain, the first recorded tractor sale was the oil-burning Hornsby-Ackroyd Patent Safety Oil Traction engine, in 1897. However, the first
commercially successful design was Dan Albone's three-wheel Ivel tractor of 1902. In 1908, the Saunderson Tractor and Implement Co. of Bedford introduced a four-wheel design, and went on to become the largest tractor manufacturer outside the U.S. at that time.

While unpopular at first, these gasoline-powered machines began to catch on in the 1910s when they became smaller and more affordable. Henry Ford introduced the Fordson, the first mass-produced tractor in 1917. They were built in the U.S., Ireland, England and Russia and by 1923, Fordson had 77% of the U.S. market. The Fordson dispensed with a frame, using the strength of the engine block to hold the machine together. By the 1920s, tractors with a gasoline-powered internal combustion engine had become the norm.

1.1.7 Tractor configurations

Tractors can be generally classified as two-wheel drive, two-wheel drive with front wheel assist, four-wheel drive (often with articulated steering), or track tractors (with either two or four powered rubber tracks).

The classic farm tractor is a simple open vehicle, with two very large driving wheels on an axle below and slightly behind a single seat (the seat and steering wheel consequently are in the center), and the engine in front of the driver, with two steerable wheels below the engine compartment. This basic design has remained unchanged for a number of years, but enclosed cabs are fitted on almost all modern models, for reasons of operator safety and comfort.

In some localities with heavy or wet soils, notably in the Central Valley of California, the "Caterpillar" or "crawler" type of tracked tractor became popular in the 1930s, due to superior traction and floatation.
These were usually maneuvered through the use of turning brake pedals and separate track clutches operated by levers rather than a steering wheel.

1.1.8 Farm Tractor Technical Evaluation

Four-wheel drive tractors began to appear in the 1960s. Some four-wheel drive tractors have the standard "two large, two small" configuration typical of smaller tractors, while some have four large powered wheels. The larger tractors are typically an articulated center-hinged design steered by hydraulic cylinders that move the forward power unit while the trailing unit is not steered separately.

In the early 21st century, articulated or non-articulated, steerable multi-track "tractors" have largely supplanted the "Caterpillar" type for farm use. Larger types of modern farm tractors include articulated four wheel or eight wheel drive units with one or two power units which are hinged in the middle and steered by hydraulic clutches or pumps.

A relatively recent development is the replacement of wheels or steel crawler-type tracks with flexible steel-reinforced rubber tracks, usually powered by hydrostatic or completely hydraulic driving mechanisms. The configuration of these tractors bears little resemblance to the classic farm tractor design.

1.1.9 Engine and fuels

The predecessors of modern tractors, traction engines, used steam engines for power. Since the turn of the 20th century, internal combustion engines have been the power source of choice. Between 1900 and 1960, gasoline was the predominant fuel, with kerosene and ethanol being common alternatives. Generally one engine could burn any of those, although cold
starting was easiest on gasoline. Often a small auxiliary fuel tank was available to hold gasoline for cold starting and warm-up, while the main fuel tank held whatever fuel was most convenient or least expensive for the particular farmer. Diesel engine gained momentum starting in the 1960s, and modern farm tractors usually employ diesel engines, which range in power output from 18 to 575 horsepower (15 to 480 kW).

Size and output are dependent on application, with smaller tractors for lawn moving, landscaping, orchard work, and truck farming, and larger tractors for vast fields of wheat, maize, soya, and other bulk crops. Liquefied petroleum gas (LPG) or propane also have been used as tractor fuels, but require special pressurized fuel tanks and filling equipment so are less prevalent in most markets.

1.1.10 Transmission

Most ancient farm tractors use a manual transmission. They have several gear ratios, typically 3 to 6, sometimes multiplied into 2 or 3 ranges. This arrangement provides a set of discrete ratios that, combined with the varying of the throttle, allow final-drive speeds from less than one mile per hour up to about 25 miles per hour (40 km/h), with the lower speeds used for working the land and the highest speeds used on the road.

Slow, controllable speeds are necessary for most operations that are performed with a tractor. They help give the farmer a larger degree of control in certain situations, such as field work. However, when travelling on public roads, the slow operating speeds can cause problems, such as long queues or tailbacks, which can delay or annoy motorists in cars and trucks. These motorists are responsible for being duly careful around farm tractors and sharing the road with them, but many shirk this
responsibility, so various ways to minimize the interaction or minimize the speed differential are employed where feasible. Some countries (for example the Netherlands) employ a road sign on some roads that means "no farm tractors". Some modern tractors, such as the JCB Fastrac, are now capable of much higher road speeds of around 50 mph (80 km/h). Older tractors usually have unsynchronized transmission design, which often requires that the operator stop the tractor in order to shift between gears. This mode of use is inherently not suited to some of the work that tractors do, and has been circumvented in various ways over the years. For existing unsynchronized tractors, the methods of circumvention are double clutching or power-shifting, both of which require the operator to rely on skill to speed-match the gears while shifting. Both of these solutions are undesirable from a risk-mitigation standpoint because of what can go wrong if the operator makes a mistake – transmission damage is possible, and loss of vehicle control can occur if the tractor is towing a heavy load either uphill or downhill – something that tractors often do. Therefore, operator's manuals for most of these tractors state that one must always stop the tractor before shifting, and they do not even mention the alternatives. As already said, that mode of use is inherently unsuited to some of the work that tractors do, so better options were pursued for newer tractor designs.

In these, unsynchronized transmission designs were replaced with synchronization or with a continuously variable transmission (CVT). Either a synchronized manual transmission with enough available gear ratios (often achieved with dual ranges, high and low) or a CVT allow the engine speed to be matched to the desired final-drive speed while keeping engine speed within the appropriate rpm range for power generation (the working range) (whereas throttling back to achieve the desired final-drive
speed is a trade-off that leaves the working range). The problems, solutions, and developments described here also describe the history of transmission evolution in semi-trailer trucks.

### 1.1.11 How a tractor is used for farming - Hitches and power applications

The power produced by the engine must be transmitted to the implement or equipment in order to do the actual work intended for the equipment. This may be accomplished via a drawbar or hitch system if the implement is to be towed or otherwise pulled through the traction power of the engine, or via a pulley or power takeoff system if the implement is stationary, or a combination of the two.

#### 1.1.12 Drawbars

Until the 1950s, ploughs and other tillage equipment usually were connected to the tractor via a drawbar, or a proprietary connecting system. The classic drawbar is simply a steel bar attached to the tractor (or in some cases, as in the early Fordsons, cast as part of the rear transmission housing) to which the hitch of the implement was attached with a pin or by a loop and clevis. The implement could be readily attached and removed, allowing the tractor to be used for other purposes on a daily basis. If the tractor was equipped with a swinging drawbar, the drawbar could be set at the center or offset from center to allow the tractor to run outside the path of the implement.

The drawbar system necessitated that the implement have its own running gear (usually wheels) and in the case of a plow, chisel cultivator or harrow, some sort of lift mechanism to raise it out of the ground at turns or for transport. Drawbars necessarily posed a rollover risk depending on how the torque was applied. The Fordson tractors (of which more units...
were produced and placed in service than any other farm tractor) was extremely prone to roll over backwards due to an excessively short wheel base. The linkage between the implement and the tractor usually had some slack which could lead to jerky starts and greater wear and tear on the tractor and the equipment.

Drawbars were appropriate for mechanization, because they were very simple in concept and because as the tractor replaced the horse, existing horse-drawn implements usually already had running gear. As the history of mechanization progressed, however, the advantages of other hitching systems became apparent, leading to new developments, Depending on the function for which a tractor is used, however, the drawbar is still one of the usual means of attaching an implement to a tractor.

1.1.13 Fixed mounts on Farm Tractors
Some tractor manufacturers produced matching equipment that could be directly mounted on the tractor. Examples included front-end loaders, belly movers, row crop cultivators, corn pickers and corn planters. In most cases, these fixed mounts were proprietary and unique to each make of tractor, so that an implement produced by John Deere, for example, could not be attached to a Minneapolis Moline tractor. Another disadvantage was that mounting usually required some time and labor, resulting in the implement being semi-permanently attached with bolts or other mounting hardware.

Usually it was impractical to remove the implement and reinstall it on a day-to-day basis. As a result, the tractor was unavailable for other uses and dedicated to a single use for an appreciable period of time. An implement generally would be mounted at the beginning of its season of
use, such as tillage, planting or harvesting and removed only when the likely use season had ended.

1.1.14 Three-point hitches and quick hitches

The drawbar system was virtually the exclusive method of attaching implements (other than direct attachment to the tractor) before Harry Ferguson developed the three-point hitch. Equipment attached to the three-point hitch can be raised or lowered hydraulically with a control lever. The equipment attached to the three-point hitch is usually completely supported by the tractor. Another way to attach an implement is via a Quick Hitch, which is attached to the three-point hitch. This enables a single person to attach an implement quicker and put the person in less danger when attaching the implement.

The three-point hitch revolutionized farm tractors and their implements. Almost every tractor today features Ferguson's 3 point linkage or a derivative of it. The three-point hitch allows for easy attachment and detachment of implements while allowing the implement to function as a part of the tractor almost as if it were attached by a fixed mount. Previously, when the implement hit an obstacle the towing link would break or the tractor could flip over. Ferguson's genius was to combine a connection via two lower and one upper lift arms that were connected to a hydraulic lifting ram. The ram was in turn connected to the upper of the 3 links so that increased drag (as when a plough hits a rock) caused the hydraulics to lift the implement until the obstacle was passed.

Other manufacturers copied Ferguson's invention, or developed variations of it. For example, International Harvester's Farmall tractors.
These tractors had a two-point "Fast Hitch" and John Deere had a power lift that was similar but not as flexible as the Ferguson invention. Compact tractors are now also being fitted with quick-connect attachments for their front-end loaders.

1.1.15 Power take-off systems and hydraulics

In addition to towing an implement or supplying traction power through the wheels, most tractors have a means to transfer power to another machine such as a baler, mover. Unless it functions solely by pulling it through or over the ground, a towed implement needs its own power source - such as a baler or combine with a separate engine or else a means of transmitting power from the tractor to the mechanical operations of the equipment.

Early tractors used belts or cables wrapped around the flywheel or a separate belt pulley to power stationary equipment, such as a threshing machine, buzz saw, silage blower, or stationary baler. In most cases, it was not be practical for the tractor and equipment to move with a flexible belt or cable between them, so this system necessitated that the tractor remain in one location with the work brought to the equipment, or that the tractor be relocated at each turn and the power set-up reapplied.

Modern tractors use a power take-off (PTO) shaft to provide rotary power to machinery that may be stationary or pulled. The PTO shaft generally is at the rear of the tractor, and can be connected to an implement that is either towed by a drawbar or a three-point hitch. This eliminates the need for a separate implement-mounted power source, which is almost never seen in modern farm equipment.
Virtually all modern tractors can also provide external hydraulic fluid and electrical power to the equipment they are towing, either by hoses or wires.

1.1.16 Operation
Modern tractors have many electrical switches and levers in the cab for controlling the multitude of different functions available on the tractor.

1.1.17 Pedals
Modern farm tractors usually have four or five foot-pedals for the operator on the floor of the tractor.

The pedal on the left is the clutch. The operator presses on this pedal to disengage the transmission for either shifting gears or stopping the tractor. Some modern tractors have (or as optional equipment) a button on the gear stick for controlling the clutch, in addition to the standard pedal. Two of the pedals on the right are the brakes. The left brake pedal stops the left rear wheel and the right brake pedal does the same with the right side. This independent left and right wheel braking augments the steering of the tractor when only the two rear wheels are driven. This is usually done when it is necessary to make a sharp turn. The split brake pedal is also used in mud or soft dirt to control a tire that spins due to loss of traction. The operator presses both pedals together to stop the tractor. For tractors with additional front-wheel drive, this operation often engages the 4-wheel locking differential (diff-lock) to help stop the tractor when traveling at road speeds.

The pedal furthest to the right is the foot throttle. Unlike in automobiles, it can also be controlled from a hand-operated lever ("hand throttle").
This helps provide a constant speed in field work. It also helps provide continuous power for stationary tractors that are operating an implement by shaft or belt. The foot throttle gives the operator more automobile-like control over the speed of the tractor for road work. This is a feature of more recent tractors; older tractors often did not have this feature.

Some tractors, especially those designed for row-crop work, have a 'de-accelerator' pedal, which operates in the reverse fashion to an automobile throttle, in that the pedal is pushed down to slow the engine. This is to allow fine control over the speed of the tractor when maneuvering at the end of crop rows in fields- the operating speed of the engine is set using the hand throttle, and if the operator wishes to slow the tractor to turn, he simply has to press the pedal, turn and release it once the turn is completed, rather than having to alter the setting of the hand throttle twice during the maneuver.

A fifth pedal is traditionally included just in front of the driver's seat to operate the rear diff-lock, which prevents wheel slip. The differential normally allows the outside wheel to travel faster than the inside wheel during a turn. However, in low-traction conditions on a soft surface the same mechanism could allow one wheel to slip, further reducing traction. The diff-lock overrides this, forcing both wheels to turn at the same speed, reducing wheel slip and improving traction. Care must be taken to unlock the differential before turning, usually by hitting the pedal a second time, since the tractor cannot perform a turn with the diff-lock engaged. In modern tractors this pedal is replaced with an electrical switch.

1.1.18 Levers and switches
Many functions that were once controlled with a lever have been replaced with some model of electrical switch with the rise of indirect computer controlling of functions in modern tractors.

Until the beginning of the 60's tractors had a single register of gears, hence one gear lever. Often 3-5 forwards and 1 reverse. Then group gears were introduced, hence another gear lever came in existence. Later on control of the reverse gear was moved to a special lever that controls direction and adding a gear lever attached at the side of the steering wheel. Nowadays with Continuously Variable Transmission or other clutch-free gear types there are fewer sticks for controlling the transmission, some replaced with electrical switches or totally computer controlled.

The three-point hitch was controlled with a lever for adjusting the position, or as with the earliest ones, just the function for raising or lowering the hitch. With modern electrical systems it is often replaced with a potentiometer for lower bound position and another one for the upper bound and a switch allowing automatic adjustment of the hitch between these settings.

The external hydraulics also originally had levers but nowadays often replaced with some form of electrical switch, the same goes for the power take-off shaft.

1.1.19 Safety

Agriculture in the United States is one of the most hazardous industries, only surpassed by mining and construction. No other farm machine is so identified with the hazards of production agriculture as the tractor.[10] Tractor-related injuries account for approximately 32% of the fatalities
and 6% of the non-fatal injuries in agriculture. Over 50% is attributed to tractor overturns.

The roll over protection structure (ROPS) and seat belt, when worn, are the two most important safety devices to protect operators from death during tractor overturns.

Modern tractors have rollover protection systems (ROPS) to prevent an operator from being crushed if the tractor overturns. It is important to remember that the ROPS does not prevent tractor overturns. Rather, it prevents the operator from being crushed during an overturn. This is especially important in open-air tractors, where the ROPS is a steel beam that extends above the operator's seat. For tractors with operator cabs, the ROPS is part of the frame of the cab. A ROPS with enclosed cab further reduces the likelihood of serious injury because the operator is protected by the sides and windows of the cab.

ROPS were first required by legislation in Sweden in 1959. Before ROPS were required, some farmers died when their tractors rolled on top of them. Row-crop tractors, before ROPS, were particularly dangerous because of their 'tricycle' design with the two front wheels spaced close together and angled inward toward the ground. Some farmers were killed by rollovers while operating tractors along steep slopes. Others have been killed while attempting to tow or pull an excessive load from above axle height, or when cold weather caused the tires to freeze to the ground, in both cases causing the tractor to pivot around the rear axle.

For the ROPS to work as designed, the operator must stay within the protective frame of the ROPS. This means the operator must wear the seat belt. Not wearing the seat belt may defeat the primary purpose of the ROPS.
1.1.20 Farm tractor applications

The most common use of the term "tractor" is for the vehicles used on farms. The farm tractor is used for pulling or pushing agricultural machinery or trailers, for plowing, tilling, disking, harrowing, planting, and similar tasks.

A variety of specialty farm tractors have been developed for particular uses. These include "row crop" tractors with adjustable tread width to allow the tractor to pass down rows of corn, tomatoes or other crops without crushing the plants, "wheat land" or "standard" tractors with non-adjustable fixed wheels and a lower center of gravity for plowing and other heavy field work for broadcast crops, and "high crop" tractors with adjustable tread and increased ground clearance, often used in the cultivation of cotton and other high-growing row crop plant operations, and "utility tractors", typically smaller tractors with a low center of gravity and short turning radius, used for general purposes around the farmstead. Many utility tractors are used for non-farm grading, landscape maintenance and excavation purposes, particularly with loaders, backhoes, pallet forks and similar devices. Small garden or lawn tractors designed for suburban and semi-rural gardening and landscape maintenance also exist in a variety of configurations.

1.1.21 Precision agriculture

Space technology has been incorporated into agriculture in the form of GPS devices, and robust on-board computers installed as optional features on farm tractors. These technologies are used in modern, precision farming techniques. The spin-offs from the space race have actually facilitated automation in plowing and the use of auto steer
systems drone on tractors that are manned but only steered at the end of a row, the idea being to neither overlap and use more fuel nor leave streaks when performing jobs such as cultivating.

1.1.22 Engineering tractors - non farm tractors

The durability and engine power of tractors made them very suitable for engineering tasks. Tractors can be fitted with engineering tools such as dozer blade, bucket, hoe, ripper, and so on. The most common attachments for the front of a tractor are dozer blade or a bucket. When attached with engineering tools the tractor is called an engineering vehicle.

A bulldozer is a track-type tractor attached with blade in the front and a rope-winch behind. Bulldozers are very powerful tractors and have excellent ground-hold, as their main tasks are to push or drag things. Bulldozers have been further modified over time to evolve into new machines which are capable of working in ways that the original bulldozer can not. One example is that loader tractors were created by removing the blade and substituting a large volume bucket and hydraulic arms which can raise and lower the bucket, thus making it useful for scooping up earth, rock and similar loose material to load it into trucks.

A front-loader or loader is a tractor with an engineering tool which consists of two hydraulic powered arms on either side of the front engine compartment and a tilting implement. This is usually a wide open box called a bucket but other common attachments are a pallet fork and a bale grapple.

Other modifications to the original bulldozer include making the machine smaller to let it operate in small work areas where movement is limited. There are also tiny wheeled loaders, officially called Skid-steer loaders.
but nicknamed "Bobcat" after the original manufacturer, which are particularly suited for small excavation projects in confined areas.

1.1.23 Backhoe loader

The most common variation of the classic farm tractor is the hoe, also called a hoe-loader. As the name implies, it has a loader assembly on the front and a backhoe on the back. Backhoes attach to a 3 point hitch on farm or industrial tractors. Industrial tractors are often heavier in construction particularly with regards to the use of steel grill for protection from rocks and the use of construction tires. When the backhoe is permanently attached, the machine usually has a seat that can swivel to the rear to face the hoe controls. Removable backhoe attachments almost always have a separate seat on the attachment.

Backhoe-loaders are very common and can be used for a wide variety of tasks: construction, small demolitions, light transportation of building materials, powering building equipment, digging holes, loading trucks, breaking asphalt and paving roads. Some buckets have a retractable bottom, enabling them to empty their load more quickly and efficiently. Buckets with retractable bottoms are also often used for grading and scratching off sand. The front assembly may be a removable attachment or permanently mounted. Often the bucket can be replaced with other devices or tools.

Their relatively small frame and precise control make backhoe-loaders very useful and common in urban engineering projects such as construction and repairs in areas too small for larger equipment. Their versatility and compact size makes them one of the most popular urban construction vehicles.
1.1.24 Compact Utility Tractors

A Compact Utility Tractor, also called a CUT is a smaller version of an agricultural tractor but designed primarily for landscaping and estate management type tasks rather than for planting and harvesting on a commercial scale. Typical CUTs range in from 20 to 50 horse power with available power take off (PTO) horsepower ranging from 15 to 45 hp. CUTs are often equipped with both a mid-mounted PTO and a standard rear PTO, especially those below 40 horsepower. The mid-mount PTO shaft typically rotates at/near 2000 rpm and is typically used to power such implements as mid-mount finish mower, a front mounted snow blower or front mounted rotary broom. The rear PTO is standardized at 540 rpm for the North American markets, but in some parts of the world a dual 540/1000 rpm PTO is standard and implements are available for either standard in those markets.

One of the most common attachment for a Compact Utility Tractor is the front end loader. Like the larger agricultural tractors, a CUT will have an adjustable three-point hitch that is hydraulically controlled. Typically a CUT will have four wheel drive, or more correctly 4 wheel assist. Modern Compact Utility Tractors often feature a Hydrostatic transmission, but many variants of gear drive transmissions are also offered from low priced simple gear transmissions to synchronized transmissions to advanced glide-shift transmissions. All modern CUTs feature a government mandated roll over protection structure (ROPS) just like agricultural tractors. Although less common, compact backhoes are often attached to compact utility tractors.

Compact Utility Tractors require special smaller implements than full size agricultural tractors. Very common implements include the box
blade, the grader blade, the landscape rake, the post hole digger (or post hole auger), the rotary cutter (also called a slasher or a brush hog), a mid or rear mount finish mower, broadcast seeder, sub soiler and the rototiller (also rotary tiller). There are many more implement brands than there are tractor brands offering CUT owners a wide selection of choice.

For small scale farming or large scale gardening, there are some planting and harvesting implements sized for CUTs. One and two row planting units are commonly available as are cultivators, sprayers and different types of seeders (slit, rotary and drop).

1.1.25 Row-crop Farm tractor
A row-crop tractor is a tractor tailored specifically to the growing of row crops (crops grown in rows, as in Soyabean farming), and most especially to cultivating. Cultivating can take place anytime from soon after the crop plants have sprouted until soon before they are harvested. Several rounds of cultivating may be done over the season. A row-crop tractor essentially brings together a farm tractor and its cultivator into one machine, in the same way that motive power has been combined into other machinery.

The earliest win from introducing tractors to mechanize agriculture was in reducing the heavy efforts of plough and harrowing before planting, which could often be (almost literally) backbreaking tasks for humans and draft animals. Early tractors were used mainly to alleviate this drudgery. But they tended to be very big and heavy, so they were not well suited to getting into a field of already-planted row crops to do weed control. Row-crop tractors—light, affordable, and reliable—corrected this flaw.
Row crop itself refers to any farm crop that is cultivated in rows, in individual rows that are spaced to permit machine traffic during the early parts of the growing season

1.1.26 Row-crop Farm tractor history
The first tractors designed for the ability to fit between rows of crops were made by International Harvester (IH), with development beginning in the 1920s. The first row-crop tractors made by IH were called "Farmalls". The cultivator mounted in the front so it was easily visible. Additionally, the tractor had a narrow front end; the front tires were spaced very closely and angled in towards the bottom. The back wheels straddled two rows and it could cultivate four rows at once.

1.1.27 Row-crop Farm tractor safety
Many early row-crop tractors had a tricycle design with two closely spaced front tires, and some even had a single front tire. This made it dangerous to operate on the side of a steep hill, and, as a result, many farmers died from tractor rollovers. Also, early row-crop tractors had no rollover protection system (ROPS), meaning that if the tractor flipped back the operator could be crushed. Sweden was the first country which passed legislation requiring ROPS, in 1959. Over 50% of tractor related injuries and deaths are attributed to tractor rollover.

1.1.28 Modern row-crop Farm tractors
The Canadian agricultural equipment manufacturer Versatile makes row-crop tractors that are 250 and 280 hp, powered by an 8.3 liter Cummins Diesel engine. Modern row crop tractors have rollover protection systems in the form of a reinforced cab or a roll bar.
1.1.29 Garden Tractors
Garden Tractors (also called Mini Tractors) are small, light and simple tractors designed for use in domestic gardens. Garden Tractors are usually designed primarily for cutting grass, being fitted with horizontal rotary cutting decks. Visually, the distinction between a garden tractor and a ride-on lawnmower is often hard to make - generally Garden Tractors are more sturdily built, with stronger frames, axles and transmissions rated for ground-engaging applications. Garden Tractors are generally capable of mounting other implements such as harrows, cultivators / rotavators, sweepers, rollers and dozer-blades.

1.1.30 Two-wheel farm tractors
Although most people think first of four-wheel vehicles when they think of tractors, a tractor may have one or more axles. The key benefit is the power itself, which only takes one axle to provide. Single-axle tractors, more often called two-wheel tractors or walk-behind tractors, have had many users ever since the beginning of internal combustion engine tractors. They tend to be small and affordable. This was especially true before the 1960s, when a walk-behind tractor could often be more affordable than a two-axle tractor of comparable power. Today's compact utility tractors and advanced garden tractors may negate most of that market advantage, but two-wheel tractors still enjoy a loyal following, especially where an already-paid-for two-wheel tractor is financially superior to a compact or garden tractor that would have to be purchased. Regions where two-wheel tractors are especially prevalent today include India, China, and Southeast Asia.
1.1.31 Orchard farm tractors
Tractors tailored to use in fruit orchards typically have features suited to passing under tree branches with impunity. These include a lower overall profile; reduced tree-branch-snagging risk (via under slung exhaust pipes rather than smoke-stack-style exhaust, and large sheet metal cowlings and fairings that allow branches to deflect and slide off rather than catch); spark arrestors on the exhaust tips; and often wire cages to protect the operator from snags.

1.1.32 Economic History of Farm Tractors in the United States
The farm tractor is one of the most important and easily recognizable technological components of modern agriculture in the United States. Its development in the first half of the twentieth century fundamentally changed the nature of farm work, significantly altered the structure of rural America, and freed up millions of workers to be absorbed into the rapidly growing manufacturing and service sectors of the country. The tractor represents an important application of the internal combustion engine, rivaling the automobile and the truck in its economic impact. A tractor is basically a machine that provides machine power for performing agricultural tasks. Tractors can be used to pull a variety of farm implements for ploughing, planting, cultivating, fertilizing, and harvesting crops, and can also be used for hauling materials and personal transportation. In the provision of motive power, tractors were a replacement for human effort and that of draft animals, both of which are still used extensively in many parts of the world.

1.1.33 Technical Description
The heart of a farm tractor is a powerful internal combustion engine that drives the wheels to provide forward motion. Direct ignition (diesel) and
spark-driven (petrol) engines are both found on tractors, just as with cars and light trucks. Power from the engine can be transmitted to the implement being used through a power take-off (PTO) shaft or belt pulley. The engine also provides energy for the electrical system, including the ignition system and lights, and for the most recent models, air conditioner, stereo system, and other creature comforts.

1.1.34 Background and Technological History
Farmers in 1900, whether engaged in growing wheat, corn, or cotton, raising livestock, producing dairy products, or combining a variety of these or other products, had only two sources of power apart from their own strength: steam engines and draft animals. Steam boilers provided motive power for threshing small grains, and a very small number of farmers were using recently-developed steam traction engines for plough and other tasks. Draft animals provided most of the power on all types of farms, however. As of 1910, there were more than 24 million horses and mules on American farms, about three or four animals for the average farm. In addition to supplying farm power, the horses were also relied upon for transportation, of both goods and people.

Horses and mules pulled an impressive variety of farm implements at the turn of the century, including plows, disks, harrow, planters, cultivators, mowers, and reapers. Several important farm tasks were typically done by hand at this time, including picking of corn and cotton. The greatest amount of power was needed for plowing, often forcing farmers to keep one or two extra horses above the number needed for the remainder of the year. As an example, power requirements during plowing have been estimated at 60% of the annual total needs for growing wheat at that time. A new source of power, then, would be valuable to the farmer if it could
replace the horsepower requirements of plowing, as long as the cost was less than that of maintaining one to two extra horses. It would be even more valuable if it could economically replace all of the functions currently performed by draft animals, and further if it could facilitate automation of the cotton and corn picking operations.

1.1.35 First Gasoline Farm Tractors
With the commercialization of the internal combustion engine, a more practical alternative emerged. Farmers bought large numbers of stationary gasoline engines in the first decade of the twentieth century, and quickly became familiar with their operation. A wide variety of household chores were simplified by the use of stationary engines, including pumping water, washing clothes, and churning butter. Companies began developing gasoline-powered traction engines during the same period; the first commercial machines were sold in 1902, and quickly became known as 'tractors'.

These tractors proved to be excellent at plowing, and were quite capable of driving mowers and reapers. The large steel wheels, low clearance, and substantial weight made them unsuitable for cultivating growing crops like corn and cotton, however.

1.1.36 Technological Improvements
Henry Ford, who had tinkered with steam and gasoline tractors prior to achieving his success with automobile production, introduced a small, inexpensive model which he called the Ford son during the World War I. This model sold well for several years, aided considerably by a war-caused shortage of horses. After a post-war crash in farm prices drastically reduced sales in 1920-21, Ford initiated a price war in 1922 by
cutting the price of its Ford son from $625 to $395. Alone of the large competitors, International Harvester matched Ford's price, and sales boomed for those two firms throughout the rest of the 1920s. Ford's production of tractors were always a sidelong to his main business of manufacturing automobiles, however, and when the Ford son production lines were needed for the critical Model-A launch in 1928, Ford decided to leave the tractor business.

The competition with Ford drove International Harvester to make significant improvements in its tractors. The first innovation to appear was the power take-off, offered after 1922. This device, a metal shaft turned by the rotation of the tractor motor, allowed implements to be driven directly by the tractor engine, as opposed to obtaining power from a wheel rolling along the ground. The power take-off quickly became a standard feature on all tractors, and implement makers began the process of re-designing their equipment to take advantage of this innovation.

An even more important improvement by International Harvester was the introduction of a general-purpose tractor, the Farmall, in 1925. This model, with high ground clearance, small front wheels, and minimal weight, was designed for cultivating, as well as for plowing and cutting. It was tested in Texas in 1923, and was released for broad scale distribution in 1925. Competitors, such as Deere, Massey-Harris, and Case rushed to develop a general-purpose tractor of their own, and by the mid-1930s, these tractors replaced the standard Fordson-type tractor. In addition, these same firms began the process of modifying their implements for these tractors, and the wholesale replacement of the horse began in earnest.
1.1.37 Emergence of A Dominant Design

Three other improvements were critical in completing the technology base for the tractor. Deere released a power lift for its models beginning in 1927. This device allowed the implement to be raised before every turn by pulling a lever. Prior to this, the farmer had to lift the implement by hand at each turn, which was a time-consuming and enervating task. As with the power takeoff, the power lift was rapidly adopted by other tractor makers. Rubber tires first became available for tractors in 1932, and by 1938 had largely replaced steel wheels. The low-pressure tires not only did less damage to fields, but also allowed a higher forward speed, due to reduced friction. Finally, the development of diesel engines in the mid-1930s gave farmers access to a lower-cost fuel for their machines. Many tractors from that time forward had a small gasoline tank for cold starts, and a large diesel tank for the majority of the operation.

International Harvester pioneered a 'one plow' tractor at about this time, and began selling it in 1934. This tractor was smaller and less expensive than the original Farmall, but had the same general-purpose capabilities. Its introduction offered operators on small farms the chance to replace their one horse or mule with a tractor, and was responsible for the beginnings of the tractor's diffusion in the South. These small tractors often featured adjustable front wheels and high ground clearance, which made them considerably more flexible than the larger models. Within a few more years, manufacturers were offering their larger models in 'high-clearance' versions as well.

A final innovation was responsible for bringing Ford back into the tractor business in 1937. In that year, the firm agreed to enter into a joint venture with Irish inventor Harry Ferguson. Ferguson had worked for almost 20
years to perfect a 'three-point hitch,' a device that produced superior plowing by continuously leveling the implement as it traveled over uneven terrain. The Ford-Ferguson tractors quickly amassed a significant market share (14% by 1940), and the hitch design was rapidly imitated. By about 1938, the technology of tractor development had achieved what is known as a 'dominant design.' The Farmall-type general-purpose tractors, both large and small, would change little, except for increasing in size and horsepower, over the next 30 years. Beginning in the mid-1930s, and despite the ongoing depression in the United States, tractor sales increased rapidly.

1.1.38 Development of Farm Tractor Related Equipment
The general-purpose tractor proved to be an excellent replacement for the horse in plowing, soil preparation, planting, and cultivating tasks for a wide variety of field crops. In addition, the tractor was fully capable of providing power for mowing hay and for harvesting of wheat and other small grains. In the latter application, it facilitated the practice known as 'combining,' the simultaneous reaping and threshing of wheat. Horse-drawn combines had been available since the 1880s, and had found limited acceptance on the larger farms of the arid West. However, a large team of horses was required to drag the heavy, complex machine through the fields. The tractors of the 1930s and 1940s had no trouble pulling a re-designed combine, and they began a process of rapid adoption in the Midwest. Eventually, a self-propelled combine was produced, with the tractor engine and cab subsumed into the combine apparatus.

The general-purpose tractor was not capable of bringing mechanization to the corn and cotton harvest until separate, but related innovations produced a corn picker in the 1920s and a mechanical cotton picker after
the Second World War. Prior to the development and adoption of the corn picker, corn was often cut with a binder, followed by manual shelling. One of the more important uses of stationary gas engines early in the twentieth century was for the shelling of corn. The picker combined the operations of cutting and shelling, and also distributed the stalks back onto the field, eliminating an additional step.

Mechanical cotton pickers fundamentally altered not only the harvesting of cotton, but the very nature of cotton growing in the United States. The mechanical picker, even after extensive development, produced higher crop losses than hand picking in the hot, humid areas where most cotton was grown -- Mississippi, Alabama, and east Texas. In the dry areas of west Texas, however, the picker was very efficient, both in terms of labor effort and crop yields. The mechanical cotton picker thus precipitated a relocation of cotton production westward, resulting in large-scale migration out of the deep South in the years after World War II.

As with the combine, self-propelled corn and cotton pickers were soon developed, combining the power train and cab of the tractor within the implement's apparatus. For this reason, pickers and combines are often considered as separate machines, and their development and diffusion are not included in discussions of the impact of the tractor. It should be pointed out, however, that none of these devices could have been powered efficiently by horses or steam; the gasoline-powered tractor was necessary for their development.

1.1.39 Recent Developments
The recent history of tractor development is less dramatic than the first 50 years. The peak year of tractor production was 1951, during which
564,000 units were made. From that time, the approaching saturation of the market produced a steady fall in production and sales. As one might expect, manufacturers responded by developing ever-larger tractors to supply farms that were growing in size. Interestingly enough, this pursuit of size left the small end of the market open to foreign competition, and, as in the case of the U.S. automobile industry, imports grew to dominate the small-tractor market.

Creature comforts have been improved markedly since the 1950s as well. Enclosed cabs soon had heating and air conditioning, and are now likely to be supplied with a television and stereo-CD. As a result, modern tractors are quite comfortable in comparison with the machines of 40 years ago, let alone versus the monsters of the early tractor era.

1.1.40 Production and Corporate History

From a slow start in the 1920s and 1930s, tractor production grew through the late Depression years, as farmers increasingly parted with their horses and mules. Figure 2 shows the annual output of farm tractors from 1909 to 1970, including the peak years of the early 1950s. It is likely that this peak would have been reached much sooner, had it not been for the disruption of the Second World War. Not only were raw materials such as steel, copper, and rubber severely limited due to wartime production needs, but the government actually limited the total number of machines that could be built each year, and allocated only the raw materials needed for that production. Many of the tractor factories were converted over to production of tanks, airplanes, vehicles, and other military goods.
Despite the presence of corporate giants such as International Harvester and Ford in the early development of the farm tractor, there were hundreds of firms that began producing or selling machines in the first two decades of the twentieth century.

1.1.4.1 Social and Economic Significance
The farm tractor had made a major impact on the social and economic fabric of the United States. By increasing the productivity of agricultural labor, mechanization freed up millions of farm operators, unpaid family workers, and farm hands. After the Second World War, many of these people relocated to the growing cities across the country and provided technically-skilled, hard-working labor to the manufacturing and service industries. Millions of others remained in rural areas, working off-farm either part-time or full-time in a variety of professions.

The landscape of the country has changed as a result. Farms have grown larger as one proprietor can manage to cultivate the land that several families would have worked in 1900. Small market towns, especially in the Plains states, have almost ceased to exist as the customer base for local businesses has dwindled. Land formerly devoted to raising and feeding horses has been converted to alternate uses or reverted to grassland or forest. Several generations of agricultural families have experienced the sadness of giving up the farm and the rural way of life.

1.2.1 National variations
In Britain, Ireland, Australia, India, Spain, Argentina, and Germany the word "tractor" usually means "farm tractor", and the use of the word "tractor" to mean other types of vehicles is familiar to the vehicle trade but unfamiliar to much of the general public.
1.2.2 Farm Tractors in India

As commercialization of agriculture grew in intensity in the mid-to-late 19th century the British Raj and the local legislatures and provinces began investing in agricultural development through support and establishment agricultural research farms and colleges and large scale irrigation schemes yet the level of mechanization was low at the time of independence in 1947. The socialist oriented five year plans of the 1950s and 60s aggressively promoted rural mechanization via joint ventures and tie-ups between local industrialists and international tractor manufacturers. Despite this aggressiveness the first three decades after independence local production of 4-wheel tractors grew slowly. Yet, by the late 1980s tractor production was nearly 140,000 units per year and by the late 1990s with production approaching 270,000 per year, India overtook the United States as the world's largest producer of four-wheel tractors with over 16 national and 4 multi-national corporations producing tractors today. Despite these impressive numbers statistics estimate that of total agricultural area in India, less than 50% is under mechanized land preparation, indicating large opportunities still exist for agricultural mechanization.

1945 to 1960

War surplus tractors and bulldozers were imported for land reclamation and cultivation in mid 1940's. In 1947 central and state tractor organizations were set up to develop and promote the supply and use of tractors in agriculture and up to 1960, the demand was met entirely through imports. There were 8,500 tractors in use in 1951, 20,000 in 1955 and 37,000 by 1960.
1961 to 1970
Local production began in 1961 with five manufacturers producing a total of 880 units per year. By 1965 this had increased to over 5000 units per year and the total in use had risen to over 52,000. By 1970 annual production had exceeded 20,000 units with over 146,000 units working in the country.

1971 to 1980
Six new manufacturers were established during this period although three companies (Kirloskar Tractors, Harsha Tractors and Pittie Tractors) did not survive. HMT, a large public sector unit, began manufacturing Agricultural Tractors in 1972 under the HMT brand name with technology acquired from Zetor of the Czech Republic. Escorts Ltd. began local manufacture of Ford tractors in 1971 in collaboration with Ford, UK and total production climbed steadily to 33,000 in 1975.

1981 to 1990
A further five manufacturers began production during this period but only one of these survived in the increasingly competitive market place. Annual production exceeded 75,000 units by 1985 and reached 140,000 in 1990 when the total in use was about 1.2 million. Then India - a net importer up to the mid-seventies - became an exporter in the 1980s mainly to countries in Africa.

1991 to 1997
Since 1992, it has not been necessary to obtain an industrial license for tractor manufacture in India. By 1997 annual production exceeded 255,000 units and the national tractor population had passed the two
million mark. India now emerged as one of the world leaders in wheeled tractor production.

1997 to 1999
Five new manufacturers have started production since 1997. In 1998 Bajaj Tempo, already well established in the motor industry, began tractor production in Pune. In April of the same year New Holland Tractor (India) Ltd launched production of 70 hp tractors with matching equipment. The company is making a $US 75 million initial investment in a state of the art plant at Greater Noida in Uttar Pradesh state with an initial capacity of 35000 units per year. Larsen and Toubro have established a joint venture with John Deere, USA for the manufacture of 35-65 hp tractors at a plant in Pune, Maharashtra and Greeves Ltd will produce Same tractors under similar arrangements with Same Deutz-Fahr of Italy. Looking to South American export markets Mahindra and Mahindra are also developing a joint venture with Case for tractors in the 60-200 hp range. Total annual production was forecast to reach 300,000 during the following year.

1999 to 2011
Facing market saturation in the traditional markets of the north west (Punjab, Haryana, Western Uttar Pradesh) tractors sales began a slow and slight decline. By 2002 sales went below 200,000. Manufacturers scrambled to push into eastern and southern India markets in an attempt to reverse the decline, and began exploring the potential for overseas markets. Sales remained in a slump, and added to the market saturation problems also came increased problems of "prestige" loan defaults, where farmers who were not financially able took tractors in moves to increase their family prestige. There were also reported increased misuse of these
loans for buying either lifestyle goods, or for social functions. Government and private banks have both tightened their lending for this sector adding to the industry and farmers woes. By 2004 a slight upward sales seen once again due to stronger demand in national and to some extent international markets. But by 2006 sales once again were down to 216,000 and later in 2007-08 have slide further to just over 200,000.

A golden era of mechanization has just kicked off in the year 2009-10 where total tractor sale volume exceeded 400,000 numbers and further in the year 2010-11 total tractor sale has touched and all time high sale of 545,000 numbers.

1.2.3 Farm Tractor Manufacturers Association

The Tractor Manufacturers' Association of India (TMA) is housed under The Confederation of Indian Industry (CII), New Delhi. Though not all manufacturers are members TMA is recognized as the main trade group representing the agricultural tractor industry in India.

1.2.4. Current Manufacturers of Farm Tractors in India

Angad Tractors, SAS Motors Limited

SAS Motors Limited, the manufacturer of 'Angad' Tractors, is a public limited company incorporated in April 2003. Its flagship product is ‘Angad’ 240 D tractor. The company is engaged in sourcing, assembling, manufacturing, and marketing of ‘Angad’ brand tractors and farm machineries. SAS Motors also provides a range of agricultural equipments.

Angad Tractors (SAS Motors Limited) main mission is to make low cost tractors, power tillers, and other farm machineries designed on ‘appropriate technology’ platform available to the Indian farmers.
Currently, SAS Motors Limited currently manufactures Tractors (ranging from 15-35 horsepower), Power Tillers, Mini Tillers / Power Weeders and Agricultural Machineries such as Rotavator etc.

**Balwan Tractors, Force Motors Ltd**
Formerly known as Bajaj Tempo Ltd. until 2005, Force Motors Ltd., makers of India's ubiquitous 3-wheeler Tempos since 1957 in a collaboration with Vidal & Sohn Tempo Werke, Germany. In 1999 began production of Ox and Ox 45 Brand Tractors both which incorporated transmission technology from the German manufacturer ZF. Additional line Balwan was introduced in 2004 and between the lines Force Motors offers a line of two-wheel and four-wheel tractors in a horsepower range from 10 to 50 HP.[4] In India BALWAN 600 launched shortly. It has a 60 HP engine. Balwan Tractors are one of the good tractors in India for agricultural purposes. They have a Benz engine.

**Captain Tractors Pvt. Ltd**
Founded in May 1994 and located in Rajkot, India, Captain Tractors manufactures mini-tractors under the Captain brand.

**Crossword Agro Industries**
Located in Rajkot, India, Crossword manufactures small tractors under the Nissan, Atmak and Captain brand names.

**Eicher**
In 1949, Eicher GoodEarth, was set up in India with technical collaboration with Gebr. Eicher a of Germany, imported and sold about 1500 tractors in India. On April 24, 1959 Eicher came out with the first locally assembled tractor from its Faridabad factory and in a period from 1965 to 1974 became the first fully manufactured (100% indigenization)
tractor in India. In December, 1987 Eicher Tractors went public and in June, 2005 Eicher Motors Limited sold Eicher Tractors & Engines to a subsidiary of TAFE called TAFE Motors and Tractors Limited.

Eicher also produced tractors under the Euro Power and Eicher Valtra brands under license from Valtra, an AGCO brand.

**Escorts (Escort, Powertrac and Farmtrac)**

Escorts Ltd began local manufacture of Ford tractors in 1971 in collaboration with Ford, UK and total production climbed steadily to 33,000 in 1975, reaching 71,000 by 1980. Ford (Ford - New Holland) was sold in 1992. Ford Motor Company proper quit the tractors business, but the name was allowed to continue as per agreement until 2000, when Escorts relabeled its Ford models under the Escort brand. Escort manufactures produces tractors in the 27-75 HP range and has already sold over 6 lakh tractors. Its tractors are marketed under three brand names, Escort, Powertrac and Farmtrac. The Escorts Group, is among India's leading engineering conglomerates operating in the high growth sectors of agri-machinery, construction & material handling equipment, railway equipment and auto components.

**HMT Tractors**

HMT is a large public sector unit and began manufacturing Agricultural Tractors in 1972 under the HMT brand name with technology acquired from Zetor of the Czech Republic. It manufactures its tractors in Pinjore, Panchkula in a large factory that also manufactures machine-tools, and Hyderabad. It has a capacity of 20,000 tractors per annum. In the Machine-tool company is a large foundry. It produces tractors in a range from 25 HP to 75 HP. HMT has also exported tractors to the USA under
the Zebra brand, which were marketed by Zetor distributors and dealers there. The company is controlled by the Ministry of Heavy industry that provides to the public its financial performance.

**Indo Farm**

www.indofarm.in Founded in Baddi, Himachal Pradesh, India in 1999, Indo Farms builds tractors in the 33 to 90 hp ranges. Company is also manufacturing 9 to 18 ton cranes and 15 to 50 kv silent gen sets. Ursus Poland is its technical partners. Indo farm tractors are becoming famous in Indian tractor customers because of their better working performance, quality and reasonable prices. Company is exporting their products to many developed countries like: New Zealand, UK, Poland, Germany etc. Tractor manufacturing is fully computerised and marketing team is very dedicated and experienced.[8]

**John Deere**

In 2000, John Deere set up production in a joint venture with Larsen & Toubro Ltd in Sanaswadi, in a rural area near Pune, Maharashtra. It was known as L&T John Deere Private Ltd, and manufactured tractors under the L&T - John Deere name for sale in India, and under the John Deere name for worldwide sales.[9][10]

In 2005, Deere & Company acquired nearly all the remaining shares in this joint venture. The new enterprise, is known as John Deere Equipment Private Limited. The factory currently produces tractors in of 35, 38, 40, 42, 45, 50, 55, 65, 75 and 89 HP capacities for domestic markets and for export to the USA, Mexico, Turkey, North and South Africa, and South East Asia. Pune factory started to produce new 55 to 75 Hp 5003 series tractors for European market in 2008.
John Deere India Private Limited is a subsidiary of Deere & Company, USA in India. Its factory, located at Sanaswadi, Pune, manufactures 5000 Series agricultural tractors. The Indian operations of Deere & Company include a technology center located at Magarpatta City Pune and John Deere Water Vadodara. The technology center provides services in the areas of Information technology, engineering, supply management, embedded systems and technical authoring for company’s operations world wide. John Deere Water, formed by the acquisitions of Plastro Irrigation Systems, T-Systems International, and Roberts Irrigation Products, is one of the leading irrigation companies in the world today.

**Mahindra Gujarat Tractor Limited (MGTL)**

The company was originally incorporated in the state of Gujarat in 1963 with technical collaboration with Motokov-Praha of Czechoslovakia as Gujarat Tractor Corporate Ltd. It was taken over by Mahindra & Mahindra Limited on 17 December 1999 (holds 60% equity) and re-christened Mahindra Gujarat Tractor Ltd as part of Mahindra Tractors. The company is engaged in manufacturing of tractors in a range of 30-60 hp which are marketed under Shaktiman brand. They were previously marketed under the Mahindra Gujarat name, and before that the 'Hindustan' name.

**Mahindra & Mahindra**

M&M's Farm Equipment Sector origins lie in a joint venture in 1963 between the Company, International Harvester Inc., and Voltas Limited, and was named International Tractor Company of India (ITCI). In 1977, ITCI merged with M&M and became its Tractor Division. After M&M's organizational restructuring in 1994, this division was called the Farm Equipment Sector. The Farm Equipment Sector has also ventured into manufacturing of Industrial Engines. M&M Industrial engines are used
for various applications like generator sets, industrial, construction, marine, compressors, etc. These engines are manufactured at the Company's engine assembly plants at Kandivli and Nagpur. M&M has two main tractor manufacturing plants located at Mumbai and Nagpur in Maharashtra. Apart from these two main manufacturing units, the Farm Equipment Sector has satellite plants located at Rudrapur in Uttarachal and Jaipur in Rajasthan. The Farm Equipment Sector as reported by the Company has a dealer network of over 450 dealers. This dealer network is managed by 28 area offices, situated in all the major cities and covering all the principal states and M&M tractors has sold more than 13,00,000 tractors since its inception. M&M's Farm Equipment Sector is perhaps the largest exporter of Indian tractors to the USA and the west. And in a reversal to earlier trends of Indian tractor manufactures with joint ventures with western tractor companies, M&M, in 2004 announced that they had bought majority stake (80%) in Jiaoling Tractor Company, and renamed it Mahindra Jiaoling Motor Co Group (JMCG). This is the first instance of Indian tractor industries participating in India's reverse FDI. The plant in China reportedly has a production capacity of 12,000 tractors annually.

In March 2007, M&M bought a controlling 43% stake in the Mohali-based tractor firm Punjab Tractors (Swaraj) that will reportedly increase M&M's share in the domestic farm equipment market from just over 30% to 40%. The 43% stake includes 29% owned by private equity firm Actis Capital and 14.2% by the Delhi-based Burman family. In July 2007, Mahindra upped its stake to 64.6%.
MARS Farm Equipments Ltd.
Originally established in 1976, the MARS Group is engaged in manufacturing/marketing of dump trucks, loaders, foggers, and agricultural tractors and attachments. Based in Lucknow, U.P., it began manufacturing two mini-tractor models under the Marshal name in 2005, Captain DI 2600 of 25 HP and Trishul MT DI 625 10 HP.

New Holland
New Holland Ag's entry into India was facilitated by FIAT's acquisition of Ford-New Holland in 1991. By 1998 New Holland Ag. (India) completed the construction of a new plant in Noida, near New Delhi, with a capacity of 5000 tractors in the 35 - 75 hp range. In 1999, New Holland Ag.'s parent company FIAT bought 70% of holdings of Case Corporation and created Case New Holland Global (CNH one of the top three tractor/agricultural/construction machinery manufacturers in the world), the new holding company New Holland Ag. (India). In 2000, the capacity of the Noida plant rose to 12,000 tractors per year and in 2007 the company manufactured 24,000 tractors for the domestic and export markets. New Holland India exports fully built tractors to 51 countries in Africa, Australia, South-East Asia, West Asia, North America and Latin America. The India plant of New Holland was originally built in 1998 to cater only to India domestic market. However due to slow down of economy by year 2001-2002 and slump in domestic demand, it became a challenge to utilize the installed capacity of the factory. Hence the company started looking its market beyond India borders. New Holland was the second largest tractor exporter from India after John Deere. In year 2007, India exported around 32,000 tractors of which 25% share was of New Holland.
Preet Tractors
Preet Agro began manufacturing tractors in 2002 at Nabha, Punjab, India. They currently manufacture in the 35-70 hp range.

Sonalika (International Tractors Ltd.)
International Tractors Limited was incorporated on October 17, 1995 and began manufacturing tractors designed by Central Mechanical Engineering Research Institute (CMERI). Its engines were initially designed on the successful HMT brand of engines, and gear-box as per PTL design. ITL currently is manufacturing Sonalika tractors between 30 HP to 90 HP, and the CERES brand between 60HP to 90HP. ITL went into collaboration with Renault Agricultural of France in July 2000. Renault Agriculture is a subsidiary of the Renault Group. Renault Agriculture was bought by CLAAS of Germany in 2003. Incidentally CLAAS already has a strong presence in India market producing its Crop Tiger range of Combine Harvesters in a plant in Faridabad (near New Delhi) since 1992. CLASS has opened a new plant in Punjab at Morinda in 2006. Sonalika is now having collaboration with YANMAR(Japan), and raised its production to 200 tractors per day.

Standard
Standard Combine began building tractors in Barnala, Punjab, India. In Standard Tractors, tractors are being manufactured in the range of 35, 45, 50, 60, and 75 HP with respective model names: Standard 335, Standard 345, Standard 450, Standard 460, and Standard 475. Engines for all these tractor models, except the last one, are manufactured within the plant as ‘Standard Engines’, in specific names – SE 335, SE 345, SE 450 and SE 460, respectively. All the above-mentioned models of Standard Engines have shown compliance to the TREM-III emission norms, as have been
verified by the ARAI. However, two new variants of tractor of 35 hp (Standard 335-I) and 45 hp (Standard 345-I), equipped with famous Perkins engines (assembled within the Standard Tractors plant), and two completely new models of tractor of 30 hp (Standard 330) and 40 hp (Standard 340) are on the verge to be launched. Besides these, three 3-wheelers (two passenger-carriers and one cargo), one 4-wheeler (cargo), a crane, an electric 3-wheeled mini-car, and two 2-wheelers (scooters) are either in the process of development or on the verge of launch from the Standard Tractor Division.

**TAFE Tractors**

Tractors and Farm Equipment Limited (TAFE) was established in 1961 to manufacture and market Massey Ferguson tractors and related farm equipment in India. AGCO, the owner of Massey Ferguson, now owns 24% of TAFE. Tractors are built and sold in India under both the TAFE and Massey Ferguson brands, and exported under both brands as well. In 2005, TAFE bought the Eicher Motors tractor and engine division.

**VST Tillers**

VST Tillers was set up in 1965 in Bangalore, India. In collaboration with Mitsubishi Agricultural Machinery of Japan, they manufacture 18HP tractors under various brands, including Mitsubishi-Shakti’, Shakti, Eurotrac-VST and Euro-Trac. They have been exported to Asia, the Middle East, Europe and the USA.

**Previous Indian Tractor Companies**

Tractor companies that did not survive and were not acquired by other companies are:
Auto Tractors Ltd., Pratapgarh
Had manufacturing plant at Pratapgarh (U.P.) and were making tractors with Leyland engines.

Asian Tractors Ltd
Began building tractors in 1989 from their own designs.

Ford Tractors

Harsha Tractors
In 1975, Harsha Tractors Ltd began manufacturing tractors in conjunction with Motoimport of Russia. Tractor production never amounted to much, and has since ceased.

Haryana Tractors Ltd
As a part of Pratap Steel Rolling Mills Ltd., Haryana began building tractors from their own designs in 1983.
Kirloskar Tractors

Founded in cooperation with Deutz-Fahr of Germany in 1974. It has since ceased to manufacture tractors. However, the company continues to manufacture engines under license from Deutz.

Pittie Tractors

Pittie Tractors was set up by a young and dynamic engineer - Shrikant Pittie and started out as Pittie Tools. The Pittie family are prominent industrialists in Pune and the family set up the first private industry in Pune - The Raja Bahadur Motilal Poona Mills Ltd. in 1893. Pittie Tractors indigenously developed and manufactured tractors and was well set to capture a large share of the market in India. However, due to an unfortunate labor strike at company lost nearly a year of production. As a result, the company fell into financial difficulty and ultimately had to wind-up operations.

In India Products are classified according to the need of various geography as per the need of the farmers, there is no stand rd method in case of selection of a farm tractor in any geography however by utilization in a geography, type of land and type of crop along with irrigation availability are the key determining factors.

As it happens in any automotive purchase decision, Farm Tractors do have major impact of Financial strength of Farmers which is normally a factor of land holding, crops sown and irrigation availability with market prices of harvest.

It is evident from the data available that every geography has some potential of each horse power tractors however looking into statistical
data tractors are classified in 5 major class Below 18 HP, 19-30HP, 30-35 HP, upto 40 HP, 40-50HP, & above 50 HP.

Tractors are governed by ministry of agriculture and every tractor sold in Indian Soil need to undergo a detailed testing and certification by Central Testing & Training Institute Budni –Madhya Pradesh.

Tractors are also required to be certified for Carbon Emission norms under motor vehicle act and need to obtain CMVR certification for registration.

All the states have made it mandatory to register tractors under State Road Transport however except Gujarat where tractor is treated as commercial vehicle all states charge Road tax at a very nominal percentage rates.

Tractors are being considered as major development vehicle and various state and central government; provide concessional interest rates, for tractor finance RBI has made a special provision by earmarking 18% of Priority Sector lending for Farm Mechanization in which 90% is used for tractor finance only.

In broad category in Malwa region following range of tractors are prominent and they are compared for various farm utility features, for prominent manufacturers, these are broad category under which farmers are having various options to choose from to suit their various farm and non farm related need thru a farm tractors.
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### Table No. 1.1.3

**Malwa- Sub 50HP- Farm Tractors**

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</tr>
<tr>
<td>Brake</td>
<td>OIB</td>
<td>OIB</td>
<td>OIB</td>
<td>OIB</td>
<td>OIB</td>
<td></td>
</tr>
<tr>
<td>Tyre Size-Front</td>
<td>7.50*16</td>
<td>7.50*16</td>
<td>6.0*16</td>
<td>6.0*16</td>
<td>7.50*16</td>
<td></td>
</tr>
<tr>
<td>Hyd Lift Capacity</td>
<td>1800 KG</td>
<td>2000 KG</td>
<td>1800 KG</td>
<td>1700 KG</td>
<td>1700 KG</td>
<td></td>
</tr>
<tr>
<td>PTO</td>
<td>Multispeed RPTO</td>
<td>Dual 540/1000</td>
<td>Single 540rpm with Reverse PTO</td>
<td>Single 540rpm</td>
<td>Ground PTO</td>
<td></td>
</tr>
<tr>
<td>Seat</td>
<td>Adjustable</td>
<td>Adjustable</td>
<td>Adjustable</td>
<td>Adjustable</td>
<td>Adjustable</td>
<td></td>
</tr>
</tbody>
</table>
1.3.1 Farmer’s buying process and the stimuli affecting the buying decisions.

A farmer as a buyer is unique and this uniqueness is reflected in the purchasing pattern and process of purchasing showing his behavioral characteristics. The study of farmer purchase decision making provides us with reasons why farmers differ from one another in buying & using Farm tractors, machineries and its application related services. Farmers receive stimuli from the environment and the specifics of the marketing strategies of different Farm tractors, machineries and its related services, and responds to these stimuli in terms of either buying or not buying product. In between the stage of receiving the stimuli and responding to it, the farmer goes through the process of making his decision.

Farmer purchase behavior for major farm machinery does not have, and may not need, a model of its own. From a naive perspective, it may be assumed that farmer’s major implement purchases are governed by the same behavioral and environmental forces as are individual consumer’s decisions for products of similar value. The farmer, after all, is always a person and usually a family member. Naively, one could question why the farmer should behave differently in buying a durable input for farm use than when buying an equivalent valued input for household use. True, it is often difficult to distinguish between personal and family use on the one hand and farm use on the other, as in the purchase of transportation vehicles and computers.

However, farmers are owners or managers of economic production operations and their purchase behavior might more appropriately be analyzed by industrial or organizational buying behavior concepts; Foxall (1979a) claims that farmers buying decisions for tractors tend to parallel
the behavior of industrial buyers. Furthermore, the purpose of buying farm inputs is primarily to facilitate the production of other goods (livestock, crops, etc.) and, were production to cease, the farmer would no longer buy farm machinery inputs such as tractors and combines. That is, farmers are subject to a derived demand situation virtually identical to industrial buyers and their behavioral process for durables purchases might closely parallel those of the more rational industrial buyers.

There are a number of sources for farm machinery purchase behavior studies but all vary in the frequency and accessibility of relevant studies. Published journals are accessible but are relatively low volume sources. Consumer research and marketing research journals have virtually ignored farmer buying behavior. General marketing management journals and agricultural economics oriented journals have published studies occasionally. A more abundant source of studies are agricultural/agribusiness colleges and government departments.

Unfortunately, the reports produced are frequently inaccessible; they seldom get distilled and distributed in article form and often they are considered proprietary (e.g. Farm equipment marketing company, trade association or governmental agency) has a vested interest in the results. Perhaps the greatest source of studies is the private sector; most major marketers of farm machinery and other farm inputs have no doubt carried out dozens of proprietary studies to service their marketing analysis, planning and control needs.

The measures are classified by stage of the farm machinery decision process and the sample size (number of respondents) and product focus of the studies are indicated. As indicated, all stages of the decision process
have been investigated, though seldom in a single study. Evaluation behavior and dimensions of search receive the most attention by researchers. Tractors were the focus of most studies and, in some; tractors were the decision “object” in question. Present study combined both a product choice and a choice of distribution outlet in its use of “Tractor Dealer” as the focus of questioning.

Interestingly, few studies measured potential covariates or segmenting variables and when these were addressed they tend to be limited to selected characteristics of the farm (e.g. type, size) and farmer (e.g. age). Only one study measured any of the many environmental forces to which farmers are subjected.

The general message is that there are large gaps in the research coverage pertaining to farm machinery purchase decision making.

1.3.2 Rationale of Study:
Share of agriculture in Our Indian economy was around 17.4 % of GDP in 2008, which is one of the highest across regions, and that is why the Indian economy has a major contribution of Agricultural sector. As per latest economic survey, In 2011-12, agriculture and allied sectors grew 2.5% and their share in the GDP fell from 14.7% in 2009-10 to 13.9% in 2011-12. Agriculture's share in the economy's overall gross capital formation also declined from 8.3% in 2008-9 to 7.2% in 2010-11.

India has ousted Taiwan from the second spot in emerging economies, Developed countries including India, will overtake the developed countries in economic growth by 2050, with the popularity of India and China as investment destination is rising while the attractiveness of
Europe and North America is slipping. "The seven new global powers by 2050 will comprise the so-called BRIC economies (Brazil, Russia, India and China) together with Indonesia, Mexico and Turkey," as per the Ernst and Young European Attractiveness Survey 2007.

In the fiscal year 2008, 09 & 10 industrial production continued a CAGR growth of 9%, estimated growth for fiscal 2011 is 7% plus.

India is mainly an agriculture country, accounts for approximately 25% of India’s GDP, Agriculture in India is the mean of livelihood of almost two third of the workforce in the country and employs nearly 62% of the population, it accounts for 13% of India’s exports. About 42% of India’s geographical area is used for agricultural activity. It is therefore considered to be the most vital sector of the Indian economy.

1.3.3 GROWTH OF TRACTOR INDUSTRY
Prior to the 1960s, India had to import most of its food. But improved farming techniques, including farm mechanization the use of irrigation and high-yield grains, have greatly increased the food production and allowed India to become self-reliant with regards to food. However, since most of the cropped area, even now, does not have any assured irrigation, monsoons assume a crucial role in influencing agricultural production.

1.3.4 Agricultural development
Agricultural development in India can be categorized into four major periods:
1. Pre-Green revolution- this was before 1960s, when there was boost in the productivity growth of coarse grains and pulses per unit of land.
Green Revolution (mid 1960s to mid 1980s) - This was a period of expansion of area and rapid growth in productivity of wheat and rice, expansion of agricultural research and establishment of national infrastructure.

Post-Green Revolution (mid 1980s – 2000s) – This was a period of continued growth in productivity achieved through intensification of chemical use and labor, and also expansion of area under maize, cotton, sugarcane and oil seeds.

The Current stage (2000- present)- The current stage is characterized by the following:

- Further diversification of cropping patterns from low value to high-value crops, such as fruits, vegetables, flowers and other horticultural crops for domestic consumption, processing and export
- Regaining “Agricultural Dynamism,” a key goal of eleventh Five Year plan
- Aiming to achieve a sustained growth rate of four to five percent.
- Improvements in farm mechanization

1.3.5 Highlights of the Indian Agricultural Sector

Key sector of economy contributes to 25 percent of Indian GDP

- Accounts for 13 percent of India’s exports
- Second largest producer of rice and wheat in the world
- Largest producer of pulses
- Fourth largest producer of coarse grains
- Second largest producer of vegetables, groundnuts & fruits
1.4 CURRENT STATUS OF INDIAN TRACTOR INDUSTRY

The Indian Tractor Industry is the largest in the world, accounting for one third of global production. The other major tractor markets in the world are China and the USA. The global spotlight on tractor manufacturing in terms of unit volume seems to be swinging away from the USA, UK and Western and Eastern Europe towards India and China, where growth in the number of producers and the total volume of production in recent year has been impressive.

Until 1960, the demand for tractors was met entirely through imports indigenous manufacture of tractors began in 1961, but India continued to import tractors to bridge the total needs up to the late 1970s. The Indian Tractor Industry has come a long way since then. Volume growth in the past four decades show a CAGR of 10 percent, despite seasonal variations that cause natural fluctuations in the demand for tractors, subsequently impacting industry volumes.

1.4.1 Industry Status 2004 to 2006

The tractors industry, which grew at a CAGR of 16 percent between 1994 and 1998, reached a plateau in 1999 to 2001. 2001 to 2003 saw the industry shrinking at a negative CAGR of 13.5 percent. The recovery phase started from mid-2004 and is the current phase.

Strong monsoons, increased lending by the nationalized banks, and the entry of private commercial banks created a positive outlook, Firming up of commodity prices and money availability catapulted tractor demand, helping the industry regain the volumes at a CAGR of 19.3 percent.
Agricultural and allied GDP (at constant prices of 1999 to 2000) is estimated to have grown by 2.3 percent in 2005 to 2006 after increasing by 0.7 percent in 2004 to 2005. This growth was mainly driven by a nearly normal monsoon, rise in minimum support prices and the continued thrust of the government to boost agricultural output.

This helped the industry in 2005 to 2006 to surpass the industry best of 2000 to 2001, reaching the new peak of 292,908 tractor sales.

The government continues to focus on increasing agricultural output. In fact, the government has targeted a four percent growth in agricultural GDP, primarily to achieve its overall GDP growth target of ten percent or more.

During union budget 2006-2007, the finance minister relived the farmers of interest liability up to two percent on crop loans of principal up to Rs 100,000 taken during kharif and rabi seasons in 2005-2006. Also, the government has set a target that the short-term credit available to farmers should not exceed seven percent during 2006-2007 owing to rising interest rates. It also provided to compensate the financiers for this subsidized lending rate. Although these waivers were for short-term loans, such measures augment the incomes of the farmers. Therefore, the buoyant trend and industry growth is continued in the fiscal 2006-07 and industry grew more than 30% in 2006-07.

1.4.2 Industry Status 2007-2011
Tractor industry has shown a very positive trend and has been growing at a fastest pace in the last two decade with an average growth in excess
of 20% in last 3 years and expected to exceed 5,75,000 numbers by the year 2012.

2007-08 Total tractor sale volume stood at 3,50,000 nos. which is a growth of 12% with respect to previous year and have shown a see change in farmers buying segment shifting from major 35 horse power to 50 horse power owing this in 2008-09 Tractor industry de grew to 3,40,000 and Grew in 2009-10 to 4,40,000 and have also indicated a change of seasonality in terms of skewed buying behavior to more uniform cash sale, rather than bank finance dependent sale.

2009-10 The tractor industry witnessed a strong y-o-y growth of 28.3% during 2009-10, with most of the States reporting positive growth during the year. The biggest markets for the tractor industry include States like Uttar Pradesh (UP), Andhra Pradesh (AP), Madhya Pradesh (MP), Rajasthan, and Maharashtra, which together accounted for around 50% of the total tractor sales in India during 2009-10.

Farm Tractor industry surpassed 5,40,000 numbers in the year 2011-12 and became biggest farm tractor market in the world, this spurt in farm tractor is triggered in markets with high cash crop components within states followed by good monsoon.

Tractor and farm machinery has come up of an age of quantum growth and also there is significant increase in tractor and high end farm equipment sales growing towards large horse power and bigger equipments it is also studied that tractors are now being deployed for usage, more number of hours per day and farmers are now becoming a small business unit converting tractors to loaders excavators for
construction and civil engineering work, all this is an outcome of serious government intervention in farm sector with deep rooted long term changes, in rural employment guarantee program and tractors are allowed to trip in day time for haulage in city, tractors are exempted to road taxes as well as toll taxes. Various majors by government at centre have further been reinforced by state govt.

1.5 Statement of Problem

Factors affecting Farmer’s purchase decision, based on the Characteristics of Farmers

Classification of Farmer based on the Profile

<table>
<thead>
<tr>
<th>Type of Farmer</th>
<th>Rural profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovator</td>
<td>Young progressive farmers, urban exposure, additional income (part time service, agent.</td>
</tr>
<tr>
<td>Early adopter</td>
<td>Rich farmer, high disposable income, urban exposure, high social status.</td>
</tr>
<tr>
<td>Early majority</td>
<td>Mediocre farmer, member of cooperative society, willing to adopt technology products.</td>
</tr>
<tr>
<td>Late majority</td>
<td>Hesitates to take agri-loan, member of cooperative society, adopt only time tested technology.</td>
</tr>
<tr>
<td>Laggard</td>
<td>Marginal farmer using traditional forms of cultivation.</td>
</tr>
</tbody>
</table>

The behaviour of farmers is the product of two broad categories of influence; these are:

- Endogenous factors (i.e. those internal to the individual)
- Exogenous factors (i.e. those external to the individual
The present study is entitled as

"Study of External Factors & Product Feature Affecting Purchase Decision of Farm Tractors (with reference to Malwa -MP)"

Objectives of the study

1. To study external factors affecting purchase decision of farm tractors.
2. To study product features affecting purchase decision of farm tractors.
3. To study multi utility usage of farm tractors.
4. To study farmers requirements with reference to new crops.
5. To study Marketing policies products and placements.
6. To study factors driving Farm Tractors Sales in Malwa
7. To compare the impact of after sales service Impact of farm tractors in purchase decision.
8. To Study the impact of color and aesthetics on Farm tractor purchase decision by farmers

The present study is entitled as ;

"Study of External Factors & Product Feature Affecting Purchase Decision of Farm Tractors (with reference to Malwa -MP)"

HYPOTHESIS

H01 There is no significant effect of crop pattern in purchase decision.

H02 There is no significant effect of farm land holding size in purchase decision.

H03 There is no significant effect of monsoon in purchase decision.
H04 There is no significant effect of crop prices in purchase decision.

H05 There is no significant effect of Bank finance in purchase decision.

H06 There is no significant effect of horse power in purchase decision.

H07 There is no significant effect of product prices in purchase decision.

H08 There is no significant effect of product features in purchase decision.

H09 There is no significant effect of resale prices in purchase decision.

H010 There is no significant effect of service facility in purchase decision.