The population is increasing tremendously and with this increase the demand of food. The traditional methods which were used by the farmers were not sufficient enough to fulfil these requirements. Thus, new automated methods (Drone technology) were introduced. These new methods satisfied the food requirements and also provided employment opportunities to billions of people. Drones’ technologies save the excess use of water, pesticides, and herbicides, maintains the fertility of the soil, also helps in the efficient use of man power and elevate the productivity and improve the quality. The objective of this paper is to review the usage of Drones in agriculture applications. Based on the literature, we found that a lot of agriculture applications can be done by using Drone. In the methodology, we used a comprehensive review from other researches in this world.

Applications of Drones in Agriculture

There are various applications of drones in agriculture which are briefly discussed below:

Soil and Field Analysis: Drones can be used to mount sensors which are able to analyze the soil conditions, terrain conditions, moisture content, nutrients content and fertility levels of the soil which can be further used for planning the pattern of sowing of different crops, irrigation scheduling as well as for managing fertilizers.
application considering spatial variability of the crop growth and field conditions.

**Planting Crops and Trees:** Drones can be used for planting crops which can save labour cost and reduce human drudgery. As there would be no use of tractors for sowing crops in the field, drones can save fuels, reduce the emission of harmful gases formed during fuel exhaustion. While operating tractors in the field, and can avoid the compaction of subsoil as well as formation of plough pan which generally forms due to repetitive movement of tractors on soil surface. Drones can be used to plant trees or crops in remote areas by throwing biodegradable seed pods or seed bombs. Thus, they can be used for the restoration of degraded lands by planting trees, and also for reforestation as well as afforestation activities.

**Crop Monitoring:** Drones can be used for monitoring the conditions of crops throughout the crop season so that the need-based and timely action can be taken. The quick and appropriate action can prevent yield loss. This technology will eliminate the need to visually inspecting the crops by the farmers. They can monitor the horticultural crops or other crops present in remote areas like mountainous regions. They can also monitor the tall crops and trees efficiently, which are otherwise challenging to scout physically by farmers.

**Nutrient Status and Deficiency Monitoring:** Plants need the appropriate levels of nutrients in order to thrive and produce a strong yield. The appropriate levels of nitrogen will ensure strong growth of vegetation and foliage, appropriate levels of phosphorous are required for strong root and stem growth and appropriate levels of potassium are necessary for improving the resistance to disease and also to ensure a better quality of crop. If soil lacks any of these nutrients, the plant will become stressed and will struggle to thrive. NDVI Index mosaics offer the possibility to identify exactly which areas of the crops are stressed or struggling and to target directly these areas. The NIR/multispectral imagery provided by the UAVs can identify these management zones long before the problem become visible to the naked eye. This means that these management zones can be targeted before crop development and yield is affected.

**Diseases Monitoring:** Crop diseases can be devastating and classified as fungal, bacterial or viral. Drones equipped with Infrared cameras can see inside plants, giving a clear image of the condition thereof. If a farmer can detect an infection before it spreads, preventative measures can be taken - like removing the plant - before the infection spreads to neighbour plants. Image-based tools can, thus, play an important role in detecting and recognizing plant diseases when human assessment is unsuitable, unreliable, or unavailable, especially with the extended coverage provided by UAVs. RGB and multispectral images have been preferred methods for acquiring information about the studied areas, but hyper spectral and thermal images have also been tested. The latter is employed mostly to detect water stress signs potentially caused by the targeted disease.

**Weed Identification:** Drones can be used to identify the weeds present in the field. These weeds could be timely rooted out from the field so that they do not compete for resources with the main crop.

**Crop Spraying:** Drones can be used to spray chemicals like fertilizers, pesticides, etc. based on the spatial variability of the crops and field. The amount of
chemicals to be sprayed can be adjusted depending upon the crop conditions, or the degree of severity of the insect-pest attack. In this way, drones pave the pathway to precision agriculture. This ultimately increases the efficiency of the chemicals applied, thereby reducing their adverse impacts on the environment by decreasing the soil and water pollution. Thus, it can lead towards sustainable agriculture. Drones spray chemicals at a faster rate as compared to other methods. It can also result in the saving of the amount of chemicals applied, which can reduce input cost. There is also a problem of imbalance of tractor operated machinery while spraying chemicals over tall crops which may sometimes result in accidents. So, the spraying of chemicals over tall crops can be done easily by drones without any damage.

**Geofencing Or Protecting the Field from Animal Damage:** The thermal cameras mounted over drones can detect animals or human beings during the night. So, it can be used to protect fields from the damage caused by animals, which are otherwise difficult to detect in the large fields during night time. So, it will work more efficiently than human guards.

**Crop Insurance:** Drones can be used for precisely estimating and monitoring of the crop failure. So, it can be helpful for the farmers as well as for insurance companies in providing insurance claims based on the degree of damage. This technology has great potential in accurate and effective implementation of crop insurance scheme, namely Pradhan Mantri Fasal Bima Yojana in India without any bias.

**Livestock Management:** Drones can be used to manage the large herd of livestock. The sensors having high-resolution infrared cameras present over drone can detect the diseased animal swiftly by their heat signatures. The detected diseased animal can then be separated from their fellow animals, and the early treatment can be provided. So, the drone could be used for precision dairy farming.

**Conclusion**
Drones have great potential to transform Indian agriculture. With the advancement of technology in the future, the production of drones is expected to become economical. The modern youth are not attracted towards farming due to hard work and drudgery involved in it. The implication of drones may fascinate and encourage the youth towards agriculture. Drones provide real time and high-quality aerial imagery compared to satellite imagery over agricultural areas. Also, applications for localizing weeds and diseases, determining soil properties, detecting vegetation differences and the production of an accurate elevation models are currently possible with the help of drones. Drones will enable farmers to know more about their fields. Therefore, farmers will be assisted with producing more food while using fewer chemicals. Nearly all farmers who have made use of drones have achieved some form of benefit. They can make more efficient use of their land, exterminate pests before they destroy entire crops, adjust the soil quality to improve growth in problem areas, improve irrigation to plants suffering from heat stress and track fires before they get out of control. Therefore, drones may become part and parcel of agriculture in the future by helping farmers in managing their fields and resources in a better and sustainable way.
References


