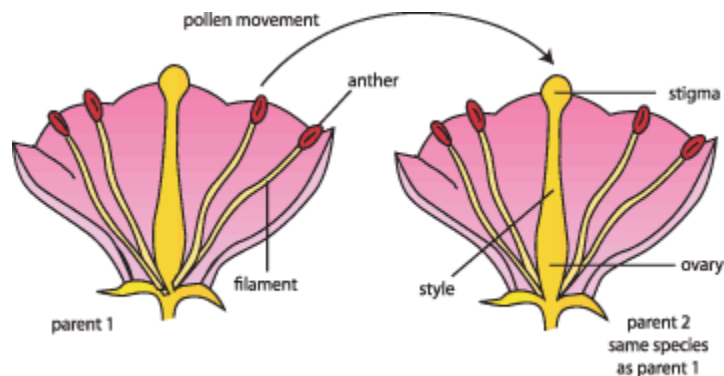


## Engineer Perspective:

Pollination is an intricate process that requires two parties to fully complete, that of flowers to produce the pollen and of animals to transfer the pollen. This natural development that takes place leads to the creation of new seeds that will grow into new born plants.

## Flowers:

Pollination takes place when pollen is transferred to the female reproductive organ of seed plants, which allows fertilization and reproduction to take place through the growth of the pollen tube and eventually, sperm. The female reproductive organ known as the pistil has the stigma sitting on top which receives the pollen. The male reproductive organ known as the stamen produces the pollen which is initially a sticky powder which needs to be transported to the stigma. The seeds are located at the base of the pistil within the ovule. When the pollen grains land on the sticky stigma, a pollen tube grows downwards and the sperm nuclei fuse with the female ovules which then develop into seeds. It is important to recognize that pollen grains come in various species and thus may have characteristics. The three important categories taken into consideration when it comes to pollen recognition are: size and shape, the number of colpi and/or germination pores, and the structure of the cell wall. Different species may have pollen that is 10 to 100 micrometers in size, as well various shapes such as round, oval, disk, or bean shaped.



Self-pollination takes place when a plant's pollen is transferred from the stamen to the same plant's stigma

Cross pollination – takes place when a plant's pollen is transferred to a different plant's stigma

The second party required to pollinate would be animals which is known as biotic pollination. Plants that are pollinated by animals are often brightly colored and have a strong attractive smell to attract their respective animal pollinators. Although this is the primary method of pollen distribution, not all plants operate via animals as some use the wind to blow pollen from one plant to another. One of the dominant pollinators found in America would be that of the bee.

## Bees:

Pollen provides an important source of protein for bees which they feed to their developing offspring. Bees are a vital component of the process due to the hairs covering their

entire bodies which attracts pollen grains through electrostatic forces. The stiff hairs on the legs enable the bees also enable them to brush the pollen into specialized small pockets that are found on the legs or body. Bees are also excellent pollinators because they require large quantities of nectar and pollen to rear their young, meaning they visit flowers regularly and in large numbers to obtain the desired amounts of food. In doing so they successfully concentrate on one species of plant at a time.

For our purposes it is important to note key facts regarding productivity of bees:

- Most active at temperatures between 60 degrees F and 105 degrees F
- Winds above 15 miles per hour reduce activity and complete stop at 25 miles per hour
- In unfavorable weather, bees may only visit plants nearest to the hive



[http://public.media.smithsonianmag.com/legacy\\_blog/Halictus-ligatus-Sam-Droege-USGS-Bee-Inventory.jpg](http://public.media.smithsonianmag.com/legacy_blog/Halictus-ligatus-Sam-Droege-USGS-Bee-Inventory.jpg)

Colony usage for pollination:

We had adopted the evolutionary sharpness of bee pollinators to benefit our own production of a wide range of fruits and nuts. The provision of bees for pollination of crop plants is a highly specialized practice which requires the proper development and selection of strong colonies that are able to provide the large force of field bees required to do the job. The number of colonies that were needed per acre of crop plants varies in attractiveness to the crop, competition from surrounding sources of pollen, and percentage of flowers that must produce fruit or seed to provide economic return. Each type of food produced requires specific types of bees and colonies, example being that for apple pollination. Colonies for apple pollination are generally housed in two-story hive with a laying queen and require four or more frames with brood and sufficient bees to cover them. There should also be a reserve food supply of 10 pounds of honey if not more. It is also essential to provide a nearby source of water as it is important for the brood rearing and cooling the hives. Bees for pollination should be placed within or beside the crop to be pollinated, usually being placed at intervals of 200 to 300 yards. Colonies are rented to pollinate crops throughout the year, and can be transported thousands of miles to the required destinations. More than one million boxes are loaded onto thousands of tractor trailers, draping nets over the boxes to catch any bees trying to get out. A typical box would contain 19,200 adult bees.

### Potential Solutions:

Coming up with solutions to this problem is not an easy task due to the intricate system that is very specifically designed to produce and distribute pollen. Without biotic pollination and a suitable replacement for pollinators, an agricultural and social revolution would be needed to take place to develop small subsistence farms through the use of hand pollination instead of larger industrial farms. Potential pushes for this could be provided through the government by providing incentives for growing personal food as well as a call for hand pollinators.

The old system of food production is not feasible without the support of bee pollination. Large industrial farms cannot conceivably be sustained anymore without some new form of large scale pollination. Hand pollination involves transferring pollen from male to female flowers using small brushes, as shown in the picture below. While this may be effective on a small scale, it is much too time consuming a process to be used on highly mechanized and very large farms.



The world's populations can no longer be supported by giant mono-crop farms, and a switch from this system of food distribution must be made to small individually maintained farms. In this new system, food is grown locally in much smaller community or personal gardens so that hand pollination is a task able to be performed. The government must make a push toward this way of growing food in order to prevent wide scale starvation and malnutrition.

Research has been conducted searching for alternative pollination methods other than hand pollination. Certain flies, such as the common blue bottle fly, have been found to be somewhat effective pollinators. Quite obviously they are not as effective as bees, as pollination is not essential part of their existence and only occurs incidentally for them. So far their use in pollination has been limited to mostly vegetables such as carrots. It is most likely that flies will never be able to support farms as large as bees were capable of. However, they can supplement hand pollination and lessen the work required to maintain a farm.

A synthetic pollen has been in productive, but so far results have been ineffective. A synthetic pollen could be widely distributed over a large area to pollinate many plants at once and revive the system of larger farms. However, the combination of hand pollination, smaller

and more local farms, and fly pollination should effectively feed the populace and create a system that would render the synthetic pollen unnecessary.

Some plants are able to use wind as a significant source of pollination. In order to take advantage of this process, research has been conducted into creating large fans that mimic wind patterns. The fans need to be powerful enough to move the pollen around, but not too strong that they damage the plants themselves. In this way, there would be another reliable method of pollination that would add to the options and allow for greater yields of crops.