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Agriculture

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Agriculture, an introduction

Due to the decreasing fertility of the arable land, everywhere in Malawi, it was no longer possible in the long run to meet the national demand for corn as the first necessity of life. Around the turn of the century and from 2011 Malawi structurally faced food shortages and became hungry. According to the World Food Programme, a United Nations aid organization, more than 1.6 million people, or 11% of the population, faced life-threatening food shortages in 2012. The government measures meanwhile provided for the issue of subsidy vouchers for "small farmers" from 2004. This allowed a small amount of fertilizer and seed to be purchased, at about a third of the normal price so that they could replenish the soil nutrients, benefit from improved seed varieties and harvest reasonably. The consequences were immediately observable. There was a relative grain surplus and a birth- explosion. In 2009, the government spent 16% of its budget on agricultural subsidies.

A lot of (foreign) scientific research has been done and published on all kinds of themes about intensive small-scale agriculture in Malawi. However, because over the years the circumstances seem unchanged, it is suspected that the recommendations have received little attention. First of all, this suggests that the publications were only intended as a study object. Apparently, the findings of the scientists were insufficiently convincing for the politicians and there was no information and further research. The situation may have remained unchanged because the conservative society has also not been able to attract individual or collective initiatives. Or the lack of resources and possibilities. After all, when the small farms are approached from the poverty line, they are not 'viable' even with very modest goals. Due to lack of cash, unprofitable work therefore remains necessary. Giving up is not an option.

Crop production in Malawi is characterized by the cultivation of corn with limited addition of nutrients. The renovation of it dates from colonial times to make plantation labor more effective. After decolonization, corn consumption has remained and the old crops such as millet and sorghum as the main food crop have disappeared.

Corn is the staple food in Malawi. From corn flour and water, 'nsima' is cooked over a wood fire between three large stones. During cooking, it is necessary to stir a lot to prevent clumping. The sticky porridge has the structure of a thick pudding.

110 kg of corn per person is needed per year.

Measured by the current circumstances, the small farms in Malawi are facing a number of restrictions, i.e.:

-the size of the arable land is on average no more than a ½ ha

-poor condition of the soil due to shortages of fertilizers and humus.

-a hard impermeable top layer

-undrained fields with periodic flooding and water shortages

-no change and intermediate cultivation possible

-monoculture with corn

- deficient agricultural knowledge

-indecent input of fertiliser and seed and the poor access when purchasing

-only hand tools for land processing.

-no mechanical operations of the fields

-minimum yields

-no storage options

-transport problems and inadecent processing of the proceeds

-deficient market forces

-low investments due to lack of resources

-annual natural disasters

The cultivation of corn

Ground

Corn thrives best in deep fertile soil, well drained, with an aqueous capacity and rich in organic matter. The ideal pH value is from 5.6 to 7.5. (slightly acidic to neutral to slightly alkaline). Preferably loam or sand loam soils.

To reduce soil loss and road flushing, it is necessary to remodel at a slope of less than 2%, perpendicular to the slope. When there is a steeper slope, it is necessary to create physical barriers with boulders, dams, etc. or by creating terraces.

Temperature

The optimal air temperature for the growth of corn is between 18 and 32 °C. Growth is greatly reduced at air temperatures above 35°C and below 10°C.

The germination will be faster and less variable at soil temperatures ranging from 16 to 18°C.

Water

Corn usually needs about 500-1500mm of rain per growing season, although some maize varieties can also do it with only 250mm of rain. The crop needs more moisture during flowering and grass supplementation. The actual need for precipitation depends on the type of corn. In drier areas, additional operations are needed such as grounding, cracking, sowing at a greater distance and choosing specific varieties. It is necessary to choose a corn variety that suits the area, the cultivation system, the intended yield and whether the farmer wants to use the seed of the harvested crop for the next season.

Expertise

In order to achieve maximum yields, knowledge is naturally necessary for the cultivation of corn. Where present, the use of mechanical tools and pesticides should be dependent on expert local advice to prevent accidents and defects. This applies in particular to the safe and effective use of mechanical agricultural tools and weed killers.

Information

Despite the fact that 'agriculture' as an educational subject is part of primary education and is also taught in secondary education, the theoretical agricultural knowledge of the farmers turns out to be minimal. Also the practical transfer of knowledge from father to son. As a result, it cannot be reflected to the cause when the harvest fails, so that the following year is re-sown in the same way and without adjustments. Research shows that 14% of households have received advice on composting, 12% on new seed varieties, 9% on fertilizer use, 8% on irrigation and on pest control, which is insufficient as basic knowledge.

Farmer Field Schools

Farmer Field Schools (FFS) are intended worldwide to let farmers learn in a discovery-led manner. This can be done by collectively discussing specific topics, exchanging experiences and knowledge and using demonstration strips. It is a place where specific knowledge is also shared in consultation that is in line with the needs and problems that farmers have to deal with

In Malawi, but also elsewhere in Africa, the most discussed topics are the degrading fields, soil restoration methods and crop cultivation. Also the errative rainfall, the lack of resources and loss of yield. About increasing yield, themes about the use of fertilistion, weeds, pests, diseases and the lack or too much water are central. Those themes aim to improve the situation of small farms and diversify sources of income. As a group, a form of cooperation with regard to market forces is also sought. Pests and the use of pesticides are considered less important.

The *Lead-Farmer* approach is a derivative of this and is common in Malawi. In that case, the local farmer leader has taken a short training on one or two specific technologies to then disseminate them as information among groups of farmers in their region. The use of test fields, crop research and supporting the FFS as a source of information is limited. Techniques and technologies are not common. The initiatives must therefore mainly come from the farming community itself.

The FFS as adult education has shown that in the process of continuing learning, the quality of life and food security of rural communities has been locally improved and a form of sustainable agriculture has been promoted. It turns out that participating in the FFS also contributes to a remarkably higher crop yield. By establishing contacts with involved government agencies and NGOs, partnerships were also created that everyone benefited from, because they adapted and the FFS ventured into disciplines outside of agriculture.

The *Farmer Field School* can be part of the Agricultural Cooperative where it is recorded that the task consists of providing help and information. Examples are the joint purchase of agricultural tools and the application of improved techniques.

Land cultivation

Soils vary in physical and biological properties from site to location and should be defined based on the prevailing characteristics in relation to the desired crop type, management practice, climatic conditions and location. Also based on the nutrient content.

Prior to the choice of the location of the field and its availability, it is necessary to:

-select the area for fertility, possibilities, accessibility and surveillance

-test the soil quality for acidity (pH), structure and content of nutrients such as nitrogen, phosphorus and potassium

-make a plan about the method of land cultivation.

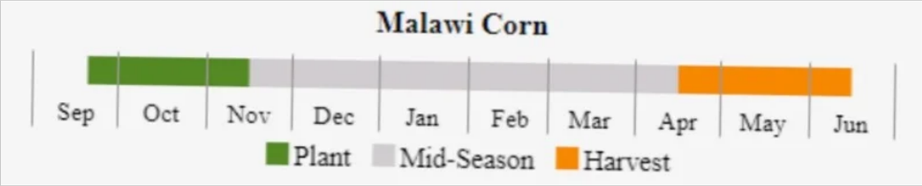
The purpose of land cultivation is to produce a seedbed that is weed-free with aerated soil in which water can insep into so that corn seeds can have close contact with the soil and from which the seedling can easily develop.

For working the fields, the farmers use hand tools. Mechanical means, purchased collectively or as contract work, are not in use.

Agricultural tools per household	Schoffel	Houweel	Att	Kapmes	Sickel	Pump	Watering	Cart
In %	86.9	15,4	41.4	49.2	34.7	0,5	15,6	1,5

Soil cultivation by method	Grounding	Terpen	Pit	None	Ripping	Minimum
In %	90,1	4.1	2,2	1,6	0,5	0,9

Agricultural labor with the handcuff. Here a partial application of the preservative tillage



Conventional soil cultivation method

Traditional tillage prior to sowing agricultural crops in large parts of Africa includes sowing-preparing and tilling the soil at an early stage.

By far the most farmers in Malawi use a hand stuffle for soil cultivation to make backs as a seedbed. The intention is to prevent the washing away of corn seeds and seedlings if possible in tropical rain showers. That method therefore moves the previously rinsed surface layer and that is a bad start to grow corn due to the lack of nutrients. Making a conventional corn seedbed with hand shefts by hand requires about 8-10 days of manual labor per hectare.

Preserving soil cultivation method

A number of experts believe that the conventional tillage system causes damage, such as:

-Exposing the substrate to rain, wind and sun, leading to soil erosion

-Destroying soil organisms

-Soil compaction, especially when using tractors or migratory animals

-The formation of a hard (top) layer by ploughing or scraping, which:

=the outflow of the surface water increases, resulting in soil erosion

=an increased water evaporation

=hindering rainwater infiltration into the soil

=a reduced groundwater replenishment

= complicating root penetration

Because of those supposed negative consequences, the so-called conservative agriculture arose locally. That system is based on three main principles:

- disrupt the soil as little as possible (minimal soil cultivation)

-keep the soil covered as much as possible with crop residues, mulch and deck crops.

-the use of alternating cultivation, intermediate crops and fruit rotations.

Mechanical tools

In the mechanical soil working method, the soil is physically detached with a tool pulled by a tractor or towing ross. Usually the soil is turned over with a plough where the surface layer is converted to a deeper soil layer. At the same time, crop residues and weeds are buried. In some cases, at a later stage, the top layer is crumbled as a seedbed with an eg or cultivator although an overly fine sowing bed, especially on sandy soils, makes the plot vulnerable to wind erosion and the biotope will be affected. A coarser slope reduces the risk of wind eroding the soil, but still allows water to infiltrate. The size of the clods should be about 6 cm or less and the soil should be cultivated to a depth of 15-30 cm.

In other cases, the ground is torn to a depth of 10 cm. Unlike plowing, the ground is not turned over. The 'ripping' is mainly done in dry soil with special tools, a ripper, pulled by oxen, donkeys or a tractor and is intended to leak rainwater into the underlayer and store it there. The tool looks like a chisel and is attached to the plough frame instead of the plough scissors.

Soil cultivation by use of resources	Handshoe	Animal power	Mechanical power
In %	98.8	1,2	0,0

The text below is based on working with a handcuff.

Hard layer

Since the 1930s, small farmers in Malawi have been encouraged to plant crops on ridges rather than, as before, on the field or on mounds. This practice was then widely applied without fertilization. By using the same sand every time, the growing soil became scraw due to lack of fertilizers; partly because remaining plant residues were not composted. In the 50s and 60s of the last century, an increasing reduction in corn yields was observed as a result. The proof of this was the harvests on both unmanured and fertilizer fields. While previously 1,700 kg/ha could be harvested on unmantilized plots with local corn, production had now fallen to an average of less than 1,000 kg/ha. In the 80s, yields in the densely populated southern region did not exceed 600- 800 kg/ha. In order to combat an increasingly common famine, fertilister was introduced, among other things. A dimple was made on the seedlings, fertilizer was sprinkled and covered with a layer of sand. Corn seeds were then planted and covered. Due to the additional use of fertilizer, the corn yield increased to even 2,000 kg/ha.

As it looks, there are no soil-restoring set-aside practices due to land pressure. In general, crope residues are still not composted so that there is no absorption of organic matter into the soil to improve the structure. As a result, small-scale agriculture in many African countries has now become totally dependent on fertilistion.

From the idea that the drastic lower yields were the result of soil erosion, Farming God's Way had meanwhile become decisive as a new farming method in Zimbabwe. The idea was to cover the soil with plant residues to prevent erosion and at the same time to better retain rainwater against leaching. This also included composting and exchange cultivation. Although certainly not general, this form of conservative agriculture also gained support in Malawi. In that new agricultural method, cultivation on ridges was no longer common. The ground was left untouched. For sowing corn, planting holes were cut into the field soil and filled with compost. Then it was sown and the seed covered. Finally, the arable land was covered with plant residues that were supplied from elsewhere. With this method, the same results were achieved as with the use of fertilizer, but due to lack of insight, knowledge and the extra work due to the supply of plant residues, that method has not been consistently applied anywhere in Malawi. The comparison may be reason to accept that the limits for achieving additional revenues have been approached. The cause must be found in the unfavourable climatic conditions in the southern part of Malawi in particular. Also because of the large population density in relation to the available arable land, which does not allow wasteland. The low agricultural yields certainly cannot be solved by the use of manipulated corn seeds and more fertilizer.

The existing reduced soil productivity has multiple causes, of which maintaining the traditional farming method is seen as the main cause by sowing on ridges without the addition of manure or compost. Under the sandy surface there is a hard crust. It is assumed that it was created by the repeated scraping of the shrop blade over the ground surface causing the macropores to sleep after rainfall. As a result, the rainwater can hardly seep through to the underlayer and most of the rainwater immediately flushes away after a heavy tropical downpour, which leads even more to erosion and soil erosion due to leaching. The water that remains on land evaporates.

The evidence of the reduced yields, as described above, may be that by sowing corn on plant ridges, the roots of the corn plant can develop with difficulty due to the underlying hard layer. As a result, the network of roots remains small and is not able to absorb enough water that is necessary for plant growth. Simultaneously, the nutrients absorbed in water remain unreachable for the plant. A second evidence may be that pinroots from plants other than corn, when reaching the hard layer below the surface, defend horizontally instead of them growing down vertically. The heavy root system of corn grows in porous sublayers sometimes up to 1 meter deep with the result that the root system usually benefits from a rain shower for 10-15 days because the roots remain moist. The growth-inhiting dehydration due to the traditional agricultural method used therefore causes faster exhaustion of the plant due to lack of water and fertilizers. So it is also necessary to look at what is happening under the ground surface, especially the soil porosity.

Root rig of a corn plant in a hard sandy layer

Root sting of a corn plant at a permeable soil

See the size of the root system, the firmness and color of the stem

In order to increase crop yield, it is in any case necessary to improve the root conditions by breaking the hard layer so that the roots can look for both moisture and nutrients. If that happens, macropores in the soil reconnect due to the formation of the soil and the soil density becomes more porous. That will improve rainwater infiltration, is reduce expectation and soil erosion. Breaking the hard layer or layers can be mechanical on the understanding that milling should be discouraged.

Technically, the most effective way to use a deep-woeler is during the dry period. The effect will be noticeable at least 3 seasons, depending on the soil type and the method of tillage. In addition to more volume for the root system, not previously reachable fertilizers will be pulled up and used. In the long run, agricultural lime is recommended to make bound fertilizers for the plant absorbable in water again. However, given the small area of the fields, a commercial processing by a deep-wowler or by ploughing within the small-scale agricultural sector in Malawi is not real. Instead, a single-axle agricultural tractor with a cultivator with extended fixed teeth can be used collectively or as contract work. Manually converting the hard layer to twice the normal cultivation depth is only possible if the labor is spread over several years. Simultaneously, plant residues or compost can be added as fertilizer that is useful for retaining moisture.

Due to the lack of a water drainage system, the existence of the hard layer after a heavy rain shower also has a destructive effect. In a swelling stream, the excess rainwater over that hard layer will find its way and destroy the existing infrastructure and personal belongings in its course. Simultaneously, corn seeds and fertilizer are lost in the fields. In the event that corn plants have stuck, the root system is exposed and is then no longer suitable for absorbing water. The existence of the hard layer therefore not only causes growth damage to crops, but also regularly material and emotional damage.

If the hard layer is broken, excess rainwater will seep along the breaks into the substrate and serve as a water reservoir for several weeks. Unlike drought, the corn plant will not be damaged by this. Preventing regional flooding only makes sense if, in consultation with a hydraulic engineer, the hard layer is broken at critical points and ponds and bedding are laid.

Fertilization

For the growing of agricultural and horticultural products, it is necessary to fortil the arable land in the right quantities. The expectation for a good harvest is always based on knowledge of the nutrients present in the soil and the knowledge and experience of the farmer. His efforts to add manure and crop residues in the soil is an investment in the future and on returns.

Usually it is not possible to express expectations about this. So the purpose of this article is not intended to maximize production. It is a pointer as a general recommendation to harvest cost-effectively within the reach of small farmers in Malawi if possible.

The recommendations are intended for the cultivation of improved corn varieties. It is less likely that this article is a cost-effective recommendation on traditional varieties. The feasible yields in corn, when good seed and fertilizer are used and agronomic practice is followed, is:

-yield according to the traditional system: 0.5->1.2 tons per hectare

-yield when applying better agricultural practices: 1.5-> tons per hectare

Nutrient deficiencies

Plants need nutrients to grow well. The absolute minimum of fertilizer is 200 kg/ha per year. If there is a nutrient deficiency, symptoms can be observed on plant parts during growth and at harvest.

It is not always possible to address deficiencies during the growing season in which those symptoms are observed, but measures can be taken in the preparation of the next crop to prevent these symptoms from recurring.

In this context, it goes too far to go into the observations as a result of the nutrient deficiencies and to describe them. The best way are observations in practice about discoloration, deaths, deformations, etc. to explain the deficiency of certain nutrients. A common example is the lack of nitrogen that is only noticeable at the end of growth, then it concerns light green leaves and yellow discoloration in a 'V'- pattern over the entire leaf length. This starts with the lower leaves. As a result, the harvest consists of small, deformed flasks that are not fully filled. Nitrogen deficiencies are common.

Causes of reduced yield

A number of factors are the cause of the current low corn yields in small-scale agriculture in Malawi.

The low nutrient levels in the arable lands are usually the result of previous cultivation practices that have severely depoverished them in nutrients, especially nitrogen, and depending on the location, phosphorus, magnesium, zinc and sulfur. Due to the lack of financial resources at the household level and the high price of fertilizers, there was insufficient supplementation of the nutrients previously withdrawn for years.

Due to a lack of agricultural land, the former soil remediation set-aside practices are no longer applied. There was also no absorption of organic matter to improve the structure of the upper layer and nutrient status. Crop residues are still burned, leaving the cultivation layer scank and erosion-sensitive and making it difficult to retain moisture and fertilizers. During the growth of the corn plant, there is then a greater chance that moisture stress will arise with irregular rainfall and a favorable biotope will form for the parasitic weed Striga in corn fields that causes a lot of damage.

One of the most important strategies advocated to counter declining soil productivity is

-promoting the use of hybrid corn and fertilizer, noting that these are artifices with a temporary effect.

-breaking the hard layer that exists everywhere to give the root system of the corn plant under the skew layer the opportunity to look for moisture and fertilizers in deeper layers.

-the inleting of plant residues.

Poor attendance, irregular growth and premature death due to fertilizer shortages

Fertilizer

When using fertiliser, the yield initially increases sharply the more fertilistis is added, but as the amount of fertilism increases abundantly, the expected additional yield decreases. Ultimately, adding more fertilizer will have no further influence. However, seedlings will die. In summary, it can be said that the return on investment in fertilises does not increase if more fertilise is used. Usually nitrogen (N) is the main nutrient for growth, followed by phosphorus (P) for fruiting and potassium (K) for plant construction and juice flow.

Fertilizer makes the soil more acidid and affects the growth of corn. If that is the case, adapted fertiliser should be used. This is also possible by spreading agricultural lime to a large extent after harvest or by processing it in compost. [Do not apply prior to cultivating the field because agricultural lime inhibits growth]. Agricultural lime has the additional effect that bound nutrients become absorbable in water in the long run.

Actual yields will vary depending on variables, including:

-characteristics of the soil type. For example, it may contain other nutrients in addition to nitrogen (N) and phosphorus (P)

-whether or not the soil reacts to fertiliser

-the weather, especially rainfall

-sowing varieties used

-apt alternate cultivation

-pests and diseases

-management practices, such as plant density and arrangement, weeding, fertilization on time, absorption of organic matter into the soil

-quality when using mineral manure

Land type

The composition of soil types varies. Some respond well to the application of mineral manure. In some cases, the yield even increases the more fertilistis are used. Other soil types do not respond: the yield does not increase or hardly increases with fertilization. There are two types of non-responsive soils:

-fertile soils that already contain a lot of nutrients

-soils that limit plant growth due to chemical causes (e.g. soil acidity), physical (e.g. hard soil), biological limitations (e.g. presence of weeds) or a combination of these.

Affected soils are often caused by human activities, such as overfertilization and monoculture. On the other hand, because the affected arable land usually contains few nutrients, they often need large amounts of organic matter for a number of years before responding to the application of mineral fertilizers. Deep soil cultivation can improve the process faster.

Basic fertilization

Basic fertilization is applied when the plot is prepared before sowing. It must provide nutrients that the crop needs early in the growth cycle. About one third of the recommended amount of nitrogen (N) of the fertilizer can be used in sowing corn. The main nutrient that corn needs during the growth cycle is nitrogen (N). For flowering and fruiting, phosphorus (P) is the most important fertilizer.

In the conventional agricultural method, a set-up fertilizer is placed as a basic fertilizer on the bottom of the planting hole and covered with a little soil. The seed is then planted at the right depth on top. The seed and the fertilizer should not touch each other, as this can damage the seed. The hole is then covered with more earth.

Top dressing

Top dressing is the administration of fertilish after the crop has started to grow. It provides nutrients needed throughout the crop's growth cycle, as well as nutrients that, if previously applied, would easily be lost from the ground before the plant could absorb them. About two-thirds of the recommended amount of N-fertilist and the whole of P-fertilist can be used as a top dressing.

Before applying the top dressing, or at the same time, the plot must be weeded so that the fertilizer benefits the corn and not the weeds. The top dressing fertilizer should be applied if the corn is knee-high (45-60 cm high). In areas with a lot of rain (more than 1000 mm during the growth period) and also where the soil is sandy, it is necessary to repeat this after 3 weeks and after 6 weeks.

Top dressing should be done when the soil is moist. Fertilizer can be applied in a circle around any plant or along the row; in both cases, the fertilizer should be applied about 10 to 15 cm from the base of the plants. The fertilizer should not touch the plants. After spreading the fertilizer, the fertilizer should be covered with soil, for example by sting.

Top dressing with fertiliser can be replaced by using slurry diluted with water or chicken droppings dissolved in water. It is not necessary to keep a wide distance from the corn stalk when admitted. Regular administration will significantly promote growth.

Organic manure

As it stands, the existing land pressure does not cause soil-reseding set-aside practices. Crop residues are often not composted so that there is no absorption of organic matter into the soil to improve the structure.

Animal and human manure are an important resource for improving corn yield. Manure along with mineral fertilizers gives better yields than just manure or only fertilizer. In addition to N and P, manure also contains other nutrients such as potassium, calcium and magnesium. The use of organic manure and wood ash prevents a potassium deficiency. Manure not only contributes to better soil fertility, but also improves soil structure, soil aeration, bottom water infiltration rate and soil water holding capacity. In addition, manure is important to reduce the acidity of the soil. These properties make manure an important resource in the yield of corn, especially on sandy soils.

Unlike mineral fertilizers where nutrients are immediately available for plant absorption, not all nutrients in manure are immediately available after administration. These will sometimes become available in manure after years as the manure disintegrates and then releases its nutrients. The availability of nutrients will even increase while the soil will also become looser due to humus.

Compost

Most fields in Malawi have a shortage of nutrients due to exhaustion that are not automatically replenished. According to a World Bank estimate, only a very small proportion of all organic plant nutrients (manure, compost and plant residues) return to the fields. Supplements of organic residues from the fields or from elsewhere can therefore contribute significantly to soil fertility as compost, including grain residues, residues of legumes, grasses, leaves and manure. Instead of 60 gr. DAP-fertile per planting hole, about 200-400 g of compost per planting hole is needed to meet the demand for nitrogen.

Everything that grows eventually is lost. Composting accelerates the process of deweling by providing an ideal environment for bacteria, fungi and other decomposing organisms such as worms, sows and nematodes to do their job. The accelerated degradation of the organic substances is achieved by combining carbon, nitrogen, oxygen and water in the right condition. Compost is rich in nutrients and is a good substitute for fertiliser. Compost often looks like fertile garden soil and is also a natural pesticide against diseases and pests in the soil.

The four ingredients for compost

-Brown: (carbon): Material with a high carbon content is usually dead and dry and brown in color. These are leaves, branches and twigs, corn remains, straw, hay, cardboard, wood ash, landouwkalk, etc. Heat is generated when the microbes break down the carbon.

-Green: (nitrogen): Nitrogen is needed to develop microorganisms to break down the carbon. These materials are usually moist and colorful such as vegetables, grasses, fruit waste and animal and human manure. In principle, everything can be used in large quantities. Preferably no seed-containing weeds.

-Air: (oxygen): The microbes need oxygen, otherwise they will die and that slows down the process. Oxygen can be added by using thick branches as a layer or converting the compost heap regularly.

-Water: Compost needs between 40% and 60% of water to effectively break down. If water drips out of the compost when squeezed out, it is too wet. Too much water ensures that it does not break down, because the water fills the spaces where air should be.

Do not add:

-Dairy products, meat products and fats should be avoided because they give off a bad smell and attract rodents and flies.

-Sick plants or insect-affected plant residues to prevent diseases from ending up on the arable land again.

-Weeds or plants sprayed with herbicide or pesticide can damage the beneficial microorganisms in compost.

-Stunny weeds with ripening seed.

(Note: build up compost heap in layers with available material

Benefits of composting

-Compost contains many nutrients that enrich the arable land and increase fertility. Compost can replace fertiliser. An are corn country requires 1m3 of compost.

- Mixing a small amount of fertilizer in compost will lead to a relatively higher yield

-It helps reduce plant diseases and ward off pests.

-Compost retains moisture and helps reduce water drainage.

-Saves money because no fertiliser is needed.

How to start composting?

-Choose a flat, clean area to start a compost heap. Defining by a 1.5x1.5m pit and high sticks on the corners.

-Making a compost heap is not tied to materials. The composition determines the nutritional value. Start by laying down some thicker branches to ensure the oxygen supply. The materials are then stacked together in layers without a sequence up to a maximum of 20 cm thick**.** It is recommended to make a starter on the bottom with some buckets of old compost so that the process will get off to a start faster or by mixing 1 part green and 3 parts brown.

-Make sure there is enough brown (carbon) and green (nitrogen) to make a stack 1 meter high. There is aversion to adding human and animal manure. The use as an intermediate layer is very important because of the variety, the added value of fertilizers and the build-up of the compost heap.

-If the mixture is too humid and stinks, you can add more carbon, increase the airflow and lower the moisture content. Too much water kills the microorganisms and causes your compost to rot instead of perishing. If it's too dry, you can mix some nitrogen (green) and water

-The ideal temperature during composting is between 55 and 60 degrees. That can be measured approximately by a stick in the compost heap. At too high a temperature, above 70o C, the useful microbes in the compost are killed.

-By regularly adding slurry, the fertilizer content will additionally increase.

-Reginting the compost heap regularly is important to allow oxygen again for the composting process.

When is compost ready for use

Composting usually takes 6 to 16 weeks from start to finish.

The process of composting is ready to use:

-When the temperature of your compost drops and it no longer emits heat

-The residues take on a brownish color and are crumbly between your fingers

-The residues feel dry

Application and use

Compost can be used in both conventional and conservative farming methods. In conventional, traditional agriculture, 200-400 gr of compost can be scooped into a planting hole on the plantar back in which the corn seed is pressed and covered with 2-5 cm of sand. In the conservation method, a planting hole is cut down in the untouched arable land, composted and sown in the same way as described in the conventional method. At the same time, weeds are then cut away.

Applying fertilization	Compost	Fertilizer	No fertilizers	Pesticides	Irrigation
In %	21,3	49.7	42.6	5.0	0.8

Sowing

Prior to the sowing period, a cultivation plan must be made and the seed chosen. Depending on the soil cultivation chosen, a sowing plan will then be made.

Maize varieties

Corn is usually grouped according to the approach used to develop varieties and also according to the length of the growth/maturity period.

Corn varieties can also be grouped based on the time it takes to mature after planting. For example, some varieties ripen in about 3 months, while others need 6 months or more. A breed is more likely to mature at lower altitudes where it is warmer than in higher, cooler places.

Different corn plants with different characteristics can cross and produce seeds. These corn species are called 'open pollinated' varieties (OPVs). Traditional corn varieties fall under this category. These corn varieties typically have a modest yield and after successive generations the yield becomes poor.

Sometimes seed of different OPV genotypes are grown together and encouraged to cross to form a 'composite' variety, This seed is normally promoted as 'improved OPV'.

For OPVs, farmers can use seed from the previous harvest 2-3 seasons, after which they have to purchase new seed.

If farmers have a plan to preserve seed from the current harvest, only the desired seed should be harvested. Seed of affected plants should not be used. To ensure a high germination rate, only seed from healthy plants should be stored and threshing should be done carefully to prevent damage. Before the seed is stored, the seed must be selected for damage and contamination. The seed should be stored separately in a dry, well-ventilated space.

Hybrid corn seed

People have been improving the quality of local crops for thousands of years, but by developing biotechnological seed, development time is significantly shortened.

Genetic manipulation refers to a selection of desired genes transferred to the genes of another organism for specific properties, changing the genetic composition of the second species. For crops, this is usually intended to develop a desired characteristic, such as increased yield, insect tolerance, drought resistance and resistance to climate change. In Western countries and Asia, but also in South-Africa, the so-called hybrids are sown as standard. Hybrids have better yields than the OPVs, especially when grown under favorable conditions. Grain from a crop grown from hybrid seed cannot be used as a seed, as the yield of such a seed would be much less than that of the first harvest.

In Malawi, the use of genetically modified crops including corn is allowed, but not generally, partly because of the high price. Its use is explained in Malawi that it is less tasteful. The local seed material therefore remains common and affects the crop yield.

Germin test

Seed of so-called local corn planted by many small farmers deteriorates qualitatively every year. In addition, recent droughts have led to the loss of many traditional varieties, because either the harvests failed altogether, or because future seed was consumed instead of being preserved for the next season. Subsequently, the farmers lacked financial resources to buy replacement seed from certified improved varieties and planted everything they could get on the spot. Corn kernels sold on the local market are usually a mixture of local, compound and recycled hybrid varieties. Once such a mixture is planted, it produces a very variable corn position.

Prior to sowing, a germination test is a guide for how many seeds need to be sown to get the desired plant population. The test gives an idea of how many seedlings you can expect from a certain number of seeds.

The test can be done 10 days or more before planting. On a seedbed, about 50 or 100 seeds can be sown and kept moist. The number of normal seedlings appearing in about 5-7 days must be counted and the germination power calculated in %. The test can also be done at home between damp newspapers. The root and shoot parts of the seedlings' germs should not be deformed and should look healthy.

If the germination power is more than 95%, the number of seeds sown may be the same as the desired plant population, as most planted seeds will hatch. But if the germination power is 80%, on average only 4 out of 5 planted seeds will hatch - so to get the desired plant population, the number of planted seeds must be increased by 25%. If the germination rate is 50%, this means that only one of the 2 planted specimens will come out on average. In such a case, it is advisable to double the amount of sowing.

Sowing corn

Corn should be sown in moist but not swampy soil, when the soil moistus has reached a depth of at least 30 cm. This usually happens shortly after the start of the rain. Defering planting once the rains have started can significantly reduce yields.

Also during the sowing of corn, care must be taken to make sure that the corn seeds are plump and undamaged. Do not use shrot or damaged seed.

Sowing method

<u>With the conventional farming method:</u>

The method of sowing depends on the farming method. If chosen for the conventional method, the backs are made by scraping the upper sand layer together. If fertilizer is used, dimples are made on the plant backs, a sized amount of fertilizer is sprinkled [60 grams DAP (N 30, P 10)] and covered with a layer of sand. Corn seeds are planted and covered. The sowing distance is 75 cm between rows, 50 cm in the row and 2 plants per planting hole. This gives a plant population of about 53,333 plants per hectare.

In drier areas, with less than 500mm of rainfall during the growing season, the distance between rows and plants should be increased, which will lead to a lower plant population by increasing the sowing distance inside and between the rows to 1 m to reduce competition for soil moide. An early ripe variety of corn seed can also be chosen.

<u>With the conservative agricultural method:</u>

If the preservative farming method has been chosen, planting holes are cut down in the untouched arable land and filled with compost (or with fertilistis, as described above). Finally, the arable land is covered with a layer of plant residues that is supplied from elsewhere. The intention is to better retain the rainwater, keep the top layer moist and reduce soil erosion.

On sandy soils with sufficient rain, a planting depth of 2-3 cm is recommended; on dry sandy soils, a planting depth of 5-10 cm is desired to create a deeper root system. For corn, the aim is 2 corn plants per planting hole.

To achieve a plant density of 53,333 plants per hectare, between 20-25 kg of cornseed per hectare is needed, assuming a germination force above 95%. If the germ test is lower, more seed is needed. For example, with 50% germination, the number of seeds per planting station must be doubled.

Use of seed to toepssing	Local corn seed	Hybrid corn seed	OPV	Overterning corn seed
In %	53.2	37.0	1,3	8,5

By gender of the head of the family, 63% of plots built by households with a female head, were planted with local corn seed, compared to 49% of households with a male head

Intermediates

Intermediate crops of corn with legumes together, has a beneficial effect on the cultivation and yield of both crops. The application depends on the priority that farmers give to corn or legumes and also on the relative value. It is important to make a considered choice about the growth of the legume that will be grown and how long it will take before it can be harvested. Is the growth mode upright, scattered or climbing? When choosing legumes as an intermediate crop, the soil and climatic conditions must also be taken into account.

There are advantages and disadvantages of growing corn along with legumes. Benefits include improved soil fertility, increased resource use, better soil cover, reduced risk, improved household nutrition, improved availability of manure and reduced influence of pests and diseases. Disadvantages include the increased level of difficulty in carrying out some agricultural activities and possible decreases in yields if sown too close.

Weed control

Weeds compete with crops for nutrients, water and light and can host pests and diseases that can affect crops. Weed seeds can infect the corn seed during harvest. Especially in the tropics it is therefore very important to regularly and consistently remove the emerging weeds by weeding.

In conventional tillage systems, weeds are destroyed by digging them in while ploughing. When working the soil with the handcuff, a back is made of sand while the weeds are scraped away at the same time. The disadvantage of the conservative agriculture is that much more effort is needed to combat weeds during the growing season. A solution to this problem is the use of herbicides, such as glyphosate after sowing.

Like early planting, early weeding is also necessary for a good harvest. The challenge that farmers face is that it often rains persistently during the period that it has to be weeded.

More ground will have to be weeded on fields with monoculture, because more ground area has been exposed. If crops cover the ground surface, weeds are smothered or less likely to grow.

When to weed?

Weeding depends on the presence of weeds and the amount of weeds. The most critical phase of weed competition in the life of a corn plant is during the first 6 to 8 weeks after emergence. Weeds that arise when the crop is young cause more damage than with emerging weeds if the crop is older. In other words, the benefits of removing weeds that arise when the crop is near fully mature are less than the benefits of weeding when the crop is young. Also, the weed density decreases as the crop grows, as the growing canopy darkens short weeds, discouraging their growth.

The first weeding should be 2-3 weeks after the corn is risen and the second weeding 2-4 weeks after the first weeding. In areas with a lot of rain, a third weeding may be needed, 3 weeks after the second weeding.

-Weeding should preferably be done in the morning when the soil is moist to prevent loss of soil moisture.

-Weeding with tools, hand tools, migratory animals or tractors should not be carried out during dry periods. In such cases, manual weeding or the use of herbicides is better, because soil disruption is reduced or avoided, resulting in less water loss from the soil.

-Root weeds before they bloom and seed.

-If there is a lot of soil attached to the roots after uprooting, shake the soil of the roots of the weeds and remove the uprooted weeds from the land.

-Ideally, fields should be free of weeds at the time of fertilization. If weeds are present at the time of fertilization, fertilization and weeding can be done at the same time.

The numbers and times of weeding proposed above are guidelines and not strict recommendations.

How to weed?

When using the handcuff, damage to the roots of crops can be reduced by chopping to a depth of less than 5 cm. Digging deeper is only allowed if necessary, for example to remove weeds with rhizomes that go deep into the ground.

If the weeds are high and small, weeds can be drawn by hand. Don't leave weeds with rooted ripe weed seeds on the arable land.

Striga

Striga gesnerioides, is a stubborn parasitic weed. Fighting Striga that affects corn requires an integrated approach that benefits from the fact that Striga is less of a problem on fertile soils. Control can:

-If available, Striga-tolerant corn varieties should be planted.

-Remove Striga by stripping and weeding weeds before they bloom and sow out.

-Spry with herbicide.

-Rotation and intermediate cultivation with legumes (e.g. soybeans, cowpea, groundnut).

-Adminsting nitrogen-rich manure (such as urea) or admenting manure or growing nitrogen-binding legumes.

Herbicides

The decision to manually weed or apply herbicides should be based on what is most cost-effective. There are more options for using herbicides in monocultures. This is because herbicides used in corn are usually targeted at broad-leaf plants, including legumes, while those in legumes are aimed at grassy weeds and will also kill corn.

Time/Application: Herbicide* chemical name:

Pre-surce** alachloor, metalochloro

alachloor and atrazin

Pre- and early post-upsite*** atrazine

Post-onsit glyphosate

** The herbicides listed here are the active ingredient (chemical name). In the agrodealer's store, products based on these chemicals will be sold under different trade names in different formulations, made by different manufacturers. The instructions on the herbicide packaging should be followed carefully to prevent damage to crops and possible damage to human health or the environment.*

***Pre-emergent herbicides, which control weeds in the germination phase, can be applied to the ground immediately after planting, before weeds and crops appear.*

****Post-emergent herbicides, which fight young growing weeds, can be applied as soon as crops and weeds rise*

Especially in conservation agriculture, it may be necessary to control the weeds with suitable herbicides when sowing the fields. In that case, equipment, herbicides and nozzles must be available, affordable and applicable. In addition, knowledge and experience are necessary when using it in order to use it in a safe and effective way.

At a later stage, if the corn plant has been developed and the corn cobs mature, the weeds can also be removed later. This remains necessary to reduce diseases and pests during the next season.

Plagues

Crops can be affected by insects during the growth period. Pests can also affect the grain after harvesting.

Regular field visits are required to search for insects in order to combat them in an effective, environmentally friendly and economically responsible manner if possible.

Early detection is important before the pest spreads, so control is only needed over small areas to save on treatment costs and to reduce impact. Attacks can be prevented by using breeds that are resistant or tolerant to pests.

Insect plays

Insects can damage plants and their yields by disrupting the movement of nutrients in plants, among other things. Corn can be attacked by cutting worms and caterpillars of moths that hide in the ground during the day and feed at night. Cutting worms fall seedlings under or on the ground surface and can kill seedlings. The plants can wither if partially bitten through. In older plants, the insects feed on leaves. Combating the presence is possible by plowing the crop residues or turning the soil to expose the larvae to the sun and birds or to fight with weeds.

If affected plants are replaced, damaged plants must be removed. If there is a cutting worm in the planting hole, it must be killed before a seed is placed in the planting hole. Even if the attack is local, the pests can be fought by digging it out of the ground and killing it. Digging should be up to 5 cm deep.

Good pest control in corn-legume systems includes:

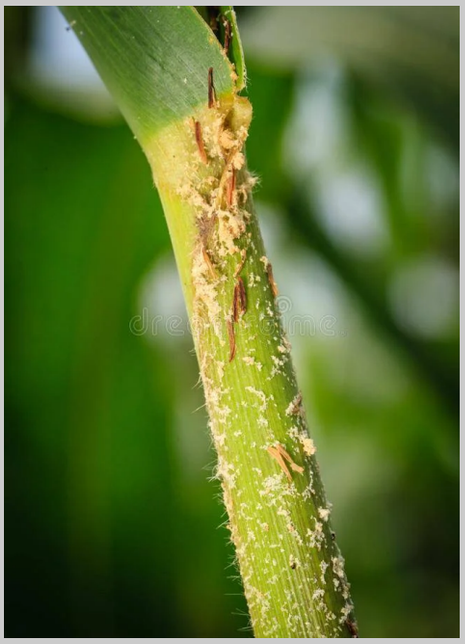
-Pulumes rotate with corn or other crops to reduce infestation by insect infestations and diseases from the previous season in the field.

-Early planting at the beginning of rain, when the soil is moist, so that the crop matures early and escapes an attack by pests, is strong enough to withstand pests and the crop does not have to compete with weeds.

-Crops that are well supplied with nutrients, disease-free, strong and healthy, are more resistant to pest pressure.

-Remove plants that look infected if the pest has not spread. Also advanced planting of grain from an earlier harvest to reduce spread. If the infection seems serious, consider fighting the pest with chemicals.

-Keep fields weed-free. Some weeds can act as alternative hosts for some pests and can also house insects that transmit diseases from plant to plant.



Stem boorder

Insects

Apart from cutting worms, other insects can also influence corn growth, such as the stem-breeders, chaffer larvae, termites, corn beetle and other larger grain-beavers.

Stammboors eat leaves and make 'windows'. Older larvae tunnel extensively into stems and eat long frass-filled galleries that can weaken stems and cause fractures. The pests survive in crop residues after the corn is harvested. The pests can be controlled by spreading crop residues on the soil surface in the hot sun after harvest, removing crop residues from the field, feeding the livestock or making compost. Sowing into strips of corn and non-herd plants, such as peas or cassava, will reduce the damage, as the stem drill's cycle is broken. Other control measures include early planting and the application of insecticides.

Chaffer larvae feed on young corn plants, causing them to dry out and die off. The pest is controlled by planting early at the start of the rain, applying alternating cultivation and using animal manure that is well digested rather than fresh or partially digested.

Termites damage above-ground biomass causing the plant to fall over. In plants in different growth stages, the inside of the roots and stems can be eaten out and then filled with soil. If the plant falls over, the termites will destroy the whole plant. Termites can be fought by destroying their nests and removing the queen, mixing corn with legumes instead of growing it as the only crop.

The larger grain drill can affect crops by eating holes in the stem and the flask. The army worm is a recent threat to the food supply in Africa. The moth's caterpillars are responsible for the catastrophic destruction of corn fields and corn cobs. Both the corn beetle and the larger grain driller can affect grain during storage. To reduce the damage to the sale, the flasks should be harvested once the crop is ready. The grain should be cleaned, sorted and dried in the sun. In the presence of insects, the grain should be covered with insecticides to kill insects or stored in airtight containers such as plastic bags to prevent the air that insects need to survive from ending up in the container. Storage containers must also be clean and dry.

Diseases

Corn suffers relatively little from diseases. Attention should be paid to the contamination in storage grains, as these diseases are common and affect the yield and quality of the grain.

Diseases can end up in or on the plant in all kinds of ways from the ground or from the air, for example through fungi and spores, but also through remaining plant residues, through other plants and by insects. Also by seeds. It is recommended to use only residual seed from disease-free fields. Certified seed purchased in stores is usually disease-free.

Points of attention

-Applying exchange cultivation with legumes and with other crops to reduce the deterioration and diseases of the previous season in the field.

-Early planting, at the beginning of the rainy period, when the soil is moist, so that the crop ripens early and is strong enough to resist diseases.

-Crops that are well supplied with nutrients are more resistant to diseases

-Remove plants that look infected from the arable land. If the infection seems serious, consider combating it with chemicals.

-Keep fields weed-free. Some weeds can act as alternative hosts for some diseases and can also house insects that transmit diseases from plant to plant.

Harvesting

The visible sign of the maturing corn plant is senescence, the dying of leaves, starting at the lower leaves and continuing upwards. The crop is fully grown when the plant has turned light brown and the grain is hard; some flasks will hang down. The maturity of the flask can also be tested by checking for the black layer that forms at the base of grains (where they connect to the flask). The layer can be seen by removing granules from the flask and scraping the base with your fingernail.

Harvesting is done by removing flasks from plants. It is important not to store unpeeled corn. Corn should be immediately peeled and dried to the recommended moisture content and then thrushed on a clean surface. When threshing corn, the grains are sorted and shaff and empty flasks are removed to be returned to land, used as animal feed or processed in compost. The grains are further dried for storage. Storing grain before it is dry can lead to loss of quality due to depletion by storage pests, fungi and diseases.

Tips to check if corn kernels are dry enough for storage

Based on experience, it is possible to determine whether grain is dry enough for storage, for example by the way it looks and by the feeling when a hand is immersed in a pile of grain. You can also see if grain is dry enough by performing simple tests. As an example: Take a few grains and teat it. When the grains burst, the corn is dry enough for storage.

You can also pour grain into a dry bottle until it is full for two-thirds. Then add 3 tablespoons of dry salt. Shake for a minute, then let the bottle rest for 15 minutes and shake again. If salt sticks to the sides of the bottle, the moisture content is higher than 14-15% and the grain must be further dried. If the salt does not stick to the sides of the bottle, the grain is dry enough to store.

Check that the salt is dry enough for use in the test by putting salt in an empty bottle and shaking. Dry salt does not stick to the sides of the bottle.

Residue management

-Feed the leftovers after harvest to the cattle or compost.

-As animal feed, those residues have little nutritional value

-Composting the remains has value as humus

-Keep the crop residues in the field because leaving them has advantages, including:

=Retension of soil foid.

=Mulch layer helps reduce soil erosion on rolling land.

=Weed control and less need for weed control.

=Stitlement of organic matter in the soil.

Storage of corn

Storage losses

Most yield losses in Africa, including Malawi, are harvest and storage losses. In most cases, the infection already starts in the field when the crop ripens or dries. After the harvest, storage loss occurs. Not so much as a result of dehydration, but by eating the grains by insects into mule.

Aflatoxin

Aflatoxin is a dangerous green-yellow fungus. Corn becomes infected with aflatoxins due to the presence of these and other fungi in the field and during storage. Aflatoxins are invisible, but they cause serious diseases in which people and cattle that eat contaminated grain die. Even if the fungus is not visible, corn can still be infected. The risk of infection in the field is greater if corn plants are under stress, for example due to drought and nutrient deficiencies. The infection is greater if the corn grain is harvested under wet conditions, stored wet or wet during storage. Infected flasks can start to rot and leaves covering the flask can stick to the flask. Infected grain can have a smell, a slimy surface and a moldy appearance, for example green, red or black, or have white stripes.

To prevent contamination, good agronomic practices are essential:

-sow in time to make maximum use of rainwater during growth. Possibly irrigate

-harvesting during the dry season,

-application of fertiliser

-fighting insect pests

-effective and timely weeding.

Save

Significant amounts of the food produced in developing countries are lost after harvest, for example, by storing the flasks with skin in their own silos where the pests have free rein. Infited corn is also brought into the store, after which storage loss occurs. A loss assessment survey conducted by the Ministry of Agriculture and Food Security in Malawi during the 2000/2001 season showed that from 1994 the loss in stored grain had increased from five percent to sixteen percent. Food losses are partly the reason for higher food prices because part of the harvest must always be written off.

There are two options to prevent storage loss, including the use of pesticides. In that case, it is essential to adhere to strict storage hygiene by ensuring that the infection is not transmitted. Storage facilities, including bags, must be handled before the harvested grain is stored. When adding the pesticides to the bags, the moisture content of the grain must be taken into account because the effect of the pesticides in humid conditions is already partially lost in a short time.

A second possibility to store corn, but also other grain and beans is in the *Purdue Improved Crop Storage* (PICS) bag that has proven to be an effective alternative to chemical pesticides. This consists of two bags of high density polyethylene (HDPE) of 80 microns and an outer bag consisting of woven polypropylene (PP) of 80 microns for use and protection during storage and transport. Together they create an oxygen-poor environment that reduces the development of insects by pressing away the air still present and separately tying the three bags. A whopping 98% of all insects will be eliminated within 1 month of storage, resulting in significantly less damage and weight loss. It is recommended to use 25 kg bags for this with a wide possibility to tie them tightly.

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