

Improved Agricultural Practices – Imperative for Sustainable Food Security in Changing Environment

¹*Osang Philip Ofre, ²Ukam Victor Efut

^{1,2}Academic Doctor/ Lecturer, Department of Agricultural Education, School of Vocational and Technical Education, Cross River State College of Education, Akamkpa-Nigeria

*Corresponding Author's E-mail: philiposang@yahoo.com

Abstract - Food is an indispensable and an important factor in nation's quest for economic growth and development. In Nigeria, most of the food need is produced by the peasant farmers who clinged to their traditional farm practices. Most of our farming lands are depleted of their fertility and cannot produce as much as they did years ago. Changes in climatic patterns have fundamentally affected agricultural production; farmers are experiencing the effect of climate change as in some parts, rains are coming earlier than before while in others, rains are coming later. Therefore, to combat this low in soil fertility and climate change effect on food production, farmers have to embrace strategies for improved yields especially location specific of sustainable agricultural intensification such as Good Agronomic Practices (GAP). GAP is practice that involved environmental, economical and social sustainability for agricultural processes and results in high quality food products. GAP involves selection of appropriate site, preparation of land on time and to the right standard, managing water resources, selection of suitable planting materials, sowing at the require time and depth, maintenance of soil fertility and application of fertilizer at the require rate and time, weeding at the require time and maintenance of quality to meet market value. Researchers have shown that GAP increase yield and market value tremendously. Therefore, it is important to sensitize farmers and create awareness on the benefits associated with improved agricultural practices so as to ensure sustainable food security.

Keywords: Good Agronomic Practices, Sustainable food security, Climate change, Global warming.

1. Introduction

Food security refers to the availability of food and one's access to it. A household is considered food secure when its occupants do not live in hunger or fear of starvation [10]. Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life [16].

In the past years, shifting cultivation which has graduated into "rotational – bush – fallow" was an efficient farming which was productive and capable of meeting the food requirement of the country's population. This was because the population was relatively low while the available land resources were very high, therefore, there was no problem in allowing cultivated land to lay fallow as many as 5 – 10 years. Currently however, the system has broken down due to population pressure on available land resources. This means that there has been increase of intensity of cultivation with a consequent rapid decline in the fertility of the land and decline in yield of food crops. Drastic reduction of the fallow period also brings about gradual soil degradation.

The production potential of a particular crop depends on the environment and the skills of the farmers in identifying and eliminating those factors that reduce the production potential. Global warming poses a potential threat to agricultural production and productivity throughout the world and this might affect the crop yields, incidence of weeds, pests and plant diseases and the economic costs of agricultural production [31].

Climate change and agriculture are interrelated processes, both of which take place on global scale. Global warming is projected to have significant impact on conditions affecting agriculture such as temperature, carbon iv oxide, rainfall, humidity and the interaction of these elements. These conditions determine the carrying capacity of the biosphere to produce enough food for the human population. The overall effect of climate change on agriculture will depend on the balance of these effects [21]. There has been an active debate whether climate change or global warming will result in a net gain or net loss in agricultural production. Global warming of a few degrees may increase agricultural production, scientists estimated that warming of up to about 3oC (5.4oF) could increase global agricultural potential, but further warming is likely to decrease this potential [20]. The consequences of global warming according to [34], are rise in sea levels and inundation of coastal areas, higher incidence of tropical storms and change in agricultural production as a result of change in precipitation and other climate elements.

Many studies considered the impact of future climates on food production, the effect of these climate changes remain unclear [24]. It is likely that warming has improved yields in some areas, reduced them in others and had negligible impacts still in others. But it is the dry tropical regions, already fragile due to population pressure that is expected to bear the brunt of climate change. These regions are experiencing shorter growing seasons with rising temperatures. There are changes in the length of the raining season and rainfall intensity, these factors of cause will have a direct impact on crop production [33].

The impact of these adverse climate changes on agriculture is exacerbated in Africa by the lack of adaptation strategies. The utmost concern should therefore be a better understanding of the potential impact of current and projected changes on Africa agriculture and to identify ways and means to adapt and mitigate its detrimental impact.

Every crop has an established cultural practice that guides its production, which were developed by crop scientists through a series of experimentations. And for the inherent yield potential of that crop to be fully expressed, such management practices must be properly adopted and carried out accordingly. Crop production in Nigeria is faced with many challenges among which are: untimely planting, incorrect plant spacing, wrong method of planting, poor sowing depth, delayed weeding, ineffective pests and diseases control, inappropriate use of fertilizers, untimely harvesting and above all usage of low yielding varieties of seeds. More often than not, such poor crop management practices become reflected in reduced crop growth and yield.

2. Concept of Agronomic Practices

Good Agronomic Practices (GAP), as defined by [11], are a “collection of principles to apply for crop production and postproduction processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability.”

According to [31], GAP can be classified in to three categories i.e. (1) Practices, which are usually applied for agricultural purposes not connected with crop protection, such as fertilization and irrigation. They may or may not have a positive or a negative side-effect on disease incidence (2) Practices that are used solely for disease management, such as sanitation and flooding and (3) Practices, which are used for both agricultural purpose and for disease management such as seedbed preparation, weed management, spacing, crop rotation etc.

3. Agricultural Practices and Sustainable Food Security

Seedbed preparation is considered as one of the factors for increasing the yield per unit area. According to [23] the primary aims of good seedbed preparation are: to control weeds, manage surface trash, provide aeration, shape or level the soil, improve physical conditions of the soil, incorporate fertilizers, break hard pans and allow better water and air infiltration. Seedbed preparation is crucial for the growth of seedlings, plant establishment and the final yield of crops. As such, a great deal of consideration is needed to determine the most suitable conditions for crop growth. An important aspect of this is the physical characteristics of the seedbed such as soil strength, bulk density, water content, aggregate size distribution, water retention, aggregate stability, temperature, oxygen and nutrient availability [9].

Soil compaction generally increase the natural density of soil at a particular The bulk density increase translates into less pore space, less water available to plants, slower water transportation and decreased roots. The roots can penetrate the compacted zone as it seeks out water and nutrients, but the formation of lateral roots can be reduce [30]. Similarly, bulk density increase due to compaction can serve to retard or divert the flow of water, resulting in pond formation or excessive run off depth [25].

Seedbed preparation practice is a very important practice to enhance good yield from crops grown. It is one of the measures used to control crop diseases and pest invasion. The purpose of seedbed preparation is to provide the best soil conditions which will enhance the successful establishment of the plants. It is one of the measures used to control crop diseases & pest invasion. The objective of seedbed preparation is to develop potential plant growth, survival, and uniformity of a crop about to be established (planted). Through proper land preparation, factors that limit crop growth are reduced [2]. Therefore, a farmer should choose to prepare his seedbed on the basis of efficient and effective use of labor available as well as soil conservation and crop yield.

Genetic (breeding) has played important role in improving crop production. There are two major factors that affect crop production: Cultivar/Variety - For high productivity in crop production, there is need for varieties which are high yielding. Old or local varieties are always associated with low yield traits such as small size fruits, low seeds production, low in nutrients (protein, starch etc), takes longer to mature etc. therefore, for high productivity, improved varieties must be used. Seed quality - Seeds are organs that brings about the continuity of life from one year to another. When seeds of poor and inferior quality are planted, crop production is affected negatively by reduction in harvest.

To have high yield, farmers should select seeds to be planted that are superior and high yielding, have good consumer acceptability, genetically pure, high germination percentage and high seedling vigour.

Dates of planting significantly influence the growth, development and yield due to such climate changes that occur during the cropping season [8]. Progressive research activities across cropping zones have shown that there is an "ideal" planting window that exists, with a decline in yield with each additional day as less light and growing degree days are available to the plant [23]; [12]. Efficient identification and utilization of such planting date window in the season is a critical factor for enhanced high yield of crop [17]. It enables crop to explore favorable conditions at critical crop growth stages. This "ideal window" may vary between zones due to environment variation. The biggest challenge therefore is to determine the ideal date for planting.

Early planting helps in early harvesting which helps to avoid possible unfavorable environmental conditions as well as save more labour and time also [28]. Avoiding late planting date or too early planting can avoid environmental stress like solar radiation, unbalanced growth period interval, low temperature that can harm plant growth and reduce grain yield. [7] Found late planting favoured plant exposure to short growth period, more pest and disease infection, drought, cold temperature, less radiation availability.

Delay planting greatly affects the growth, development and productivity of plants. It brings changes in weather parameters such as temperature, solar radiation, humidity during crop season which responsible for changes in morphology, plant physiology and molecular level of plants. Thus planting date is of prime importance for crop production due to its variation in weather. Plant cultivar response differently with different planting dates, therefore, there is optimum planting date recommended for highest yield for any cropping season.

Sowing depth is critical for seed germination both in terms of distance to soil surface, available nutrients and water content. The depth of sowing is dependent upon seed size and availability of soil water content [32]. In general, sowing aims to be deep enough to ensure good coverage and quick emergence but not sufficiently deep to prevent full shoot penetration to the surface. If seeds are sown too shallow this may prevent adequate water uptake; the smaller the seed, the shallower the sowing due to reduced seed reserves [32]. Some seeds are so tiny that you can hardly distinguish them from a grain of sand when you plant, while some are so large that it's easy to pop them in the soil. But seed sowing depth has a key role to play in germination. If you plant seeds too deep, they

may fail to germinate. Alternatively, if you plant them too shallow, you could expose tender roots at germination, or the seeds could even wash away entirely. Planting seeds either too deeply or not deep enough can impact germination and even the health of the seedling. The rule of thumb is to sow seeds at a depth of about two or three times the size of the seed sowing depth is very important to seed germination and has something of an impact on plant growth, as well. Planting seeds either too deep or too shallow can result in a failure to germinate [14].

Crop spacing is about the number of crops planted in a unit area. It is about the distance between one plant and another. Overcrowding of crops may reduce yields and it may also lower quality of the fruits produced because of competition for light and soil nutrients. Plants require nutrients, these nutrients, as we all know, come from the sun, soil and whatever amendments and fertilizers that we add to the soil throughout the season. Plants that have to compete with their neighbors for soil nutrients and sunlight are not going to be as healthy as those that have all of the nutrients that they need and also, their roots will have to compete not only for nutrients and water, but also for space. Too few plants can also be a problem. Plants like maize that require a certain number of neighbors to pollinate really do need those neighbors, so make sure that you don't end up with too few plants. Shade from properly spaced plants can crowd out weeds as they grow and keep the soil moist (without crowding each other), creating a beneficial environment that only works properly if your plants are the right space apart [19].

Spacing your plants appropriately reduces the risk of disease in two ways: contagion and improved immune system. It is easy for disease to spread from one plant to another if the plants are growing on top of one another, so plants growing too closely together are not as healthy as plants with enough space. Overcrowding also reduces air circulation, which helps to spread disease. This makes your plants much more likely to get sick. Planting too close together makes it harder to weed, which ultimately results in more weeds. Harvesting is so much easier when your plants are spaced appropriately. You can access your plant from all sides without worrying about sabotaging its neighbor, and you will be able to more accurately assess your yields. Plants spaced appropriately produce bigger yields. You will actually get more produce with fewer plants, saving you time, effort, and money [27].

Thinning is a farm technique used to remove some plants or parts of plant to allow growth of more plants or fruit. This operation is usually used to reduce competition among plants for requirements for growth, such as light, moisture and nutrients. When seedlings are thinned, there would be a bigger spacing between them which would help to better airflow and reduce the spread of diseases through limited air movement.

Fruit producing plants most especially would have a lower fruit yield when plants have to struggle for access to root space and nutrients, which would lead to reduced or low productivity from farms. Thinning can be done in different ways, although the most common practice is to uproot unwanted part of plant from the soil, leaving the healthy part of the plant. This is better done in the late evening and when the soil is soft or properly watered. Ensure thinning of plants is done before the roots are well formed, as disturbing well formed roots would be detrimental to a plants growth. Thinning ensures growing plants have adequate space - Some vegetables can be grown in small areas if they get enough other resources such as plentiful water and nutrients however there's always a limit. For example, root vegetable harvests will suffer tremendously without optimum space. It ensures plants have proper air circulation -If plants don't have plenty of air circulation they can be prone to pest and disease issues [5].

Thinning also helps ensure healthy plants, when you thin plants you should thin any that show any signs of weakness or disease. You want to keep your best plants for a productive harvest and if you choose to save seed you'll know you're saving from plants that performed the best from the start. Plants that are properly thinned will get adequate water -In some areas you may be able to provide plenty of water to thinly spaced plants however if you experience any droughts it's always better to have a safety buffer. Properly spaced plants will get enough nutrients -Crops if not thinned will have to compete with each other for nutrients they'll be less productive and more prone to disease and pest issues [6].

In many agricultural systems around the world, competition from weeds is one of the major factors reducing crop yield and farmers' income. In developing countries, herbicides are rarely accessible at a reasonable cost; hence farmers often need to rely on alternative methods for weed management. Worldwide limited success in weed control is probably the result of an over-simplification in tackling the problem. Too much emphasis has been given to the development of weed control tactics (especially synthetic herbicides) as the solution for any weed problems, while the importance of integrating different tactics (e.g. preventive, cultural and mechanical) in a cropping system-based weed management strategy has long been neglected. Preventive methods include crop rotation, cover crops (when used as green manures or dead mulches), tillage systems, seed bed preparation, management of crop residues etc. Cultural methods include crop sowing time and spatial arrangement, cover crops, intercropping, and crop fertilization [3].

Weeding of farm land should be done on or before the critical period of weed competition. The critical period of

competition defines how long weeds can compete with crops before affecting yields. Two critical periods are defined. The first involves weeds that emerge at the same time as the crop and compete until a post emergence strategy is applied. These weeds have the greatest potential to affect crop yields. The second critical period involves weeds that emerge after crop emergence. As the interval between crop and weed emergence increases there is less likelihood that the weeds will impact yields. The critical period of weed competition is the shortest time span during the crop growth when weeding results in highest economic return. The critical period of weed competition is also defined as the period between early growth during which weeds can grow without affecting crop yield and the point after which weed growth does not affect the yield. The critical period of weed competition is approximately 1/3rd of the duration of the crop.

Different crops have their different periods of weed competition, for example critical period of weed competition on maize (15 to 45 days after planting DAP), low land rice (15- 45 DAP), upland rice (entire period), soybean (15- 45 DAP), sorghum (15 – 25 DAP), millet (25 – 45 DAP). Cotton (15 – 60 DAP) [4]. Therefore weeding operations should be carried out within this critical period of weed competition for effective weed control in order to maximize yield.

Plants need different nutrient rates and ratios at different growth stages. In order for the nutrients to be available when the plant needs them, fertilizers should be applied at the right time. The optimum timing for fertilizer application is, therefore, determined by the Nutrient Uptake Pattern of the crop. For the same crop, each nutrient has an individual uptake pattern. Fertilizers or nutrients are required in most crop production systems. While almost all soils in Nigeria can supply nutrients for crop production, nutrients may not be always available in adequate amounts for economical crop production. Supplying needed nutrients for crop production involves attention to four major fertilization factors: right rate, right source, right placement, and right timing. Attention to these factors will provide adequate nutrition for crop production while minimizing the risk of loss of nutrients to the environment. [15]. These factors are often interrelated; for example, placement and timing of fertilizer may need to be addressed together, such as the right placement of bands of fertilizer for side-dressing during the appropriate stage (i.e., right timing) of crop growth during the growing season. Selecting the right source of fertilizer or the right material to deliver the nutrients is important. The right source often involves the ease of application of a nutrient and cost per unit of nutrient. In addition, efficiency of nutrient use may be considered. The right source may be manure, if the farmer would like to take advantage of the organic matter supplied along with the plant nutrients. The organic matter may

increase the water-holding capacity and nutrient supply of the soil. Crops require a certain amount of plant nutrients for production of profitable crops. Part of this nutrient quantity can be supplied from the soil, and the remainder must come from fertilizer, either synthetic sources or organic forms (such as livestock wastes, composts) or green manure crops. The first key to practicing the right rate concept is soil testing. Before the crop is planted and any fertilizer is to be applied, soil testing can help determine the portion of the crop nutrient requirement that is already available from the soil. Using a strong research information base on soil test calibration for that given location, the recommendation for the right rate of fertilizer can be made from the soil test result. The right rate refers to the amount of fertilizer needed for the crop production season and is based on extensive research over locations, crops, varieties, and years. The right rate also refers to the amount of fertilizer applied at one time in the growing season. For example, the farmer needs to know, depending on the cropping system used, the right rate of fertilizer to apply in the pre-plant application, as a starter fertilizer for direct-seeded crops like yam, maize, or cotton and in a single side-dressing during the growing season. The right timing of nutrients takes into consideration the growth pattern of the crop and, therefore, natural changes in nutrient demand during the season [15].

Crop development begins slowing from seed germination or transplanting, then increases through fruiting, and finally slows down at maturation. This pattern for crop development is referred to as sigmoidal growth. Anticipating changes in growth and nutrient demand is important so that fertilizer application can be timed to meet the needs of growth. The right timing is often interrelated with the right rate and right placement. For example, as the tomato crop develops, the rate changes with time so that smaller rates are applied later in the growing season. Greater rates of nutrients are applied at or just before the time when the vegetative growth rate is maximal and fruits are being developed.

Rainfall is difficult to predict; however, when possible, fertilizer application should be timed to minimize the chance of leaching of nutrients due to heavy rainfall. For maximum nutrient efficiency, nutrients need to be placed where the plant will have the best access to the nutrients. For most crops, the right placement is in the root zone or just ahead of the advancing root system. Most nutrient uptake occurs through the root system, so placing the nutrients in the root zone maximizes the likelihood of absorption by the plant.

Banding and broadcasting are two general approaches to nutrient placement. Banding is the placement of fertilizer in concentrated streams or bands in the soil, typically near the developing plant. Broadcasting is the spreading of fertilizer

uniformly over the surface of the soil. Whether to use banding or broadcasting often depends on the type of crop and the development or spread of the root system. Broadcasting is usually most effective either later in the season when roots of a row-crop have explored the space between the rows, or for forage crops that cover the entire soil surface [1].

The right placement is also related to the nutrient in question. For example, phosphorus can become fixed in unavailable forms when it is mixed in with some soils. The main reason P is banded is that it is immobile in the soils and therefore has to be placed nearer to the roots (or the roots have to grow towards the P granule). In sandy loams, P applied to the surface will get adsorbed and can accumulate over time. Accumulations also occur in soils applied with P sourced from organic or manure related amendments. In these situations, banding of the fertilizer reduces, at least temporarily, the mixing of the fertilizer with the soil and increases the chance that phosphorus will remain in a soluble form for root uptake. For example, banding starter-phosphorus may be preferable to broadcasting [15].

Applying fertilizer at the right rate, right source, right time and right placement is very important for maximizing fertilizer-use efficiency, promoting profitable crop production, and protecting the environment from pollution due to losses of nutrients from agricultural land. Selecting the right fertilizer rate, right fertilizer source, right fertilizer placement, and right fertilizer timing are important aspects of best management practices. Farmers should consider all the options for each "right" component and select the best combinations for maximizing crop profitability and minimizing negative environmental impacts.

Climate change has twin effect in front of agricultural production. First, the frequent outburst of diseases is obviously due to break of resistance chain of the respective crops and fast acclimation of disease causing agent i.e casual organism under changing climate condition (IPCC, 2007). Under these circumstances good agronomic practices (GAP) often offer the opportunity to alter the environment, the condition of the host, and/or the behaviour of the causal agent, to achieve economic management of the disease. Most cultural practices used to management the plant disease are preventive in nature. Integration of cultural practices, host resistance and pesticides or bio-control agents may be necessary to provide option for controlling economically important plant diseases [31].

One of the most effective controls of plant pests and diseases is to keep the pathogen away from the host (Exclusion) by using materials that would not or does not carry pathogen to infect host plants such as usage of certified

seeds from known sources or planting of crops in areas where pathogen has not invaded (Evasion). Flooding of cultivated land for a period of time reduces disease incidence for example in areas where bananas are attack by the wilt organism *Fusariumoxysporium* partial control of the disease was achieved by flooding fields for 6mths to 2 years. Practicing crop rotation offer solution to disease problems because different crops have different types of disease affecting them, mostly crops of the same family are attack by the same pests and diseases, therefore, rotating crops of different families on a piece of land for several years well help to reduce the incidence of disease which must have be left on the soil from other crop families [31].

Seed development is the period between fertilization and maximization of fresh weight accumulation and seed maturation begins at the end of seed development and continues till harvest [13]. The seed reaches its maximum dry weight at physiological maturity and seeds should be harvested at this time to ensure their quality in terms of germinability and vigour. If the seeds are retained on mother plant after physiological maturity, physiological changes in seed may lead to formation of hard seeds or off colour seeds.

Maximum seed viability and seed vigour may be achieved if seeds are harvested at the correct stage of maturity. If harvesting is delayed seed quality may decline due to adverse environmental conditions such as high temperature, high humidity, rainfall, over drying, attacks by diseases, pests or damage by birds and animals [26]. As crop are grown in different agro metrological zone which make their sowing/planting and harvesting time different. The harvesting time or the stage is one of the most important parameter affecting all crops grown around the world. Their quantity, quality, keeping quality, storage, shelf life all are dependent on the harvesting time. The harvesting time will decide the end result of the hard work done throughout crop season. Harvesting of crop mainly depend upon the stage required by the human. If any crop is used for table purpose than it is harvested early as compare when it is grown for the seed purpose but in both the cases the quantity and quality are important. To get the bumper yield and hefty profits the crop should be harvested at the optimum time. If the harvesting delayed in some of the crops the yield will decrease on per day basis. So it is important to harvest at the best possible time.

Harvesting of crop varies from crop to crop and by the purpose for which it is going to be utilized. The crop should be harvested at the time which gives us the best result in both the terms of the quantity and quality. The harvesting dates are whole and sole important for the end result of any crop. A crop harvested before or after the optimum time will reduce the yield and other quality attributes. To get the maximum

profit from a crop a farmer should do the harvest at the best time possible.

4. Conclusion and Recommendation

The ability of an improve variety to produce high yield depends on the agronomic practices involved. Many agronomic practices have been developed with the objectives of increasing crop production. The adoption of Good Agronomic Practices (GAP) such as ploughing to the require depth, seed bed preparation to the require standard, planting at the appropriate time, using the required seed rate and plant spacing, thinning when the plant density is too high, weeding at the appropriate time, application of correct fertilizer rate and at the appropriate time and harvesting at the right time is highly recommended. Experience and research has shown that, proper timing of agronomic practices improved crop yield tremendously. If Good Agronomic Practices is adopted by farmers, it will help to increase production there by solving the problem of food insecurity in the country. Therefore, awareness is needed to implement these good Agricultural Practices that will lead not only to improvement in terms of yield and productivity and improving farmers' income, but also to reduce environment impact and food insecurity. Also stalk holders need to put in place policy and adequate resources to facilitate the improvement of these agricultural practices to guide against food insecurity.

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