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# BIOTECHNOLOGY FOR PREVENT THE DUPLICATION OF SEED BY USING GENETIC USE RESTRICTION TECHNOLOGIES (GURTs) WITHOUT AFFECTING HUMAN HEALTH

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**Abstract**

The terminator technology is a genetically engineered suicide mechanism that can be triggered off by specific external stimuli. The preferred trigger is antibiotic tetracycline, which is applied to seeds. As a result of which the seeds of the next generation will self-destruct by auto-poisoning. The main version of the terminator includes a set of three novel genes inserted into one plant that haven't any negative effect on human health. However, there is another version, which divides two or three genes on to two plants that are later to be cross-pollinated. The ultimate outcome is a dead seed in the following generation. Many consider terminator technology a problem due to the fact that the top 10 largest seed companies globally control half the world's commercial seed market. Therefore, if terminator technology is commercialized, corporations will most likely try to incorporate this technology into all of their seeds. This would secure a much stronger monopoly on the seed market compared to patents because this technology would ensure that it is impossible for farmers to re-use their once harvested seeds without affect human health.

**Keywords:** Seed, Seed processing and terminator technology.

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## INTRODUCTION

Botanically, all the seed produced plants particularly cereal crop life was start from germination of healthy seed and seed is a fertile and ripened ovule which contains an embryonic plant usually supplied with food storage tissue, and surrounded by a protective coat (Ellis et al, 1985). However, physiologically, seed is the organ for propagating plant species. Seed being a living organism, respires by absorbing oxygen and giving off carbon dioxide and water vapour and producing heat at the same time. These phenomena play a major role in the preservation of seeds, (Jean, 1987).The seed is a very important element in the quality of seedlings produced in the nursery since the quality of the seedling is determined by the genotype of the seed from which it originates. Hence, to produce high quality crop one has to sow high quality seeds and have to maintain the quality of that seed from harvest till it is germinate (Feistritzer, 1975).

Genetic use restriction technologies (GURTs) are the name given to methods, providing specific genetic switch mechanisms that restrict the unauthorized use of genetic material by hampering reproduction (variety-specific V-GURT) or the expression of a trait (trait-specific T-GURT) in a genetically modified (GM) plant. (FAO, 2001). Genetic use restriction technologies (GURTs), also known as terminator technologies, were developed with the aim to restrict the access to genetic materials and their phenotypic traits of plant seed to stop germination for second generation, without affecting community health by using technology (VANACKER et al., 2007).

This terminator technology works at two plant life process such as, V-GURT restricts the use of the variety through blocking the plant reproduction via production of non-viable seeds. Theater is, the T-GURT regulates the expression of certain genes that confer desirable agronomic traits to produce quality seed, such as stress tolerance, pest resistance (insects and diseases) and herbicide resistance. Plants carrying T-GURT produce viable seeds, but the offspring did not express the transgenes of interest, however most of the time farmers are confused about the use of technology that came by using seed terminator mechanism because of fearing of technological negative impact on their health by consuming seed but no any kind of negative impact on human and animal health but these farmer impact on the production of crop to feed availed population (PENDLETON, 2004). Farmers use seed fro their stored one that have low productivity from year to year that violate seed property right that develop by researcher and respective company.

Based on seed individual property right problem the initial restricted germination technology was created based on the V-GURT class or type of restriction technology in order to generate

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plants that produce sterile seeds after production of season seed, preventing its use in successive generations. The original patent, registered in 1998 entitled "Control of gene expression" was developed to prevent the unauthorized use of seeds from new crop varieties (OLIVER et al., 1998).

Transgenic crops have become a reality in present day Agriculture. About 28 million hectares of genetically engineered crops were grown in 1998 season with soybeans, maize, cotton, potato and canola/rapeseed being the five principal transgenic crops. Transgenic upland cotton was 79% up from 76% in the year 2004 in the United States of America based on the negative impact of GMO plant, farmers think sterilized seed is toxic to eat for human but it is not true at all (Anonymous, 2005; Anonymous, 1999)

These seed terminator technology work with the help of Biotechnology techniques are being applied to plants to produce plant materials with improved composition, functional characteristics or organoleptic properties. Genetic modifications of horticultural crop have produced fruits that can ripen on the vine for better taste yet have a longer shelf life through delayed pectin degradation or altered responses to the plant hormone ethylene with sterilized seed without affecting human health (Bleecker, 1989; Bennett et al., 1989; Gross, 1988)

Genetic use restriction technologies (GURTs) can able to produce a crop normally using the new seeds but the second generation seeds will die before they mature without affecting the human health . As a result, farmers will have to purchase new supply of seeds each year of any variety that incorporates this technology. So far, the technique has been shown to work in cotton and tobacco seed but Delta and pine Land Company believes it should be effective in other crops, including food crops of importance to developing countries. (Anonymous,1999)

The main goal for which GURTs were designed is the technological protection of genetic resources and innovations; however, their possible application would be further useful for preventing undesired transgene flow and obtaining specific agronomic/economic benefits. Some concerns regarding these technologies have been raised. These may have negative impacts on non-target organisms and environment specifically on human health (Mukherjee and Senthil Kumar, 2014). So this paper had prepared with the following objective to review the application of biotechnology to terminate the duplication of seed and to understand the impact of seed terminator technology on human health.

## The biological nature of seed

Biology is the science of life; it is the study of living things or nature of life. All living things share certain key characteristics: order, sensitivity, growth, development and reproduction, regulation and homeostasis. Science is the determination of general principles from observation and experimentation (Raven et al., 1999; Jonson, 2002 and Mauseth, 201; Chaffey, 2014).

Seed is a living biological product ,that means true botanical seed, bulbs, tubers, cuttings, rhizomes, roots, seedlings or any other plant propagating material intended for planting. Seeds are a fundamental component of the plant life cycle, as they store the genetic information necessary for the next generation of plants to disperse, establish, develop and eventually reproduce to maintain the species (Herrera, 2016 and Kaplan, 2001). A seed develops from an ovule after fertilization. It consists three primary parts of a seed, embryo, endosperm and testa. This triploid nucleus gives rise to a starchy substance called endosperm, which nourishes the developing embryo, and, in dicots, the seedling. Angiosperm seeds, which develop from ovules, are also distinguished from gymnosperm seeds because they are enclosed in protective ovaries. The embryo is the young multicellular organism before it emerges from the seed. The endosperm is a source of stored food, consisting primarily of starches. The testa, a tough, hard, outer coat, protects the seed from fungi, bacteria and insects. It has to be split open by the radicle before germination can proceed (Prego, et al., 1998, Schmidt, 2000, ISTA, 2004 and Herrera, 2016).

In favorable conditions the seed can grow and become a fully independent plant, bearing flowers and seeds during its life cycle. In the embryo of the seed are all the potentialities of development and growth to a mature plant resembling other members of its species in almost every detail of leaf shape, cell distribution and flower colour and structure. The internal structure of a seed consist, hilum, micropyle, radicle, Cotyledons, plumule, epicotyl.The hilum is a scar left by the stalk which attached the ovule to the ovary wall. Hypocotyl is the axial part of the embryo between the cotyledons and the radicle (Prego, et al., 1998 and Schmidt, 2000).

The micropyle is a tiny pore in the testa opposite the tip of the radicle. It admits water to the embryo before active germination. The radicle is the embryonic root which grows and develops into the root system of the plant. The plumule is the embryonic shoot (also called the epicotyl). Epicotyl is the growing point for further leave. The cotyledon contains the food stores for the seed and forms the embryonic leaves available at (Prego, et al., 1998 and Schmidt, 2000).

**The negative impact that farmers use in intellectual property rights (IPRs)**

Human rights effects of IPRs on seeds and specifies how human rights supporters can help to ensure that intellectual property (IP) protection in agriculture is reliable with human rights and

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sustainable agriculture. IP refers to creations of the mind: inventions, Literary and artistic works, symbols, names, images, and designs used in commerce (Field., 2006)

IPRs are a recent invention, the first IPRs on plants were implemented in the mid- 1900s, when some industrialized countries began to offer limited forms of plant variety protection (PVP) to breeders of new crop varieties. IPRs are a recent phenomenon in the seed sectors of developing countries also emphasizes farmers' right to share benefits arising from the use of local varieties and they have developed over generations. (Field, 2006; Louwaars, 2007; Kuyek, 2002 and Feyissa, 2006).

In most of the developing world, seed breeding continues to be carried out by farmers. Farmers' rights are considered as largely collective or public in nature and tend to be none exclusive, since they promote sharing and exchange of materials and knowledge (Feyissa, 2006 and Goodman, 2009). The recognition of farmers' rights rose as a response to concerns relating to disparity in the distribution of benefits between farmers and professional breeders, especially the harmful effects on small-scale farmers in the face of increasingly stronger IPRs. Various efforts have been made to formulate policies that recognize farmers' and community rights. The right of farmers to save seed has been gradually restricted over the past 50 years in subsequent Acts of the Union for the Protection of New Varieties of Plants (UPOV) Convention (Van Genugten, and Meijknecht, 2011 and Feyissa, 2006). The first UPOV was adopted in 1961 and it has since been updated several times, Membership of the UPOV began to expand in the early 1990s and this expansion continued following the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organization (WTO) that provides minimum requirements for national IPR laws in all WTO member countries (Yagci, 2016 and Louwaars, 2007).

The recently determined discussions that led to the establishment of the World Trade Organization require that member countries provide some kind of intellectual property protection for plant varieties. Variety and seed regulatory frameworks and seed control institutions have been developed in most countries primarily to regulate the formal seed sector. In 1997, Ethiopia enacted seed legislation to devise seed transaction mechanisms, ensure that farmers had access to quality seed, protect and promote the country's seed resources, and guard the interests of seed users/farmers, originators, and traders. (Abebe and Alemu, 2017;Louwaars, 2007 and Gemeda, 2001).

The seed industry does not share the perspective of African small farmers (Kuyek, 2002). Many factors contribute to a successful – or challenging—operating environment for seed production in Ethiopia, from government targets and policy on seed production, to seed

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quality control, seed prices and information access by farmers. Seed systems are complex and dynamic – not least due to inherent variations in products, supply and demand Side factors and their interrelated associations with the policy environment. (Almekinders and Louwaars, 2002; Spielman et al., 2010 and Louwaars and De Boef, 2012 and Louwaars, 2007).The policy and institutional framework exists both for variety release, plant variety protection and seed quality assurance, but they still remain weak due to lack of capacity and competence as activities are distributed among different actors. (Bishaw and Louwaars, 2012).

The Plant Protection Decree (No. 56/1971), the Plant Quarantine Regulation (No. 4/1992), moreover, major stakeholders were also reconstituted into new legal entities through various proclamations and regulations including the EIAR (Proclamation No. 79/1997), the Institute of Biodiversity Conservation (IBC, Proclamation No. 120/1998) and the ESE (Regulation No. 154/1993). The Ethiopian Plant Breeder's Right Proclamation (No 481/2006) and the Access to Genetic Resources and Community Knowledge and Community Rights Proclamation (No. 482/2006). Accepted unequivocally the notion of intellectual property protection of new plant varieties (Bishaw et al, 2008; Bishaw and Atilaw, 2016).

**Mechanism of genetic use restriction technologies (GURTs)**

Operon concept was put forth by Jacob Monad in 1961, which explains the gene regulations in all organisms. Based on this mechanism of gene expression, this technology was developed. Three stretches of DNA, which carry genetic information, was introduced into the plant for this purpose. The first bit of DNA has a particular type of promoter. A promoter is a stretch of DNA where the process of converting a gene into a protein is initiated. The promoter used for the terminator genes would become active only in the later stages of seed maturation.

However if only this promoter and lethal gene were inserted into plants, then even the first generation seeds would not sprout. Having a „blocking sequence" between the promoter and the lethal gene so that the latter it is prevented from being expressed. The second bit of DNA carries the gene for an enzyme called recombinase which is able to recognize the excision sequences and remove these, along with blocking sequence, from the first strip of DNA. The recombinase (repressor) gene is kept in control by another type of promoter. This promoter can be repressed the recombinase enzyme will not then be produced if a particular protein is pre-sent. A gene on the third bit of DNA keeps producing the protein, which represses the promoter for recombinase.

Plant cells are genetically modified by introducing the strips of DNA and plants are regenerated through tissue culture methods. Since the promoter is active only during a certain stage of seed formation; the lethal gene has no chance of being expressed. When the first

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generation plants go about the business of producing seeds, the blocking sequence is firmly in place to pre-vent the lethal gene for being active. The first generation seeds are therefore formed without any trouble. When the first generation seed mature, they are exposed to a certain chemical. This chemical is able to repress the protein by third strip of DNA and prevent it from repressing the promoter attached to the recombinase enzyme. With this repression removed, the cells of the mature seed produce recombinase. The recombinase promptly removes the excision and blocking sequences in the first-strand of DNA.

Although the promoter and lethal gene are brought together, the lethal gene is not ex-pressed because the promoter has been chosen to be active only at an earlier stage of seed development, which is not safely past. As a result, these seed can be sold to farmers, and germinate properly to produce healthy plants. However, these second generation plants carry the promoter and lethal gene bidding their time to spring into action. A time comes when the second generation plants start producing seeds. At the stage when the promoter becomes active, the lethal gene springs to life and the chemicals it produces disrupts the process of seed formation. As a result the second generation seeds will not be fertile.

According to the patent document, the promoter becomes active only in late embryogenesis, virtually the last stage in seed formation after most other fruits and seed structures, but will not germinate if planted. An alternative technique suggested in the patent is to use a pair of genetically modified plants and then hybridized them. The first strip of DNA (carrying the promoter for expression in late embryogenesis, the excision sequences, the blocking sequences and the lethal gene) is introduced into a plant cell and regenerated to produce one transgenic parent plant. In a similar fashion, another parent plant is genetically modified to carry a germination specific promoter linked to the recombinase gene.

The crossing of the two plants produces plants, which inherit both strips of DNA. When the first generation seeds are planted, the recombination gene is activated during germination and removes the excision and blocking sequences from the first strip of DNA. As in the earlier case, the lethal gene becomes activated only when the plant tries to produce the second-generation seeds, which become sterile as a result. The promoter for the lethal gene; the patent points out that this promoter should not be a “leaky” one: it should be active substantially only during a well-define phase of plant growth or under particular environmental conditions, and should be inactive at all other times.

A promoter active in late embryogenesis, such as the LEA promoter, was ideal when the aim was to have a trait appear after the first generation. Such a promoter would be “active only after the first generation plant has completed a season of vegetative growth (embryogenesis is

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virtually the last stage in formation, after most other fruits and seed structure are formed)", the patent point out.

## CONCLUSION

It is difficult to predict the development of GURTs in the near future because they seem still to be very far from commercialization. T-GURTs could be received by public opinion as a favorable innovation as they would allow farmers to decide for activation of valuable trait. T-GURTs would not impede plant viability and would not affect the traditional conservation practices and exchange of seeds, offering at the same time a solution to the problem of genetic pollution by preventing the spread of the engineered traits.

In contrast, the ethical concerns against V-GURTs that led to the global moratorium remain to date too strong overcome and will surely play a pre-eminent role in the future political debate to decide whether to use or not use these technologies. After all, over one billion people, the majority of whom live in developing countries, depend on seed saving and exchanging of seeds with their neighbors, whereas these technologies are conceived (and perceived) as a means to protect multinational corporations and their patents.

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